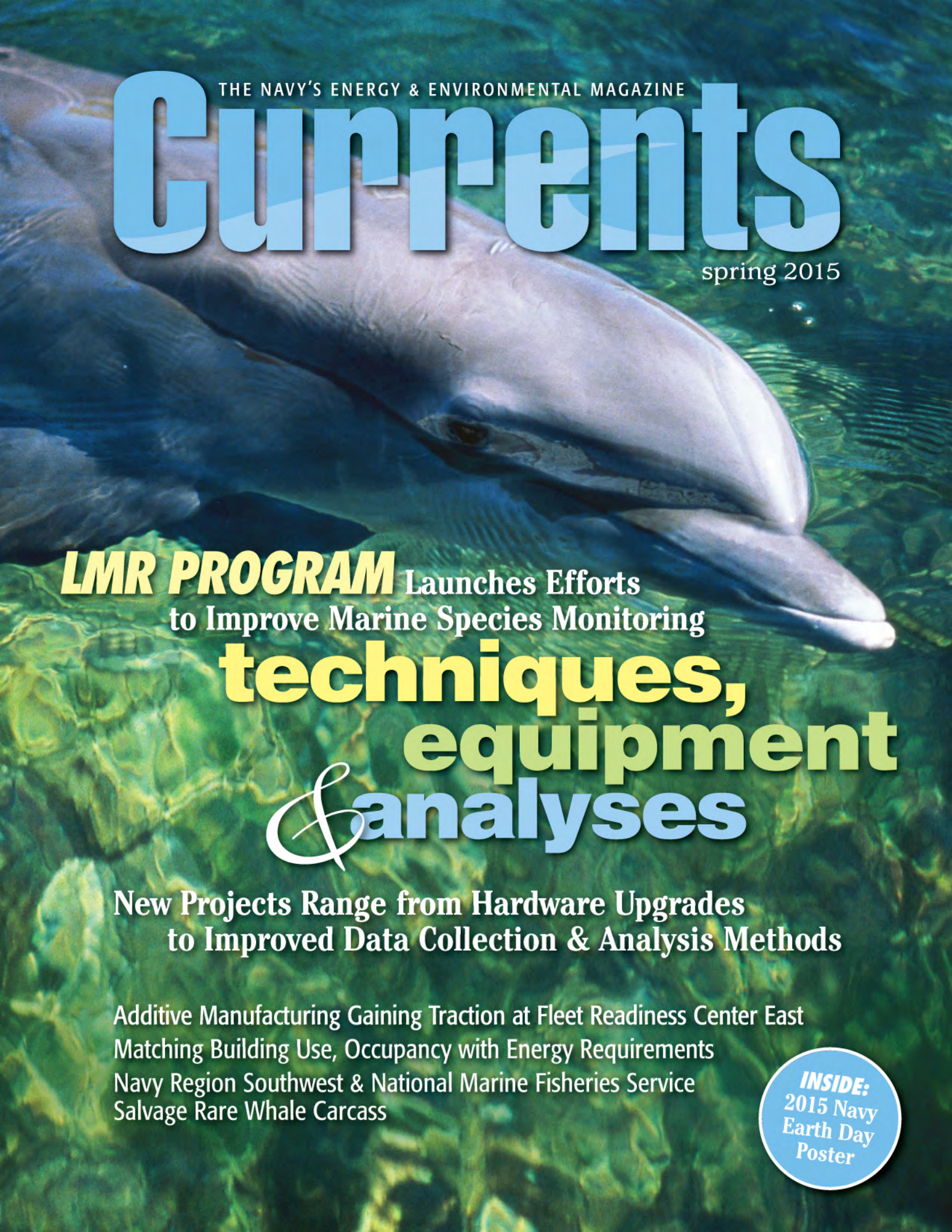


THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

Currents

spring 2015

LMR PROGRAM Launches Efforts to Improve Marine Species Monitoring techniques, equipment & analyses

New Projects Range from Hardware Upgrades to Improved Data Collection & Analysis Methods

Additive Manufacturing Gaining Traction at Fleet Readiness Center East

Matching Building Use, Occupancy with Energy Requirements

Navy Region Southwest & National Marine Fisheries Service Salvage Rare Whale Carcass

INSIDE: 2015 Navy Earth Day Poster

THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

Currents

Chief of Naval Operations
Energy and Environmental Readiness Division

"Like" *Currents* on Facebook by logging onto your account at www.facebook.com, searching for "U.S. Navy Currents magazine," then clicking the "Like" button. You can also find us at www.facebook.com/navycurrents.

Follow *Currents* on Twitter at www.twitter.com/navycurrents.

View the *Currents* photo archive on Flickr at www.flickr.com/photos/navycurrents.

cover

The Living Marine Resources program recently launched several new projects to increase the capability of U.S. Navy marine species monitoring programs–programs critical to the ongoing operation of the Navy's testing and training ranges.

Currents (ISSN 1544-6603) is the official energy and environmental magazine of the U.S. Navy, Chief of Naval Operations Energy and Environmental Readiness Division (N45).

Article submissions should be submitted directly to *Currents*' Managing Editor, Bruce McCaffrey, using the *Currents* article template. A public affairs review must be completed before *Currents* management can consider an article for publication.

Browse the *Currents* archive at http://greenfleet.dodlive.mil/currents. Commands that receive hard copies can contact Lorraine Wass (ljwass@outlook.com) with requests for changes to mailing addresses and shipping quantities.

features

departments

A Sustainable Future Begins With You

WELCOME TO THE spring 2015 issue of *Currents*. I'd like to take this opportunity to say a few words about Earth Day, highlight some of the great stories we have included in this issue of the magazine, and mention some noteworthy energy and environmental items.

As the pull-out poster in the center of this issue attests, it's Earth Day season. The theme for Earth Day this year is *A Sustainable Future Begins with You*, underscoring the impact of our individual actions in preserving the environment for generations to come. Around the world, Navy commands and individuals have been showcasing efforts to protect the environment and conserve energy through Earth Day activities such as beach and neighborhood cleanups, recycling drives, and educational programs with local communities. Thanks to each of you for sustaining the Navy's environmental stewardship and helping to tell the Navy's good story.

Featured in this issue is the Navy's Living Marine Resources program and its new initiatives to enhance Navy marine species monitoring programs. I encourage you to take some time to familiarize yourself with the program's nine new projects and the benefits they're expected to bring to our ability to monitor species on our at-sea testing and training ranges.

Also in this issue are three stories about successful projects sponsored by the Navy Environmental Sustainability Development to Integration program. These efforts, led by Principal Investigators from the Space and Naval Warfare Systems Command, Systems Center Pacific, accomplished the following objectives:

1. Demonstrated that a new kind of passive sampler has the potential to provide more definitive answers regarding the presence of munition constituents in the marine environment.
2. Developed a modeling tool to identify source areas of copper and zinc on Navy facilities.
3. Studied the effectiveness of power vacuuming and high-pressure washing to reduce toxicity levels in stormwater.

You've likely heard of the increased focus in recent months on innovation-related ideas and practices Navy-wide. Along those lines, we've talked to you about the ongoing push to incorporate additive manufacturing processes (also known as 3-D printing) into our operations where it is feasible to do so. Our colleagues at the Fleet Readiness Center East in Cherry Point, North Carolina have helped to advance this conversation by identifying the potential environmental impacts and workplace safety measures associated with this advanced technology in our article "Additive Manufacturing Gaining Traction at Fleet Readiness Center East."

The theme for Earth Day this year is *A Sustainable Future Begins with You*, underscoring the impact of our individual actions in preserving the environment for generations to come.

Our article "Navy Region Southwest & National Marine Fisheries Service Salvage Rare Whale Carcass" is a great example of Navy Region Southwest's efforts to test the Navy's stranding response procedures and strengthen relationships with the National Marine Fisheries Service (NMFS) and Southwest Fisheries Science Center. And in our "Trends of the Environment" section, we introduce

you to one of the Navy's new R&D programs—the Navy Shore Energy Technology Transition and Insertion (NSETTI) program. The NSETTI program is focused on demonstrating innovative energy technologies for use by the Navy's shore community.

This past February, I accompanied Ms. Donna Wieting, Director of the Office of Protected Resources and members of her staff at NMFS on a visit to U.S. Fleet Forces Command (USFF) in Norfolk. We met with representatives from the USFF Environmental Readiness Division to discuss Navy training requirements and environmental stewardship efforts. We also visited with the commanders and crews of USS Arlington (LPD 24), USS Bainbridge (DDG 96), and USS Newport News (SSN 750), who effectively demonstrated how environmental permitting requirements are integrated into operational directives and executed with Navy professionalism and proficiency. It was a memorable visit that allowed the NMFS team to see first-hand how USFF and our operators lead environmental efforts in support of the Navy mission to maintain, train and equip combat-ready military forces capable of winning wars, deterring aggression, and maintaining freedom of the seas.

In March, I visited Naval Air Station Jacksonville and met with Ms. Maureen Sullivan, Director, Environment, Safety and Occupational Health in the Office of the Secretary of Defense, and Rear Admiral Mary Jackson, Commander Navy Region Southeast to discuss energy, environmental, safety and compatibility initiatives and challenges on base and in the region. Ms. Sullivan and I also visited Naval Station Mayport for briefings on upcoming projects and associated environmental planning efforts at this active installation. We had a chance to speak with environmental, public works and safety officers and were impressed by the breadth and depth of the programs that support the missions at the installations, ranging from environmental compliance and pollution prevention, natural and cultural resources protection, energy conservation, land use compatibility, assessment of vulnerability to sea level rise, and personnel safety.

I also want to mention a recent memo from the Office of the Assistant Secretary of the Navy for Research, Development and Acquisition that directs program managers for new construction ships to pursue installation of light-emitting diodes (LED) as part of a strategy to increase time on-station, decrease time spent on maintenance, and prevent shipboard injuries. The memo, released this past February, authorizes program managers to spend up to $2 million per ship, or more in some cases, subject to funding availability. LEDs' lower energy consumption means the bulbs will "pay for themselves" in one to five years. But even greater benefits of LEDs are better quality of light, easier storage, and longer bulb life.

Finally, we're happy to announce that *Currents* has added another award to its rich history of recognition over the past several years. The magazine received an honorable mention in the Navy Media Awards competition for fiscal year 2014. We realize it is the great work you and your colleagues are doing to safeguard the environment and optimize energy use that provides the basis for this and past awards that have been earned by the magazine. We look forward to promoting more of your efforts in the months and years to come. ⚓

We realize it is the great work you and your colleagues are doing to safeguard the environment and optimize energy use that provides the basis for this and past awards that have been earned by the magazine.

Karnig H. Ohannessian

Deputy Director, Chief of Naval Operation Energy and Environmental Readiness Division

LMR PROGRAM Launches Efforts to Improve Marine Species Monitoring techniques, equipment & analyses

New Projects Range from Hardware Upgrades to Improved Data Collection & Analysis Methods

The Living Marine Resources (LMR) program recently launched several new projects to increase the capability of U.S. Navy marine species monitoring programs—programs critical to the ongoing operation of the Navy's testing and training ranges.

In order to comply with a host of federal regulations, including the Endangered Species Act and the Marine Mammal Protection Act, federal agencies must conduct environmental reviews to consider the potential impacts on the environment by their proposed actions. The Navy is responsible for meeting specific requirements for monitoring and reporting on military readiness activities involving active sonar and underwater detonations from explosives and explosive munitions. These military readiness activities include Fleet training events and Navy-funded research, development, test and evaluation activities.

To address these requirements, a set of individual range complex monitoring plans were initially developed across the various geographic regions where the Navy trains. These plans were designed as a collection of broad "studies" intended to address questions such as whether or not marine mammals and sea turtles are exposed to mid-frequency sonar at levels that result in adverse effects, and what are the behavioral responses, if any, of that exposure.

Monitoring methods used across the range complexes include field techniques such as visual surveys from vessels or airplanes, marine mammal observers aboard U.S. Navy vessels during training exercises, and passive acoustic monitoring (PAM).

PAM is a proven means of detecting and classifying vocally active marine mammals, as well as a number of fish species, through underwater microphones known as hydrophone sensors. Sensors can be moored, drifting, vessel-towed or mounted on unmanned mobile platforms.

These monitoring systems, while functional, are lacking in several areas. First, there is no single recording system standard across all Navy facilities. In addition, a unified signal processing system has yet to be identified that can efficiently sort through the massive quantity of sound files generated by these systems.

The latest projects funded by the LMR program are seeking answers to some of these questions.

The Basics About the LMR Program

The LMR program seeks to develop, demonstrate, and assess data and technology solutions to protect living marine resources by minimizing the environmental risks of Navy at-sea training and testing activities while preserving core Navy readiness capabilities. This mission is accomplished through the following five primary focus areas:

1. **Providing science-based information to support Navy environmental effects assessments for at-sea training and testing.**
2. **Improving knowledge of the ecology and population dynamics of marine species of concern.**
3. **Developing the scientific basis for the criteria and thresholds to measure the biological effects of Navy-generated sound.**
4. **Improving understanding of underwater sound and sound field characterization unique to assessing the biological consequences of underwater sound (as opposed to tactical applications of underwater sound or propagation loss modeling for military communications or tactical applications).**
5. **Developing technologies and methods to mitigate and monitor environmental consequences to living marine resources resulting from naval activities on at-sea training and testing ranges.**

The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California.

For more information, visit the LMR program web site at www.lmr.navy.mil or contact Anu Kumar, the LMR Program Manager at 805-982-4853, DSN: 551-4853 or anu.kumar@navy.mil.

Determining the effect of sonar and other underwater sounds on marine mammals is difficult without a thorough understanding of how marine mammals hear.

Getting Down to Basics

All forms of marine mammal passive acoustic monitoring can document an animal's vocal activity level before, during and after a sound event. However, determining exactly what that animal is hearing is a different story. A project team (LMR project no. 9) headed by James Finneran of the Space and Naval Warfare Systems Command (SPAWAR), Systems Center Pacific (SSC Pacific) is improving methods for determining how these animals actually hear.

In humans, noise exposure is quantified by "weighting" sound exposures to emphasize frequencies where auditory sensitivity is high. The weighting functions are obtained by asking human listeners to compare the perceived loudness of one sound to another sound at a different frequency.

A similar experiment was previously conducted at SPAWAR to measure subjective loudness levels in a bottlenose dolphin—the only time such a measurement has been done in a non-human animal (Finneran and Schlundt, 2011). This experiment, sponsored by the Office of Naval Research (ONR), consisted of a loudness comparison task, where a dolphin was trained to report which of two sequential tones was louder. While successful, the time required to train the subject and collect the data make future direct measurement of subjective loudness impractical for large numbers of individuals or more exotic species. For these reasons, follow-on studies at SPAWAR have utilized measurements of auditory reaction time as a proxy for loudness.

Reaction time measurements only require subjects to be trained for a simple tonal detection task; however, these measurements still require access to trained animals for many weeks to collect the necessary data. This limits the number of individuals and species for whom data can be obtained, forcing extrapolations to estimate weighting functions for untested species.

The project team is exploring the use of electrophysiological measurements in obtaining hearing data for the design of marine mammal weighting functions. Electrophysiological measurements use non-invasive surface electrodes placed on subjects' heads to measure small voltages (called auditory evoked potentials (AEP)) generated by the brain and auditory nervous system in response to sound.

Previous studies have examined the feasibility of utilizing AEPs to predict perceived loudness in humans. In order to determine whether similar techniques can be used in dolphins and sea lions, a feasibility study was conducted where sounds were delivered to dolphins and sea lions while brain activity was simultaneously monitored via surface electrodes. AEPs were measured at a variety of sound frequencies and levels. Analyses of the data demonstrated that the AEP methods did not provide a reliable prediction of subjective loudness, especially at low frequencies where data are critical for the design of Navy weighting functions.

A bottlenose dolphin during AEP measurements conducted in San Diego Bay. The AEPs are measured using surface electrodes embedded in soft suction cups placed on the dolphin's head and dorsal surface.

Simply stated, loudness is a psychological phenomenon, and this study only measured voltages generated by the brain in response to simple stimuli. While those voltages are clearly related to how the brain later interprets the loudness of a sound, they are only part of the entire story, and simply measuring them with electrodes doesn't appear to provide the complete picture of how they are processed by the brain into the psychological phenomenon of loudness.

Current research by the team is therefore focusing on identifying modifications of stimulus and recording parameters that will allow for estimation of low-frequency hearing thresholds in marine mammals, which is a type of data critical to Navy compliance documents. Protocols will also be developed for opportunistic access to novel species including stranding situations.

Determining the effect of sonar and other underwater sounds on marine mammals is difficult without a thorough understanding of how marine mammals hear and the relative effects of sounds at different frequencies. The data gathered in this project will guide the derivation of auditory weighting functions in the acoustic effects analyses sections of Navy environmental documents. The data will be applicable to all Navy documents analyzing acoustic effects of tonal sounds (e.g., sonars) and will allow for more realistic predictions of the effects of Navy sonars and explosive sources on marine mammals.

Expanding the PAM Range

To help answer the call for improved passive acoustic sensing technology, Principal Investigators Philip Abbot and Vince Premus are leveraging the technology and hardware they developed for two ONR-related projects.

Currently, most PAM monitoring is done with single hydrophones, which limits the range of detection coverage. While other configurations have been used (including towed, platform-mounted and drifting platforms), there is a more promising option.

For the past five years, under two separate ONR projects, Abbot and Premus from Ocean Acoustical Services and Instrumentation Systems (OASIS) have developed a system for real-time acoustic monitoring for surveillance purposes via autonomous underwater vehicles (AUV). This technology utilizes new acoustic sensor and digital signal processing (DSP) technology developed by OASIS, as well as existing vehicle hardware developed and maintained by the Woods Hole Oceanographic Institution. The sensor and DSP technology has previously been demonstrated using Slocum 200 and G2 gliders as its AUV, and was able to provide real-time detection of humpback whales.

For this project (LMR project no. 2), the team is utilizing a self-propelled AUV known as the REMUS 600, which has previously been used for underwater mapping and mine detection. The REMUS 600 is a faster, more powerful alternative to the gliders previously used.

Since it is self-propelled, an AUV can operate in the presence of currents, following any predetermined course.

Sei whale.
Tom Kieckhefer, NMFS Permit 14451

Since it is self-propelled, an AUV can operate in the presence of currents, following any predetermined course.

IRAP system during a dockside dip test. The LF sensor is coiled and suspended at the vehicle mid-section. The HF sensor is visible protruding from the underside of the vehicle a couple of feet aft of the nose.

The Integrated, Real-time Autonomous PAM (IRAP) system.

This stands in contrast to the glider, whose course is often subject to the ambient current distribution and the density profile of the water column.

The Integrated, Real-time Autonomous PAM (IRAP) system will consist of a REMUS AUV, integrated with the OASIS low- to mid-frequency (LF/MF) towed sensor and an attached High Frequency (HF) sensor. Both sensors will include onboard digital signal processors for the autonomous detection, classification, localization, and tracking (DCLT) of vocalizations from lower frequency baleen whales and higher frequency beaked whales. DCLT contact reports will be transmitted in near real-time from the vehicle payload when surfaced, to a shore-side command and control facility via satellite. Key to the system is the autonomous processing of raw acoustic data performed by custom software hosted on an embedded, commercial-off-the-shelf computer.

The objective of this project is to integrate and demonstrate the technology over the course of three years. Currently, the focus is on the integration of the LF/MF sensor and the humpback whale classifier (one of the marine mammal-specific classifiers previously developed and demonstrated under ONR sponsorship) into the existing REMUS AUV payload. Concurrent with this, the project team will complete data analyses for the 2013 OASIS HF sensor/G2 sea trials performed at the Navy's Atlantic Undersea Test and Evaluation Center.

In the second year, the integrated LF/MF/HF system will be demonstrated during an operational test concurrent with a regularly scheduled National Oceanic and Atmospheric Administration marine mammal survey on the east coast. Also during the second year, a beaked whale classifier will be integrated into the HF signal processor.

In the third year, the beaked whale classifier and OASIS IRAP sensors will be integrated into the REMUS AUV payload and the full IRAP system will be tested in conjunction with a full-scale U.S. Navy fleet test.

Successful demonstration of autonomous DCLT for humpback and beaked whales will provide the basis for future system enhancements such as the ability to autonomously classify a wide variety of other marine mammals.

The autonomous system will have the ability to track low-frequency baleen and high-frequency beaked whales while simultaneously monitoring the operation of mid-frequency active sonar, thereby mitigating possible harm to these animals caused by the use of active sonar during at-sea exercises. Due to its mobility and broadband frequency, the IRAP will also improve detection coverage over a much wider area, improving the accuracy and completeness of existing animal density estimation techniques.

Toward Autonomous Monitoring

Another project (LMR project no. 4) is seeking to enable truly autonomous PAM by testing a glider and a float platform.

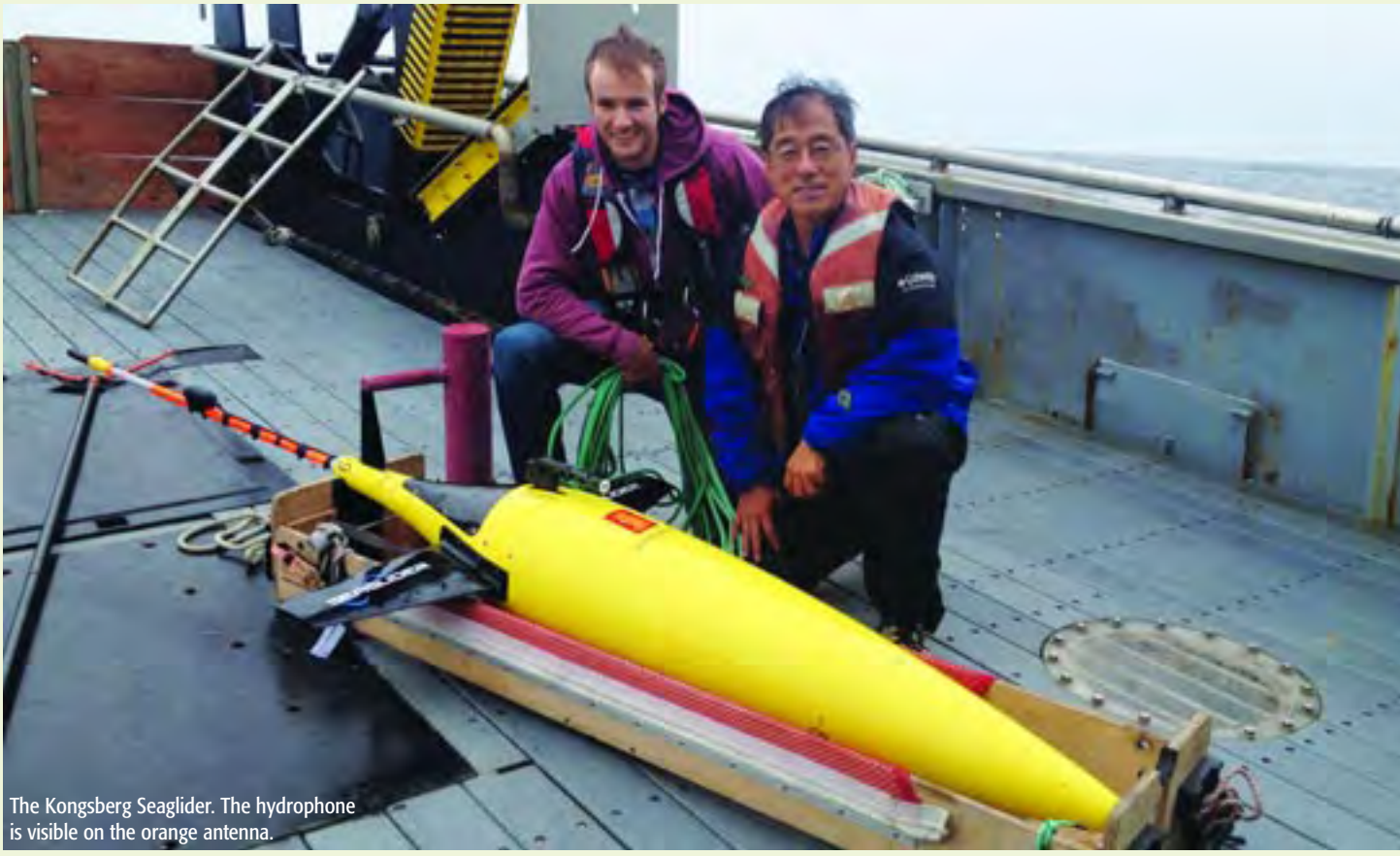
Both platforms will include an acoustic system that was developed by Oregon State University (OSU) with ONR funding. The OSU PAM board is based on an advanced digital signal processor (DSP) and low-noise pre-amplifier that achieve a signal-to-noise ratio higher than 96 decibels. The electronic noise level of this system is well below the ambient background noise of a typical calm ocean, maximizing the listening range and detection performance in a wide variety of ocean conditions. This listening capability covers the frequency range of almost all cetaceans except for porpoises.

The DSP system has already been used in previous ONR-sponsored work with the APEX float from Teledyne Webb Research. This project will compare the APEX float with the Seaglider from Kongsberg. Both platforms are buoyancy-driven, deep-

Acoustic float descending during the off-Hawaii test.
Ben Allsup

Short-finned pilot whales.
Jessica M. Aschettino, NMFS Permit 16239

This technology will enable the Navy to monitor marine mammals cost-effectively in real-time.



The Kongsberg Seaglider. The hydrophone is visible on the orange antenna.

The PAM board installed in the Kongsberg Seaglider.

diving vehicles capable of descending to 1,000 meters (glider) and 1,500 meters (float). While gliders can be steered remotely, profiler floats simply drift with the ocean current. The advantage of the float lies in its comparatively low cost, approximately 25 percent of the cost of a glider. Although the two mobile platforms are acoustically quiet, there are differences in body shape, steering mechanism, water flow, pump and motor activities, and internal electronics noise. These differences likely impact the passive acoustic performance of the systems and need to be examined and evaluated.

The first task undertaken under this project, headed by Haru Matsumoto of OSU, was to integrate the OSU PAM board with the Seaglider. In October 2014, OSU conducted the first engineering test of the PAM-installed Seaglider off the Oregon coast. The test provided valuable data on the system which will be used to enhance its detection capability.

n the spring of 2015, a two-week test will be conducted to compare the Seaglider's capabilities to those of a bottom-moored High-frequency Acoustic Recording Package (HARP) at the Quinault Training Range in Washington State. Subsequently, both platforms will be demonstrated with the Marine Mammal Monitoring on Navy Ranges (M3R) system at the Southern California Offshore Range (SCORE).

An additional goal of this project is to provide a more robust acoustic data set for the presence, distribution and density estimation of beaked whales.

At the end of this project, a detailed report will be issued comparing the performance of each system with the HARP and M3R systems. A detailed installation and user's guide will also be developed.

This technology will enable the Navy to monitor marine mammals cost-effectively in real-time, in areas of interest where cabled hydrophone arrays are not available or poor weather conditions prohibit ship-based visual observation.

Leveraging Existing Algorithms to Improve Digital Signal Processing

Another LMR project (no. 8) is applying some of the analytical methods that have been developed for active and passive sonar to improve the Navy's PAM systems.

As part of his Ph.D. thesis, Principal Investigator Tyler Helble (along with his advisor, Gerald D'Spain) developed a detection algorithm known as a Generalized Power Law (GPL) processor. Power law processors are the optimal detectors for transient signals, in the situation where the signal has an unknown frequency content, location, duration, and strength. Conventional detection of humpback vocalizations is often based on the assumption that energy (square of the Fourier amplitude) is the appropriate metric. Power law processors allow for a higher power of the Fourier amplitude, appropriate when the signal occupies a limited but unknown subset of these frequencies. Simply stated, sound in the ocean is rarely stationary, and a power law metric is a more accurate way of isolating and identifying specific sounds.

Raw counts of marine mammal call detections by themselves can be very misleading. They should be corrected for variability in environmental properties before any interpretations can be made. For instance, when ocean noise levels are very low, more humpback whales are detected. However, while the probability of detection rises during these time frames, the animals may very well have been present all along.

The GPL processor is able to detect weak transient whale vocalizations in the presence of considerable anthropogenic and biological noise. This has proven to hold true even during periods of mid-frequency active sonar transmissions typical in U.S. Navy training events. The processor has been used with great success in the collection of humpback whale data by the autonomous HARP devices that are currently being used for PAM at several Navy testing and training ranges.

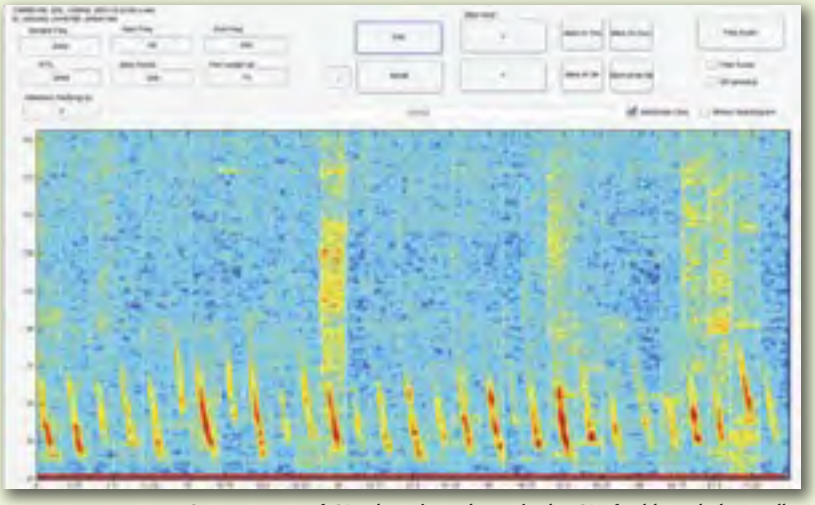
When ocean noise levels are very low, more humpback whales are detected.

The GPL processor is able to detect weak transient whale vocalizations in the presence of considerable anthropogenic and biological noise.

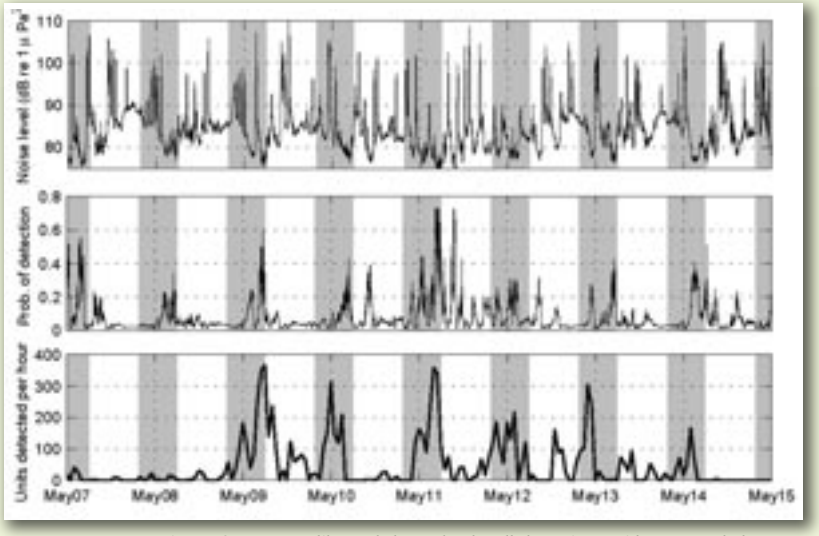
Any algorithms developed for GPL processing are constrained by the need for pre-processing adaptation to accommodate the ambient noise at each location, as well as the noise created by the platform itself. In addition, ocean bathymetry greatly influences PAM readings. For these reasons, the creation of a fully automated system is not feasible. This project will design a system that "calls out" potential signals of interest for examination by a human operator.

Working closely with other LMR-sponsored project teams, the team will first adjust GPL algorithms for use with specific marine mammals and then test and implement these algorithms using data from existing Naval Facilities Engineering Command PAM systems, including SCORE and the Pacific Missile Range Facility (PMRF) in Kauai Hawaii.

To date, the project team has tuned and calibrated the GPL detectors for three species (humpbacks, minke and blue whales) from HARP recordings deployed throughout southern California. An auto-tuning algorithm for baleen whales has also been created using the PMRF data.



Spectrograms of GPL detections shown in the GUI for blue whale D calls. The GUI allows the operator to quickly accept/reject detections provided by the GPL.



Comparison of raw (uncalibrated) humpback call detections with temporal changes in ocean noise levels, and the resulting changes in the probability of detection.

This project will improve the Navy's PAM capabilities in two critical areas. First, it will implement automated detectors optimized for specific marine mammal species that will filter down the massive amount of recorded data, vastly reducing the time and cost for human operators to manually examine a data set. This effort will also provide the methods for calibrating the detector output call counts for spatially and temporally varying ocean environmental conditions.

The end result of this project will be a software package containing all pre-processing and detection software and the graphical user interfaces (GUI). Implementation of this technology at Navy sites will increase computational costs (and may require acquisition of additional computer resources), but will vastly reduce human operator time required to examine the passive acoustic recordings. Therefore, a significant net cost (and time) savings are expected.

New Interface Will Triple Data Storage Capability

The HARP system, currently used on several Navy ranges for marine mammal passive acoustic monitoring, is a state-of-the-art recording system that features high bandwidth (up to 160 kilohertz) and large data storage (five terabytes (TB)) combined with low power requirements. While there is no issue with HARP performance, the amount of data this system generates is overwhelming its current storage capabilities.

Current HARP data storage is based on Integrated Drive Electronics (IDE), a standard electronic interface for disk storage devices, originally developed by Western Digital and adopted by the American National Standards Institute (ANSI) in 1990. (After adoption, ANSI changed the name to Advanced Technology Attachment (ATA).) More recently the Serial ATA (SATA) interface has become the industry standard. Serial ATA offers several advantages over the parallel ATA interface—reduced cable size and cost, and faster and more efficient data transfer. Just as important, the currently used IDE disks are no longer available, so an upgrade to SATA disks is necessary to keep the Navy's HARP systems serviceable.

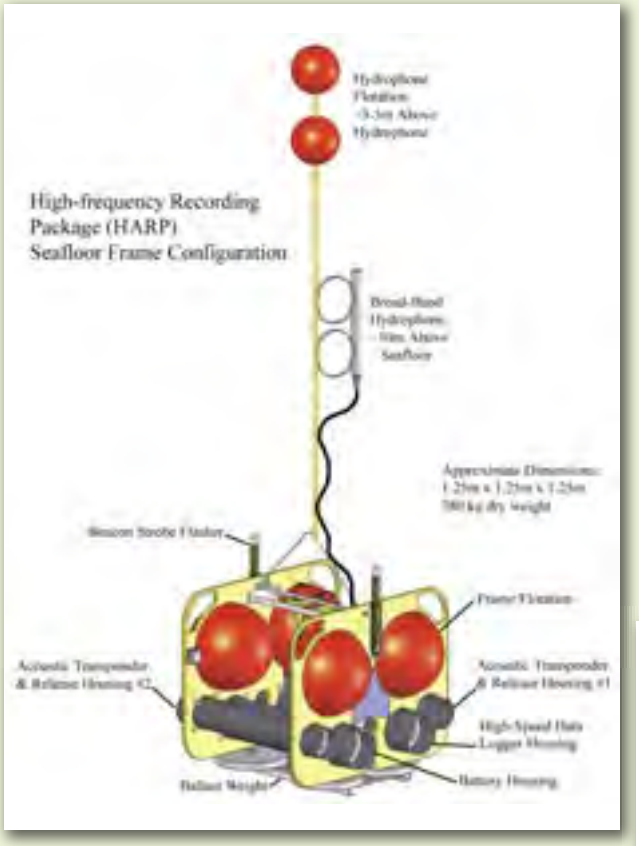
The current HARP system has a maximum storage capacity of five TBs or ten TB compressed storage. Once the SATA interface is installed, HARP storage capacity will be dramatically increased to 16 TB (32 TB compressed) based on currently available hard disk drives. It is anticipated that this capacity will increase as disks with larger capacities become available, as has been the case for this technology throughout the years.

This project (LMR project no. 7), headed by John Hildebrand of Scripps Institution of Oceanography,

The current HARP data logger electronics attached to a pressure housing endcap with electrical feed-thru connectors. The modular data logger consists of five removable circuit boards to allow for ease in upgrading and repair, and an array of 16 IDE hard disk drives for long-term high-bandwidth data storage.

Sperm whale.
Suzanne E. Yin, NMFS Permit 14451

The modular nature of the HARP electronics should allow upgrading by replacement of a select set of electronics boards, rather than the need to replace the entire system.



The HARP system was developed by Sean Wiggins, John Hildebrand and their colleagues at the Scripps Institution of Oceanography.

will first design the HARP electronic disk interface. Subsequently, it will be installed on a HARP system and tested, first at sea, and then on a Navy range. After a deployment of several months, data from the new system will be analyzed. Assuming acceptable performance, the SATA drives will be installed on all 13 existing Navy HARP systems. The modular nature of the HARP electronics should allow upgrading by replacement of a select set of electronics boards, rather than the need to replace the entire system.

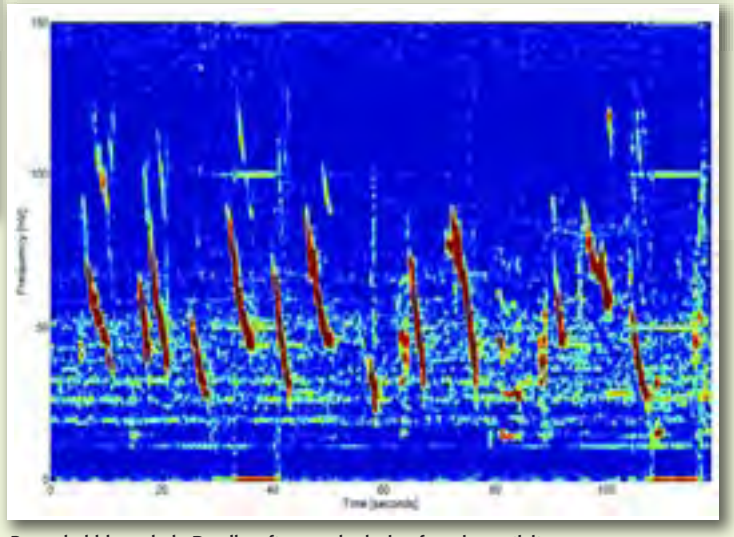
Upgrade of currently deployed HARPs for SATA disk storage capacity will yield reduced costs per deployment and potentially fewer service trips for sites that are difficult or expensive to access. The project is expected to be completed in the spring of 2016.

Making Sense of All That Data

As mentioned above, the amount of data generated by the current HARP marine monitoring system is overwhelming its current storage capabilities. This amount of data can also be overwhelming and costly to process.

This project intends to simplify the data management process so that non-expert users can access and process the data gathered by monitoring systems.

The current state-of-the art for processing large PAM data sets in the Navy is a hybrid between manual scanning of the data and automatic call detection. This approach allows accurate analysis of large data volumes—and is the baseline against which the efficiency of automatic detection and classification algorithms must be compared.



Recorded blue whale D calls, often made during foraging activity.

This project (LMR project no. 6) will develop metrics for assessing the performance of existing and future data processing algorithms for PAM data. To do so, the team will construct marine mammal sound datasets specific to each naval training area, then compose a standardized set of metrics to assess the performance of both existing algorithms and potential new algorithms.

During the first year, the project team is compiling an extensive set of training and test data based on acoustic recordings already collected at naval training areas on the west coast. In later years, they will examine data from the east coast and central/western Pacific. This work will be undertaken by co-Principal Investigators John Hildebrand, Simone Baumann-Pickering and Ana Sirovic of Scripps Institution of Oceanography and Marie Roch of San Diego State University.

Each dataset will be focused on particular species and signal types, and will sample the range of variability of the signal, the ocean noise environment in which the signals occur, seasonal variables, and the contribution of variations in the recording system. The team is focusing on species that are found across multiple naval training sites, that are relatively ubiquitous, and whose signals are well characterized, such as blue, fin and humpback whales, a variety of beaked whales, and Risso's dolphins. A category of unidentified cetacean signals will also be labeled.

These data will be shared with the marine mammal researcher community for use in developing automatic algorithms related to call detection and classification. This protocol follows the well-developed path of the Advanced Processor Build program utilized in the Anti-Submarine Warfare community.

A parallel effort will engage the marine mammal detection and classification community to develop a standardized set of metrics for evaluating automatic detector and classification outputs. The first year will focus on metrics for baleen whale calls. Later years will consider odontocete (toothed whale) signals. These metrics will then be universally applicable to both existing and potential new automatic detection algorithms for specific baleen whale calls and odontocete signals.

New algorithms can be promulgated to all U.S. Navy-funded PAM operators once they have been demonstrated to provide the necessary recall and precision for a particular species call.

The ultimate goal is to develop a comprehensive dataset of marine mammal calls for use in the development of robust detectors and classifiers—one that covers the full range of species of interest at every training location. Automated methods to detect and classify marine mammal sounds would simplify data analysis and reduce data processing costs.

The Challenges Associated with Auto Detection

As stated above, the large and increasing volume of acoustic data collected by marine mammal passive acoustic monitoring systems is difficult to process and interpret in a timely manner. In order for this state-of-the-art technology to be efficiently utilized, software for detection and classification of sounds produced by marine mammals is needed.

The variability inherent in many sounds produced by odontocetes (toothed whales such as dolphins and beaked whales) and the overlap in time-frequency characteristics among species, makes it difficult to automatically detect and classify them. Sounds produced by odontocetes can be

The team will focus on species, such as humpback whales, that are found across multiple naval training sites and have well-characterized signals.

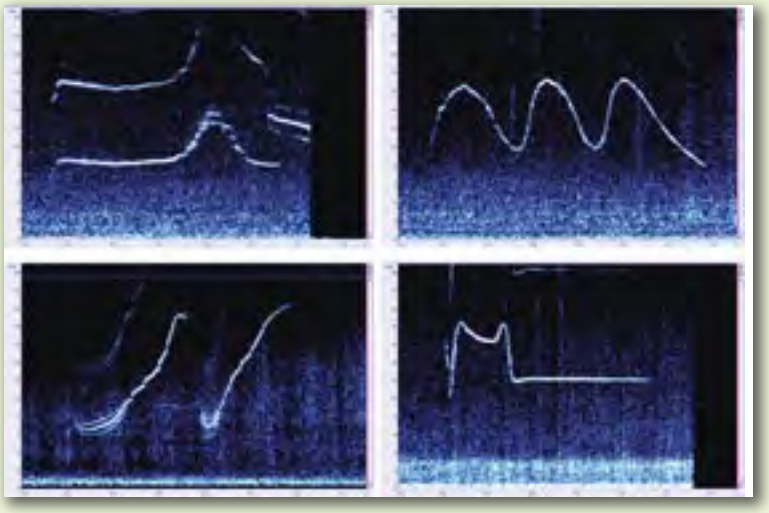
An automated classifier that includes information from both whistles and clicks would advance the science of automatic classification.

grouped into one of two broad categories—whistles and pulsed sounds (clicks).

Previously, separate whistle and click classifiers have been developed for specific dolphin species. However, not all species produce whistles, or they may only produce whistles or clicks in specific behavioral contexts. Therefore, an automated classifier that includes information from both whistles and clicks would advance the science of automatic classification. In addition, including information about acoustic behavior and the specific location where a recording was made may also increase classification success. A classifier that is able to combine information from different types of sounds as well as information pertaining to behavior and location may be more successful in identifying species than one that only considers one sound-type at a time.

The variability inherent in many sounds produced by odontocetes such as striped dolphins makes it difficult to automatically detect and classify them.

It is the goal of this project team to develop such classifiers. Using acoustic recordings from the Western Atlantic Ocean, Principal Investigators Julie Oswald and Tina Yack of Bio-Waves Inc., will first detect/extract whistles using three different automated tonal detectors. The output of the three automated detectors will be tested and compared for accuracy. The detector that exhibits the best performance will then be integrated with an existing whistle classifier software (the Real-time Odontocete Call Classification Algorithm (called ROCCA)). ROCCA currently is available as a module in the marine mammal passive acoustic processing program called PAMGuard.



Whistles, clicks and pulsed calls produced by killer whales.

Clicks will be detected and measured using PAMGuard's automated click detector. The click detector will send measurements to ROCCA for classification analysis. Finally, in a related ONR-funded effort, 'behavior and location' feature vectors will be created and tests will be run to determine how best to include them in the classifier. Classification models will then be developed that identify encounters to species based on all of the available feature vectors. Methods will be developed and tested during the ONR portion of this project using data from the northwest Atlantic and Hawaii. The classification approach developed in the ONR portion of the project will then be used to create classifiers for species in the temperate Pacific Ocean. This portion of the project will be funded by the LMR program.

At the end of the project, all new classifiers will be integrated into PAMGuard and another software platform for processing acoustic data, Ishmael. Current users of PAMGuard and Ishmael software will be able to download the updated versions as soon as they are available.

The fully automated methods developed under this project will significantly reduce the time and cost required for the processing of PAM data. In addition, adding classifiers for clicks and behavior/location data is expected to provide better classifications and therefore a more accurate representation of species distribution on and around Navy training ranges.

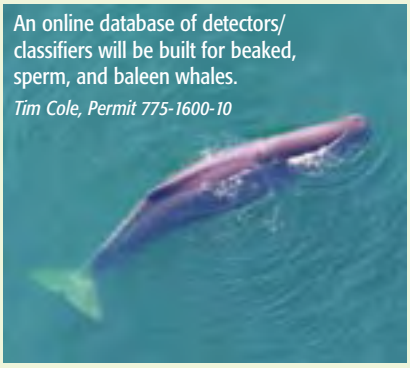
Improving the Software

Another team sponsored by the LMR program is approaching the problem of marine mammal sound classification by testing the accuracy of the detectors and classifiers currently in use.

In order to detect and classify marine mammals, specific characteristics of their signals must be extracted from the audio signal received by the PAM system. A project team headed by Dave Mellinger of OSU (under LMR project no. 3) is creating a database of performance-characterized detectors/classifiers for many marine mammal species that can be integrated into the current PAM software package called Ishmael. (A detector is a file that detects a sound and a classifier categorizes the sound according to species.) The Ishmael program, originally developed by Mellinger with ONR funding, is one of the most popular bioacoustics programs used in the field today. It includes displays of sound waveforms and spectrograms, recording capability for real-time input, and several methods for acoustic localization and automatic call recognition.

The detectors/classifiers currently in the PAM system database will be characterized and evaluated by testing them against sound files found at www.mobysound.org. This web site houses a publicly accessible archive of sound recordings of over 35 marine mammal species. MobySound recordings have been annotated to indicate where (in time and frequency) each call occurs and what its signal-to-noise ratio is—information crucial to evaluating detector/classifier performance.

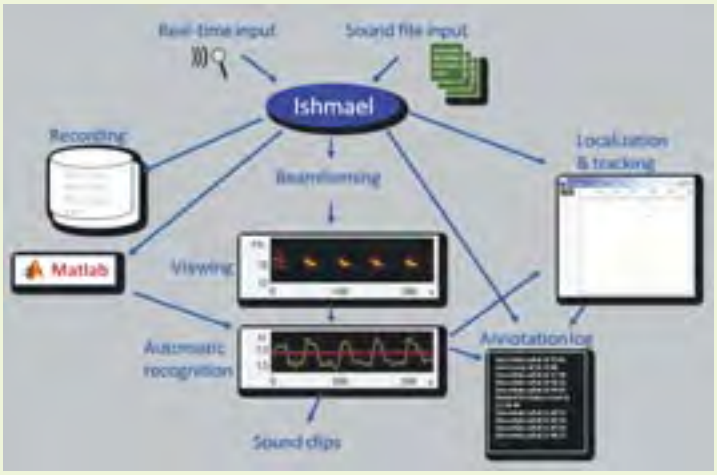
To achieve this, the Ishmael software interface is being enhanced so that it can communicate seamlessly with MATLAB, a language widely used to easily implement detectors and classifiers.



An online database of detectors/classifiers will be built for beaked, sperm, and baleen whales.
Tim Cole, Permit 775-1600-10

Killer whale.

A relatively naive user will be able to sit down, choose what species to monitor, and the system will provide detections and other performance measures for those species.



Components of Ishmael.

Then, an online database of detectors/classifiers will be built for beaked, sperm, and baleen whales as well as a number of delphinids (small to medium cetaceans, such as pilot whales and dolphins). These detectors/classifiers will then be tested against the sound files in MobySound to provide performance information for each one.

By early 2017, an Ishmael-to-database interface will be created to display detectors and performance data in Ishmael and make it simple to download and install any of the available detectors/classifiers. This will be followed by documentation and training for Navy personnel and private (contractor) marine mammal observers as well as regulators who are involved in Navy mitigation issues. Training will be provided by adding a new module to an existing Bio-Waves training course for passive acoustics technicians. Stand-alone training on the new software will also be available.

When this new software is integrated into Ishmael, a relatively naive user will be able to sit down, choose what species to monitor, and the system will provide detections and other performance measures for those species.

Having a system for marine mammal detection that is both straightforward to use and well-characterized will make adoption of acoustic monitoring faster, easier, and therefore more widespread within the Navy, enabling easier compliance with environmental law and practice.

Expanding the Knowledge Base

Currently, the single most cited resource for information on the effects of noise on marine mammals is a book that was published in 1995 (*Marine Mammals and Noise*, Academic Press, San Diego). This book has been a valuable resource for the Navy, environmental planners, regulators and scientists. However, in the last 20 years the literature related to the issue of marine mammals and noise has expanded greatly and there is more information to consider when assessing effects of noise on marine mammals. There is a pressing need to update this book that is shared by multiple stakeholders who rely heavily this resource.

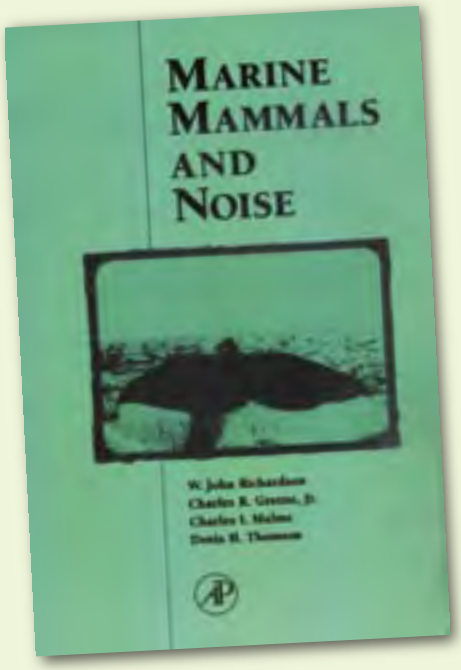
Since there are many stakeholders involved and the effort is so large, this project is leveraged with funding from ONR, the National Marine Fisheries Service, and the Joint Industry Program. The LMR component of the project is led by Christine Erbe, Director of the Center for Marine Science & Technology at Curtin University, Australia.

The tasks to be undertaken during the LMR portion of this effort include:

1. Developing a publicly accessible database of literature on marine mammal bioacoustics.
2. Reviewing the literature and publicly available data on the sounds produced by marine mammals and on marine mammal hearing.
3. Preparing a subsequent essay on how marine mammal bioacoustic data can inform both conservation efforts and the management of marine resources based on the literature review conducted.

Members of the project team have their own research database from which to gather information. The team will also actively solicit articles and reports from the scientific community, including "grey" literature (reports that were not published in scientific journals). The team members will assemble all relevant information into a publicly accessible database of literature on marine mammal bioacoustics. The information gathered in this

project will be summarized into two final reports—one on marine mammal sound generation and a second on marine mammal hearing. An essay will also be published summarizing the overall findings.



Marine Mammals and Noise, published in 1995, is the single most cited source for marine mammal data. This LMR project will develop an updated source for information on marine mammal bioacoustics.

Once this project is complete at the end of fiscal year 2016, the team will leverage this work and solicit sufficient additional funds to produce a book compiling the team's findings.

All stakeholders concerned about the impact of anthropogenic noise on marine mammals would benefit from the first single source in 20 years to bring together available research on marine mammal sound production and hearing. It is expected that an updated, authoritative information source would also help alleviate overly conservative values sometimes used by regulators. The project's final essay will provide Navy-specific recommendations.

Facilitating the Permitting Process

The Navy commits significant funding and manpower to improve understanding of the occurrence, exposure, response, and consequences of marine mammals within and near Navy at-sea training and testing activities. The research and technologies supported by LMR have two over-arching goals:

1. To improve the available information regarding the potential impacts to marine mammals from Navy activities.
2. To improve the technology available to the U.S. Navy marine species monitoring program.

The information garnered from these efforts will inform the Navy's at-sea environmental compliance and permitting processes and lead to improved impact analysis, marine mammal take estimates, and mitigation measures.

Downloadable (pdf) summaries of all of these projects are available on the LMR web site at www.lmr.navy.mil/ProjectHighlights.aspx. ⚓

Mandy Shoemaker
Naval Facilities Engineering and Expeditionary Warfare Center
805-982-5872
DSN: 551-5872
mandy.shoemaker@navy.mil

Anu Kumar
Naval Facilities Engineering and Expeditionary Warfare Center
805-982-4853
DSN: 551-4853
anu.kumar@navy.mil

Fin whale.
Brenda K. Rone, NMFS Permit 15330

Currents Snags Another Navy Media Award

2014 Navy Media Award Added to Magazine's Long History of Honors

Currents magazine was among the winners of the 2014 Russell Egnor Navy Media Awards program–recipient of an honorable mention in the "Funded News Publication" category. While announcing this round of awardees, Rear Admiral Dawn Cutler, director of the Navy Office of Information (CHINFO) said, "I am continually impressed by the quality of work our Mass Communication Specialists produce. This year's competition was tough with more than 1,200 entries submitted. We are doing great work out there and I couldn't be more proud of all of you."

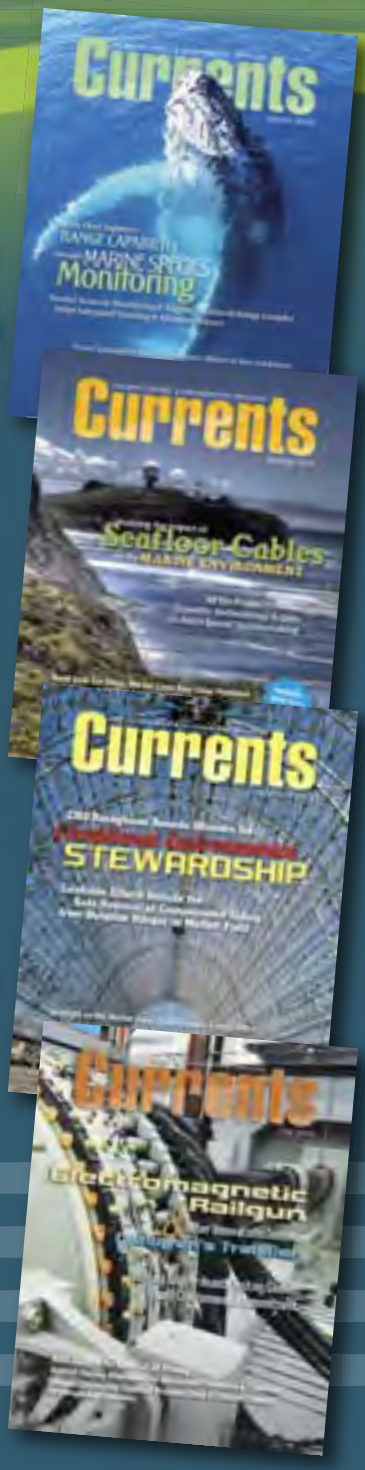
This is proper recognition for a truly first class publication.

–Admiral Kevin R. Slates

Named in honor of retired Senior Chief Journalist Russell D. Egnor, the award program recognizes excellence in Navy journalism, photography, videography, and graphic arts among Navy commands and their public affairs and visual information specialists. Egnor served the Navy for more than 40 years as an active duty and reserve Navy journalist and as a Navy civilian (director of the Navy's News Photo Division at the Navy Office of Information).

Upon hearing the news of the magazine's most recent award, Admiral Kevin R. Slates, director of the Chief of Naval Operations Energy and Environmental Readiness Division said, "This is proper recognition for a truly first class publication."

Although it was the editors and staff of *Currents* who received this award, we realize that is actually the stories from our colleagues at Navy and Marine Corps installations around the world that make *Currents* an award winner. So we share this award with all of you who have contributed stories to the magazine over the years. We couldn't do it without you.



Currents Magazine's History of Awards

Year	Award	Place
2014	Russell Egnor Navy Media Award	Honorable mention in "Funded News Publication" category
2011	CHINFO Merit Award	First place medal ("Best magazine in the Navy")
2008	CHINFO Merit Award	First place medal ("Best magazine in the Navy")
2004	CHINFO Merit Award	First place medal ("Best magazine in the Navy")
2004	DoD Thomas Jefferson Award	First place medal ("Best magazine in DoD")
2003	CHINFO Merit Award	Second place medal
2001	CHINFO Merit Award	Third place medal

Managing the Navy's History Collections

A Surprising Trip through Time Via the Naval History and Heritage Command

THEY ARE PART-DETECTIVE, part-researcher, technology-savvy defenders with a smidgeon of enforcer. They are the curators of the Collections Management Division at the Naval History and Heritage Command (NHHC).

The Navy is big on tradition, and that tradition comes with a collection of items that range from a $4.4 million dollar sterling silver trophy to a simple Thanksgiving menu from a destroyer during World War II.

NHHC is the keeper of 10,864 reels of microfilm and 5.67 terabytes of electronic data, along with 200 million pages documenting history. While the Command has undergone a number of name changes over the years, its mission has not—the acquisition, custody, distribution and exhibit of items of historical or patriotic value to the Navy. NHHC personnel also provide guidance on the preservation and storage of historical material and make those items available to the public and provide maintenance when necessary.

The entire collections division is undergoing an artifact baseline reset, which means the staff is going through the collection, item-by-item, to make sure it is correctly cataloged, photographed, inventoried and if necessary, rehoused under the proper conditions, which includes a constant temperature and humidity. It also allows the division to evaluate the collection to determine the condition of the items and whether they should be retained or donated to another organization.

With almost no staff for many years, it was all collections division personnel could do to keep up with items on loan to a variety of museums and organizations in every state of the union while at the same time storing and cataloging boxes and boxes of items donated from families of former Sailors.

The Navy's tradition comes with a collection of items that range from a $4.4 million dollar sterling silver trophy to a simple Thanksgiving menu from a destroyer during World War II.

Some are hand-chosen from decommissioned ships by the curators themselves, others are donated by those who served the Navy, plucked from a moment in time to inspire people decades later. And some are just items found while cleaning out the attic.

"We often joke the last time we were caught up with our extensive inventory was right after the first item was donated to the Navy," said NHHC's head curator Karen France.

It's up to a relatively small staff to keep track of the 595,000 artifacts, of which more than 30,000 are on loan throughout the world. The Underwater Archeology Branch (UAB) catalogs more than 17,000 sunken military ships and aircraft around the world.

From 2003–2009, Frank Thompson, Collection Management Division deputy director, and France were the only two collection managers,

Kate Morrand, one of NHHC's archeological conservators, points out the embossing of a two-mast ship on a leather wallet to German Embassy Naval Attache Capt. Karl Setzer and his aide, Cmdr. Tobias Voss. The wallet was found by a diver near the wreck of a World War II German U-boat and then given to the Navy Criminal Investigative Service.

MC1 Tim Comerford

responsible for a collection of more than 150,000 items.

Real progress has been made in updating the NHHC's inventory as staff go through boxes to see what treasures might be mixed in with the plaques and other private donations. "People would call us about things in their attic and if we wanted only one item, we would end up taking it all," France laughed.

While that "generosity" certainly contributed to the backlog of items to be cataloged, part of the job is also culling out what doesn't belong—items in poor condition and redundant to the collection.

An inspector general report in 2011 determined some artifacts were at risk, items sensitive to temperature and humidity, such as textiles and art, microfilm and photographs.

For More Information

FOR A GREAT example of some of the work overseen by UAB personnel, read our article "Raising the War of 1812: USS Scorpion May Be Part of Bicentennial Celebration" from the winter 2013 issue of *Currents*. To browse the *Currents* archives, visit the Department of the Navy's Energy, Environment and Climate Change web site at http://greenfleet.dodlive.mil/currents-magazine.

Kate Morrand uses a borescope to look at the internal workings of the midsection of Howell Torpedo Number 24 at the warehouse at the Washington Navy Yard. UAB personnel discovered deck logs stating that the torpedo was lost by the battleship Iowa (BB 4) during a training operation in December 1899. The torpedo was discovered in March 2014 by U.S. Navy dolphins off the coast of San Diego.

MC1 Tim Comerford

NHHC's Master Chief Information Systems Technician Jim Leuci explains the different chief uniforms during a Hampton Roads Surface Navy Association luncheon honoring the Year of the Chief.

MC1 Julie R. Matyascik

"The report suggested the department consolidate where they could, cull the collection and inventory it to get it to the right size," France said.

As they catalogue the items, many are photographed and displayed on NHHC's Flickr site (at www.flickr.com/photos/navalhistory) since most of the artifacts are not stored at the Washington Navy Yard. Case in point—the sterling silver Spokane Naval Trophy given each year to the Pacific-based ship with the best record in battle efficiency. It's currently on display in San Diego. When the trophy was crafted in 1908, it was valued at $10,000. When appraised 100 years later, its value had skyrocketed to over four million dollars.

Some of the artifacts come from companies not typically associated with the Navy. One of the items taken off a decommissioned submarine was a 1960 Steinway upright piano. Steinway & Sons contacted the command and offered to restore it if they could display it for a while. The restored piano is now in the submarine mess deck display at the Cold War Gallery at the Washington Navy Yard.

"Other businesses with items in the Navy collection that might surprise a few include the jewelry companies of Tiffany and Bailey, Banks & Biddle," France said.

"The Chelsea Clock Company of Massachusetts has had a long history with the Navy, having supplied thousands of

The Spokane Trophy is awarded to ships that demonstrate overall excellence in surface ship combat system readiness and warfare operations during work-ups and operational missions. The trophy is made of 400 ounces of silver and is valued at over four million dollars.

Karen France examines the World War II battle flag of the destroyer USS Zellars (DD 777) after its recent conservation. The flag, damaged during a 1945 kamikaze attack, was preserved through the efforts of NHHC, USS Zellars Association, and the Stillwater Textile Conservation Studio. Zellars saw combat service in both World War II and Korea, was attacked by three kamikazes during the Battle of Okinawa and suffered 64 killed when two hit the ship. The conservation of the flag was especially meaningful to the USS Zellars Association's 30 surviving World War II members.

clocks for Navy ships over the years," Thompson said.

When a donated Chelsea clock turned out to be one of the rarer ones due to a low production rate, the company asked if they could restore the clock and then display it to show the company's long and storied history with the Navy. In all of these cases, the companies contacted the Navy offering to restore the pieces made by their own companies.

It's the "loaning" and "borrowing" aspect of the job that can often be the most challenging. "We have more than 15,000 objects in the loan program, and there's something in every state," Thompson said.

Complicating that task is the fact that in the past, loans were sometimes not as controlled as they are today. Loan agreements can sometimes include language that unintentionally complicates matters, mistakenly using the word "gift" instead of "loan," for example. Then, when the agreement is revisited years later, it's difficult to determine ownership of the artifact. That's when curators turn into sleuths.

They don't always win their battles. Most of the time, just a bit of bluffing will work. But with no real enforcement, the staff can only ask for people to do the right thing and return the artifacts.

"We are upgrading our records to properly distinguish a gift from a loan," Thompson said. "We've also tightened up our policies so there are no more open-ended loans. If the custodians show they have been good stewards of the artifact, they can continue to hold on to it."

For now, the work of the artifact baseline reset continues while the collections division is consolidating a large portion of its artifact collection from three different locations to a single warehouse in Richmond, Virginia.

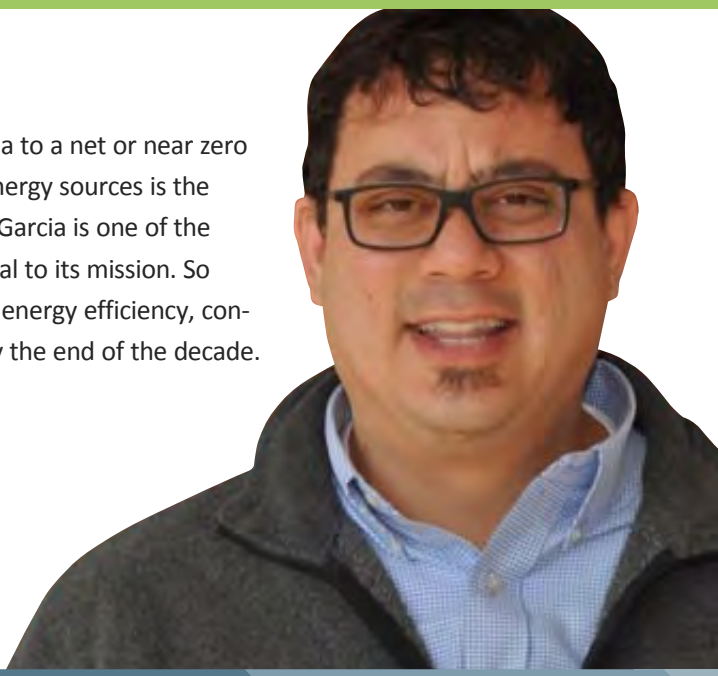
"We have literally tons of material, some of which is priceless, and nearly all of it irreplaceable," said France. "But the work is well worth it if it means Sailors and citizens can better appreciate what the Navy has meant to our country since its inception." ⚓

Paul Taylor
Naval History and Heritage Command
202-433-7880
william.p.taylor@navy.mil

DID YOU KNOW?

How did I save energy for the Navy?

One of Far East's current energy initiatives is bringing Diego Garcia to a net or near zero footprint. That means that the power generated by renewable energy sources is the same as the energy consumed at the installation. Because Diego Garcia is one of the most remote of all U.S. Navy installations, energy security is critical to its mission. So we're creating an energy roadmap for Diego Garcia that includes energy efficiency, conservation and renewable generation to meet our net zero goal by the end of the decade.



Name: Michael Owens

Age: 41

Hometown: San Diego, CA

Job: Far East Energy Program Manager

Command: Naval Facilities Engineering Command (NAVFAC) Far East

Do you think culture change with regard to energy conservation is important for our Navy?

Apathy is one of the Navy's biggest energy related challenges. To reduce our energy consumption, the status quo has to change. Effective energy conservation will only come about when behaviors and mindsets change. Energy-efficient technologies will help us reduce consumption although efficiency alone won't get us there. We need to change the conversation about energy in the Navy.

ENERGY SECURITY ENHANCES COMBAT CAPABILITY

Did you know that light emitting diodes are 50 percent more efficient than fluorescent lights, last seven to ten times longer, and are not considered hazardous waste?

In response to the one gigawatt renewable production goal set by Secretary of the Navy Ray Mabus in 2009, renewable energy production and efficiency has become a new priority in the Far East energy strategy. While not an easy goal to achieve—we currently consume nearly 3.5 million British thermal units (MBTU) per year—we are determined to try to meet this goal and reduce our energy consumption across Far East installations which include Japan, Singapore, Diego Garcia, and South Korea. We have implemented numerous energy-saving projects ranging from solar photovoltaic to solar thermal domestic hot water systems. These projects have generated approximately 8,200 MBTU per year in energy savings. The ultimate goal is reduce energy consumption so that the limited amount of renewable generation available overseas has a bigger contribution to the region's target of 50 percent of energy from renewable resources.

By reducing energy consumption and increasing our cost savings, we are better able to support the warfighter. Ultimately, conserving energy for the Navy is a function of dollars, and every dollar saved on energy is one that can go toward the Sailor, Airman, Soldier and Marine. Providing more resources to the warfighter is something I take very seriously. My goal is to help people understand that their energy-related actions while ashore do in fact have an impact on combat readiness and the warfighter.

The more we conserve, the more time we give ourselves to invent, develop, and bring about energy solutions to reality. My job is to find creative solutions to current energy challenges throughout Far East Navy installations and for the Navy as a whole. Of course, I don't do this alone. I have a great team that helps me implement these energy projects. Currently, we are working towards increasing the Navy's renewable energy generation footprint by constructing new renewable energy systems, such as wind turbines, photovoltaic and hot water systems, when and where applicable and economically feasible. High construction costs and limited space have made the installation of renewables challenging. But our team keeps plugging away and seizing opportunities where we see them.

U.S. DEPARTMENT OF THE NAVY ENERGY SECURITY

@NavalEnergy

facebook.com/NavalEnergy

http://greenfleet.dodlive.mil/energy

Additive Manufacturing Gaining Traction at Fleet Readiness Center East

Potential Safety & Environmental Impacts Addressed

TO SUPPORT THE Fleet-wide push toward additive manufacturing, personnel from the Fleet Readiness Center East (FRCE) in Cherry Point, North Carolina have identified the potential environmental impacts and workplace safety measures associated with this advanced technology.

AM can be a more cost-efficient method of manufacturing parts. Energy costs are lowered because there is no casting process and fewer production steps, inventory is reduced because items can be made one at a time, and flexibility is greatly enhanced, allowing for precise, intricate designs. Small-scale produce thermoplastic tooling and parts using Fused Deposition Modeling (FDM) technology. A computer-aided manufacturing software package within the Fortus system controls the process. A coiled thermoplastic filament is supplied to a five-centimeter-long extrusion

Additive manufacturing reduces adverse environmental impact and health risk by minimizing high temperature foundry operation and hazardous materials usage.

Additive Manufacturing

The terms additive manufacturing (AM) and three-dimensional (3D) printing are often used synonymously in mainstream media. However, 3D printing is technically a subset of additive manufacturing processes that refer to material buildup through a nozzle or other printing technology. Traditional subtractive manufacturing entails the removal of material (often by lathing, cutting, chipping or grinding) to create a final product. In contrast, AM uses an additive process, creating objects layer by layer through the use of a nozzle.

AM processes may even be used onboard a ship, potentially allowing for on-the-spot repairs.

In general, AM processes involves three basic steps, once design of the AM part or assembly is complete:

1. AM part building
2. Removal of support material
3. Final surface finishing

Step 1: Additive Manufacturing Part Building

FRCE uses two Fortus systems (manufactured by Stratasys Ltd.) to nozzle head which heats the material to the proper temperature, then ejects the molten plastic which hardens immediately to produce a product. Depending on part geometry and orientation, some down-facing surfaces will require supports as the part is being formed. This support material is extruded through a second nozzle during operation.

AM reduces adverse environmental impact and health risk by minimizing high temperature foundry operation and hazardous materials usage, such as metal working fluids, lubricants, and biocide.

Air emissions appear to be a non-issue as well. Although some fumes and ultra-fine particles are released when plastics are heated to the softening point during extrusion, Stratasys Ltd. has analyzed air samples taken at the operator control panel located at the edge of the door opening and opposite the exhaust fan vents. Among chemicals collected were styrene, acrylonitrile, methyl methacrylate, butadiene, and hydrogen cyanide. Samples representative of an 8-hour exposure were compared with the Occupational Safety and Health Administration (OSHA) Permissible Exposure Limits (PEL). Results found that the toxic chemical emissions released from the Fortus systems were all below the OSHA PEL. Personnel from FRCE's Industrial Hygiene Division will conduct their own survey in the near future to confirm that emissions are as reported.

An example of the cost and time savings made possible by AM is the stretch forming of sheet metal to make aircraft skins. The conventional manufacturing process, using foundry processes followed by hand forming the surface, takes approximately three months to complete. Changing to AM and "printing" the part reduces the process time to two weeks—minimizing labor hours, raw materials usage, and hazardous waste. Another example is an AV8-B drill guide which is made in one week by AM methods as opposed to the previous three-to-five week process.

Personal protective equipment needed for AM part building includes safety eyewear and heat-resistant gloves for use when taking a product out of the machine.

This form block and top were created through the AM process. Sheet metal to make aircraft skins will be formed with these parts.

This AV8-B Harrier jet drill guide is made in one week by AM– a time savings of two to four weeks.
Ramsey Davis

LEFT: The nozzle inside the Fortus computer ejects molten plastic which hardens into the desired shape to make a part.

RIGHT: A radiography scanner is necessary for inspecting for defects internal to denser metallic parts. Safety measures must be taken to ensure that the scanner is not activated when technicians are in the area.
Keiko Sapp

Patternmaker Caleb Guelich, left, and engineer Justin Reynolds from FRCE, inspect polymer form blocks made through FDM, a type of AM. The form blocks, made in a matter of hours overnight, were used to create repair parts for a damaged AV-8B Harrier. Using conventional methods, creating these tools could have taken two to three weeks.

Step 2: Support Material Removal Process

Support material is removed by hand or by a chemical immersion process. Hand removal can be accomplished by using tools such as pliers, and the removed plastic materials can be recycled. The chemical removal process uses a heated ultrasonic tank with a caustic solution at the operating temperature of 160 to 170 degrees Fahrenheit. The caustic solution dissolves the plastic support material; however, large-sized undissolved plastics that come off the product must be removed by filtering in order to extend the solution's operating capability. As the pH depletes, the plastic removal process will take longer, and the solution color becomes a milky brown that can discolor products. For this reason, the manufacturer recommends replenishing the solution when the pH level drops below nine. Although the manufacturer does not require a post-rinse process, FRCE is establishing immersion rinse tanks to remove any residual contaminants from products after the caustic immersion process. Although the spent solution is considered hazardous waste, the impact of the spent waste solution for disposal via FRCE's industrial waste treatment plant is unknown at this time.

The heated caustic solution can irritate or burn the skin, eyes, and respiratory tract. Adequate ventilation, emergency showers, and eye-wash stations are required per OSHA 29 CFR 1910.124, General Requirements for Dipping Operations.

Step 3: Final Surface Finishing Process

The final step is surface finishing, which smooths out the surface by sanding or varnishing. FRCE accomplishes the final surface finish by hand. Although the amount of plastic dust created by the hand sanding process is small, dust can accumulate quickly and is considered combustible. Local exhaust ventilation systems are used to eliminate plastic dust during sanding, and wet cloth wipes are used to clean up the work benches. Housekeeping is the key to keep fire hazards under control and prevent possible flash fires or explosions.

Findings

The environmental benefits of AM are energy savings through the elimination of high temperature foundry operations, reduced hazardous material usage compared to conventional machining processes, and reduced spent metal working fluid disposal cost. The environmental impacts of spent caustic solutions with dissolved plastics need to be evaluated.

More cost savings can be gained by minimized the use of raw materials and lead time improvement. The lifespan of plastic tooling is unknown; however, proper indoor storage to avoid direct sun light is recommended.

From a safety standpoint, AM provides a safer work environment by reducing hazardous material usage, and presumes reductions in mishaps by minimizing the physical labor hours of conventional processes.

Future References for Additive Manufacturing Metal Products

FRCE is evaluating another form of AM known as directed energy deposition for manufacturing metal aircraft components, metal tooling, and for performing component

repairs. These technologies use either a laser beam or electron beam to melt metal powder and/or wire to produce the end product. Compared to thermoplastic FMD technology, safety concerns and environmental impacts are greater with directed energy deposition technologies. These concerns are due to the nature of the metal powder, the use of laser or electron beams, and the advanced radiography scanner used for inspection.

During directed energy deposition processes, metal powder is transported by an inert gas and fused by a laser. Metal powders including nickel, cobalt, stainless steel, titanium and aluminum alloy are currently under evaluation at FRCE for this process. Since titanium alloy and aluminum alloy powders are highly combustible, care must be taken in the storing, handling, and processing of these metal powders. Ventilation, explosion-proof vacuum cleaners, natural fiber bristle brooms/brushes should be used to avoid accumulation of metal dust in the work environment. Metal powders must be stored in climate controlled storage separately from water, acids, halogens, oils, and general combustibles, such as paper and wood. In case of fire, blankets and Class D fire extinguishers must be available. Water, ABC-type fire extinguishers, and carbon dioxide may not be used on this type of fire.

The laser used in directed energy deposition is a Class 4 hazard. This means that there is a hazard to the eye from the direct beam, from specular reflections (the mirror-like reflection in which a ray is reflected in a single outgoing direction), and possibly from diffuse reflections. This type of laser also has the potential to damage skin and start fires. Necessary personal protective equipment includes static dissipating safety shoes, long heat-resistant gloves, laser safety spectacles or goggles, and coveralls as required.

Oxygen monitors are also required in the work area to prevent inert gas asphyxiation.

For the denser metallic parts, the use of a radiography scanner is necessary for inspecting for defects internal to the part. The scanner is a large X-ray inspection tool housed in a room that can hold at least one or two inspectors. The scanning space is guarded by lead shielding or lead glass walls to protect from X-ray emission. Additionally, lockout/tagout procedures are needed to prevent the scanner from accidentally being turned on while inspectors are inside.

Conclusion

AM at the FRC level has great potential to support the warfighter and maintenance activities safely and cost-effectively. By using AM, the impact on the environment is minimized as AM is a cleaner fabrication process compared to the foundry operation and conventional machining processes. AM produces near zero raw material waste and reduces the amount of spent metal working fluid used. The health and safety of the user, however, must remain on the forefront. ⚓

Keiko Sapp
Fleet Readiness Center East
252-464-5259
DSN: 451-5259
keiko.sapp@navy.mil

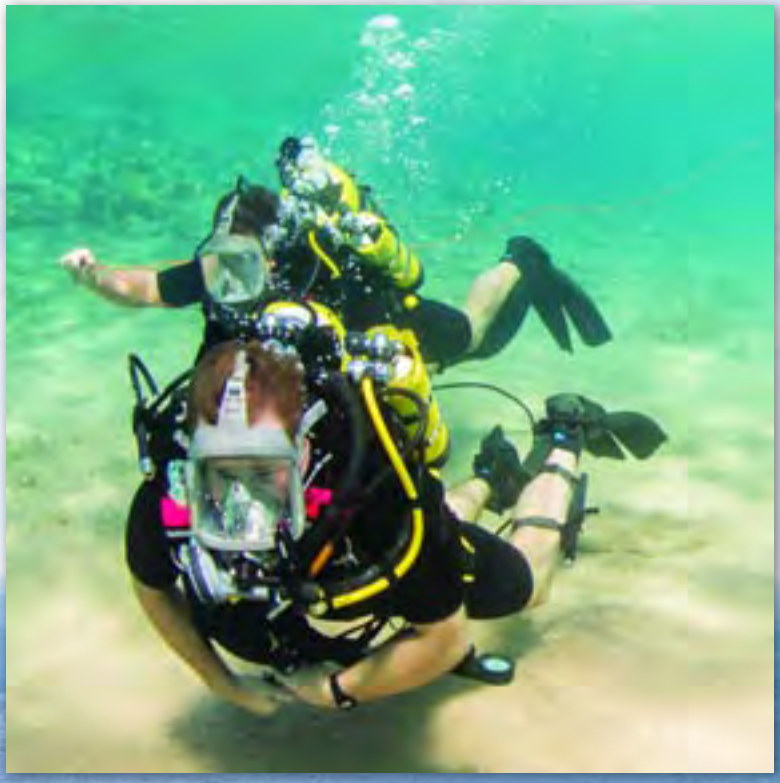
For More Information

FOR MORE INSIGHTS into the in-roads made by AM technologies into Fleet operations, read our article "Navy Explores the Future of 3D Printing: CDSA Dam Neck, CNSL & NAVAIR Host Workshops for Deckplate Sailors & Industry Partners" in the fall 2014 issue of *Currents*. You can browse the *Currents* archives at the Department of the Navy's Energy, Environment and Climate Change web site at http://greenfleet.dodlive.mil/currents-magazine.

NAVY EART

A sustainable future

H DAY 2015



begins with you.

GREENFLEET.DODLIVE.MIL

Navy Region Southwest & National Marine Fisheries Service Salvage Rare Whale Carcass

Cooperative Efforts Provide Navy with Opportunity to Test Stranding Response Procedures

NAVY REGION SOUTHWEST (NRSW) personnel leveraged the stranding of a rare Bryde's whale as an opportunity to strengthen its network of resources and relationships with the National Marine Fisheries Service (NMFS) and Southwest Fisheries Science Center (SWFSC) and provided marine mammal researchers at the San Diego Natural History Museum (SDNHM) a unique opportunity to study an uncommon carcass.

Early on December 8, 2014, Naval Base Coronado (NBC) Port Operations personnel discovered the carcass of a small 15-foot whale that had washed up against one of the base's piers. Under a regional stranding assistance agreement between the Navy and NMFS, NRSW personnel immediately contacted NMFS SWFSC's Marine Biologist and Southern California Stranding Coordinator Kerri Danil.

Byrde's whale.
©Morningdew, Wikimedia Commons

Once on the pier, the team rolled the carcass over, right side up, and were amazed to discover three ridges on its head– the markings of a rare Bryde's whale.

There was no indication what caused the whale's death, and the only apparent link to the Navy was its location at the NBC pier. Because it was a cetacean (whale or dolphin), the Navy understood the carcass would garner some interest from NMFS.

Shortly after discovering the carcass, NRSW met with SWFSC at NBC for an initial investigation. The specimen, floating upside down, appeared to be a minke whale—the most plentiful rorqual whale in the world. (Note: A rorqual whale is in the family of large baleen whales (as a blue whale or humpback whale) having the skin of the throat marked with deep longitudinal furrows.) The coordinators realized that the body, small and fully intact, would make an excellent museum carcass. However, both the Los Angeles and San Diego museums of natural history declined the stranding coordinators' initial offer, on the assumption that it was a common minke whale.

This left NMFS with one requirement—salvage as much information as possible before discarding the carcass. Given its location next to a naval facility, NMFS and SWFSC would need time and Navy support to conduct the investigation. NRSW stranding coordinators engaged NBC Commanding Officer, Captain Christopher Sund, to explain the data collection process and requested more time. Captain Sund supported the effort, pleased to grant the requested 24 hours so as much data as possible could be collected.

Ventral pleats (grooves) along the jaw of the Bryde's whale carcass as it was found upside down at NBC piers.
Walter Wilson

NMFS West Coast Region and SWFSC stranding coordinators and NRSW marine biologists began a whirlwind process of coordination. By that afternoon, all three organizations had a plan in place to move the carcass the following morning. NBC Port Operations personnel agreed to move the carcass to the nearby carrier piers where a gantry crane could reach it for lifting. NMFS West Coast Region Stranding Coordinator Justin Viezbicke contracted a local trucking company to provide a truck that would allow SWFSC personnel to cut into the carcass and extract as much biological data as possible before transporting it.

On the morning of December 9, NBC Public Works personnel realized how difficult it was to move a carcass that weighed nearly 2,000 pounds. So they devised a makeshift metal ramp with a large wooden pallet that could be lowered into the water and positioned it under the carcass to lift it onto the pier. This solution averted the need to use various straps and slings gathered from Sea World and SWFSC and also ensured minimal damage to the carcass.

Once on the pier, the team rolled the carcass over, right side up, and were amazed to discover three

NOAA SWFSC biologists collect initial sampling data at the NBC piers.
Kerri Danil

ridges on its head—the markings of a rare Bryde's whale (*Balaenoptera brydei/edeni*).

Minke and small (juvenile) Bryde's (pronounced BROO-dez) whales are of similar size and form. But the telltale ridges indicated this animal was far more unusual than it initially appeared. In fact, according to the International Union for Conservation of Nature and Natural Resources (IUCN) "red" list, the Bryde's whale's conservation status is "data insufficient." (For more information about the IUCN "red" list, visit www.iucnredlist.org/news/support-the-iucn-red-list.)

Although common in tropical waters, Bryde's whale sightings off the California Coast are very rare. (Since 2000, there have been fewer than ten documented sightings.) However,

The Basics About the San Diego Natural History Museum

SDNHM'S MISSION IS to interpret the natural world through research, education and exhibits, promote understanding of the evolution and diversity of southern California and the peninsula of Baja California, and inspire in all a respect for nature and the environment. Museum personnel accomplish this mission by:

1. Emphasizing the unique and diverse region of southern California while maintaining a global perspective
2. Collecting and preserving scientific specimens for research and as a continuous record of the changing world for future generations
3. Serving as a center for the scientific study of biological diversity and evolution
4. Providing dynamic leadership in natural history and environmental education through exhibits, publications, and educational programs, and striving to make this outreach relevant to all the people of the San Diego region.
5. Fostering cooperative efforts in natural history research and education throughout the southern California region

For more information about the museum and its programs, visit http://sdnhm.org.

acoustic recordings suggest that the number of Bryde's whales off southern California is increasing, and this stranding may be an indication of that population increase.

Knowing that the retrieval of this uncommon species would arouse research interest, NMFS re-engaged the natural history museums in search of a possible home for the carcass. Within five minutes, SDNHM jumped at the chance. The museum's Director of Paleontology, Tom Deméré, explained the recovery's importance. "As with the death of any stranded cetacean (marine mammal), we try to make the best of a sad situation. In the case of the recent Bryde's whale carcass found floating in San Diego Bay, we were given a rare opportunity to study and sample a specimen of this uncommon species of rorqual."

Deméré said there is only one specimen of a Bryde's whale on the west coast. The Los Angeles Natural History Museum has its skull and associated baleen, but not the whole skeleton. Specimen KX0258, as this find was designated, will be the "only complete skeleton of a Bryde's whale on this coast and, with the recovery of the full baleen array, will be one of the only preserved specimens with both the skeleton and baleen."

The carcass required preparation before it could be transported to the museum. Fortunately, the contracted truck driver happened to be a volunteer for the San Diego Zoo and one of NBC's California least tern monitors. Having an understanding of natural history and an appreci-

NBC Public Works personnel raise the Bryde's whale carcass out of the harbor.
Walter Wilson

NBC Public Works personnel transfer the Bryde's whale carcass into the truck.
Walter Wilson

SDNHM Paleontologist Tom Deméré (left) and NAVFAC SW Marine Biologist Jessica Bredvik cut through the blubber and muscle of the carcass.
Walter Wilson

ation of the significance of this specimen, he offered to contact his employer for help. His employer, who owns a large agriculture operation in San Diego County, agreed that the specimen could initially be stored and examined at their farm.

On December 10, two days after specimen KX0258's discovery, the team of scientists from the Navy, NMFS, SWFSC and SDNHM gathered at the farm to flense the carcass and prepare it for museum collection. (Note: Flensing is the act of stripping the blubber or skin from, in this case, a whale.) As with any Navy operation, safety was a primary concern. In the confined truck bed, the team of five used a variety of large knives and sharp blubber hooks to remove the flesh from the carcass. The safety brief also covered the procedures and precautions necessary to ensure proper preservation of the carcass both for its museum display and for a detailed investigation on the cause of death.

Additional team members supported the flensing team by keeping the array of knives sharpened, ferrying sampling gear in and out of the truck, recording data, and taking pictures. Naval Facilities Engineering Command Southwest (NAVFAC SW) Marine Biologists Jessica Bredvik and Christiana Boerger were part of the team conducting the necropsy under the guidance of NMFS Marine Mammal Biologist Justin Greenman and SDMNH Paleontologist Deméré. Both NAVFAC SW marine biologists described the flensing as an "awesome experience and learning opportunity."

The NMFS stranding team also used this opportunity to conduct outreach with local school children. They provided classroom and assembly presentations on marine mammals, and explained the importance of studying salvaged specimens.

The fully intact baleen rack just after the stranding team removed it from the Bryde's whale carcass.
Walter Wilson

The team collected the entire skeleton and prepared it for burial in compost. In a few months, a completely cleaned skeleton will be available for the museum to study. Specifically, they hope to be able to describe its skull and eating habits. Such a study has not been done before and will be a welcome addition to the museum's research program. The museum will also add the whale's baleen rack to its display.

Deméré said, "The baleen will be an important addition to our growing sample of intact baleen racks and will provide significant comparative information for our ongoing research on the form and function of baleen."

The baleen rack is a filter-feeder system inside the mouth of certain whale species, including Bryde's. Baleen hair is similar to bristles and allows the whale to take water into its mouth and then push the water out through its baleen bristles, leaving food behind.

"I'm surprised the full baleen rack remained. When we removed it, it practically fell out," said Walt Wilson, NRSW marine biologist. When a baleen whale dies, it is not uncommon for the baleen rack to be the first portion of the carcass lost.

Cooperating in this team effort afforded the Navy a number of opportunities including:

- Helping federal regulatory partners gain a scientific research opportunity
- Testing the standard procedures of stranding response
- Providing invaluable training to marine biologists
- Successfully salvaging a rare specimen to be cataloged in a research facility.

Danil concluded, "I sincerely appreciated the support of the Commanding Officer and the amazing ability of NBC Port Operations and Public Works to move a two-ton carcass with ease. This, in combination with assistance from NAVFAC SW marine biologists, made the logistically challenging situation unfold with ease."

This cooperative approach to environmental stewardship of ocean resources reemphasized the open and positive relationship among regulators, the Navy, and the public. NRSW successfully leveraged this whale's demise as an opportunity to strengthen its network of resources and relationships with NMFS and SWFSC, while giving marine mammal researches the unique opportunity to study a rare Bryde's whale—contributing to the knowledge base of this species for years to come. ⚓

National Oceanic and Atmospheric Administration (NOAA) California Stranding Coordinator Justin Viezbieke explains the function of baleen to local school children.
Walter Wilson

Walt Wilson
Navy Region Southwest
619-532-2747
DSN: 522-2747
walter.l.wilson2@navy.mil

LTJG Gia DeHart
Naval Base Coronado
619-997-4445
DSN: 735-4445
gia.dehart@navy.mil

SPAWAR Validates Sampler for Underwater Detection of Munitions Constituents

Polar Organic Chemical Integrative Samplers Deemed More Effective Than Other Methods

A RESEARCH EFFORT led by Gunther Rosen of the Space and Naval Warfare Systems Command, Systems Center Pacific (SSC Pacific), and funded by the Navy Environmental Sustainability Development to Integration (NESDI) program and Environmental Security Technology Certification Program (ESTCP), demonstrated that a new kind of passive sampler has the potential to provide the first truly definitive answers with regard to the presence of munition constituents in the marine environment.

Navy's firing ranges are, or were, located near coastal environments, there is concern regarding their potential for blast-related risks to humans or ecological damage to the environment. Discarded military munitions (DMM), which have been purposefully and improperly disposed of in underwater environments, present similar concerns.

Underwater munitions may pose a risk to the marine environment if the unexploded weapon becomes corroded or breaches, which may cause the explosive fill material to leak or dissolve into the surrounding environment. UXO or DMM may contain munitions constituents (MC) such as 2,4,6-trinitrotoluene (TNT) and hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), which are among the most widely-used high explosives.

Although the Navy and others have recently developed an improved understanding of the environmental fate and effects of MC that could leak from underwater munitions through extensive laboratory experimentation, there are still questions about what constitutes environmentally relevant concentrations of munition constituents.

Identifying leaking underwater munitions and measuring MC at low concentrations is highly challenging, in part because introduction of the constituents to the water column may be episodic in nature and grab sampling is unlikely to accurately characterize water concentrations over time. (Note: "Grab sampling" is the common phrase used to describe the collection of a water sample into a bottle at a distinct moment of time).

Without the ability to accurately assess the risks posed by underwater UXO, Navy ranges are faced with increasing regulatory scrutiny which may result in costly assessment and cleanup that can jeopardize routine operations.

Underwater Munitions

Unexploded ordnance (UXO) are explosive weapons (including bombs, projectiles, and mines) that did not explode when they were employed, and therefore, still pose a risk of detonation, in many cases, decades after they were fired during live-fire training or testing. Because many of the

Without the ability to accurately assess the risks posed by underwater UXO, Navy ranges are faced with increasing regulatory scrutiny which may result in costly assessment and cleanup that can jeopardize routine operations.

This project was formed to identify a cost-effective, field deployable sampling method that features detection at ultra-low concentrations, and provides time-weighted average concentrations (i.e., average estimated water concentrations over deployments of two weeks or more) for improved characterization of MC at underwater UXO sites.

Example of Composition B.

Personnel from SSC Pacific and the U.S. Army Engineer Research and Development Center, with assistance from Oklahoma State University, optimized the use of a commercially available Polar Organic Chemical Integrative Sampler (POCIS) for the detection of MC in aquatic environments. The POCIS is a high-sorption sampler widely used to detect polar contaminants including pesticides, pharmaceuticals and household products.

Phase 1 of the project involved laboratory testing of two types of POCIS samplers. Both sampler types, one originally developed for detection of pharmaceuticals and one for pesticides, were placed in 10-gallon aquarium tanks. Both were able to detect and quantify small quantities of RDX and TNT dissolved from the common explosive formulation Composition B (a combination of TNT and RDX), even at high levels of water replacement (five turnovers per day) and when the Composition B was partially encased, minimizing contact with surrounding water.

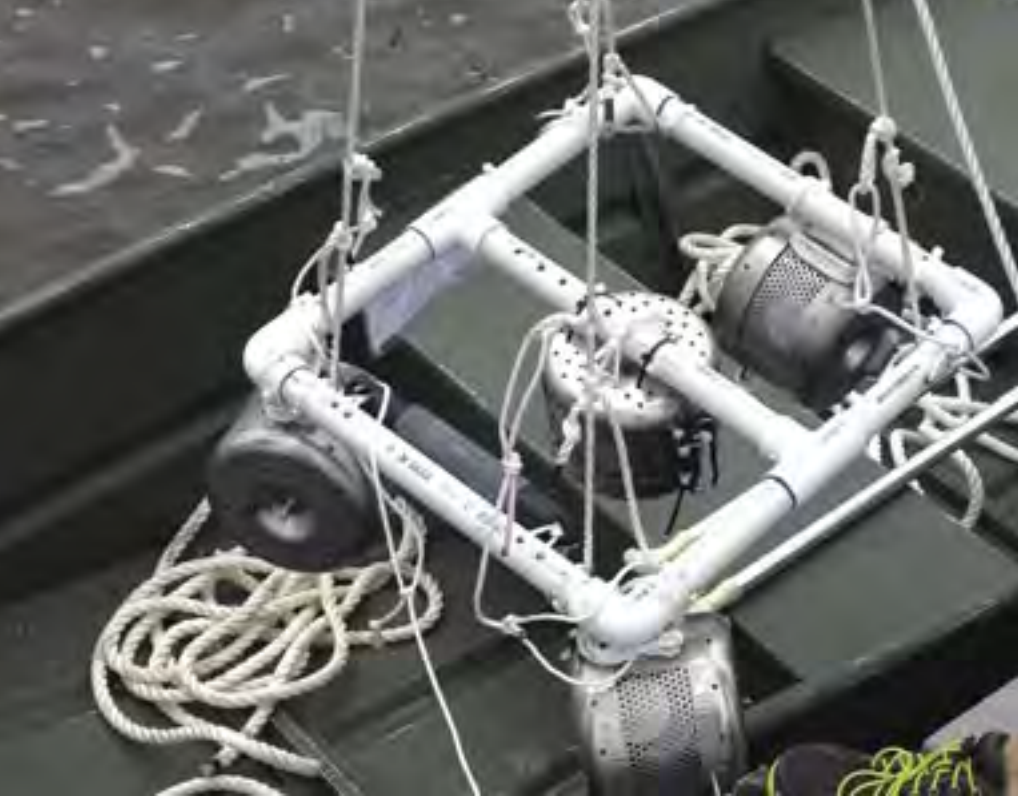
About POCIS

POCIS simplifies the sampling process by eliminating the time and effort involved to conduct multiple grab sampling events and multiple analyses. The ability to deliver time-weighted average (TWA) concentrations means that the POCIS will record intermittent emissions that may otherwise be missed by scheduled grab sampling events. The POCIS is also more sensitive, recording chemicals at ultra-low levels, and preserves the contaminants of concern once they come into contact with the sorbent. Traditionally-collected water samples can degrade during storage and transport from the field to the laboratory. POCIS sampling also eliminates the electrical or fuel powering requirements associated with other types of sample preparation.

Enabling the Field Demonstration

COOPERATION BETWEEN MULTIPLE entities was required to make the POCIS demonstration a success. The following permissions, permits or documents were required before work could commence.

- The Florida Department of Environmental Protection. This agency granted authorization to use State submerged lands without obtaining a regulatory permit.
- U.S. Army Corps of Engineers (USACE) Nationwide Permit 5. The Corps evaluates permit applications for essentially all construction activities that occur in the nation's waters, including wetlands.
- Technical fact sheets for TNT and other chemicals were reviewed and utilized. Review of the USACE Engineer Research and Development Center Health and Safety plan for environmental research conducted with high explosives.
- EPA's Gulf Ecology Division. Coordination with the safety and health manager.



Fragments of Composition B were added to metal canisters with mesh-like sides and suspended from a research dock just above the sea floor.

The Toxicity Issue

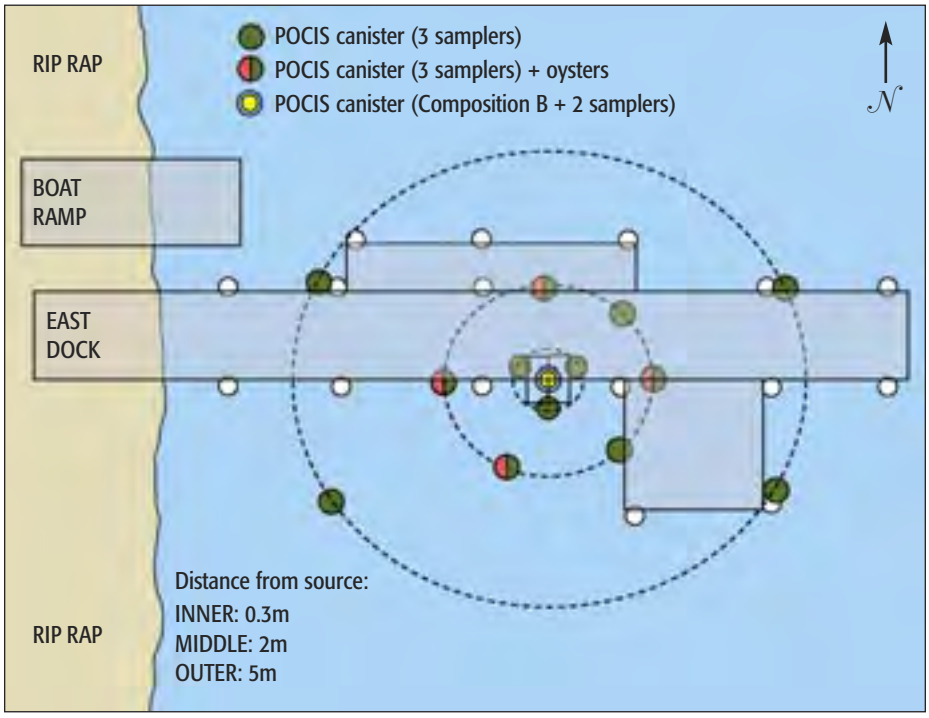
A previous NESDI project (project no. 258) focused on the development of toxicity and bioaccumulation benchmarks for common MC, including TNT, RDX, and their degradation products. The project results suggested low ecological risk under expected exposure scenarios in the marine environment. This conclusion is substantiated by the development of a large body of data illustrating that these chemicals typically undergo extensive degradation processes upon contact with marine sediment, and that relatively high concentrations of these chemicals would be required to produce toxic effects. Additionally, these chemicals have virtually no potential for trophic transfer from invertebrates to fish, and thus, very low likelihood of exposure to humans via the food chain. The minimal potential for toxicity under realistic exposure conditions is also related to the very low propensity for these chemicals to bioaccumulate. NESDI-funded toxicity and bioaccumulation studies have consistently exhibited similar results relating to low toxicity and bioaccumulation using a variety of species, including benthic (bottom-dwelling) and pelagic (deep sea) invertebrates and fish.

Laboratory-based experiments show that MC presence, at concentrations of concern in aquatic environments, are expected to be localized (i.e., adjacent to leaking shells), episodic (very slow and intermittent), and influenced by the level of projectile corrosion and site conditions (e.g., temperature, currents).

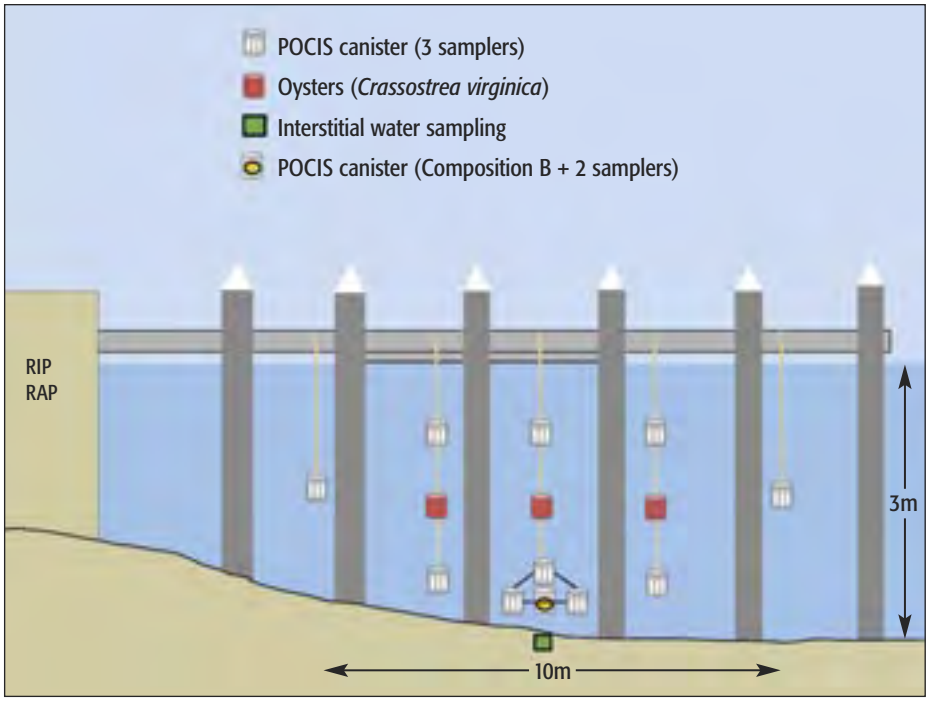
The laboratory tests conducted by this project team confirmed that method detection limits for POCIS were expected to be under 50 nanograms per liter for most compounds—well below levels associated with biological impacts.

The Field Demonstration

A field demonstration of the POCIS was conducted in 2014 adjacent to the U.S. Environmental Protection



A concentric circle sampling design was employed to examine uptake by the POCIS at increasing distances from the source.



Schematic of canister placement.

Agency's (EPA) Gulf Ecology Division at Santa Rosa Sound, Florida. This site, near Pensacola Bay, was chosen because it exhibits some of the same physical characteristics as many sites where Department of Defense (DoD) training ranges exist (i.e., sandy sediment, brackish water, and subtropical temperatures), and was previously established as not having any MC in a preliminary study.

Fragments of Composition B were added to metal canisters with mesh-like sides and suspended from a research dock just above the sea floor. This configuration roughly simulated exposure of explosive fill material inside a breached munition, providing a point source for potential exposure to the water column. For each of the 20 sampling locations, three POCIS samplers were placed inside identical canisters and deployed at varying distances, directions, and depths, from the "source" canister containing Composition B. The source canister also contained two POCIS samplers for measuring MC concentration inside the canister. A concentric circle sampling design was employed to examine uptake by the POCIS at increasing distances from the source.

Because bivalves have often been used as natural "samplers" for the detection of contaminants, oysters were also deployed. Concurrent grab water and sediment sampling was also conducted.

After 13 days, all samplers were removed and sent to Dr. Jason Belden at an environmental toxicology laboratory at Oklahoma State University for analysis. The highest concentrations of TNT and RDX (the most common constituents measured), based on POCIS-derived average water concentration, occurred within 0.3 meters from the source, with rapid reduction to non-detectable levels only several meters away. However, all POCIS-derived water concentrations were several orders of magnitude lower than those required to be toxic.

The POCIS sampler alongside a more traditional sampling method, oysters.

Boat deployment to visit the next POCIS demonstration site at Bahia Salina del Sur, Vieques, Puerto Rico.

The tissue, grab water samples and sediment samples returned non-detectible concentrations for all constituents, confirming that the POCIS is the more sensitive instrument, with lower limits of detection.

A second 32-day deployment was conducted on a smaller scale. The TWA water concentrations for all constituents showed the same trends of lower MC concentration with increasing distance from the source, but were substantially lower than the 13-day averages. The reasons for this difference are still under investigation and could be due to a variety of environmental factors, including biofouling, which may have affected Composition B dissolution and uptake by the samplers.

What's Next

The next phase of this effort, sponsored by ESTCP, will be implementation of the POCIS at Vieques, a former naval training range in Puerto Rico. From the mid-1940s until 2003, more than 300,000 munitions items were fired during military training operations on and around this island, including naval gunfire, air-to-ground bombing, and marine artillery fire. So far, approximately 40,000 munitions items have been recovered, but it is estimated that up to 9,000 acres of the property may contain munitions and munitions-related items. Many of these items are likely "dummy" bombs or even pieces of debris. Placement of POCIS samplers in the area will provide critical information as to whether or not these items are actively contributing MC into the underwater environment, and help determine whether removal is warranted. This demonstration is scheduled to commence in late 2015.

The Bottom Line

For decades, the absence of definitive sampling and analysis techniques have subjected former military training and bombing ranges to high uncertainty, and potentially unnecessary and overly conservative assumptions of

The Basics About ESTCP

ESTCP IS DOD'S environmental technology demonstration and validation program. The program was established in 1995 to promote the transfer of innovative technologies that have successfully established proof of concept to field or production use. ESTCP demonstrations collect cost and performance data to overcome the barriers to employ an innovative technology because of concerns regarding technical or programmatic risk.

The program's goal is to identify and demonstrate the most promising innovative and cost-effective technologies and methods that address DoD's high-priority environmental requirements. Formal demonstrations are conducted at DoD facilities and sites in operational settings to generate full documentation towards the goals of full field validation, improved performance and cost savings. To ensure the demonstrated technologies have a real impact, ESTCP engages with end users and regulators throughout the development and execution of each demonstration. Transition challenges are overcome with rigorous and well-documented demonstrations that provide the information needed by all stakeholders for acceptance of the technology.

For more information, visit the program's web site at www.serdp-estcp.org.

Examples of munitions debris in near-shore environments.
U.S. Army Corps of Engineers

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) research, development, test and evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to ESTCP which conducts demonstration and validation of technologies most relevant to the tri-Services, EPA and Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or n.kaempffe@navy.mil.

ecological risk. POCIS is the first continuous sampling technology that records ultra-low levels of constituents of concern at low cost with more accuracy than any previous system. It is expected that their use will contribute towards environmental evaluations of risk, and assist with cleanup decisions, while easing concerns of both regulators and the general public.

The final report containing the results of laboratory work, the field work conducted in Santa Rosa Sound, and user guidelines is expected to be complete by press time. For a copy, contact the Principal Investigator (below) or search for "project 465" on the NESDI web site at www.nesdi.navy.mil (username and password required). ⚓

Gunther Rosen
Space and Naval Warfare Systems Command, Systems Center Pacific
619-553-0886
DSN: 553-0886
gunther.rosen@navy.mil

Annual Marine Corps Expeditionary Energy Technology Demonstration Seeks Battlefield Solutions

2015 Camp Lejeune Gathering Seeks to Accelerate Future Energy Innovations

THE MARINE CORPS will host its annual Expeditionary Energy Concepts (E2C) technology demonstration (formerly known as the Experimental Forward Operating Base (ExFOB)), June 23-25, 2015 at Marine Corps Base (MCB) Camp Lejeune, North Carolina.

E2C is the Marine Corps' innovative process to identify and evaluate energy efficient technologies that can increase the self-sufficiency of expeditionary forces. By providing industry with opportunities to demonstrate new capabilities, E2C can quickly move technologies from concept to combat.

Created by the Commandant in 2009, E2C brings together energy stakeholders from across the Marine Corps requirements, acquisition, and science and technology development communities, as well as from the other military services, to leverage ideas and resources and identify energy solutions to meet warfighter needs.

Each year, the Marine Corps invites select industry participants to E2C to demonstrate commercial technologies with potential to reduce battlefield energy and water requirements and extend the operational reach of the Marine Corps.

The E2C 2015 demonstration will evaluate technologies that enable small unit distributed operations. Specifically, E2C 2015 will focus on the following three technology areas:

1. Hybrid/electric all-terrain vehicles
2. Advanced batteries and energy storage
3. Fuel cells (up to 10 kilowatts)

Hybrid/Electric All-Terrain Vehicles

Small unit distributed operations require small, highly mobile, tactical vehicles that can travel for extended range without fuel resupply. Hybrid-electric and pure electric all-terrain vehicles offer significant fuel savings and have the potential to extend the operational reach of Marines on the move.

Advanced Batteries & Energy Storage Technology

Marines use batteries to power a wide range of equipment and platforms in training and on the battlefield. Rechargeable batteries and energy storage solutions for specific military applications that offer greater energy density than the batteries used today can lighten the carried load, help increase infantry mobility, and extend operational reach.

Fuel Cells

Fuel cells will play a critical role in reducing future fuel requirements and achieving the Commandant's aggressive 2025 energy goals to increase operational reach, improve readiness, and use only mobility fuel.

E2C is not a tradeshow. During the week-long demonstration, a team of engineers will collect data on system performance and Marine operators will provide qualitative feedback on what they see. Following the demonstration, promising technologies may be evaluated in a controlled laboratory environment and then put into the hands of Marines for field testing in combat conditions. Laboratory and field evaluation results will inform Marine Corps requirements development and may lead to future fielding.

Systems that make it through the five phases of E2C—from demonstration to fielding—can enable a more self-sufficient, combat-effective future force.

The first E2C technology demonstration (then known as ExFOB) was held in March 2010 at MCB Quantico, Virginia. The E2C process helps quickly identify and evaluate commercial technologies that reduce battlefield energy and water requirements and extend the operational reach of the Marine Corps.

U.S. Marine Corps

E2C Results "From Concept-to-Combat"

SINCE 2009, THE E2C team has:

- Conducted seven demonstrations at Marine Corps bases across the country.
- Reviewed over 300 technologies through the E2C RFI process.
- Assessed over 100 technologies at E2C demonstrations.
- Evaluated 26 systems in the laboratory/field following E2C.
- Transitioned five systems to Programs of Record.

Through the E2C process, the Marine Corps has conducted seven demonstrations at bases across the country, reviewed over 300 technologies through the E2C Request for Information (RFI) process, assessed over 100 technologies at E2C demonstrations, evaluated 26 systems in laboratory and field following E2C, and transitioned five systems to Programs of Record.

This June, subject matter experts from across the Marine Corps and other services will gather at MCB Camp Lejeune to once again test potential energy solutions that can help extend the operational reach of the Marine Corps, and ultimately, help to achieve the Commandant's energy goals.

The following five renewable energy systems, first introduced by industry at past E2C technology demonstrations (formerly ExFOB), are currently Programs of Record:

1. Solar Portable Alternative Communications Energy System (SPACES)

   SPACES is a lightweight, portable, renewable energy system designed to provide power for platoon and squad size units operating in remote locations. Marines use SPACES to recharge batteries that power communications equipment like satellite communication radios, reducing the number of batteries carried on extended patrol.

2. Ground Renewable Expeditionary Energy Network System (GREENS)

   GREENS is a portable power generation system that incorporates solar panels, energy storage, and AC/DC power sources. GREENS provides an average continuous output of 300 watts or 1,000 watts peak—enough to power a battalion combat operations center.

3. Radiant Barrier

   This shelter liner, designed for a Base-X 305 medium soft shelter, doubles the R-value (thermal resistance) of the tent. Marines use radiant barriers to keep cool air in and hot air out, reducing the number of environmental control units required in a combat environment.

4. Light Emitting Diode (LED) Lights

   LED light sets for medium soft shelters and general purpose use are more efficient than traditional fluorescent lights. Marines light their tents with these systems to keep power requirements at a minimum.

5. Mobile Electric Hybrid Power Sources (MEHPS)

   MEHPS power generation—combining batteries, solar, and smart controls with traditional diesel generators—has demonstrated up to 50 percent fuel savings and up to 80 percent reduced generator run time. The Marine Corps is working closely with the Army to develop joint requirements for and field hybrid power systems that will increase the combat effectiveness of both services.

For more information about E2C and other expeditionary energy efforts underway, visit the Marine Corps Expeditionary Energy Office's web site at www.hqmc.marines.mil/e2o.

Katie Hantson
U.S. Marine Corps Expeditionary Energy Office
703-614-4230
katherine.hantson@usmc.mil

Join SERDP & ESTCP for an Upcoming Webinar

Online Series Promotes the Transfer of Innovative, Cost-Effective & Sustainable Solutions

THE STRATEGIC ENVIRONMENTAL Research and Development Program (SERDP) and the Environmental Security Technology Certification Program (ESTCP) will continue their webinar series in 2015 to promote the transfer of innovative, cost-effective and sustainable solutions developed by both programs. The series targets end users, including practitioners, the regulatory community and researchers. The primary objective of the series is to provide end users with cutting-edge and practical information from sponsored research and technology demonstrations in an easily accessible format at no cost to the participant.

The webinars are held approximately every two weeks on Thursdays from 12:00 to 1:30 PM Eastern time. Each webinar features distinguished speakers from one of SERDP and ESTCP's five program areas:

1. Energy and Water
2. Environmental Restoration
3. Munitions Response
4. Resource Conservation and Climate Change
5. Weapons Systems and Platforms

To view the complete schedule of upcoming webinars, visit www.serdp-estcp.org/Tools-and-Training/Webinar-Series.

Webinar topics in 2015 include management strategies for contaminant source zones, the use of bio-based methodologies at Department of Defense (DoD) installations for the production of environmentally sustainable materials, acoustic methods for underwater munitions, solar technologies, bioremediation approaches at chlorinated solvent sites, blast noise measurements and community response, munitions mobility, and others.

Following the completion of each live webinar, archives of the presentation and audio will be available online.

To view the complete schedule of upcoming webinars and to access archived files of past webinars, visit www.serdp-estcp.org/Tools-and-Training/Webinar-Series.

SERDP is DoD's environmental science and technology program, planned and executed in partnership with the Department of Energy and U.S. Environmental Protection Agency, with participation by numerous other Federal and non-Federal organizations. The program focuses on cross-service requirements and pursues solutions to DoD's environmental challenges while enhancing and sustaining military readiness.

ESTCP is DoD's environmental technology demonstration and validation program. Projects conduct formal demonstrations at DoD facilities and sites in operational settings to document and validate improved performance and cost savings. Demonstration results are subject to rigorous technical reviews to ensure that the conclusions are accurate and well supported by data.

For more information, visit www.serdp-estcp.org.

Lucia Valentino
SERDP and ESTCP Support Office
703-736-4549
lvalentino@hgl.com

Navy Announces 2014 CNO Environmental Award Winners

Annual Awards Recognize Outstanding Environmental Stewardship

VICE ADMIRAL PHIL CULLOM, deputy chief of naval operations for fleet readiness and logistics (N4), announced the winners of the fiscal year (FY) 2014 Chief of Naval Operations (CNO) Environmental Awards competition.

Each year, the CNO Environmental Awards honor ships, installations, individuals, and teams for their outstanding achievements in Navy environmental programs. The FY 2014 winners, listed alphabetically within each category, are provided below.

- Natural Resources, Large Installation
  Joint Base Pearl Harbor-Hickam, HI
- Environmental Quality, Industrial Installation
  Fleet Readiness Center Southeast, Jacksonville, FL
  Fleet Readiness Center Southwest, San Diego, CA
  Naval Base Kitsap, Bremerton, WA
- Environmental Quality, Overseas Installation
  Naval Air Facility Atsugi, Japan
  Naval Hospital Yokosuka, Japan
  Naval Support Activity Bahrain
- Sustainability, Non-Industrial Installation
  Naval Base San Diego, CA
  Naval Medical Center San Diego, CA
  Naval Support Activity Monterey, CA
- Sustainability, Individual or Team
  Naval Base Coronado, CA
  Naval Supply Systems Command Fleet Logistics Center, San Diego, CA
  Navy Region Southwest Sustainable Solid Waste Program, San Diego, CA
- Environmental Restoration, Installation
  Former Naval Air Station Alameda, CA
  Naval Submarine Base New London, Groton, CT
  Portsmouth Naval Shipyard, NH
- Cultural Resources Management, Small Installation
  Naval Air Facility Atsugi, Japan
  Pacific Missile Range Facility, HI
  Portsmouth Naval Shipyard, NH
- Cultural Resources Management, Individual or Team
  Mrs. Heather Robbins of Naval Facilities Engineering Command Mid-Atlantic, Norfolk, VA
  Mr. Jeffrey Pantaleo of Joint Base Pearl Harbor-Hickam, HI
  Mr. Michael Smolek, Sr. of Naval Air Station, Patuxent River, MD
- Environmental Planning, Team
  Hawaii-Southern California Training and Testing EIS Team, Pearl Harbor, HI
  Supplemental EIS for the Introduction of P-8A Aircraft into U.S. Navy, Norfolk, VA
  U.S. Navy F-35C West Coast Home Basing Environmental Planning Team, Norfolk, VA
- Afloat
  Large Deck Combatant: USS Essex (LHD 2)
  Littoral or Amphibious Warfare: LCS Crew 102
  Submarine: USS Tennessee (SSBN 734)
  Surface Combatant: USS Dewey (DDG 105)

In a naval message announcing the winners, Cullom saluted the awardees.

"I would like to congratulate all the nominees and winners of the FY 2014 CNO Environmental Awards. Their participation in this competition exemplifies their dedication to environmental stewardship in pursuit of our Navy's overall mission. These achievements underscore that each contribution can have a tremendous long term impact in conserving our environmental surroundings and resources."

All CNO winners advance to the Secretary of the Navy level of competition.

For more information on the CNO Environmental Awards program, visit http://greenfleet.dodlive.mil/environment/awards.

Ashley Tolbert
Chief of Naval Operations Energy and Environmental Readiness Division
703-695-5116
DSN: 225-5116
ashley.tolbert.ctr@navy.mil

Navy Shore Energy Technology Transition & Insertion Program Launches First Solicitation for Needs

Deadline for Submittals is June 8, 2015

THE NAVY SHORE Energy Technology Transition & Insertion (NSETTI) program is soliciting the Navy Shore Energy community for their for installation and facility energy needs. And if you want your need to be considered in the Fiscal Year (FY) 2016 evaluation cycle, it must be submitted by June 8, 2015.

The mission of the NSETTI program is to provide solutions by demonstrating, validating and integrating reliable, cost-effective, innovative technologies, processes, and filling knowledge gaps to ensure energy security and legal compliance while increasing infrastructure, energy efficiency and mission-compatible alternative energy resources.

To submit a need to the program, visit the NSETTI program web site at www.nsetti.navy.mil.

The NSETTI program, under the Directed Energy program element, is sponsored by the Chief of Naval Operations (CNO) Shore Readiness Division (N46) and managed by the Naval Facilities Engineering Command Engineering and Expeditionary Warfare Center (NAVFAC EXWC). The program is focused on three primary objectives that influence management priorities and directly affect the program's success:

1. Collect, Validate & Rank Energy RDT&E Needs
   Expand awareness of program opportunities within the Navy shore side community to encourage and facilitate the submittal of well-defined energy needs and requirements.
2. Resolve High Priority Needs
   Ensure that program investments and the resulting projects maintain a direct and consistent link to the defined user needs.
3. Integrate Solutions & Validate Benefits
   Maximize the number of program-derived solutions that are successfully integrated into the shore side facility environment and verify that the solutions provide the anticipated benefits.

The NSETTI program seeks to meet current Navy policy, guidance and mandates through the demonstration/validation of technologies that fill identified gaps in the following thrust areas:

1. Renewable/Alternative Energy
2. Efficiency and Systems (e.g., lighting, HVAC, microgrids)
3. Energy Storage
4. Transportation and Fuels (non-tactical)

In an effort to identify ongoing challenges in the Navy shore side energy community, the NSETTI program is opening up its needs collection process. All NSETTI program decisions and investments are based on energy needs which meet the following conditions:

- Identifies an existing gap in knowledge, technology, and/or capability
- Is associated with an energy policy, instruction or mandate
- Can be categorized under one of the program's thrust areas

Anyone in the Navy may submit their needs for consideration by the NSETTI program. To submit a need to the program, visit the NSETTI program web site at www.nsetti.navy.mil then select "Needs" from the navigational menu on the left. You will be taken to the following page:

Once on the "Energy Needs" page, select "Submit Your Need Now" and you will be taken to the following page where you can actually submit your need:

In order to complete this needs submission form, you will need to enter the following information:

- Contact information for the need originator
- Title of the need
- Detailed description of the need
- Explanation of the ramifications if the need is not met
- Key Navy policy and regulatory drivers
- Suggested solutions to the need

Once you have provided all of the above information, select "Spell Check" to correct any data entry errors then select "Submit Need."

To have your need considered in the FY 2016 evaluation cycle, it must be submitted by June 8, 2015.

Once a need is submitted, it is evaluated by technical experts assembled by program management—the NSETTI Working Group (NWG). After reviewing the needs, the NWG makes recommendations to the NSETTI program manager with final review and approval from NAVFAC Headquarters, Commander Navy Installations Command and CNO leadership about which needs will move forward to the next stage in the process—the solicitation for proposals to address priority needs.

For more information about the NSETTI program and its needs solicitation process, contact Katelyn Staton at the information provided below.

Katelyn Staton
Naval Facilities Engineering and Expeditionary Warfare Center
805-982-1657
DSN: 551-1657
navfac_hq_nset@navy.mil

Tell Your Story in *Currents* • Due Date for Fall 2015 Issue Submissions is July 17, 2015

Have some good news about your energy or environmental program? Want to share it with others? *Currents* is the place to do it. *Currents*, the Navy's official energy and environmental magazine, has won first place in the Navy's Chief of Information Merit awards competition three times. And it's people like you and the stories you submit that make *Currents* the best magazine in the Navy.

So if you have a story that you'd like us to promote in our fall 2015 issue, submit your text and images by Friday, July 17, 2015. Any submissions received after this date will be considered for our winter 2016 issue.

You can get a copy of the *Currents* article template by sending an email to Bruce McCaffrey, our Managing Editor, at brucemccaffrey@sbcglobal.net. This template has proven to be a tremendous asset in helping us edit and track your article submissions. Bruce is also available at 773-376-6200 if you have any questions or would like to discuss your story ideas. And don't worry. If writing isn't one of your strengths, we'll handle all of the editing necessary to get your submission into publishable form.

As a reminder, your Public Affairs Officer must approve your article before we can consider it for inclusion in the magazine.

Don't forget to "like" us on Facebook at www.facebook/navycurrents. *Currents'* Facebook page helps expand the reach of the magazine and spread the news about all the great work you're doing as the Navy's energy and environmental guardians.

Currents Deadlines

Fall 2015 Issue: Friday, July 17, 2015
Winter 2016 Issue: Friday, October 16, 2015
Spring 2016 Issue: Friday, January 15, 2016
Summer 2016 Issue: Friday, April 15, 2016

You can also refer to your *Currents* calendar for reminders about these deadlines.

NESDI Project Studies Pier Cleaning to Reduce Toxicity in Stormwater

Technique Combines Power Vacuuming & High-Pressure Washing

A RECENTLY-COMPLETED effort by Chuck Katz and Brandon Swope of the Space and Naval Warfare Systems Command (SPAWAR), Systems Center Pacific and sponsored by the Navy Environmental Sustainability Development to Integration (NESDI) program, studied the effectiveness of power vacuuming and high-pressure washing to reduce toxicity levels in stormwater.

Navy facilities have new challenges to comply with stricter limits on copper, zinc, and toxicity in stormwater runoff. Although solutions for long-term compliance will require considerable time and/or expense, this NESDI project demonstrated that a low-tech pier surface cleaning procedure was effective at reducing metals in runoff.

The Compliance Issue

The Navy's National Pollutant Discharge Elimination System (NPDES) permits have benchmarks or numeric concentration limits for metals such as copper and zinc. These limits are designed to ensure that water quality standards are met within the water bodies that receive the discharge. Over the past 10 years, these requirements have become more stringent across the country. Many Navy facilities are struggling to comply with these limits for a variety of reasons. These include the presence of condensed industrial operations, site materials containing metals, a high percentage of impervious surfaces, a considerable amount of

High-pressure washing technology at work.

This project demonstrated and validated one such BMP—a high-pressure wash-down and vacuuming regimen.

vehicular traffic, and the fact that these facilities have very short conveyance distances to reach receiving waters. These site conditions can and do lead to relatively high stormwater copper and zinc levels and associated failed acute toxicity testing (a measure of overall water toxicity).

While other efforts are studying long-term solutions to this complex problem, this NESDI project validated the effectiveness of a high-pressure wash down/vacuum system in meeting short-term compliance requirements.

Best Management Practices

There are a number of Best Management Practices (BMP) being utilized at Navy facilities that may be effective at reducing copper and zinc to levels to meet permit requirements. However, very few of these options have been tested and validated at Navy sites to determine if they meet site-specific requirements, long-term sustainability, and cost limitations.

This project team demonstrated and validated one such BMP—a high-pressure wash-down and vacuuming regimen. This is a combination of routine power vacuuming and sweeping, and a high-pressure wash-down followed by a vacuum recovery system to remove contaminants from work areas before a rain event washes them into the water body. Various power vacuuming options using commercially available street sweepers have been utilized in the past; however no technique combining vacuuming with power washing has previously been studied.

Using commercially available equipment, the SPAWAR project team demonstrated the procedure on half of three piers at Naval Base San Diego between 2011 and 2013. The team measured the amounts of copper and zinc collected and composited from multiple random areas on the half of each pier where the cleaning was applied and compared them to the amounts collected on the other half of the pier where the BMP had not been applied. Particles were collected weekly or bi-weekly with a backpack style high-efficiency vacuum cleaner and evaluated for total particulate mass and copper and zinc concentration.

Stormwater samples were collected on both halves of the three piers to determine whether the surface cleaning was effective in reducing contaminant concentrations and toxicity below compliance requirements.

The Results

A post-demonstration analysis determined that the BMP procedure decreased the overall loading of parti-

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside (6.4) Research, Development, Test and Evaluation program. The program is sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Command out of the Naval Facilities Engineering and Expeditionary Warfare Center in Port Hueneme, California. The program is the Navy's complement to the Department of Defense's Environmental Security Technology Certification Program which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or ken.kaempffe@navy.mil.

High-pressure washing and vacuuming were conducted on one-half of the pier over a 2-year period.

The BMP procedure decreased the overall loading of particles, as well as copper and zinc levels on all three piers.

cles, as well as copper and zinc levels on all three piers under varying operational tempos. Total particulate mass was reduced between 32 and 72 percent compared to the non-BMP areas. Similarly, copper and zinc concentrations on the piers showed a reduction with the BMP implementation of between 60 and 84 percent compared to the untreated side. Copper and zinc concentrations in stormwater runoff samples collected from the BMP-treated side of the pier showed an average reduction of approximately 40 percent versus the non-BMP side.

Although a significant reduction was observed in particle, copper, and zinc loads on the piers, the reduction was not enough to consistently meet the current copper and zinc benchmarks in Naval Base San Diego's NPDES permits, nor the acute toxicity requirement.

However, the technology may be considered in conjunction with other strategies to reduce copper and zinc loading in stormwater runoff. Each facility needs to weigh the benefits for implementing this surface cleaning control practice against its cost and likelihood for gaining regulatory relief.

A technical report has been produced describing the results, costs, implementation strategies, and lessons learned for this project. It has been distributed to 29 potential end users, and is available at www.nesdi.navy.mil, or by contacting the Principal Investigator at the information provided below. ⚓

Chuck Katz
Space and Naval Warfare Systems Command, Systems Center Pacific
619-553-5332
DSN: 553-5332
chuck.katz@navy.mil

ONE OF MY Best Shots

I captured this image of a male white tail deer (*Odocoileus virginianus*) as he swam to our boat in Guantanamo Bay, Cuba. He then darted off to the nearest island.

I used a Kodak Z740 Zoom, focal length 51mm, ISO-80 at f/3.6.

Christopher Creighton ◉ Lead Environmental Protection Specialist
Naval Air Station Oceana ◉ christopher.creighto@navy.mil

Submit your own Best Shot to Bruce McCaffrey ◉ *Currents*' Managing Editor ◉ brucemccaffrey@sbcglobal.net

Matching Building Energy Use to Requirements and Occupancy

NAS Whidbey Island Ensures Energy Use Correlates with Energy Demands

PERSONNEL FROM NAVAL Air Station Whidbey Island (NASWI) in Washington State, led by Chris Taylor, Installation Energy Manager, saved over $500,000 (10.5 percent) in 2013 in energy costs, largely due to matching heating and cooling loads to actual building occupancy.

The Air Station, home to over 9,000 sailors, civilians and contractors occupying more than 280 buildings and 3.9 million square feet, was tasked with reducing utility bills by 10 percent base wide to meet Sequestration budget constraints during the period April through September 2013. They exceeded this goal by employing the following methodology:

- Identifying prospective users and matching claimed occupancy to actual occupancy.
- Using advanced metering infrastructure (smart meters) to construct building and base load profiles and measure progress.

Background

In March of 2013, naval leadership directed that due to Sequestration's significant budget cuts, utility costs would have to be reduced significantly. NASWI has the primary mission of supporting 21 aviation squadrons as well as an aviation intermediate maintenance depot and an ocean processing facility. The ocean processing facility operates much like a data center providing maritime surveillance.

NASWI has a strong energy and water conservation program in place, having won five Secretary of the Navy Platinum and four Gold awards for Energy and Water Conservation. Having achieved Energy Independence and Security Act (EISA) of 2007 goals early, NASWI sits at 37.6 percent below the energy baseline and 51.0 percent below the water baseline. A small city itself, it also supports training facilities, data centers, bachelor housing, dining, shopping, recreation, facility maintenance, a steam plant and a small hospital. Annual energy usage for the Air Station is about 460,000 million British Thermal Units (MBTU) and 88 million gallons of water. This does not include family housing—a privatized venture located about three miles away. Annual energy costs are approximately $4.9 million.

Having achieved Energy Independence and Security Act of 2007 goals early, NASWI sits at 37.6 percent below the energy baseline and 51.0 percent below the water baseline.

Navy Culture

As a military installation, all active duty squadrons and many facilities work on the assumption that 24 hour operations may occur at any time. With all support services provided by a single large contractor, many tenants believe

that once heating, ventilation, and air conditioning (HVAC) controls or temperatures are changed, they can never be reset (actual response time is two hours). This builds a culture with a common belief that one should keep a building warm/cool/ready with the lights on "just in case." In actuality, 24/7 operations are rare or sporadic. The first lesson was discerning the difference between "24/7 Operations" versus "24/7 Capable." A building that is occupied only during a normal "work week" of 40 hours is actually empty 77 percent of the time.

Facilities that do run actual 24/7 operations are comparable to data centers. Working from the old paradigm that computers need to be really cold to prevent failure, these facility managers keep their buildings as cold as allowable. Again, with no bill, and an evaluation that is based on the productivity of electronics, the mindset is to run the HVAC as cold as they can. One flight simulator building was kept at 59 degrees Fahrenheit (°F), when specifications called for an operating range of 65 to 75°F.

The Navy uses an internal working capital fund, charging a burdened rate to tenant command customers, utilizing the differential cost to fund utility sustainment, restoration and modernization efforts. While tenants are charged for utilities consumed, almost no one in the command sees "the bill;" perhaps only a financial management person at a separate location. NASWI's total annual utility budget is approximately $9.2 million; from this NASWI's share in the reduction effort was $570,000. With six months of the fiscal year in the rear view mirror, finding another 10 percent reduction in consumption would prove to be a formidable task.

Top 10 Facilities with Highest Raw Consumption

Facility ID	No.	Name	MBTU Usage
NFA100000840192	2547	FRC Facility	1,897.2
NFA100000837259	382	Admiral Nimitz Hall	1,237.8
NFA100000847943	2700	Naval Ocean Processing Facility	1,093.5
NFA100000839854	993	Hospital–Oak Harbor	940.0
NFA100000839630	976	Aircrew Systems Training Building	925.0
NFA100000837945	410	Maintenance Hangar 6	901.6
NFA100000846864	2593	Electronic Attack Simulator	791.2
NFA100000847952	2701	BRKS 13 (Mt. Rainier Building)	777.6
NFA100000848381	2738	Flight Simulator Building	701.6
NFA100000848452	2742	Commissary Store	636.0

The Methodology

In 2012, NASWI installed 493 Advanced Metering Infrastructure (AMI) smart meters allowing program managers to profile a building's utility consumption. These meters in turn aggregate data in the working capital fund's billing program called CIRCUITS (for Centralized and Integrated reporting for the Comprehensive Utilities Information Tracking System) as the central database for utility information. CIRCUITS also feeds a component of the Navy Geospatial Portal called NSGEM (for Navy Shore Geospatial Energy Module). These three tools allow Navy energy managers to examine consumption characteristics from a macro to micro level. Both NSGEM and CIRCUITS allow users to rank facilities by total energy consumption, and CIRCUITS allows users to rank individual commodities such as steam or electricity. A portion of this report is shown above. NSGEM produces a "Heat Map" based upon the facility's energy intensity measured in MBTU per thousand square feet (KSF). (See figures on the following page.)

Given that only the late spring and summer months remained to realize the utility reduction, NASWI personnel knew that only minimal savings could be had from steam heating cutbacks or efficiencies. Changing to a summer heating schedule four weeks early and setting building thermostats to a maximum heating temperature of 66°F saved $175,000 in the first month; after that, the steam was effectively off except for minimal domestic hot water production.

Since the majority of natural gas for the base was used for steam production and hangar bay heating and both of these uses were severely curtailed for the remaining portion of the fiscal year, NASWI personnel shifted their focus to electricity consumption.

Based upon examination of NSGEM and CIRCUITS ranking data, NASWI personnel discovered that the top 10 facilities at NASWI consumed 45 percent of the total electricity for the base. Although the examination of AMI meter data is both tedious and time consuming, it provides excellent resolution about a facility's energy use patterns and nearly immediate feedback on the impact of energy conservation measures.

Using CIRCUITS rankings to isolate the top 10 electrical users allowed NASWI personnel to avoid wasting time on AMI meter data for facilities that could not significantly contribute to the $500,000 goal.

NSGEM "Heat Map."

Building 2547—The Number One Consumer

The Fleet Readiness Center (FRC) is an aviation intermediate maintenance depot that provides spare parts for NASWI based aircraft. This industrial center works on such things as:

- Avionics and armament (the "600 Division")
- Open bays, tires, jet engines (the "400 Division")
- Ovens, welding, and paint booths (the "500 Division")

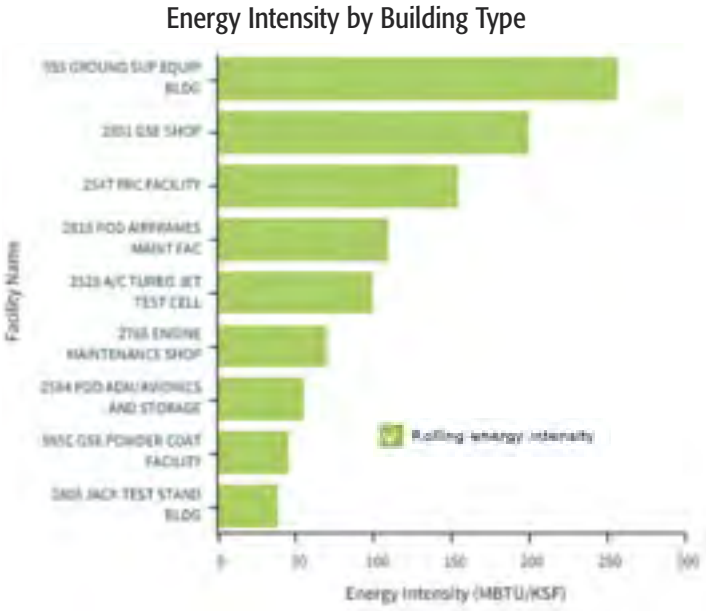
At 187,000 square feet, the FRC consumes 10 percent of the base's electricity.

NASWI personnel examined the AMI data from four meters placed on the building; two on the 600 Division and one each for the 400 and the 500 Divisions. Large HVAC loads drive consumption for the 600 Division, keeping avionics test benches cool. The avionics test benches repair aircraft electronics that are normally (in an operational environment) cooled by the very cold air of the upper atmosphere flowing through the aircraft. To test repairs on these equipment on the ground, large amounts of cold air are forced over them. These four AMI meters provided 15 minute interval data on electrical usage for each of the divisions.

The next step was to interview building tenants and facility managers to determine actual occupancy and shift times, as well as any special needs. Questions about cooling needs and operating times were met with fear and sometimes anger. "I'm not changing anything that would affect production," said one warrant officer. Others cautioned, "Don't touch the cooling system. We need this eight-degree buffer or the machines will shut themselves down!"

Any potential changes to cooling temperatures or schedules were initially met as a threat to production levels and equipment reliability, even when they weren't there. A night time audit of the 400 Division showed temperatures of 72°F on Sunday morning at 1:00 am. Interviews with 600 Division workers determined that circulation fans and pumps ran all weekend to no useful end.

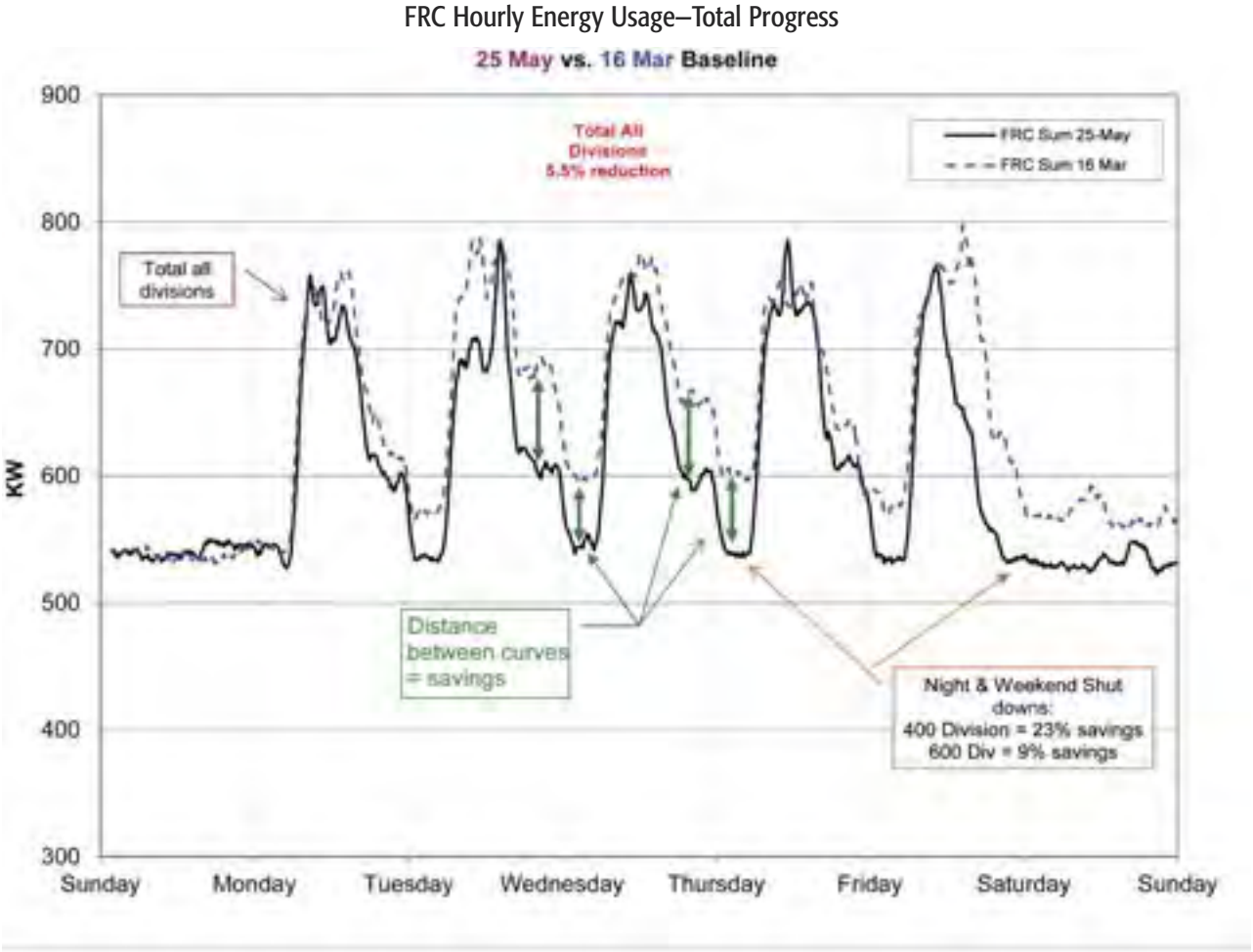
Once the actual work schedule for different parts of the building were mapped out, these schedules were programmed into the control systems by the HVAC technicians. Changes were also introduced slowly over a course of weeks. Building loads were monitored using the AMI smart meters to determine building use at 15 minute intervals.



The effect of matching actual building occupancy to HVAC scheduling can be seen in the graph below. Building load in kilowatts is shown on the vertical axis while time of day for one week is shown on the horizontal axis, beginning with midnight on Sunday. Vertical grey bars depict midnight. A baseline week of 16–22 March 2013 is shown in blue, and the comparison week of 25–31 May 2013 is shown in purple. Monday 27 May 2013 was Memorial Day, but HVAC schedules were not changed.

FRC building and divisions.

The heating degree days for both weeks were approximately the same. Reduced energy usage can be seen nearly each night beginning at midnight and lasting about six hours. This was the result of staff interviews which determined that circulation fans and pumps were running needlessly. Previously, building tenants reported shift work that ran each night until midnight for the entire building. Interviews determined that this was actually only occurring in the 600 Division, in a few rooms, Monday through Thursday. Tailoring the HVAC system to meet just the needs of those rooms on those nights further reduced energy usage. This can be seen in the differential between the blue and purple lines just before midnight. Substantial savings were found when it was determined that there was no Saturday shift. Again, the mindset was to report the shift work occurring every weekend to the support contractors who schedule the HVAC systems on the chance they may need space conditioning in the future.



Lastly, follow-up with building tenants is critical to ensure that any future changes are met with acceptance. Here, changes were well timed. When meeting with one manager after several weeks of the implemented efficiency measures, he asked "When will you start making changes to the cooling system?"

researched the existing load profile through the AMI smart meters. Knowing the building had a complex HVAC system with loads that varied throughout the building, NASWI personnel toured the spaces with the facility manager. Again, interviews indicated that building occupancy was reported on the expectation that

sometimes on Saturdays, but that the next one might be scheduled in November, four months later. It was also discovered that one of the rooms with avionics test benches that had a high cooling load was rarely being used and that the room was about 20 degrees colder than the temperature control requirement for automatic

Follow-up with building tenants is critical to ensure that any future changes are met with acceptance.

Aircrew Maintenance Training Facility, Building 976

Similarly, building 976, a 97,000 square foot maintenance training facility, has mixed aircraft maintenance training classrooms and conventional classrooms.

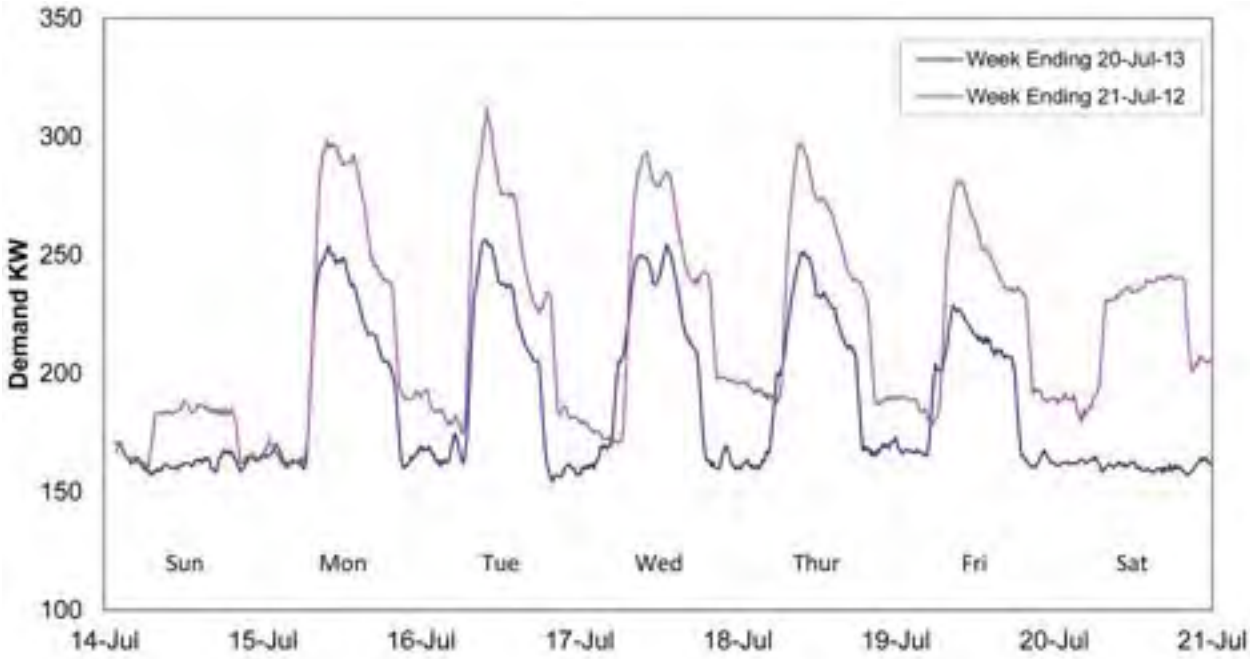
This building was identified as a top ten energy consumer through the CIRCUITS program. NASWI personnel

in the future, there would be a need for heating/cooling in the evenings or weekends. Occupants were asked when they held classes, which rooms and wings were occupied and where classes were held. Immediate answers were that they held classes until 2300 every night and on Saturdays. Additional questions revealed that this really meant they sometimes held classes after hours and

shutdown. The information gathered from these interviews was used to adjust the HVAC systems to match the needs of the facility more precisely, tailoring the time schedule to meet class needs and cooling the test bench rooms only when classes were using them.

The graph below shows the effects of these adjustments. Building load

Effect of Occupancy Matching at Building 976



Building 976 aircrew systems training.

in kilowatts is shown on the vertical axis and days of the week are shown on the horizontal axis. Load profile data from 2012 are shown in blue and 2013 data are shown in purple.

HVAC technicians also reduced the night time fan loads. Note the reductions for the weekends. These had previously been scheduled because (in effect) the tenants might have classes. Daytime peaks are reduced due to temperature changes and shutting off areas not occupied. Note also the night time reductions on the graph.

While the daily temperature was on average two degrees warmer in 2012, additional analysis indicates that the HVAC cooling loads are relatively independent of small temperature changes of this scale. On Monday 15 July 2013 the high temperature was 64, while two days later on Wednesday the high was 75 and yet the maximum demand remains within one to two kilowatts (kw). Additionally, between 2012 and 2013, NASWI personnel implemented a lighting retrofit that would account for about 18 kw in the daytime.

Follow-up with building tenants again showed no adverse effects from the adjustments to the heating and cooling schedules. Similar savings continued on subsequent weeks and months.

Conclusions & Lessons Learned

Matching building heating and cooling to actual building occupancy was shown to significantly increase energy savings. With today's tight budget constraints, gone are the days of "leaving the lights on." While the analogy to lighting is there, the impact of HVAC systems running silently in the background when no one is there is much more significant and costly. Here NASWI personnel developed a methodology to more closely match the needs of the user to the capacity of the system—methodologies that are applicable to other military installations, university and corporate campuses.

> If you're doing it right, nobody notices.
>
> *—Chris Taylor*

Summarizing the methodology employed at NASWI:

1. Use campus wide utility applications to determine the most significant energy users. Heat maps and energy rankings provide direction.
2. Profile the significant facilities to determine existing use patterns, equipment inventory, tenant operational use requirements and special needs. Smart meter data should be used to develop a baseline energy use profile.
3. Meet with facility managers and HVAC system technicians to match up existi77ng needs on a zone-by-zone basis to HVAC system programming.
4. Implement setback schedules according to the needs of the facility users, matching system utilization as closely as possible to the current schedule.
5. Verify that system changes are making an impact via smart meter data comparison to the baseline data, being careful to account for additional variables such as weather and significant building use patterns.
6. Follow up with tenants to ensure system changes are not impacting mission operations or production levels.

And, according to Chris Taylor, "If you're doing it right, nobody notices." ⚓

Chris Taylor
Naval Air Station Whidbey Island
360-257-3026
DSN: 820-3026
chris.taylor2@navy.mil

SPAWAR Validates New Tool for Quantifying Copper and Zinc in Stormwater

WinSLAMM Use Supports Development of Control Practices to Reduce Metal Concentrations

A PROJECT SPONSORED by the Navy Environmental Sustainability Development to Integration (NESDI) program recently completed the development of a modeling tool to identify source areas of copper and zinc on Navy facilities. The simple spreadsheet tool and guidance document, available this spring from the Defense Technical Information (DTIC) website at www.dtic.mil, should be used when developing and implementing control practices to reduce metal concentrations in stormwater runoff.

How Metals Form in Stormwater Runoff

Elevated metal concentrations in stormwater runoff are a serious issue in urban and industrial areas around the country. At Navy facilities, a high percentage of impervious surfaces, condensed industrial operations, and high vehicular traffic generally combine to generate runoff with relatively high particle and metal concentrations. At Navy facilities, stormwater copper and zinc concentrations commonly exceed National Pollutant Discharge Elimination System (NPDES) permit benchmarks, creating the potential for Notices of Violation and civil lawsuits.

Identifying the relative magnitude of metal sources in a drainage is a first step in determining how to best mitigate them. The NESDI project demonstrated and validated an off-the-shelf stormwater model known as the Windows Source Loading and Management Model (WinSLAMM) to quantify relative metal source areas specifically for Navy facilities. The project was performed by the Energy and Environmental Sciences Group at the Space and Naval Warfare Systems Command, Systems Center Pacific in collaboration with Dr. Robert Pitt of the University of Alabama, the originator of the WinSLAMM model.

Calibrating WinSLAMM

WinSLAMM, developed by PV & Associates, is a small-scale watershed hydrology modeling tool that has been applied to various industrial and municipal sites around the country. While widely used, the model requires the input of land-use specific data to optimize its predictive accuracy in quantifying stormwater contaminant loading. The project effort therefore focused on gathering Navy facility-specific source and stormwater parameter data to calibrate, validate, and optimize the model for Navy use.

Identifying the relative magnitude of metal sources in a drainage is a first step in determining how to best mitigate them.

WinSLAMM was successfully calibrated for Navy facilities based on a comparison of over 300 datasets and detailed site characterizations from 19 separate drainage areas at 11 bases

across Navy Regions Southwest, Northwest, and Mid-Atlantic. Each drainage area was characterized by detailing land use specifics, stormwater management, practices and stormwater conveyance systems. The characterization was done using a combination of site visits, available Geographic Information System data, and aerial photos.

The calibrations were developed using land use data along with detailed regional historical rainfall and stormwater discharge data for each site. The final regional calibrations were evaluated by comparing the model results to the historical discharge datasets.

Part of this project included a leachate study, which measured the relative amount of copper and zinc that was generated from common materials when exposed to water, a surrogate to actual runoff. The materials leaching significant copper included hull paint, galvanized and brass metal, and treated wood products. The materials leaching significant zinc included items made of galvanized metal including scaffolding, storm drain grates, stairs, building materials, and artificial turf. Charts listing these and other common sources are included in the final report.

Using the Model

It was determined that a simple-to-use spreadsheet tool would be the best method for time-pressed facility managers to implement the model. A spreadsheet tool was therefore developed from WinSLAMM that has all of the underlying calibration calculations for the three Navy regions.

Because variations in rainfall differ greatly from one geographical region to another, a spreadsheet was generated for each of the three Navy Regions where the calibration was performed. For example, the Navy Region Southwest calibration was based on San Diego area rainfall, which is generally characterized by intense, short duration storms with limited overall totals, and long dry periods. Rains in the San Diego area are characterized as being heavily seasonal with most of the rain occurring from the late fall to spring, and with a long dry period during the summer. Calibrations for regions Northwest and Mid-Atlantic were based on very different seasonal patterns. Navy installation environmental managers should follow the model that meshes most closely with the climate and rainfall patterns in their area.

Facility managers must perform a site characterization before the spreadsheet tool can be run. This is a crucial but potentially a time-consuming step to measure out the spatial extent of the site as defined by 53 pre-defined land use cate-

Example of a street/parking area with an indirect connection to the storm drain conveyance system.

The leachate report evaluated various materials for their relative contributions of copper and zinc as a result of washoff.

This roughly 1000-square foot heavy laydown area contains roughly 75 percent galvanized materials. These statistics would be entered into the WinSLAMM spreadsheet tool to identify relative sources in a drainage area.

gories, and to list all materials present. Specific guidance is provided in the project report on how to best perform the site characterization, which includes walking the site and reviewing what structural materials are present, to what extent, and how they're connected to the storm conveyance system.

The project has created a simple tool that facility managers can use to identify where and relatively how much copper and zinc are generated throughout their drainages. The tool can be used when developing strategies to implement control practices to meet compliance.

Galvanized metal leaches significant amounts of both copper and zinc.

The final report contains a table of the top 14 industrial source land uses for both copper and zinc across all three regions to provide a general overview of relative sources. The report appendices provide information on measured source strengths of many common materials found on Navy facilities, specific guidance with an example for conducting a site characterization, and the model calibration reports including candidate stormwater control practices with a measure of their potential effectiveness in each of the three Navy regions. The spreadsheet tool will be included as a CD with the hard copy of the final report and will also be available electronically. For a hard copy, contact the Principal Investigator at the information provided below. The report may also be downloaded from the NESDI program's web site at www.nesdi.navy.mil under project 455 (username and password required).

Chuck Katz
Space and Naval Warfare Systems Command, Systems Center Pacific
619-553-5332
DSN: 553-5332
chuck.katz@navy.mil

2015-16 Currents Calendar

Highlights SECNAV Environment & Energy Winners

The Secretary of the Navy (SECNAV) Environmental and Energy & Water awards return to the *Currents* calendar stage for 2015–2016. Continuing with our 18-month format, we present the winners of each of the SECNAV awards and keep you covered through June 2016.

Here are a few of the award winners that are featured in the calendar:

July 2015: USS Nimitz was recognized for its role in the first Carrier Strike Group-wide use of JP-5 biofuel. One hundred fifty-three aircraft were fueled with the JP-5 over three flying days.

September 2015: Improvements to Joint Expeditionary Base Little Creek's steam plant are significantly reducing water consumption, saving up to one million gallons per year.

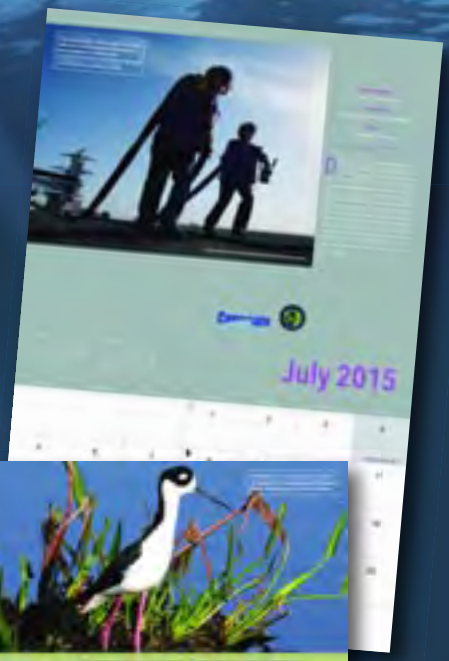
January 2016: Remediation efforts at Hunters Point Naval Shipyard reused and recycled materials, ultimately reducing costs and effects on the local communities.

As the Navy's official energy and environmental magazine, *Currents* has the privilege to share the many ways the Navy's energy and environmental personnel and Sailors work to find and implement the best techniques to achieve their goals. *Currents* provides a forum in which all of you can share your knowledge and successes with your colleagues.

You can view the calendar online at http://viewer.zmags.com/publication/b98abbbd.

If you subscribe to *Currents*, you should have received your 2015–16 calendar. If you didn't receive your calendar, contact Lorraine Wass, our distribution manager, at ljwass@outlook.com or 207-384-5249 to request a copy. And don't forget to check us out online at http://greenfleet.dodlive.mil/currents-magazine.

Thanks for all of your great work and we look forward to seeing more from you in the pages of *Currents*!



facebook.com/navycurrents
twitter.com/navycurrents
flickr.com/photos/navycurrents

Kenneth Hess
CNO Energy and Environmental Readiness Division (Code N45)
2000 Navy Pentagon, Room 2E258
Washington, DC 20350-2000

OFFICIAL BUSINESS

CHANGE SERVICE REQUESTED