THE NAVY'S ENERGY & ENVIRONMENTAL MAGAZINE

Currents

fall 2015

CARDEROCK Targets Monitoring & Control of Emissions from PUGET SHIPBREAKING

New Technologies Target Thermal Cutting Operations & Fugitive Emissions

Being Energy Smart Creates More Combat Capability: Vice Admiral Philip H. Cullom Shares His Perspectives with *National Defense* Magazine

ONR Program Evaluates Emerging Energy Technologies at Naval Facilities

China Lake Revisits Strategies to Protect Endangered Fish

ENERGY WARRIOR POSTER INSIDE!

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Currents

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cover

With resources provided by the Navy Environmental Sustainability Development to Integration program, a number of engineers from the Naval Surface Warfare Center, Carderock Division are tackling the mounting challenges posed by tighter and tighter air emission standards associated with shipbreaking processes at Puget Sound Naval Shipyard and Intermediate Maintenance Facility.

MCSN Jose L. Hernandez

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Rear Admiral Slates Bids Farewell to Navy Team

WELCOME TO THE fall 2015 issue of *Currents*. This will be my final column as the director of OPNAV N45. By the time this issue is in your hands, Rear Admiral Doug Morton will have taken over my position and I will have transitioned out of the Navy. Admiral Morton comes to N45 from the Office of the Defense Representative, Pakistan where he served as the Deputy for Security Cooperation. Prior to this assignment, he was the commander, Naval Facilities Engineering Command, Atlantic. I am confident that he will be just as impressed as I was with the professionalism and the quality of support he receives from the staff here at N45 and across the Fleet and System Commands on issues related to energy, environment, and compatibility.

I'd like to draw your attention, one last time, to some of the stories we have included in this issue of the magazine.

In our article "Office of Naval Research (ONR) Program Evaluates Emerging Energy Technologies," we introduce readers to the Energy Systems Technology and Evaluation Program recently launched by our ONR colleagues. The program is currently sponsoring 20 innovative, in-house government energy demonstration and validation projects, ranging from energy management to alternative energy and storage technologies, all of which are highlighted in this article.

Our friends at *National Defense* magazine were kind enough to let us republish an article authored by Vice Admiral Philip H. Cullom titled, "Being Energy Smart Creates More Combat Capability." A great article that gets to the very heart of why we've focused so much on the importance of energy...$E = MC^2$ (energy is more combat capability). It's all about increasing our combat capability through greater distance, more time on station, and increased payloads.

In another feature story—"Pacific Northwest Growler Training Essential for 21st Century Battles"—we provide some insights into the essential need for EA-18G Growler pilot training and the Pacific Northwest's continuing role as our Navy-wide Growler homebasing and training location. Training with this aircraft is an essential piece of our nation's defense systems and is conducted, as always, in strict accordance with environmental compliance standards.

In our "Trends of the Environment" section, we alert you to a collaborative effort underway by U.S. Fleet Forces Command, Commander, Naval Surface Force Atlantic and Commander, Pacific Fleet to conduct waterfront energy conservation training. In our article "Fleet Forces Command, Pacific Fleet Partner to Conduct Energy Conservation Training," we profile the Ship Visit program which is designed to accelerate energy culture change throughout the Fleet and, ultimately, create a more effective and efficient Navy by bringing energy conservation

In the center spread in this issue, you will find one of our "Energy Warrior" posters which you can detach and hang on the wall in your office to help us promote this campaign and recognize October as Energy Action Month.

messages, approaches, lessons, and best practices to the waterfront via tailored ship visits.

Finally, in the center spread in this issue, you will find one of our "Energy Warrior" posters which you can detach and hang on the wall in your office to help us promote this campaign and recognize October as Energy Action Month. We've also provided you with some ideas to help you save energy at the office and in your home in our "2015 Energy Action Month Inspires Cultural & Behavioral Change Across the Globe" advertisement.

Over the last three years we've been able to accomplish a lot by working together and I'd like to briefly touch on three important areas.

First, environmental planning. We've successfully completed three of our five major at-sea environmental planning efforts to ensure that our Fleet is able to train and our new systems can be tested while minimizing impacts on the environment and marine mammals. We've also developed a standardized template for our National Environmental Policy Act actions that should reduce time as well as cost, and we will continue to look for opportunities along with our regulatory partners to streamline or improve the process.

Secondly, sustaining our ability to train and test to ensure that our Navy is ready to operate forward where and when it matters. We've put in place processes to quickly identify and address potential compatibility concerns, while increasing awareness and collaboration across the Navy. We support compatible development around these key areas, and have successfully been able to mitigate impacts by aggressively working with developers early on in the planning process. One item of growing concern is the potential threat posed by foreign-owned and controlled companies and their desire to co-locate near some of our most critical ranges or under our restricted airspace which raises potential national security concerns. This is an area we will have to continue to watch and develop processes to counter when there are national security implications.

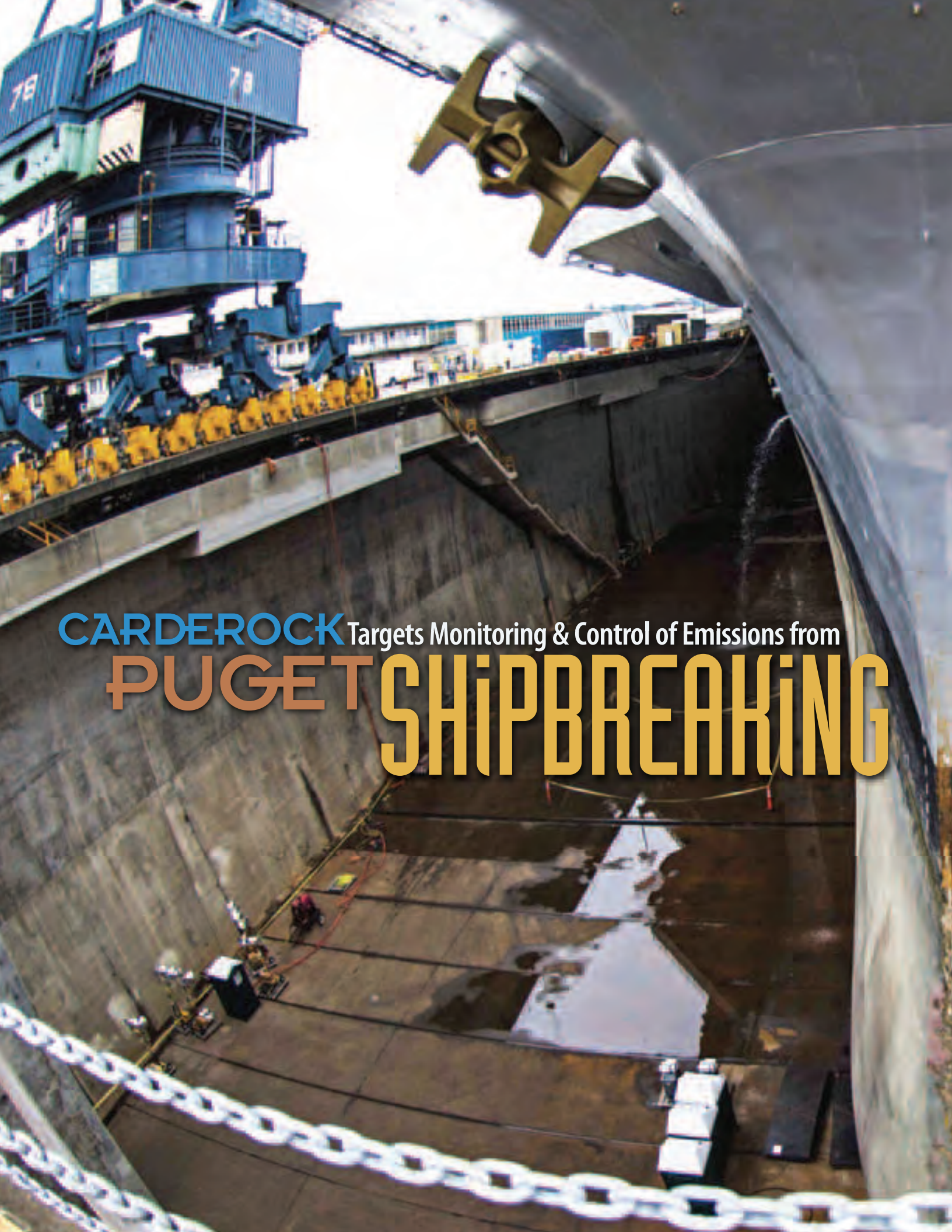
Lastly, operational energy. We've been able to increase awareness and understanding that our operational energy program is about "capability," not about being green or saving money which are also attractive secondary benefits. The real focus is and will continue to be about how we can more effectively use our energy to increase our operational capability. Whether it's a new technology that we are installing on a ship, or a revised operational procedure that allows us to do more with less fuel we need to be talking in terms of capability...additional days at sea, additional distance or endurance, or increased payload carrying capacity. Our "Energy Warrior" campaign focuses on just that and that is the message we are trying to convey to all Sailors along with seeking their input for innovative ideas of how we can do things differently to more efficiently use fuel.

I'm proud of what we've been able to accomplish as a team over the last three years and look forward to seeing our great Navy continue to lead the way in the responsible use of energy, environmental stewardship, and sustainability.

I'm proud of what we've been able to accomplish as a team over the last three years and look forward to seeing our great Navy continue to lead the way in the responsible use of energy, environmental stewardship, and sustainability. I want to thank you one last time for your continued support during my tenure at N45, and for everything you will do to help Admiral Morton continue to advance our energy and environmental programs tomorrow and for years to come. ⚓

Rear Admiral Kevin R. Slates

Director, Chief of Naval Operation Energy and Environmental Readiness Division



CARDEROCK Targets Monitoring & Control of Emissions from PUGET SHIPBREAKING

New Technologies Target Thermal Cutting Operations & Fugitive Emissions

Personnel from the Naval Surface Warfare Center, Carderock Division (NSWCCD) with resources provided by the Navy Environmental Sustainability Development to Integration (NESDI) program are tackling the mounting challenges posed by tighter and tighter air emission standards associated with shipbreaking processes at Puget Sound Naval Shipyard and Intermediate Maintenance Facility (PSNS&IMF).

When a ship or submarine reaches the end of its service life, PSNS&IMF—the Navy's nuclear shipbreaking facility—is tasked with dismantling it and turning it into scrap metal. Presently, oxygen-fuel cutting is the most prevalent method utilized for these large-scale metal cutting operations, as it is both efficient and cost-effective. Unfortunately, this process, also known as hot cutting, generates visible emissions, metal fumes and debris containing chromium, manganese, iron oxides and other metals that may pollute the air and be harmful to human health. Clean Air Act (CAA) regulations require that visible emissions not exceed a specified opacity limit, and the National Pollutant Discharge Elimination System (NPDES) program regulates the concentration of metals in discharged water.

At PSNS&IMF, the fumes generated during hot cutting have the potential to exceed the Puget Sound Clean Air Agency's (PSCAA) Visible Emission Standard—a stringent 20 percent opacity.

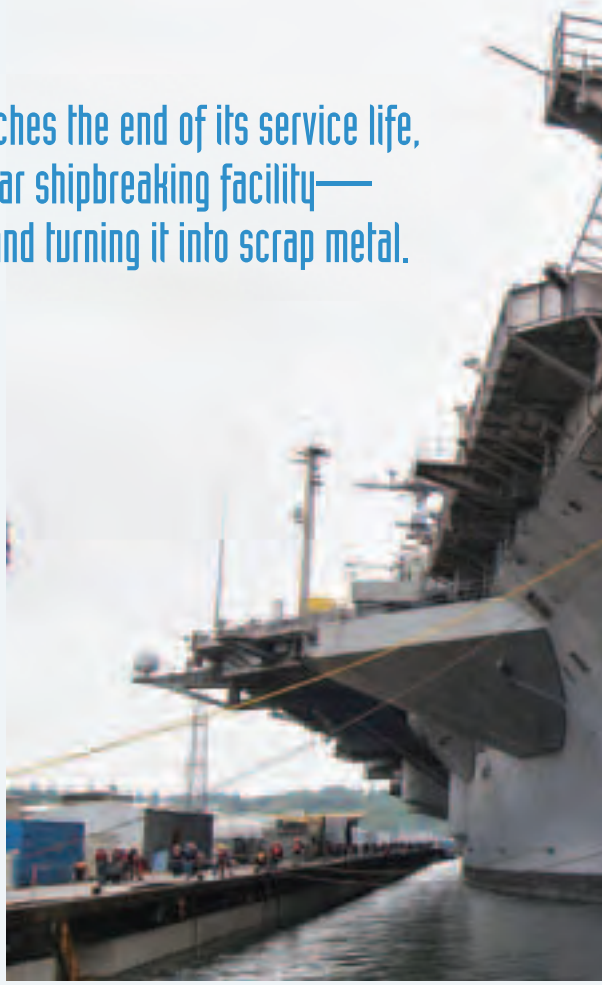
The Inactivation, Reactor Compartment Disposal, and Recycling (IRR) program at PSNS&IMF spends a significant level of effort and resources mitigating visible air emissions associated with this process.

When a ship or submarine reaches the end of its service life, PSNS&IMF—the Navy's nuclear shipbreaking facility—is tasked with dismantling it and turning it into scrap metal.

The IRR program has certified personnel to conduct visible emission monitoring using U.S. Environmental Protection Agency (EPA) Method 9, but the results provided an unacceptable margin of error, and place excessive burden on the certified opacity readers and the production personnel who rely on the timely receipt of these readings.

Therefore, PSNS&IMF has moved to using tent-like structures with ventilation to control potential visible emissions from hot cutting operations on submarines. These structures are an added cost and impediment to daily mission execution. In addition, this approach is not practical for recycling large surface ships, which cannot be tented due to their size.

An ever-increasing workload at PSNS&IMF is only compounding the problem. In addition to dismantling two submarines per year, the IRR program is currently dismantling the ex-USS Long Beach (CGN 9), an 800-foot cruiser. Another large ship, the aircraft carrier USS Enterprise (CVN 65), is scheduled for dismantling beginning in 2018. As Kurt Doehnert from the Naval Sea Systems Command (NAVSEA) stated, "These opacity abatement NESDI demonstration projects are the highest priority in our corporate naval shipyard technology program project portfolio."



The Nimitz-class aircraft carrier USS John C. Stennis (CVN 74) enters dry dock at PSNS&IMF.
Wendy Hallmark

EARLY EFFORTS

Over the last several years, numerous projects, sponsored by the NESDI and other programs, have been launched to mitigate the air emissions associated with the shipbreaking process.

The Nimitz-class aircraft carrier USS John C. Stennis (CVN 74) enters dry dock at PSNS&IMF to begin a scheduled docking planned incremental availability. The dry dock provides Sailors and shipyard workers access to the ship below the waterline for maintenance, repairs and refurbishments.
Wendy Hallmark

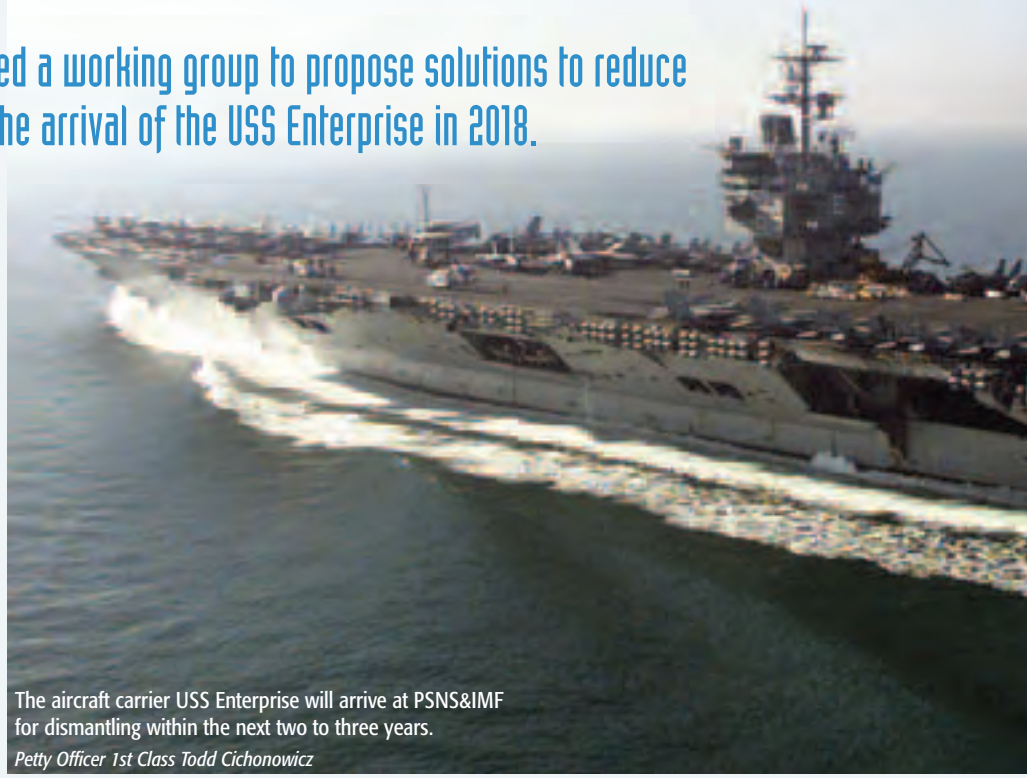
The first NESDI project, "Innovative Technologies to Control/Reduce Emissions from Metal Cutting Operations" (no. 452), an Initiation Decision Report (IDR), identified the best available alternatives to oxy-fuel cutting to bring daily opacity levels below air quality limits. The IDR was developed by NSWCCD personnel in partnership with personnel from the former Naval Facilities Engineering Service Center now the Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC). The IDR recommended the exploration of an alternative hot cutting gas, MagneGas™ to replace propane, as well as an alternative process, cold cutting, which


The hot cutting process on a submarine hull sample.

METAL CUTTING TECHNOLOGIES: HOT VERSUS COLD

A METAL CUTTING TECHNOLOGY can usually be distinguished as either cold or hot. Oxy-fuel, plasma arc, and laser are examples of hot cutting technologies. These technologies generally have high lineal cutting speed, but tend to have high levels of visible particulate matter emissions and can cause heat-affected zones that lead to re-fusion, hampering demolition work. Mechanical cutting instruments are usually synonymous with cold cutting, and are generally slower than hot cutting; however, they benefit from little or no particulate matter emissions.

PSNS&IMF personnel established a working group to propose solutions to reduce smoke emissions in time for the arrival of the USS Enterprise in 2018.



The aircraft carrier USS Enterprise will arrive at PSNS&IMF for dismantling within the next two to three years.
Petty Officer 1st Class Todd Cichonowicz

completely eliminates opacity. Two follow-on NESDI projects were initiated to demonstrate this technology.

A follow-on project, "Alternative Metal Hot Cutting Operations for Opacity" (NESDI project no. 480), performed a demonstration to test MagneGas against the current gas in use at PSNS&IMF. This effort, conducted by NAVFAC EXWC personnel, determined that the alternative fuel did not produce significantly less opacity than propane.

Another project, "Controlling Opacity During Ship Hull Cutting and Cold Work" (NESDI project no. 481), focused on a different approach to ship dismantling. Mechanical or "cold" cutting instruments benefit from little or no particulate matter emissions. However, these technologies are generally slower and pose increased risks for workers. Despite provisions for some user convenience, heavy, hand-held cold cutting tools have been linked to increased risks for repeated movement injuries. This project, also conducted by NAVFAC EXWC personnel at PSNS&IMF, has developed a prototype reciprocating saw that has the potential to minimize user risk while delivering acceptable performance. This saw is currently being modified so that it can be mobile, fully automated, and able to attach easily to the hull of a ship. For more about this project, visit www.nesdi.navy.mil and search for project number 481.

The 25-foot-long prototype test enclosure.
Jim Howell

NSWCCD personnel with funding provided by the NESDI program and the Office of Naval Research (ONR), are currently working with PSNS&IMF on two more new technologies designed to better manage thermal cutting operations and mitigate the use of containment units (e.g., tents) to collect fugitive emissions.

EMISSIONS CAPTURE TECHNOLOGY FOR OXY-FUEL HULL CUTTING OPERATIONS

In early 2013, PSNS&IMF personnel, under the direction of NAVSEA, established a working group to propose solutions to reduce smoke emissions in time for the arrival of the USS Enterprise in 2018. The working group was tasked with identifying both current surface ship breaking limitations and new technologies/requirements needed to successfully dismantle such a large vessel. After meeting with the working group, it was determined that personnel from the Plant Equipment Engineering Group would develop and test a system for surface ship bulkheads

(interior spaces) while NSWCCD personnel would address exterior hull emissions capture and ventilation.

In 2014, Plant Equipment Engineering Group personnel designed and developed an internal bulkhead system to capture emissions at the cutting source. Initial bench testing of this system showed that it successfully achieved the objectives for an easily deployable opacity control unit. Plant Equipment Engineering Group personnel are now making minor system design changes to improve the installation and durability of the system.

To capture external emissions, NSWCCD personnel designed a prototype containment shroud that can be moved by a crane or shipyard high-reach device and utilized with large ships such as aircraft carriers. The enclosure is not only designed to contain the fumes/emissions generated during cutting and welding, but also incorporates a means of deflecting the molten slag stream produced by cutting torches to the drydock floor.

NSWCCD personnel conducted two rounds of laboratory testing of the device. The goals of the first round of testing were to:

- Determine slag and smoke plume generation rates, velocities, and volumes.
- Evaluate the ability and performance of various flame-retardant materials to withstand the impact and high temperatures associated with the cutting process.
- Determine effective and practical geometries for a possible slag shield.

Based on the data received from this testing, NSWCCD personnel were able to construct and test a conceptual enclosure design made of lightweight aluminum with Plexiglass windows. The second round of testing was completed in January 2015. The objectives for this round of testing were to:

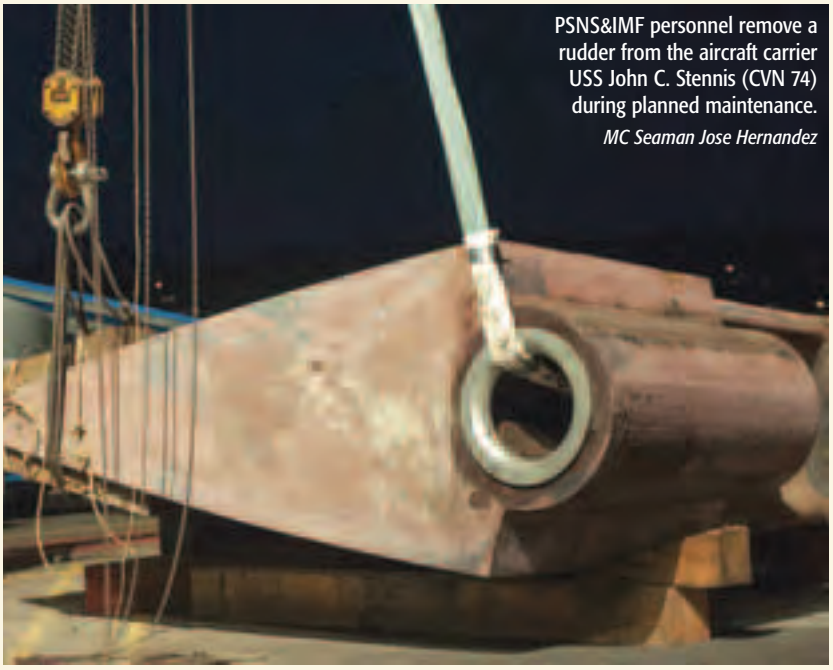
- Test air flow/blower and filter requirements to move a high volume of smoke across a 25-foot distance (the optimal "cut size" for a section of ship).
- Test the enclosure's variable air intake section at various opening distances.
- Test hot-cutting temperature threshold data (on both stainless steel and actual submarine hull section) to help determine the unit's movement scheme along the hull surface.

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 NAVFAC out of NAVFAC EWXC 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, the U.S. Environmental Protection Agency and the 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.



PSNS&IMF personnel remove a rudder from the aircraft carrier USS John C. Stennis (CVN 74) during planned maintenance.
MC Seaman Jose Hernandez

PSNS&IMF personnel remove a propeller from the aircraft carrier USS John C. Stennis (CVN 74) for maintenance.
MC Seaman Jose Hernandez

- Test a high-temperature hose's ability to withstand a molten slag stream.

NSWCCD personnel will continue to work with PSNS&IMF personnel to refine and test the external enclosure design configuration in terms of optimal size, point of exhaust, optimal materials/coatings for enclosure and deflection area, and means of portability. Full operational testing will be conducted at PSNS&IMF later in 2015.

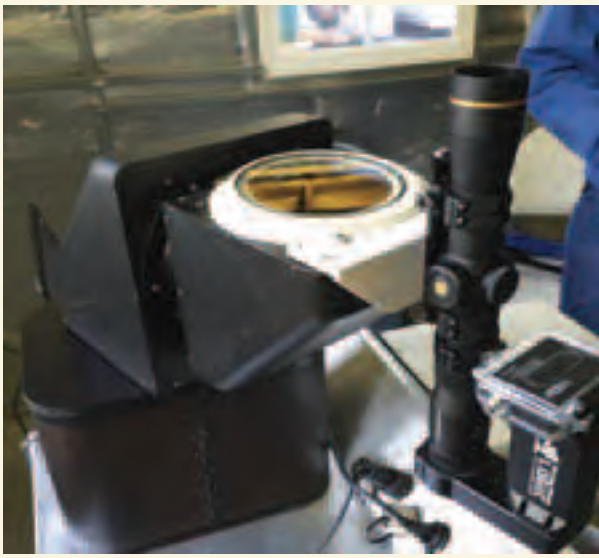
For more about this project, visit www.nesdi.navy.mil and search for project 498.

DEVELOPMENT OF A REAL-TIME OPACITY READER

The technologies traditionally used to measure opacity present their own challenges for PSNS&IMF personnel as they seek to maintain compliance with their established opacity limits. The currently accepted procedure is known as EPA Method 9. This is a visual monitoring method which depends on trained observers to measure the smoke plume. Not only is this a somewhat subjective process, Method 9 also relies on a specific set of conditions that are not always readily available in the dynamic environment of the shipyard, including ambient and background light levels as well as proximity and angle of the observer to the operation in question.

There is an available "upgrade" to the Method 9 procedure, known as a Digital Opacity Compliance System. In this system, a digital camera takes a picture of the smoke plume which is then e-mailed or uploaded to a Method 9 certified operator, who then analyzes the image, and provides the results. However, this system still holds the potential for human error, takes several minutes for results, and generates substantial paperwork.

Development of a real-time opacity monitor would circumvent these problems, without requiring the use of a containment shroud.



The Mini-MPL system consists of the laser, a 2-axis scanner for beam steering, a camera for co-registered screen capture, a weather station for surface observations, and a Global Positioning System for location information. The camera is programmed to follow the LIDAR beam to capture images of the measurement region. A sealed, all-weather enclosure contains the system power supply, cooling fan and equipment interfaces.

A goal of this project is to add an alarm to the system that would sound within 30 seconds if an exceedance of 20 percent opacity is reached.

To achieve the real-time capture of opacity information, NSWCCD and PSNS&IMF personnel are testing Laser Illuminated Detection And Ranging (LIDAR) technology. LIDAR is similar to radar in concept, using light instead of radio waves to detect obstructions and determine ranges. LIDAR works by illuminating a target with a laser and analyzing the reflected light.

LIDAR was first tested and proven to quantitatively measure smoke plume (visible emissions) in the late 1960's and 1970's, and it is currently used extensively by meteorologists, atmospheric and environmental regulators, airports and air traffic controllers, and more recently, wind farm planners.

NSWCCD personnel are teaming with Sigma Space Corp. to optimize their Mini-Micro Pulse LIDAR (MPL) for operations within the shipyard facilities environment. The Mini-MPL captures data through its camera which is programmed to capture images of smoke emission; and opacity reporting can be obtained from raw data to prove compliance. A goal of this project is to add an alarm to the system that would sound within 30 seconds if an exceedance of 20 percent opacity is reached.

The current Mini-Micro Pulse product line is designed for long range (far-field) sensing; however, opacity measurements at Navy shipyards require a short range LIDAR with a minimal blind zone of less than 100 feet. This project effort is directed at modifying and validating the Mini-MPL for drydock utilization. Once the new prototype is available, it will be tested during actual thermal cutting operations at PSNS&IMF.

EPA has determined that LIDAR is an accurate technology to measure plume opacity during all hours of the day, independent of lighting conditions or the contrast between backgrounds. This is in contrast to EPA Method 9, which requires ambient sunlight exposure to accurately determine opacity. This requirement has made Method 9 unreliable for use at ship breaking facilities. This project team is working with PSCAA and local EPA officials to gain acceptance from the EPA on the use of this method as an alternative to Method 9. As part of this effort, a custom software package was developed that follows this alternate procedure.

This technology will provide a means to reduce the burden of employing large-scale containment and ventilation solutions currently employed at Navy shipyards. With EPA acceptance, the LIDAR-based method could be incorporated into shipyard air permits as an alternative to EPA Method 9.

For more about this project, visit www.nesdi.navy.mil and search for project 516.

While PSNS&IMF is the only organization currently affected by the opacity limit, the emerging trend of increasing stringency on regulatory enforcements for environmental compliance is expected to involve more organizations in similar predicaments. The extensive work done by these project teams is available for shipyards and others who may face problems with opacity in the future.

View through the optics of the MPL during an EPA stack opacity test in Pueblo, Colorado.
Daniel Garver

OTHER NESDI SHIPYARD PROJECTS

The NESDI program is making some other investments in the safe and efficient management of other shipyard industrial processes including the proper management of cooling water and protecting oil booms from biofouling.

Managing Cooling Water

In addition to tightened limits for air emissions, shipyards are facing a similar water-related challenges. A large ship requires a constant supply of cooling water to pass through its heat exchangers and equipment to keep them functioning properly. This water, called once-through cooling water, is simply drawn from the ocean and discharged back into the sea when a ship is underway.

However, when a ship is in drydock, many of its systems remain active, requiring millions of gallons per day of cooling water, creating challenges going into and coming out of the ship's heat exchangers and other equipment.

The amount of water required for system cooling has the potential to entrain and impinge large numbers of fish, fish eggs and larvae. A new EPA rule is poised to affect cooling water intake structures at all Navy facilities. This rule requires that all intake structures be designed and operated such that flow rates through the intake screen holes are less than six inches per second. A project team from the Space and Naval Warfare Systems Command (SPAWAR) Systems Center Pacific is studying the ramifications of this new requirement under NESDI project no. 506, "Compliance Options for NPDES for Cooling Water Intake Structures at Existing Facilities." After existing intake structures are reviewed, the team will present options for achieving compliance.

Cooling water discharges typically contain heavy metals such as copper, usually in the 10–12 parts per billion (ppb) range (based on a monthly average). NPDES permit levels in Washington State are currently set at 19 ppb, but a draft permit will drastically reduce the level to 2.5 ppb in the near future. New permit levels at Pearl Harbor Naval Shipyard have also just been reduced to 3.5 ppb.

The aircraft carrier USS John C. Stennis (CVN 74) exits drydock after undergoing maintenance at PSNS&IMF.
MC3 Jordan Crouch

Two NESDI-sponsored projects have been initiated to address this problem. The first, "Design Closed-loop Cooling Water System to Accommodate Ship Cooling Water Needs" (NESDI project no. 513) is researching, evaluating and ranking various options to be compiled into an IDR. One of the most promising technologies is a closed-loop system, in which cooling water would be discharged directly into a system of pipes with no leakage into adjacent waters. This type of system would also aid in addressing a related problem, biofouling of intake water which sometimes occurs when saltwater from a harbor location enters a ship's cooling water system. This project is being conducted by personnel from NAVFAC EXWC.

FOR MORE INFORMATION

FOR MORE INSIGHTS into this NESDI project, read our article "Carderock Testing New Oil Boom Fouling Release Material: New Material Reduces Biofouling, Simplifies Cleaning" from the summer 2015 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.

One of the most promising technologies is a closed-loop system, in which cooling water would be discharged directly into a system of pipes with no leakage into adjacent waters.

A second NESDI project (no. 507) is exploring the feasibility of creating a closed-loop system based on the principals of radiant heating, a technology widely used in homes and office buildings. In this system, pipes would be embedded underground to take advantage of the ground's natural cooling abilities. The project, "Radiant Cooling for Closed-loop Water Containment" is exploring what materials would be feasible for such a system, what the layout requirements are, and whether it would be cost-effective. Team members from SPAWAR envision PSNS&IMF as an ideal first customer for this technology, should it prove viable.

Protecting Oil Booms from Biofouling

When a ship arrives in port for maintenance, a protective barrier known as an oil boom is deployed to prevent the possibility of oil migrating into the water body. These booms experience extensive marine biofouling (sea grasses, tubeworms, and/or hard-shelled organisms) when left in the water for long periods of time. This can compromise the performance of the boom. For this reason, booms need to be cleaned twice yearly at significant expense.

To help mitigate the need for frequent cleaning, the NESDI program sponsored a project (no. 489) to test a protective, silicone-based coating that has previously been used on oceanographic instrument platforms such as offshore buoys and autonomous gliders. Three prototype boom sections (with and without coating) were installed in 2014. Results of the first field test indicate that the coated boom cleaned twice as easily as the uncoated boom in out-of-water cleaning. The results were promising for in-water cleaning as well. The project team needs to complete additional cleaning and mechanical testing to qualify this boom for use.

There are approximately 300 NESDI-sponsored projects in various stages of development. Fact sheets summarizing each of these projects and detailing their goals and accomplishments are available to the public on the NESDI program's web site. Go to www.nesdi.navy.mil, select "Projects" then select the "Fact Sheet" link for the project you're interested in. ⚓

The aircraft carrier USS Nimitz (CVN 68) moors pierside at its new home port at Naval Base Kitsap Bremerton. Nimitz underwent a planned incremental availability at PSNS&IMF where the ship will receive scheduled maintenance and upgrades.

MC2 Ryan J. Mayes

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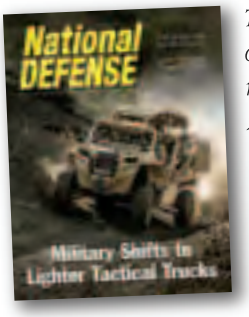
Being Energy Smart Creates More Combat Capability

Vice Admiral Philip H. Cullom Shares His Perspectives with *National Defense* Magazine



The following is a reprint of an article that originally appeared in the July 2015 issue of National Defense *Magazine. Used with permission. See www.nationaldefensemagazine.org for more information.*

ENERGY IS AT the core of U.S. Navy capabilities. Without nuclear power or liquid fuels, Navy ships cannot operate. Without charged batteries, SEALs' radios and night vision goggles are useless. Without quality fuel, aviators are grounded.

Conversely, secure energy supplies with a robust logistics train enables an enduring Navy presence around the globe.

Across the service, from operational planning to educational programs to procurement decision making, this simple truth is becoming more embedded in our thinking and actions.

Established by former Chief of Naval Operations Admiral Gary Roughead five years ago and reinvigorated by the current chief, Admiral Jonathan Greenert, Task Force Energy works to find the most cost-effective paths to improve energy security, which is the ability to assure that warfighters have the necessary energy resources when and how they require them.

While we all know that energy—in all forms—is critical for naval operations, only in the last five years have we begun to truly comprehend the significance of moving to an energy smart Navy.

Even before my days at the Naval Academy, I knew from reading history that energy mattered for military forces. In Operation Paukenschlag (Drumbeat), German U-boats targeted tankers off the East Coast in 1942.

But it wasn't just reading. As a young boy, I was riveted by my uncle's personal recollections of North Atlantic convoy duty in the early years of World War II, with ships afire at night as his destroyer escort raced to screen the rest of the convoy, dropping depth charges and hedge hogs along the way. Of course, toward the end of the war the tables were turned. Convoy duty became routine,

Vice Admiral Philip H. Cullom

The guided missile destroyer USS Mitscher (DDG 57).
MC2 Brian M. Brooks

Only in the last five years have we begun to truly comprehend the significance of moving to an energy smart Navy.

and in the Pacific, U.S. submarines had crippled the Japanese navy by cutting off fuel supplies from conquered territories.

As with all surface warfare officers, I spent a good deal of my formative time at-sea below the waterline, focused on understanding the complex engineering behind what made our surface combatants able to fight robustly. Energy—from monitoring the quality of fuel in the tanks to making sure that the electrons moved around the ship—was part and parcel of my daily life. For a long time, however, energy efficiency remained somewhat of an afterthought. The Navy's supply officers are top-notch in managing the flow of logistics and our tankers keep the ships topped off.

Like so many others, perhaps I simply assumed that this arena didn't require that much attention. I always had the fuel that I required. Energy was like air—always there and seemingly without cost to the warrior. Even as I learned how to measure fuel inventory and quality and conduct at-sea refueling evolutions, my real concern was on mastering the weapons systems and learning how to fight.

In the spring of 1998, U.S. forces stood on alert for potential military operations against Serbia to protect Kosovo civilians. My ship, the Aegis-guided missile destroyer USS Mitscher (DDG 57), was in the Adriatic Sea. Our load of Tomahawk missiles was the most rapid strike option available in theater. To refuel, we had to leave our patrol station, sometimes for eight to 12 hours, at least once a week. Refueling left the combatant commander without this capability. Not a single Sailor aboard Mitscher wanted to miss our opportunity to launch a strike due to refueling. The challenge was to minimize the risk that we wouldn't be there when the president called.

The incentivized Energy Conservation (i-ENCON) program began as a pilot program in the early 1990s. Ships that reduced fuel demand would share in the savings. The Navy did not want efforts to shave off energy demands to interfere with combat capabilities, thus the i-ENCON program didn't apply to operational environments. Many took this as a subtle signal that those energy efficiency measures weren't meant for combat environments.

With our eyes on potential combat threats in the Persian Gulf and elsewhere, the tricks to shave out fuel demand often fell by the wayside.

USS Mitscher (DDG 57).
Paul Farley

For my Mitscher Sailors in the Adriatic, we realized that i-ENCON wasn't a challenge for when we weren't worrying about combat operations but was actually a combat capability enabler.

Taking a page from the i-ENCON playbook, we began to sprint and drift when operationally feasible—a tactic adapted from an old fishing trick. We took a good look at the currents within our operating box. The navigator then charted courses so that we would steam to the edge of our operating box and ride a current down to the other end of our box.

During that drift time and depending on the tactical situation, we could manage our fuel burn by shutting down some engines. As prudent mariners, we watched traffic density and patterns; our engineers practiced rapid, reliable engine starts; and our combat systems teams drilled incessantly with the engineers in carrying out rapid responses to perceived or real air and surface threats.

My crew got so good at this that the fleet staff would radio us—"It's been four days, time to go unrep and get refueled." We would tell them that it wasn't necessary, that our tanks were still healthy in the green range. On several occasions, their incredulity required resounding tanks to convince them that we didn't need to leave station just yet.

In the end, due to this and other measures to minimize fuel use, we cut our refueling from every four-to-five days to well less than once a week. My crew's ingenuity and determination increased our operational availability, in a potential war zone, by perhaps 50 percent—while reducing demands on the strike group's logistics train and reducing fuel costs.

This was an epiphany deployment for me—the moment that light-emitting diode (LED) light bulb truly went off. Paying serious attention to energy in the operational environment is a path to reduce risks while delivering more combat capability. Part of that realization also involved a window on the networked complexity of the Navy's energy system. Aboard Mitscher, we played the hand we were dealt. As her captain, I couldn't modify her hull, change her engines or install more efficient heating and cooling systems to reduce fuel demand and increase endurance. That great warship resulted from decades of experience, technical development, and procurement decisions. But we did have a choice in operating that same equipment in a deliberately innovative manner.

In reality, however, choices in the operational environment can only go so far.

This requires a Navy-wide strategic focus on energy, as pursued by Task Force Energy, in collaboration with U.S. Fleet Forces and Pacific Fleet. Starting with targeted research and development by the Office of Naval Research (ONR), detailed engineering analysis at systems commands and then evaluation on our ranges, these promising energy projects reveal their expected lifecycle cost and a

Sailors aboard the USS Mitscher (DDG 57) line up after an underway replenishment and refueling at sea.
MC2 Anthony R. Martinez

combat edge. Our training and education programs benefit from them as well.

We have several initiatives under way. The Naval Air Systems Command is working on the "intelligent engine demonstrator" which has an objective not just to squeeze more power out of every drop of fuel but to deliver and manage electricity more effectively to the aircraft's systems, which could include directed energy weapons.

A critical energy enabler is finding more energy dense battery options to support unmanned underwater vehicles. Battery power is a key limiter to operational endurance. This effort—spanning across the Department of Defense, the Department of Energy and private industry—has had solid results that will enable far more capable unmanned undersea vehicles by the end of the decade than many thought possible even a few years ago.

The Defense Production Act (DPA) assists developing drop-in biofuel plants and refineries, capable of producing advanced second-generation biofuels at cost-competitive prices for the Navy-Marine Corps team. DPA funds capital investment of companies that will drive down the price of military-grade biofuel. Three companies—Emerald Biofuels, Fulcrum BioEnergy and Red Rock Biofuels—were awarded phase two contracts in September 2014 to construct commercial-scale, integrated bio-refineries to produce alternative military specification fuels that are cost-competitive with conventional petroleum. Production begins in 2016 at an estimated cost of $3.45 per gallon, below the current price of $3.61 per gallon for F-76 and $3.64 per gallon for JP-5.

Many think this move is just about being green. Green it may be, but more powerfully it diversifies our energy portfolio and provides liquid aviation and maritime fuel that is consistently at, or cheaper than, the price of conventionally derived petroleum. That may allow us to train more to become better warriors or facilitate use of this resource for other readiness needs for the Navy.

Off in the far distant future, ONR is working on a program to make fuel from seawater. If this seems like fantasy, an unmanned aircraft has already flown with the fuel. We know it works, at least on a very small scale. The challenge is to develop a cost-effective path so that someday every strike group is making its own fuel and we can finally cut the fuel umbilical cord. This won't be the Navy of 2025 but could be a reality in a few decades.

And most recently, several energy companies have publicly announced the pursuit of fusion with plans to field a compact fusion reactor prototype within three years and potential initial production in a decade. If these initiatives are successful, it's possible that the Navy will not only have installations but ships powered by compact fusion reactors. Energy may then become the resource for propulsion and sensors as well as the weapon itself.

It is our Sailors who will unlock and unleash the ideas of this energy culture change and marry them with new efficient technologies.

The research, development, testing and evaluation program spans from these large-scale game changers to specific technology advances that are being leveraged now. For decades, Navy researchers have been involved with solid-state lighting and LEDs. Uncertainty about performance in the maritime environment, combined with steep upfront costs, has limited the applicability to our acquisition programs. However, we now understand these systems far better, and the purchase costs have plummeted. With each passing day, LEDs are providing high-quality lighting to ever more Sailors operating at the tip of the spear.

Across our acquisition programs, from the major platforms to LED lighting, analysis is playing a key role. We want to understand trade-offs. Costs are not just monetary but include training time, implications for maintenance, inventory control and, most importantly, uncertain impacts on the operational environment. Benefits are also complex and not just financial.

We will only move forward if we have confidence that the benefits, especially in operational capability, outweigh any costs. This analytical effort ranges from including energy as a "key performance parameter" in major acquisition programs—seeking to assure that the program incorporates the most effective use of energy—to financial analysis of how fast an energy efficiency measure will provide a financial payback.

The reality is that, in a great number of cases, the returns are far better than what investors see from Wall Street. The Navy is adding stern flaps to an increasing number of platforms. The stern flap reduces drag and allows the ship to move more efficiently through the seas like a spoiler on a sports car. Financially, these stern flaps pay for themselves in less than two years. More importantly, the few percent of fuel savings translates to greater range.

One of Task Force Energy's great realizations is that our best payoffs don't always come from big silver bullets but from the cumulative value from a range of silver BBs. Stern flaps save a few percent of fuel demand. Putting an energy dashboard on the bridge, with detailed information on energy performance, enables more informed decisions and cuts another percent. The Navy is deploying a navigation aide that, when the operational environment allows, automatically leverages ocean currents to advantage for, again, a percent or two greater efficiency across the surface fleet. A percent here and a percent there begin to add up to serious numbers.

Some larger payoff opportunities do exist. These include the hybrid propul-

The amphibious assault ship USS Makin Island (LHD 8).

Sailors and Marines man the rails aboard the USS Makin Island (LHD 8).
MC2 Alan Gragg

sion system, which is moving into additional platforms after an extremely successful performance in the USS Makin Island (LHD 8) amphibious assault ship. Some nickname Makin Island the "Prius of the Seas." Simply put, at lower speeds and while in holding patterns, she uses an auxiliary engine to generate electricity efficiently for propulsion and reserves the gas turbines for higher speeds.

Too much of the discussion around Makin Island has focused on the fuel savings as a monetary payoff. While the ship is saving money by using far less fuel, far more important is that its fuel savings equate to 50 additional underway days a year, or 17 percent longer operational endurance without refueling. This same technology is available for smaller surface combatants like DDGs where they too, particularly in a ballistic missile defense role, spend significant time in a cruiser-destroyer holding pattern. The first retrofit of those DDGs will make its debut in 2016 and forward fits make an even more compelling case.

Opportunities exist to improve understanding of energy issues and become more effective in our use of energy. It is our Sailors who will unlock and unleash the ideas of this energy culture change and marry them with new efficient technologies. The Naval Postgraduate School's energy master's degree program develops officers with the detailed analytical skills to understand the complexity of energy issues and support internal Navy decision making to determine the best investments moving forward.

Throughout the Navy, energy awareness sessions provide education regarding energy smart measures—from turning off light bulbs to the importance of assuring that pumps are operating efficiently—that will both save money and strengthen the force. Whether the surface fleet's i-ENCON or the Aviation Energy Conservation Program, our operating forces are being incentivized to find paths toward more effective and efficient use of energy in ways that will not adversely affect mission performance or safety. In fact, in a surprisingly large number of situations, these measures actually improve mission performance and safety. And we've recently established the Energy Warrior digital app as a tool to communicate across the fleet, especially with young Sailors, about how everyone in the Navy enterprise—from the civilian engineer at a base to the Sailor deployed forward—can find ways to be ever more effective in the management and use of energy.

The Energy Warrior program, in part, seeks to recognize those across the Navy who have had their LED moments and who perhaps have discovered paths to reduce non-mission essential energy demands amid an operation and thus increased endurance and helped foster sharing of those lessons and methods across the Navy. They're figuring out how, just as we did on Mitscher, to more effectively play the energy hand they've been dealt.

My job as deputy chief of naval operations for fleet readiness and logistics is to stack the deck for today's and tomorrow's Sailors by providing platforms and systems with greater capabilities than our adversaries, across the entire conflict spectrum. Our training programs—from Top Gun to energy awareness classes—seek to create a team that can play that hand to the maximum.

Energy is one of the Navy's most critical enablers while potentially representing the most significant vulnerability to adversaries. Taking energy seriously in our research programs, acquisition, education and training reduces those vulnerabilities and enhances our strategic, operational and tactical advantages. It is time for all of us to positively disrupt our energy future for our 22nd century Sailors. ⚓

Power.Presence.

2015 Energy Action Month Inspires Cultural & Behavioral Change Across the Globe

Worldwide, naval commands are participating in Energy Action Month by taking action to reduce energy consumption, disseminate information on energy efficiency and Navy-related initiatives, and inspire a cultural shift of greater energy awareness.

President Obama declared October as Energy Action Month in a 2012 proclamation to encourage Americans nationwide to collectively achieve energy security through smart energy conservation practices. The objective of Navy Energy Action Month is to promote cultural and behavioral change that facilitates energy security and operational capability.

The Department of Defense (DoD) is the largest consumer of energy in the United States and the greatest institutional consumer of fossil fuels worldwide. DoD constitutes 92 percent of the U.S. government's energy consumption. The Navy accounts for 28 percent of the DoD's total petroleum consumption. Fleet operations exhaust 84 percent of the Navy's overall energy usage. These consumption rates underscore how vital energy is to the Navy's mission. Diversifying the Navy's energy portfolio significantly reduces vulnerabilities and boosts mission capability to maintain an omnipresent force.

Deputy Assistant Secretary of the Navy for Energy Joseph Bryan explains, "We are a driver for energy solutions, pushing innovation and building partnerships that advance the Navy's goal of optimizing energy use to enhance combat capability and energy security."

The Navy will promote Energy Action Month with electronic displays and posters illustrating Navy energy programs and initiatives. Energy Action Month also provides a great opportunity to highlight how each Sailor and Navy civilian can take concrete steps to save energy while on duty during missions, in the workplace, and at home.

"Opportunities exist to improve understanding of energy issues and become more effective in our use of energy," said Vice Admiral Philip H. Cullom, deputy chief of naval operations for fleet readiness and logistics. "It is our Sailors who will unlock and unleash the ideas of this energy culture change and marry them with new efficient technologies."

From an operational standpoint, the Navy has made great strides to maximize fuel and energy efficiency. Across the fleet, the Navy is installing light-emitting diode (LED) lighting following a directive from Secretary of the Navy Ray Mabus. Ships are utilizing stern flaps to decrease drag, turbulence and hull resistance. Crews are using an Energy Dashboard's real-time measurements to gain situational awareness of the ship's overall energy consumption. For more examples of job-specific energy saving factsheets, visit http://greenfleet.dodlive.mil/energy/energy-action-month.

See the opposite page for other steps that can be taken on the shore side, in a home or in an office. For a complete list of energy saving tips, follow the coverage on our Task Force Energy Facebook (https://www.facebook.com/NavalEnergy) and Twitter (https://twitter.com/NavalEnergy) pages throughout the month of October.

What are you doing to save energy? What does energy resiliency mean to you? Join the conversation at #NavyEnergy. And for more information and resources, visit the Navy Energy Action Month webpage at http://dld.bz/energy-action-month.

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What are you doing to save energy?

Energy Action Month IDEAS

Plant Trees

Plant a well-positioned tree that provides adequate shade to reduce overall household energy consumption by up to 25 percent. It can also serve as a windbreaker during winter months to reduce wind chill.

http://energy.gov/energysaver/articles/tips-landscaping

Drive Responsibly

Avoid aggressive driving to get the best fuel efficiency out of your vehicle. Rapid accelerations, speeding and hard braking can all lower fuel efficiency by up to 33 percent (highways) and five percent (cities). Minimize speeds above 50 miles per hour, as gas mileage at faster speeds drops significantly.

http://energy.gov/energysaver/articles/tips-saving-money-gas

Choose the Right Cookware

Use flat bottom cookware to allow more contact with the heating element. Warped bottom pots can use 50 percent more energy to boil water. Copper bottom pans heat up faster than regular pans. Glass and ceramic dishes also heat faster and can allow the oven to be turned down 25 degrees. Keeping cookware clean will ensure the reflective material can effectively heat the food.

http://energy.gov/energysaver/articles/cooking-some-energy-saving-tips

Upgrade Appliances

Upgrade older appliances to Energy Star efficient products. These products are certified as energy efficient and can often qualify for tax rebates. The Energy Star website lists appliances for all home and office appliances.

www.energystar.gov/products

Keep Blinds Closed

Close blinds and curtains during the day in the summer to prevent heat from increasing temperatures inside. During winter, keep blinds and curtains closed at night to keep the heat inside.

www.facebook.com/nassigonella/posts/10153527112813336

Operate Appliances with Full Loads

Run washing machines and dishwashers with full loads to ensure efficiency and no wasted water or heat on light loads. Washing by hand actually uses more water.

www.facebook.com/USNavalStationRota/posts/10153431485389241

Swap Fluorescents for LEDs

Switch to energy efficient lighting, including LEDs and motion sensors to avoid lighting rooms that aren't occupied. LED lights use 50 percent less energy and last up to five times as long as conventional fluorescent lights.

www.navy.mil/submit/display.asp?story_id=86532

Unplug Unused Electronics

Disconnect electronics when not in use. Many electronics draw power even when they are not in use or switched off. These are often referred to as "vampire loads" which can add $200 in energy costs for the average home annually. Remove battery chargers when not in use as they can draw as much as five to 20 times more energy than what is stored in the battery.

www.facebook.com/NSABahrain/posts/1015206791847567

Optimize Thermostat Setting

Adjust thermostat settings in the winter to 68 degrees Fahrenheit (°F) during waking hours at home. Lower the temperature during sleep and when away. Lowering the thermostat 10 to 15 degrees for an eight-hour time period can result in a five to 10 percent savings on an annual heating bill. The thermostat should ideally be set to 78°F when at home in the summer for best efficiency.

http://energy.gov/energysaver/articles/thermostats

Take Shorter Showers

Shower in five minutes or less to conserve water and energy to heat the water. Soap with the water off and then turn the water back on to rinse. Five minute showers use less energy and water than a full bath. For a standard shower head, every minute in the shower equals 2.5 gallons of water.

www.washingtonpost.com/news/energy-environment/wp/2015/03/04/your-shower-is-wasting-huge-amounts-of-energy-and-water-heres-what-to-do-about-it

Wash Clothes with Cold Water

Use cold water and cold water detergent to save on energy used to heat water. Water heating typically accounts for 90 percent of the energy used for washing clothes. Have you washed a load of clothes with cold water? How did it compare to using hot water?

http://energy.gov/energysaver/articles/tips-laundry

Diving Headfirst into Naval History

Navy Archaeologists Conserve & Protect Underwater Wrecks Around the World

ARCHAEOLOGISTS FROM THE Underwater Archaeology Branch (UAB) of the Naval History and Heritage Command (NHHC) work tirelessly to conserve and protect thousands of ship and aircraft wrecks around the world.

It was a simple pottery jar with cork in it. But when NHHC's UAB team eased the cork out of it, the gust of air that escaped was nearly 200 years old—perhaps created by the organic material it had stored on the sloop-rigged floating battery Scorpion before it was scuttled on August 22, 1814.

Robert Neyland, UAB director, doesn't always get to work in such rarified air, but that was just one of many remarkable moments of his career in managing one of the lesser known, but widest-reaching organizations in the Navy.

The branch headquarters and laboratory are tucked away in the many historic buildings at the Washington Navy Yard. And just like the shipwrecks the branch monitors and manages, it takes a map and a little inside knowledge to find them.

But within its offices are the people who conserve and protect the more than 17,000 ship and aircraft wrecks around the world, its collection of more than 3,000 artifacts recovered from sunken military craft sites, and an artifact loan program of 6,000-plus items to national and international museums and other qualified facilities throughout the world.

For More Insights

FOR MORE INSIGHTS into UAB's efforts to unearth the Scorpion–a gunboat that was scuttled nearly 200 years ago in the Patuxent River–read our article "Raising the War of 1812: USS Scorpion May Be Part of Bicentennial Celebration" in the winter 2013 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.

The branch itself was created in 1993 through the Department of Defense (DoD) Legacy Resource Management Program. Robert Neyland followed soon after. Neyland, a native of Palestine, Texas, earned his doctorate and master's degrees in anthropology at Texas A&M. So what did it take to get this Texas boy out of Texas? Mixing his love for diving with archaeology.

Protecting Underwater Grave Sites

Diving into the murky waters of rivers can be as cloudy as navigating government regulation. That's why one of UAB's responsibilities includes arranging for permitting authority for the Department of the Navy under the 2004 Sunken Military Craft Act (SMCA).

serve as war graves, safeguard state secrets, carry environmental and safety hazards such as oil and ordnance, and hold significant historical value.

The SMCA provides that U.S. government-owned military ships, aircraft and spacecraft remain the property of the government, no matter their condition,

It's not a "finders-keepers" situation if divers recover artifacts from or around wreck sites.

He's traveled the world, diving some of the world's oldest shipwrecks. His scientific expertise and experience in management led him on assignment from Texas A&M to the Naval Historical Center in 1994 to help the Navy develop policies and a program in underwater archaeology. The work was so intriguing he left Texas A&M and became a federal government employee in 1996.

Neyland's Navy work has taken him to dives on Revolutionary War ships in Maine, surveys of World War II wrecks off the beaches of Normandy, France, and rare downed aircraft under the waves off the Marshall Islands. He's led the Navy archaeology team seeking the resting site of the World War II submarine USS Pompano, which sank somewhere off the coast of Japan.

Diving for archaeology, however, isn't always in pristine recreational areas such as the waters of the Caribbean or Mediterranean Seas.

"The visibility for diving isn't that great in harbors and rivers," Neyland said. "But we dive where the wrecks are."

The SMCA was enacted on October 28, 2004. Its primary purpose is to preserve and protect from unauthorized disturbance all sunken military craft that are owned by the United States government as well as foreign sunken military craft that lie within U.S. waters. These wrecks represent a collection of more than 17,000 fragile, non-renewable artifacts that often

age or location. Still, Neyland said the law was written in the public interest to protect grave sites, and preserve the nation's and Navy's history, while at the same time providing non-intrusive access to wrecks for the diving public. The permitting process UAB manages even allows for excavation at the sites for archaeological, historical, or educational purposes.

For More Information

FOR MORE INFORMATION about the SMCA, visit www.history.navy.mil/research/underwater-archaeology/sunken-military-craft-act.html.

"When there is an intentional violation of the SMCA, the Navy can impose penalties—a unique responsibility within the Navy," Neyland said. "Many of these wrecks are burial sites of U.S. military personnel and war graves. The Act applies equally to U.S. military ships lost today as it does to the earliest examples lost by the Continental Army and Navy during the American Revolution."

It's not a "finders-keepers" situation if divers recover artifacts from or around wreck sites. Just recently, a trumpet taken from the site of USS Houston was returned to the Navy, but had suffered degradation after its removal from the marine environment and exposure to the atmospheric oxygen. The UAB archaeology and conservation laboratory is working to mitigate that damage now. USS Houston sank in the Java Sea after intense fire from the Japanese fleet during the Battle of Sunda Strait February 28, 1942.

"The public expects that the Navy will look after theses wrecks as archeological sites and as war graves," said Neyland.

"Laws and ethics do not keep up with the advances in technology that allow for deeper dives and locating wrecks. The Navy's wrecks are no longer protected by immersion in the marine environment," Neyland said. "In many ways, these are like undiscovered islands, but which are already titled as U.S. property and are distributed worldwide."

But with those remains may also lay environmental issues still buried with the wreck, such as oil, ordnance and weapon systems better left to experts rather than civilian divers. UAB personnel work with numerous other Navy commands to recover or protect Navy artifacts, like the Explosive Ordnance Disposal (EOD) units, Seabees, Judge Advocate General Corps and Naval Criminal Investigative Service.

But the branch is also often the starting point for outside organizations, such as the National Oceanic and Atmospheric Administration, U.S. Environmental Protection Agency, U.S. Army Corps of Engineers, cities and states, plus a slew of foreign navies and their governmental agencies. They also work with veterans associations and universities.

When fragments from a human jawbone were found embedded in the concreted outer layer covering a 32-pound cannon recovered from CSS Alabama, UAB worked with forensic scientists from the DoD Central Identification Laboratory to recover information such as the age range of the deceased and determined that the individual was probably a European sailor serving on the ship. This complements the historical records which reveal that while the officers were Southern Confederates, most of the crew were European.

Kate Morrand, archaeological conservator for NHHC's Archaeology and Conservation Laboratory, cleans artifacts recovered from the wreck of USS Huron, which sank in a storm off the coast of Nags Head, North Carolina in 1877. The artifacts were removed from the wreck site without permission in the 1960s, and require considerable conservation treatment to stabilize them.

MC2 Gina K. Morrissette

An NHHC archaeological team prepares to store a section of a late 19th century Howell torpedo in a desalination bin. The torpedo was discovered by a team of Navy dolphins off the coast of San Diego and is scheduled to undergo months of restoration at the Washington Navy Yard.
MC2 David Cothran

Training Future Archeologists

The mission of UAB is unique, and so are the professional opportunities it offers. The department has a robust intern program, now offering 13 internships a year through colleges, universities, and fellowships, including the Naval Research Laboratory, Naval Research Enterprise Internship Program (NREIP), National Research Center and the Science, Technology, Engineering and Math (STEM) program.

"This is quite the place for internships," Neyland said. "Out of 300 applications for summer internships, 39 specifically asked to work here."

Having such a strong intern program—they have had 57 interns so far—is one way to keep the department thriving as it trains the next generation of archaeologists, conservators, scientists, engineers, and policy makers. Neyland encourages the students to push for longer internships, at least through an entire semester. "It provides valuable work experience to the interns, exposure to career choices, and provides useful service to the Navy," Neyland said.

One of those who turned that internship into a career is Kate Morrand, head of UAB's Archaeology and Conservation Laboratory. In 2008, she had just moved to the Washington, D.C., area after earning a post-baccalaureate degree in Conservation of Fine Art and Archaeological Material from Studio Art Centers International, Florence, Italy.

The letters "USN" appear near the edge of a section of a late 19th-century Howell torpedo. The torpedo was discovered by a team of Navy dolphins off the coast of San Diego and is scheduled to undergo months of restoration by a NHHC archaeological team.
MC2 David Cothran

"This opportunity as an intern was different than others I've had," Morrand said. "You're very much treated like a new employee—using your particular skill set that was hand-picked from the applications received."

"Your work matters, whether it is researching documents, answering questions, or writing policy to see if it is relevant to the site we are working," Morrand said. "In some places, the opportunity to do conservation as an intern is not made immediately available.. But since most of the interns already have advanced degrees or have worked with the materials, UAB had the confidence to let us work on the collection right away."

Preserving the Past Helps the Navy Today

While the time and effort to preserve a pair of 18th century iron scissors from the effects of concretion might seem a luxury during a time of tight budgets, the lessons learned from conservation may be used to mitigate corrosion and deterioration on future ships and aircraft.

"Research on how to better preserve the hulls of USS Monitor and H.L. Hunley may also be used for modern materials, including those used by the DoD," Neyland said.

Already, UAB research has helped determine the impacts of explosions on ships and submarines. Improved technologies in diving may also be used in the military, salvage and engineering disciplines, such as allowing Navy divers to see in zero visibility and uses for underwater remotely operated vehicles and sensor packages. The technology used for logging and mapping out wrecks may be used to provide predictive modeling for oceanography.

"Underwater archaeology is dependent on advances in technology but it also pushes the science and technology forward with the research questions it asks, and its multi-disciplinary solutions can have benefits to the military and private sectors," Neyland said.

This piece of art was painted by the 20th Century artist Xanthus Smith. The 1922 artwork depicts the sinking of the Confederate ship CSS Alabama after her fight with the USS Kearsarge (seen right). Alabama was the scourge of the American merchant fleet during a two-year commerce destroying campaign before being sunk during a battle with the Kearsarge in June 1864. American archaeologists and French Navy divers recently recovered a bell from the famous Confederate commerce raider from its resting place 180 feet below the surface of the English Channel off the coast of Cherbourg, France.

Courtesy of the Franklin D. Roosevelt Library

A 32-pound cannon recovered from the wreck of the Confederate sloop-of-war CSS Alabama is seen at the NHHC laboratory warehouse. Alabama was built for the Confederate States Navy and served as a commerce raider, attacking Union merchant and naval ships during the Civil War. Alabama was sunk on June 19, 1864 during a battle with USS Kearsarge off the coast of France.

MC2 Kenneth G. Takada

Overflowing Bucket List

The UAB has no shortage of projects. They continue artifact recovery from well-known shipwreck sites, such as CSS Alabama, CSS Georgia in the Savannah River, and searching for the wreck site of the submarine USS Pompano that sank with all of her crew off the coast of Japan in September 1943.

Conservation work continues on the Howell torpedo found in July of 2013 after being alerted by two Navy-trained dolphins of something buried on the ocean bottom in San Diego.

This summer, Alexis Catsambis, UAB archeologist, will hunt for the wreck of the Bonhomme Richard off Flamborough Head near Yorkshire, England. The Continental Navy warship, commanded by the legendary John Paul Jones, was shattered during the ship's 4-hour battle with HMS Serapis on September 23, 1779. Despite his sinking ship, Jones refused to surrender to Serapis' commanding officer with his infamous: "Sir, I have not yet begun to fight!" After Jones took command of the captured British ship, the Bonhomme Richard sank September 27, 1779.

And as for that 1814 air from that pottery jar from USS Scorpion, remnants were captured and stored for future examination into what that jar might have held as part of the Chesapeake Bay Flotilla sunk in the Patuxent River during the War of 1812.

"These military wrecks are also a means of interpreting the history of the services. Other benefits to DoD also include public education, particularly as awareness pertains to the history and mission of the services and the role the military plays in the past, present and future in protecting the country," Neyland said. "Discovery of a military wreck—in the case of the missing-in-actions, the resolution for family members—captures the public's imagination and raises that awareness. This occurs in the normal process of complying with our management mandate." ⚓

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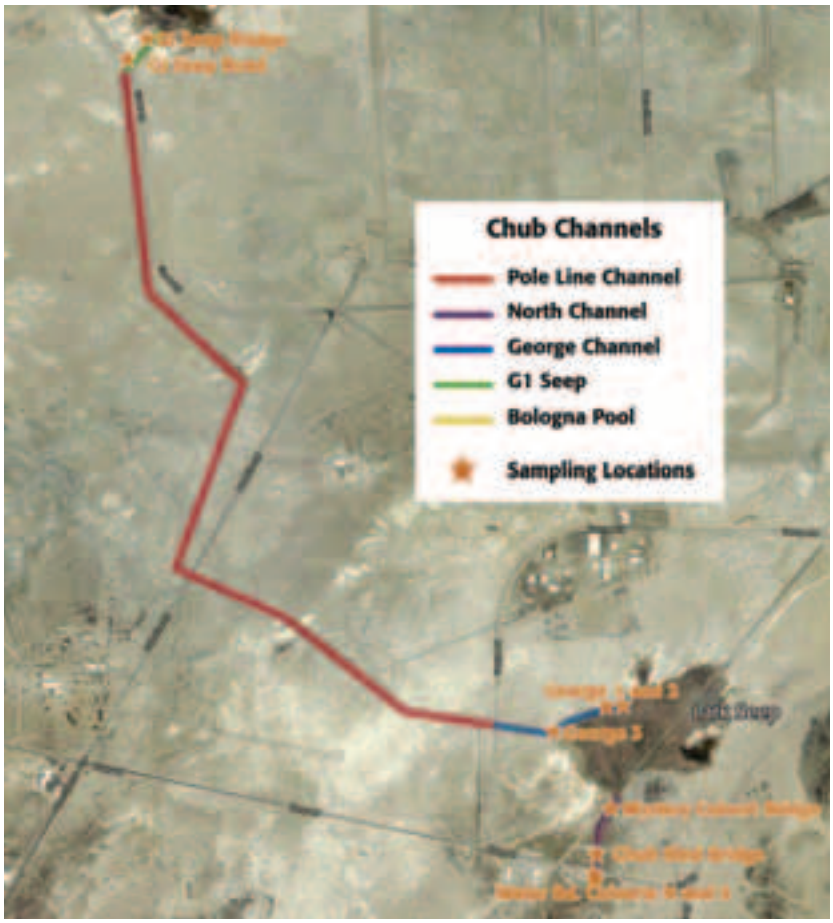
China Lake Revisits Strategies to Protect Endangered Fish

Partnerships Benefit Survival of the Mohave Tui Chub

AFTER A CLOSE call with a rare species, personnel from the Naval Air Weapons Station (NAWS) China Lake and its partners revisited strategies to improve the habitat of the Mohave tui chub and its future.

NAWS China Lake is the largest naval installation, comprising over a million acres and 43 percent of all Navy land. It is also home to the largest and most genetically diverse population of a rare, federally-listed, endangered fish called the Mohave tui chub (*Siphateles bicolor mohavensis*). The fish, which is now extinct within its native Mojave River habitat due to habitat alteration and hybridization with the introduced arroyo chub, lives in a system of constructed channels on the installation, and at only four other off-installation locations near the Mojave River. Management of this vital population has come with its own challenges. Partnership and collaboration have proven to be effective tools in overcoming such challenges, and continue to be strategies to reduce future costs and efforts for conservation of this rare species.

The NAWS China Lake population is the only one remaining from a 1972 translocation project in which the U.S. Fish and Wildlife Service (USFWS) moved genetically pure Mohave tui chub from the Mojave River to fourteen locations in an effort to establish refuge populations to save the species. Considering the fact that much of the installation lies in the Mojave Desert, it's a bit of a surprise that there is enough water to support a fish in the arid land-



scape. The China Lake Mohave tui chub habitat is located within the installation's largest body of surface water, a roughly 2.5 mile-long network of manmade channels that ultimately drain into flatter marshy areas. During the 1950's and 1960's, the channels were created to divert groundwater away from roads and facilities. As a result, water currently flows downstream from the Bologna Pool, located near Lark Seep, through the North Channel. Water also appears to flow through a large area of cattails that separates the North Channel from George Channel, through George Channel and further downstream. It eventually flows into G1 Channel and G1 Seep, marking the end of the channel system.

Key components of China Lake's Mohave tui chub management strategy have included habitat management, particularly cattail removal, in concert with population and water quality monitoring. In 1997, the North Channel was deepened and widened to improve habitat quality and prevent cattail overgrowth. In other channel areas, cattail must be regularly removed to maintain water flow, which helps to maintain dissolved oxygen levels the fish need for respiration. These levels, as well as temperatures, conductivity, and pH, have been recorded during water quality monitoring efforts. Population monitoring has included abundance surveys, which show population trends over time. In addition to providing valuable long term data, monitoring results can also signal any alarming changes occurring in the system.

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Mohave Tui Chub History

MOHAVE TUI CHUB (*Siphateles bicolor mohavensis*) are the only fish native to the Mojave River in California. Related to minnows, adult fish can range in length from four to nine inches. (Note: The name of the fish follows the Native American spelling while the name of the river does not.)

The federal government first included them on an endangered species list in 1970. As with many endangered species, the Mohave tui chub populations have been affected by habitat modification, as well as exotic species. Arroyo chubs (*Gila orcutti*), introduced into the headwaters of the Mojave River in the 1930's, reached Mohave tui chub habitat and interbreeding resulted in a hybridized chub. As noted in the USFWS's 1984 recovery plan, by 1970 there were no longer any genetically pure Mohave tui chub remaining in the river. A genetically pure population, however, was discovered in Soda Springs, which includes Lake Tuendae and Mohave Chub Spring.

The recovery plan specifies the recovery level for downlisting, from endangered to threatened, as six self-sustaining populations of at least 500 fish each. Efforts to expand the populations have included transplanting individuals from some of the remaining Mohave chub populations to other potentially viable locations. The Lark Seep population at China Lake was introduced in 1972 and 1976. The fish population subsequently expanded into the North, George and G1 channels in the Lark Seep system.

Few of the other populations transplanted during the 1970's survived. Continuing efforts to establish populations in new areas have resulted in only five currently existing populations–Soda Springs, Camp Cady, Morning Star Mine, Lewis Center, and NAWS China Lake. The populations at China Lake have maintained a strong genetic make-up and have the largest number of fish.

LEFT PAGE, TOP ROW: George Channel in 2012, before an excavator removed cattails; 2012 cattail excavation effort; Some cattails were left in the channels to leave the chub with cover and protection from predators.
MIDDLE ROW: Some vegetation regrowth has occurred since the 2012 excavation effort; Targeted manual cattail trimming has been successful at managing cattail growth in the North, George, and G1 Channels.
BOTTOM ROW: Lark Seep; A biologist trims cattails in the channels. This helps maintain water flow through the channel system.

THIS PAGE, TOP ROW: Surveyors collect elevation, water depth, and topographical information during the 2014 channel hydrologic mapping project.
MIDDLE ROW: An unusually large Mohave tui chub is weighed during population monitoring efforts; Fish length and weight are recorded for every chub captured and subsequently released; Chub are briefly held in containers before and after measurements are taken.
BOTTOM: G1 Channel in 2015, after excavation efforts restored water flow to the channel.

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This type of routine water quality monitoring of the channels in July of 2012 revealed a severe drop in the water level at G1 Channel. The water surface had dropped inches below the culvert that connects the flow within the G1 Channel to the rest of the channel system. The lack of water flow, combined with warm summer temperatures significantly increased the evaporation rate, further lowering the water level and depleting dissolved oxygen levels. This process threatened the survival of a significant number of chub stranded in small pools within the drying channel.

Responding to the situation, personnel from the NAWS China Lake's Environmental Management Division (EMD), the USFWS, and the California Department of Fish and Wildlife worked together on a plan to save the large number of stranded fish. The EMD staff conducted an intensive emergency effort to trap and relocate chub from the stagnating G1 Channel to the North Channel which still had a high water level. Over the span of three consecutive nights, approximately 1,400 chub were successfully relocated.

The team succeeded in eliminating the immediate threat to the stranded fish, but it was clear that the cause of the emergency also needed to be identified and addressed. While routine manual cattail removal efforts had been successfully managing cattail growth in the known chub habitat areas, areas with steep banks that prevent safe entry for manual cattail removal had become crowded with cattails. Evapotranspiration occurring in the large masses of cattails seemed to be contributing to the severe reduction in water flow through the channel system. With the help of Naval Facilities Engineering Command (NAVFAC) Southwest staff in San Diego and NAWS China Lake's Public Works Division (PWD), the EMD was able to secure funding and equipment to promptly address the problems immediately posed by the excessive cattail growth. PWD and EMD personnel worked together to excavate the channel areas outside of known chub habitat and remove excess cattail growth. This effort quickly restored water flow for chub living throughout the entire Lark Seep System, and also led to the discovery of additional suitable chub habitat. Since then, the G1 Channel has consistently held water throughout the year. While fundamentally successful, the effort was expensive and time intensive. Maintenance efforts in the inaccessible channel areas would likely only become more difficult over time, so new strategies needed to be developed.

George Channel, following manual cattail removal. Implementing effective habitat management strategies is necessary to efficiently maintain Mohave tui chub habitat within the channels.

In 2013, in order to minimize potential future costs, NAWS China Lake EMD personnel focused their resources on developing a strong foundation for future work. It again collaborated and partnered with federal and state agencies, and the NAVFAC Southwest Regional Office to address current and future Mohave tui chub management and conservation needs. Two priority goals were defined:

1. Collect hydrology data to support informed management decisions regarding the fish's habitat on the installation.

2. Develop a long-term habitat management and population monitoring strategy.

All agreed that subject matter expertise must be integrated into the process to ensure that the best available scientific information would guide the effort.

As plan implementation got underway in 2014, EMD personnel and supporting contractors initiated hydrology studies while continuing to collect water quality data. They deployed automated data loggers to record continuous temperature data, along with dissolved oxygen levels, in three important areas of the channels known to support chub. These data will provide important information on the channel system's dynamics. For example, water quality patterns throughout the year can be compared with environmental factors such as rain events, drought, and other significant weather patterns. Determining how weather affects the chub in those three channels areas throughout the year will help guide management efforts, including how to conduct habitat management and population surveys during optimal conditions to minimize environmental stress on the fish.

As part of the hydrology studies, hydrogeologists and surveyors began mapping the channel system. They first installed long-lasting survey markers (benchmarks) in the Lark Seep System area for the most accurate channel measurements. Next, the team worked in areas with dense cattails, mapping channel topography, including the banks, channel bottom, and water depth. They studied surface water flow volume, velocity and direction and recorded culvert locations and dimensions. Water samples from the channels and wells located around the entire Lark Seep System were collected to study water chemistry, including metals and chemical compounds. These data, in combination with previous research on hydrology and chub physiology, will help NAWS China Lake personnel better understand how the water flowing into and through the Lark Seep System could be affecting the fish.

Partnership and collaboration have proven to be effective tools in overcoming such challenges, and continue to be strategies to reduce future costs and efforts for conservation of this rare species.

In December 2014, a team of biologists met in Ridgecrest, California to discuss the history and future of the Mohave tui chub at NAWS China Lake. Biologists from the Installation, NAVFAC Southwest's Desert Integrated Product Team (IPT), the USFWS, and the California Department of Fish and Wildlife met with staff from the supporting contractor, AMEC Foster Wheeler, and subject matter experts from Colorado State University and the private sector. Participants worked together during the workshop to consolidate important information needed to develop science-based strategies for Mohave tui chub management and conservation on the installation. Drawing on the group's wide-ranging expertise, the participants analyzed chub biology, natural history and ecology; population survey methods; invasive species; monitoring and sampling strategies, including genetic techniques; and overall priorities and goals for future efforts.

The meeting results are being used to develop strategies to create a sustainable, science-based, and efficient management and monitoring plan for NAWS China Lake's Mohave chub population. The installation plans to begin implementing these strategies in the fall of 2015. ⚓

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The Basics About China Lake

NAWS CHINA LAKE provides quality shore-based infrastructure, base operating support services, safety and security, range and airfield support to the Navy's Research, Development, Acquisition, Test & Evaluation (RDAT&E) mission, Navy training capability, and other fleet and fleet support activities. Nearly every significant Navy and Marine Corps airborne weapon system in the past five decades was developed and/or tested at China Lake. Included in this mission is the significant environmental stewardship of approximately 1.1 million acres, covering all aspects of natural, cultural, and historic resources.


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Fleet Forces Command, Pacific Fleet Partner to Conduct Energy Conservation Training

"Ship Visit" Program Designed to Accelerate Energy Culture Change

U.S. FLEET FORCES Command (USFF) has partnered with Commander, Naval Surface Force Atlantic (CNSL) and Commander, Pacific Fleet (CPF) to conduct waterfront energy conservation training. The Ship Visit program is designed to accelerate energy culture change throughout the fleet and, ultimately, to create a more effective and efficient Navy by bringing energy conservation messages, approaches, lessons, and best practices to the waterfront via tailored ship visits.

USFF's Navy Operational Energy Program, which was chartered under Task Force Energy in 2008 by the Chief of Naval Operations (CNO), is focused on making energy efficiency a routine part of fleet routine.

"Our goal is to get up close and personal with fleet Sailors so that we can have honest conversations about energy conservation," said Commander Daniel "Heed" Orchard-Hays, USFF's Operational Energy Section Head. "Going ship to ship gives us the opportunity to thoroughly understand the concerns of each crew, and helps us in the process of figuring out how to decrease our energy consumption while getting the job done."

The Ship Visit program conveys the urgency of energy conservation by providing the tools for culture change, sharing best practices, raising awareness, and providing an opportunity to tour shipboard spaces with the Chief Engineer. In short, its objective is to empower Sailors to become Energy Warriors. (For more insights into CNO's Energy Warrior program, visit visit http://greenfleet.dodlive.mil/energy/energywarrior.)

> Our goal is to get up close and personal with fleet Sailors so that we can have honest conversations about energy conservation.
>
> *–Commander Daniel "Heed" Orchard-Hays*

"We constantly ask ourselves if we're really doing everything we can to make a difference." said Harold "Hank" Viado, USFF's Fleet Energy Initiatives Project Manager. "If we constantly challenge ourselves, we'll keep improving. By making conservation an integral aspect of what we do, both underway and in port, we'll ultimately make the Navy more capable and operationally ready."

As Sailors now realize, energy conservation plays a key part in making and keeping the fleet ready.

Secretary of the Navy (SECNAV) Ray Mabus' established energy goals, which he first articulated in 2009, are a key driver of the Ship Visit program. These goals are incredibly important to the Navy's long-term effectiveness and efficiency, so the Ship Visit program focuses on creating a culture where Sailors routinely operate their ships and systems in the most energy-efficient mode, unless circumstances dictate that they do otherwise. In other

The guided missile destroyer USS Cole (DDG 67) was one of the first participants in the newly-established Ship Visit program which is designed to bring energy conservation messages, approaches, lessons, and best practices to the waterfront via tailored ship visits.

words, the Navy has shifted from "Save energy if you can" to "Save energy unless you can't."

The fleet's surface and aviation communities are its two biggest consumers of fuel. Accordingly, the Navy is working diligently to track and reduce their fuel consumption by identifying, developing, and codifying operational procedures. This will allow operators to meet their tasking while reducing their overall energy consumption—thereby helping to achieve SECNAV's energy goals.

"The idea of achieving established Navy energy goals requires sustained waterfront energy conservation—not only in port, but underway as well," noted Orchard-Hays. "We won't get there based on technologies and advanced alternative fuels alone. Improving waterfront energy conservation requires fostering and sustaining desired behavior. And that starts at the deckplate level."

A primary way of achieving and sustaining this evolved energy culture involves establishing ship class energy consumption baselines, which can show a given ship's crew how they stack up against their peers. The results of these comparisons can motivate crews to identify and correct over-consumption and, ultimately, to share their practices with others.

"When we show a crew what other ships are doing to conserve energy, and highlight the benefits of that behavior, we inspire them to be better," remarked Viado. "Sailors want to do their jobs as well as they can, and we arm them with the ammunition that they need to help them improve."

While the U.S. Navy continues to be the most powerful force afloat, making every reasonable effort to save energy helps the fleet to retain its warfighting edge. ⚓

TOP: LT Rick Campbell, Chief Engineer of USS Cole and CNSL representatives Mike Gaffney and Jim Romeo pause at one of the ship's air conditioning plants. The ship's three air conditioning plants cool the entire ship, consume the most energy behind the ship's propulsion plant, and offer a large potential for energy savings.

BOTTOM: USFF and CNSL personnel conduct an energy awareness ship visit on USS Cole (DDG 67). Part of the Ship Visit program includes identifying energy saving opportunities while touring various ship spaces. During a stop in the engineering central control station, LT Rick Campbell explains to USFF representative Hank Viado and Jim Romeo how Cole monitors electrical usage.

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ONR Program Evaluates Emerging Energy Technologies at Naval Facilities

Energy Systems Technology and Evaluation Program Seeks to Increase Energy Security

THE OFFICE OF Naval Research (ONR) has launched an ambitious program to demonstrate and evaluate energy technologies using Navy and Marine Corps facilities as test beds, known as the Energy Systems Technology and Evaluation Program (ESTEP).

ESTEP focuses on energy technologies that reduce costs, increase energy security, and ultimately increase the reach and persistence of the warfighter. The entire program encompasses the following investment areas:

- Cyber and Energy Management for Information Systems
- Power and Energy Components
- Power and Energy Production/Efficiency

ESTEP, established in fiscal year 2013, is casting a wide net across the Department of the Navy, academia, and private industry to investigate and test emerging energy technologies at Navy and Marine Corps installations. At present, ESTEP conducts over 20 in-house government energy projects, ranging from energy management to alternative energy and storage technologies. Additionally, an ESTEP Broad Agency Announcement has awarded several contracts to industry in those same energy areas.

In addition to testing and evaluating performance and reliability of energy technologies, ESTEP provides mentoring (via on-the-job training and education of interns) and other workforce development opportunities by partnering with the Troops-to-Engineers program for veterans at San Diego State University and other universities. "Workforce and professional development are key components of ESTEP and integral to the success of executing and transitioning energy technology projects at naval facilities," said Dr. Richard Carlin, director of the Sea Warfare and Weapons Department at ONR as he highlighted the essential elements of the program.

ONR provides funding and oversight for ESTEP, and program management is being handled by the Space and Naval Warfare Systems Command (SPAWAR) Systems Center Pacific (SSC Pacific). The Naval Facilities Engineering and Expeditionary Warfare Center (NAVFAC EXWC) and the Naval Postgraduate School (NPS) are executing selected research projects, and every project plans to involve at

> Workforce and professional development are key components of ESTEP and integral to the success of executing and transitioning energy technology projects at naval facilities.
>
> *–Dr. Richard Carlin*

least one intern utilizing the ESTEP grant under the Troops-to-Engineers program. Students at NPS will also assess the business side of energy technologies, analyzing the costs, savings and return on investment of different efforts.

Speaking about this unique partnership, Rear Admiral Patrick Brady, SPAWAR commander, said, "The Navy benefits from the internship of highly motivated and talented individuals supporting our Navy's energy and energy management research projects. Likewise, our returning veterans gain valuable experience working in their future career field while they pursue their engineering degrees."

The purpose of the ESTEP effort is to identify viable emerging energy technologies, obtained for the most part from open-market sources and in-house government demonstrations. Technologies identified as promising by ESTEP will be demonstrated, and data will be collected to evaluate the performance and reliability of selected technologies under various environmental and operating conditions.

The Asia-Pacific Technology and Education Program

A program with similar goals in the Pacific region is the Asia-Pacific Technology and Education Partnership (APTEP), centered in Hawaii. This program was formed as a response to Hawaii's historically high energy rates and dependence on fossil fuel, and facilitated by plentiful sun and wind resources and by the local government's motivation to explore alternative energy. Though centered in Hawaii, this ONR-sponsored program has the ultimate goal of facilitating energy technologies that will benefit naval facilities and the nation.

APTEP takes a three-pronged approach:

1. Supporting cutting-edge energy research.
2. Educating students and teachers in energy-related fields.
3. Providing seed money to companies with promising technologies in the renewable energy field through its Energy Excelerator program.

Dr. Carlin is looking for ways to connect ESTEP with APTEP, such as linking SPAWAR with the University of Hawaii/West Oahu to include student veteran participation. The office is also exploring opportunities for Energy Excelerator company products to be used in ESTEP projects.

For more insights into APTEP visit www.aptep.net.

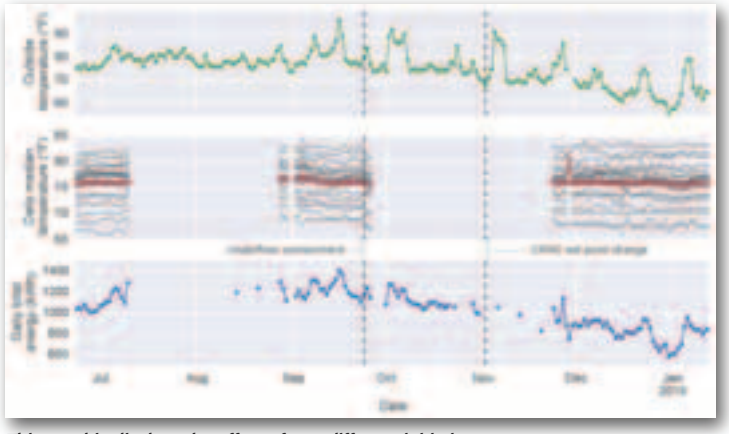
ESTEP Projects

Here is a snapshot of ESTEP projects past and present.

Data Center Smart Metering

Because data centers consume large and growing amounts of electricity, this project is aimed at reducing energy use through the use of smart metering.

Principal Investigator: Daniel Grady, Ph.D., SSC Pacific, daniel.grady@navy.mil, 619-553-2793



This graphic displays the effect of two different initiatives, underfloor cold-air containment and climate control set point adjustments, on the daily total energy used by the data center's chiller plant (bottom), ensuring that the required temperature inside the Information Technology room was maintained (red line), and correcting for external air temperature. Underfloor containment did not improve the efficiency of the system, but adjusting set points resulted in approximately $6,000 per year in energy savings.

Cyber Supervisory Control and Data Acquisition (SCADA) Capability Evaluation

This program, of special interest in the developing energy management industry, tests for vulnerabilities in a SCADA network.

Principal Investigator: Jose Romero-Mariona, Ph.D., SSC Pacific, jose.romeromariona@navy.mil, 619-553-8119

Cyber-SCADA Evaluation Capability (C-SEC) on the Move

C-SEC on the Move will leverage the C-SEC framework and tools in order to provide a mobile user experience, allow for a more diverse repository of evaluations and further integrate security and return on investment estimations.

Principal Investigator: Jose Romero-Mariona, Ph.D., SSC Pacific, jose.romeromariona@navy.mil, 619-553-8119

Virtual Smart Grids for Net Zero Capability

This program is demonstrating a virtual smart grid to manage and achieve net-zero energy goals at the regional scale.

Principal Investigator: Eric Evans, SSC Pacific, eric.evans@navy.mil, 619-553-1597

Seamless Integration of Geographic Information Systems (GIS) and Electrical Architecture Models for Smart Grids and Net-Zero Energy Goals

Using commercially available software for electrical engineering and the model built under the ESTEP Virtual Smart Grid project, this project team will integrate the model into the Navy's GIS program.

Principal Investigator: Eric Evans, SSC Pacific, eric.evans@navy.mil, 619-553-1597

Optimization Tool for Hybrid Energy Systems

This project is evaluating storage solutions for renewable energy by analyzing energy data and developing an optimization energy management strategy. The specific area being investigated involves hydrogen generation and storage.

Principal Investigators: Andrew Higier, Ph.D., SSC Pacific, andrew.higier@navy.mil, 619-553-2769

Jonathon Oiler, Ph.D., SSC Pacific, jonathon.oiler@navy.mil, 619-553-5844

Energy Efficient Cloud Computing Evaluation and Demonstration

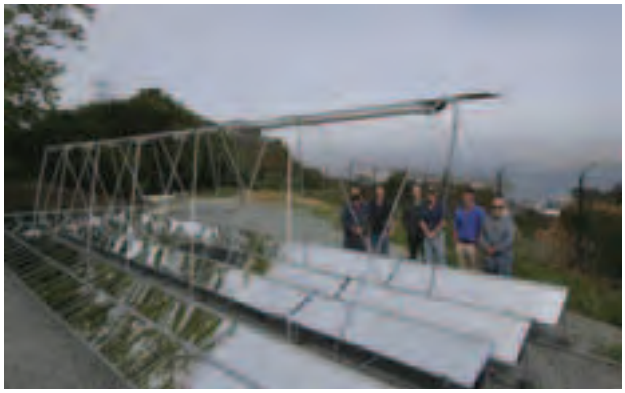
The goal of this project is to improve the energy efficiency of the Navy's cloud computing architecture.

Principal Investigator: Chris Chen, SSC Pacific, chris.chen@navy.mil, 619-553-6852

Deep Subgrid-parity Solar

This project is aiming to dramatically lower the cost of photovoltaic (PV) panels by fabricating and installing a prototype design that is lighter weight, easier to install and more efficient than current technology.

Principal Investigator: Randall Olsen, Ph.D., SSC Pacific, randall.olsen@navy.mil, 619-553-8713



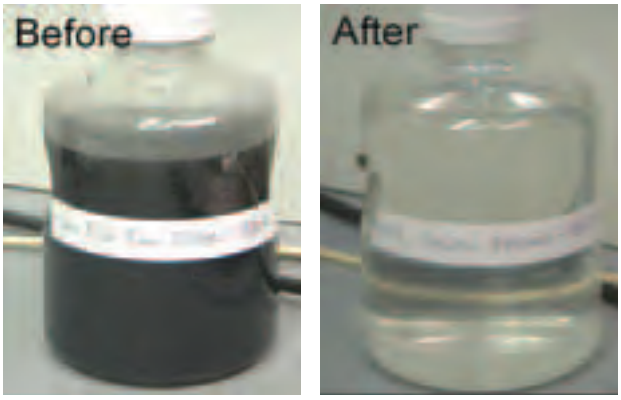
The Deep Subgrid-parity Solar project team with a prototype design.

Energy and Water Recovery by Microbial Fuel Cells

This team is exploring the possibility of utilizing microbial fuel cells to treat wastewater. (A microbial fuel cell is a bio-electrochemical system that drives a current by mimicking bacterial interactions found in nature.)

Principal Investigator: Lewis Hsu, Ph.D., SSC Pacific, lewis.hsu1@navy.mil, 619-553-4934

Pilot scale (100-gallon) microbial fuel cell reactor system operating in spill containment bins.
Orianna Bretschger



Samples of raw wastewater (left) and treated, clean effluent (right).
Orianna Bretschger

Microbial fuel cell reactor system before placement into secondary containment bins.
Orianna Bretschger

Radio Frequency Identification (RFID) Reading Outlets for Device Level Granularity in Building Energy Control

This project will install RFID tags on device plugs, conserving energy by enabling power to be turned on or off remotely.

Principal Investigator: Wayne Liu, SSC Pacific, wayne.liu@navy.mil, 619-553-1900

Marine Corps Base Hawaii Energy Management Evaluation Seed (Completed)

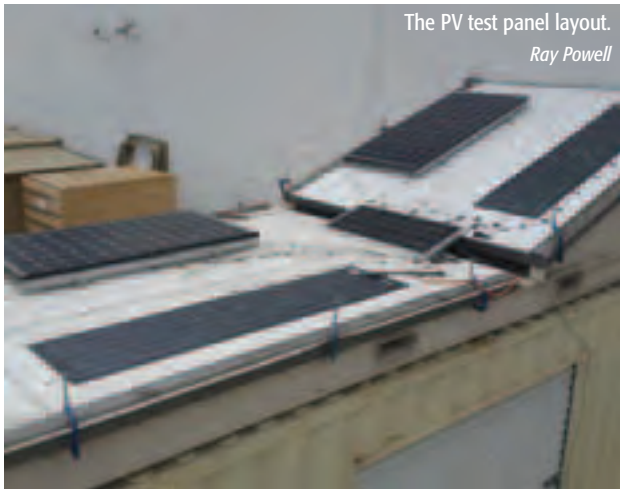
This project team supported the installation of a Smart Meter energy management system at Marine Corps Base Hawaii.

Principal Investigator: Tyler Chun, SSC Pacific, tyler.chun@navy.mil, 808-471-3494

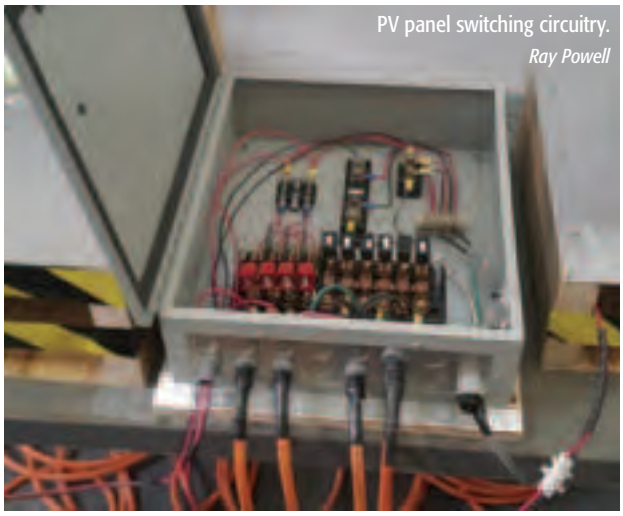
Adhered PV Reliability and Performance

The goal of this project is to compare adhered PV to traditional frame-mounted PV systems. Testing procedures will determine if adhered PV subjects the roof materials to excessively hot temperatures or affects interior air temperature. Also studied will be ease of installation, adhesion properties, and removal of malfunctioning panels.

Principal Investigator: Robert Schoff, NAVFAC EXWC, robert.schoff@navy.mil, 805-982-3572



The PV test panel layout.
Ray Powell



PV panel switching circuitry.
Ray Powell

Advance Power Electronics for PV Inverters

PV inverters convert the direct current power generated by PV systems into alternating current power that can be connected to the grid. This project will evaluate a new, more efficient PV inverter.

Principal Investigator: Ken Ho, Ph.D., NAVFAC EXWC, ken.ho@navy.mil, 805-982-1636

The Ideal Power PV converter (right) at Port Hueneme takes the place of six older converters.
Ken Ho

This electric vehicle (EV) charger has two Ideal Power converters on each side, enabling the EV charger to be bi-directional.
Ken Ho

Light Detection and Ranging (LIDAR) Wind Experiments and Validate Simulated Integration of Renewable Energy Networks (SIREN) Computer Modeling

This project is mapping shifts in wind quality over varying terrain for wind energy development applications. Additionally, the team will produce a SIREN model to help determine the transient effects of renewable components on a utility electrical system. SIREN software will be validated in field tests.

Principal Investigator: Ben Wilcox, NAVFAC EXWC, benjamin.wilcox@navy.mil, 805-982-2180

The LIDAR has been integrated into a trailer with 30-meter telescoping mast to create a trailer-based meteorological station.

The LIDAR remote sensor makes wind measurements through a hatch in the trailer roof.

Rooftop Units (RTU) Challenge

This team is researching optimal ways to meet the Department of Energy RTU challenge by identifying energy-saving rooftop heating, ventilation and air conditioning systems.

Principal Investigator: Max Hogan, NAVFAC EXWC, max.hogan@navy.mil, 805-982-1557

Modular Microgrid with Energy Storage

The project will evaluate mobile microgrid controllers and will demonstrate two systems with existing PV arrays at two locations.

Principal Investigator: Robert Okwera, NAVFAC EXWC, robert.okwera@navy.mil, 805-982-5177

DC Micro-grid for Solid State Lighting (SSL)

SSL can reduce building lighting load by up to 80 percent, and direct current SSL eliminates alternating current/direct current drivers resulting in cost savings and increased reliability.

Principal Investigator: Ken Ho, Ph.D., NAVFAC EXWC, ken.ho@navy.mil, 805-982-1636

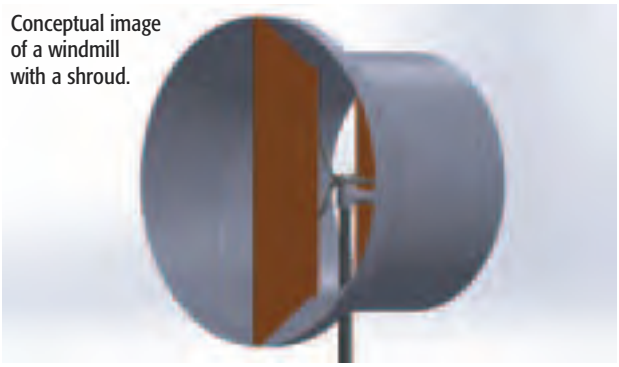
Liquid Air Energy Storage (LAES) with Combined Cycle and Power

LAES provides a low cost bulk energy storage solution using thermodynamic principles. The goal of this project is to validate the technology and prepare for full scale installation.

Principal Investigator: Ken Ho, Ph.D., NAVFAC EXWC, ken.ho@navy.mil, 805-982-1636

Shroud with Radio Frequency Mesh to Suppress Radar Cross-section of Small Wind Turbines

This project is developing two shroud concepts to suppress Doppler-filtered radar cross-section of wind turbine rotors, and also facilitate acceleration of air flow.



Conceptual image of a windmill with a shroud.

Two shroud concepts.
David Jenn

Principal Investigators: Ben Wilcox, NAVFAC EXWC, benjamin.p.wilcox@navy.mil, 805-982-2180

David Jenn, Ph.D., NPS, jenn@nps.edu, 831-656-2254

Wind Powered Cooling with Thermal Storage

Naval facilities have cooling loads such as for air-conditioning and data centers and renewable powered chiller systems would reduce the energy costs of these systems. To solve the problem of renewable energy's intermittency, this team used an ice-thermal storage system to generate ice during times of high renewable energy supply and then melt it as a thermal heat sink during times of high heat load.

Principal Investigator: Anthony Gannon, Ph.D., NPS, ajgannon@nps.edu, 831-656-2880

Renewable cooling system.

Commander Rex Boonyobhas peers into the thermal storage unit as Dr. Garth V. Hobson and Dr. Anthony Gannon look on.

Improved Wind Resistant Rooftop PV

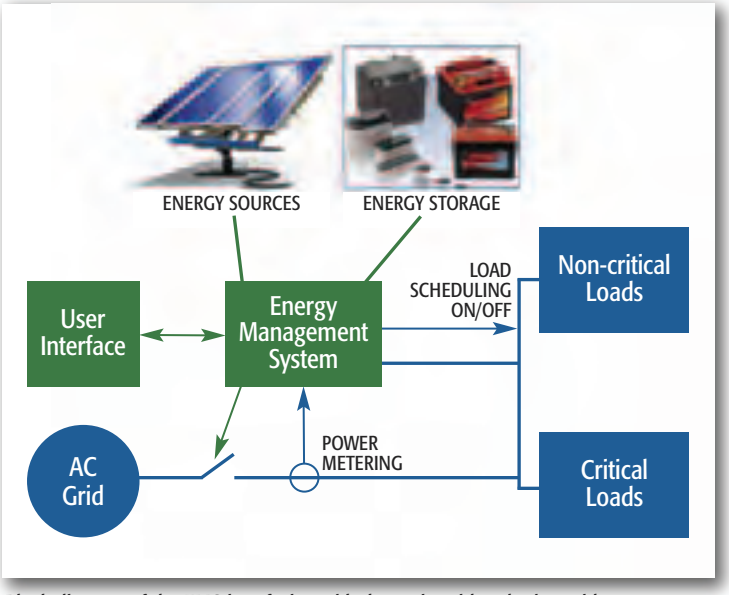
This project is assessing wind loads on a prototype PV unit so that its design can withstand a three-second gust of 150 mile-per-hour wind without the use of adhesives or additional ballasts.

Principal Investigator: M.S. Chandrasekhara, Ph.D., NPS, mchandra@nps.edu, 831-656-3585

Mobile Energy Management System (EMS) Prototype for Field Studies

The goal of this project is to design and build an EMS packaged so that it can be moved to different locations for practical demonstrations and microgrid studies.

Principal Investigator: Giovanna Oriti, NPS, goriti@nps.edu, 831-656-2637



Block diagram of the EMS interfacing with the main grid and microgrid.

Efficient Implementation of Solid State Transformers

For effective implementation of renewable power, a transformer is needed to interface between energy grids on naval bases. This project is studying the advantages of solid state transformers.

Principal Investigators: Todd Weatherford, NPS, trweathe@nps.edu, 831-656-3044

Andrew Parker, Ph.D., NPS, aaparker@nps.edu, 831-656-2483

Optimized Cooling for Concentrated Photovoltaic Systems

The goal of this project is to find optimized cooling solutions for concentrated PV systems that show promise for highest energy efficiency and reliability on Department of Defense (DoD) energy grids and to build a knowledge base across DoD organizations.

Principal Investigator: Sanjeev Sathe, Ph.D., NPS, sbsathe@nps.edu, 408-813-2800

The Navy benefits from the internship of highly motivated and talented individuals supporting our Navy's energy and energy management research projects.

–Rear Admiral Patrick Brady

Heat Recovery from Naval Base Power Plants (for hot water heating)

The goal of this project is to find waste heat recovery solutions that improve heat recovery efficiency and improve reliability without impacting the main system. Solution techniques for analyzing complex recovery systems are being developed.

Principal Investigator: Sanjeev Sathe, Ph.D., NPS, sbsathe@nps.edu, 408-813-2800

Uninterruptible, Renewable, Augmented Power Circuits

This project is demonstrating a practical way to convert individual circuits to uninterruptible power supplies that can use renewable energy and backup power when the grid fails. The participants are using super capacitors instead of batteries for the bridging power which is unique for these types of systems.

Principal Investigator: Anthony Gannon, Ph.D., NPS, ajgannon@nps.edu, 831-656-2880

Cost-Benefit Analysis of Energy Demonstration Projects

The goal of this project is to develop tools through which to evaluate the benefits and costs of ESTEP technology demonstration projects. Potential financial and non-monetized benefits will be considered.

Principal Investigator: Eva Regnier, Ph.D., NPS, eregnier@nps.edu, 831-656-2912

ESTEP fits into the five energy goals announced by Secretary of the Navy Ray Mabus in 2009. Those steps include:

1. Creating a "green" strike group of ships powered by biofuels.
2. Producing at least half of the Department of Navy's shore-based energy requirements from renewable sources.
3. Reducing petroleum use in the Navy's commercial vehicle fleet by 50 percent via hybrid fuel and electric vehicles.

Tony Velasco and Conner Guest (2014 interns) pose in front of vertical-axis wind turbines from an ESTEP project. They studied the potential reduction in utility bills achievable by renewable but intermittent energy paired with storage in a microgrid.

Eva Regnier

4. Weighing lifetime energy costs of new contracts.
5. Ensuring that by 2020, at least half of the Navy's total energy consumption comes from alternative sources.

Understanding more about the performance and reliability of emerging energy technologies will streamline their acquisition and adoption. ⚓

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2015 Expeditionary Energy Concepts Demonstration Accelerates Innovation

Annual Marine Corps Event Evaluates Energy Technologies to Give Warfighters Tactical Advantage

THE MARINE CORPS held its annual Expeditionary Energy Concepts (E2C) technology demonstration at Marine Corps Base Camp Lejeune, North Carolina on June 23–25, 2015.

E2C (or the Experimental Forward Operating Base (ExFOB), as it was originally known) is the Marine Corps' innovative process to identify, evaluate, and accelerate the fielding of energy efficient technologies that have the potential to reduce battlefield energy and water requirements and extend the operational reach of the Marine Corps.

E2C brings together energy stakeholders from across the Marine Corps, government laboratories, industry, and other military services to leverage ideas and resources and identify innovative energy solutions to meet warfighter needs.

Once a year, the Marine Corps invites selected vendors to E2C to demonstrate commercial energy technologies that can increase the self-sufficiency of expeditionary forces.

"This event is about a partnership with industry and other government organizations to try to get the best solutions for our tactical energy problems," said Col. Jim Caley, director of the Marine Corps Expeditionary Energy Office (E2O). "This is us asking the companies 'how do I fix this?'"

Companies participating in E2C develop their products based on the warfighter's energy needs and travel to E2C at their own expense. The cost effectiveness of E2C helps make the overall goal a reality.

"E2C is a great deal, not only for the Marine Corps, but for the Department of Defense (DoD)," said Caley. "We haven't spent a dime. These companies have spent their money to build prototypes for the Corps. We are getting the best ideas from industry with their initial investment."

The 2015 E2C focused on technologies that enable small unit distributed operations—giving Marines more mobility and the ability to stay out longer without being resupplied constantly.

This year's demonstration featured 32 systems (22 industry technologies and 10 government systems) with the potential to reduce fuel and battery resupply requirements for small unit distributed operations.

Technologies evaluated during the 2015 E2C included:

- Hybrid/Electric All-Terrain Vehicles
  These vehicles offer significant fuel savings and have the potential to

> This event is about a partnership with industry and other government organizations to try to get the best solutions for our tactical energy problems.
>
> *—Col. Jim Caley*

Marines from II Marine Expeditionary Force attend the Expeditionary Energy Concepts demonstration at Marine Corps Base Camp Lejeune, North Carolina, on June 23–25, 2015. The Marines are given the opportunity to fill out surveys and give their opinions on the displayed equipment.
Sgt. Larry Babilya

extend the operational reach of Marines on the move.

- Advanced Batteries and Energy Storage Technology

  These technologies can lighten the carried load, help increase infantry mobility, and extend operational reach.

- Fuel Cells (up to 10 kilowatts)

  These fuel cells play a critical role in reducing future fuel requirements.

There were also a number of government-sponsored energy systems on display, including:

- The Unit Energy Manager Program

  This is an energy command and control planning tool for Commanders which guides Marines in developing awareness and acceptance of energy efficiency efforts.

Assistant Secretary of the Navy for Energy, Installations and Environment Dennis McGinn (left), speaks to a representative from one of the civilian companies responsible for developing new, more energy efficient batteries for the Marine Corps at the 2015 E2C. The demonstration drew senior personnel from the Marine Corps, DoD and civilian organizations, as well as members of other military services and from other countries.
Cpl. Sullivan Laramie

- The Joint Infantry Company Prototype (JIC-P)

  The JIC-P is a suite of systems (e.g., backpacks, knee braces) that harvest energy from Marines on patrol.

During the multi-day demonstration, 200 Marines from II Marine Expeditionary Force (from a range of ranks and military occupational specialties) evaluated each of the systems to learn about technologies and equipment they might use in the future. After evaluating the systems, Marines completed surveys describing what they liked and what they didn't like for each of the systems on display.

Capt. Nathan Daniel, an E2O operational analyst, leads a group of Marines with II Marine Expeditionary Force at the 2015 E2C demonstration aboard Camp Lejeune. E2C gives Marines an opportunity to learn about new technologies and provide feedback directly to the developers. *Cpl. Sullivan Laramie*

"I enjoyed coming here," said Cpl. Kyle Murdoch, a refrigeration mechanic with the 2nd Marine Logistics Group. "I am the 'hands on' of the Marine Corps so it is nice for them to come to me and get my opinion."

Inputs from Marines help inform Marine Corps' requirements and ensure the gear is as practical as it is tactical.

"The last thing that I want to do is procure something for Marines on the battlefield that they think is useless," said Caley. "I want to procure something that makes sense to them. This is our attempt to put the Marine in front of the gear and give a lance corporal, a sergeant, or a staff sergeant a say in the billions of dollars of gear we buy for Marines."

Staff Sgt. Tyler Grogg, an explosive ordnance technician, said it is extremely valuable that the Marine Corps asks the junior Marines for feedback since, in the end, they are the ones who have to perform with the equipment.

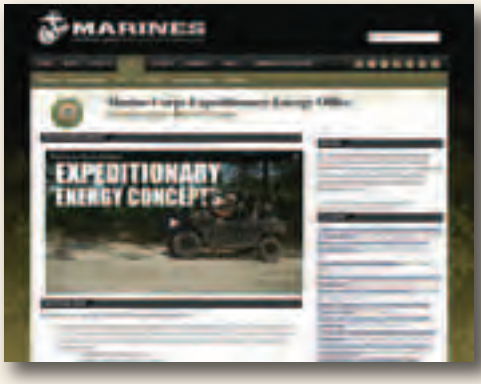
"You need to have the guys on the ground," Grogg said. "You need those guys who have that combat experience to say, 'Would this have helped me when I was alone and in the middle of nowhere?'."

Marines' evaluations are considered alongside system performance data collected by engineers to determine the products that will be selected for future testing and development.

Industry and government vendors also benefit from the ability to interact with the future end-users of their technology. Vendors receive valu-

For More Information

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.



For more insights into the 2015 E2C and information about the technology focus areas of the demonstration, read our article "Annual Marine Corps Expeditionary Energy Technology Demonstration Seeks Battlefield Solutions" in the spring 2015 issue of *Currents*.

You need those guys who have that combat experience to say, 'Would this have helped me when I was alone and in the middle of nowhere?'

—Staff Sgt. Tyler Grogg

Representatives from Naval Research Laboratory and Naval Postgraduate School speak to Marines with II Marine Expeditionary Force about a solar-powered autonomous unmanned aircraft system at the 2015 E2C. Technology such as solar and kinetic energy-harvesting equipment was on display to give Marines an idea of gear they may receive in the future, and presented an opportunity for Marines to give feedback to the developers.

Cpl. Sullivan Laramie

Master Sgt. Shawn Workman, an operational analyst with II Marine Expeditionary Force, speaks to a representative of one of the civilian companies responsible for designing an energy efficient, all-terrain utility vehicle for the Marine Corps at the 2015 E2C. E2C gives civilian and DoD developers the opportunity to demonstrate technologies with potential to address gaps in Marines Corps energy, water, and waste capabilities.

Cpl. Sullivan Laramie

able feedback from Marines who use the technology in an operational relevant environment. After reviewing feedback from Marines, companies can improve their equipment to better serve the DoD.

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.

To date, through the E2C process, the Marine Corps has:

- Conducted eight demonstrations at bases across the country.
- Reviewed over 300 technologies through the E2C Request for Information process.
- Assessed over 100 technologies at E2C demonstrations.
- Evaluated 26 systems in laboratory and field following E2C demonstrations.
- Transitioned five systems to Programs of Record.

Captain Anthony Ripley
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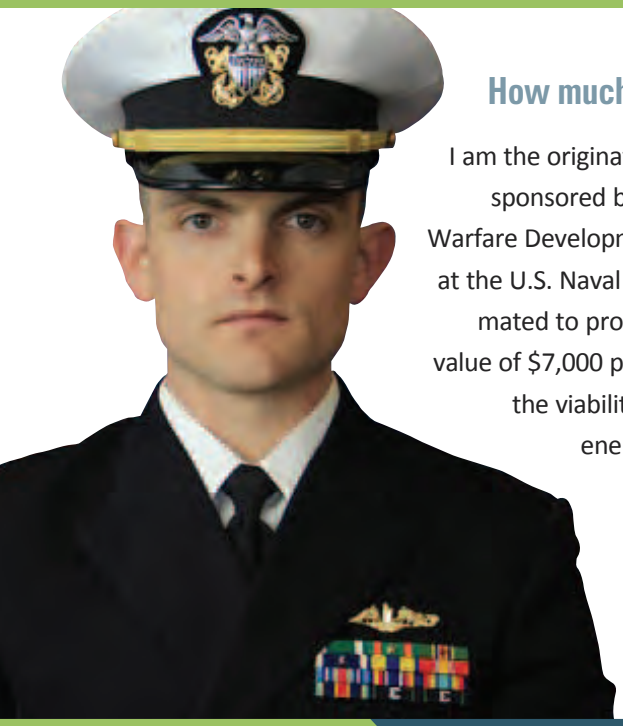
DID YOU KNOW?



How much energy could my idea save the Navy once it's implemented?

I am the originator and project manager for Waste to Watts—a renewable energy project sponsored by the Chief of Naval Operations Rapid Innovation Cell (CRIC) and the Navy Warfare Development Command—which endeavors to produce electricity from food waste at the U.S. Naval Academy. If successfully implemented, the Waste to Watts project is estimated to produce 60 megawatts of electricity per month, with an associated economic value of $7,000 per month. I hope that the Waste to Watts project serves as an example of the viability of waste-to-energy technologies to help the Navy achieve its renewable energy mandates through more widespread implementation across the Navy.

Name: Lieutenant Eric Regnier

Hometown: Rochester, Minnesota

Job: Action Officer, CRIC Project Lead

Command: Navy Warfare Development Command

Do you think an energy conservation culture change is important for our Navy?

In the coming decades the increasing strategic value of our energy resources will become a significant factor in the operational readiness and capabilities of the Fleet. Creating a culture of energy conservation in the force today will help to maximize our readiness tomorrow as we move into an increasingly resource-constrained environment.

ENERGY SECURITY ENHANCES COMBAT CAPABILITY

Did you know that the Waste to Watts project seeks to provide a renewable energy resource for naval facilities by producing electricity from food waste?

Why is it important for our Navy to be energy efficient?

The Navy depends on energy to enable all aspects of our training, missions and operations. Any uncertainty or insecurity in the logistics chain that provides our energy resources introduces a direct threat to the combat readiness and effectiveness of our ships, aircraft and personnel. As energy resources become more scarce and costly, the amount of time warfighters spend at sea training to execute their mission will also diminish. Energy security should be of equal concern to that of a missile vulnerability or cyber threat.

Why Waste to Watts?

I am passionate about innovation and energy security. The Navy needs to adopt more progressive and widespread uses of renewable and sustainable energy sources. That's what makes me passionate about the Waste to Watts project. It's an opportunity for a naval facility to reclaim a lost resource—food waste.

I hope that this project will make a significant contribution to the Naval Academy's energy conservation efforts and inspire others to make the Navy a more sustainable and capable fighting force.

How does Waste to Watts work?

The Waste to Watts project seeks to provide a renewable energy resource for naval facilities by producing electricity from food waste. During the naturally occurring process of anaerobic digestion, bacteria produce methane (a biogas) from food waste. We can then use that biogas to fuel a generator to produce electricity for a facility. Our goal is to deploy an anaerobic digester at the Naval Academy that uses food waste from the midshipmen's mess hall as feedstock for this reaction.

Why did you decide to build a prototype at the Naval Academy?

I decided to test the Waste to Watts prototype at the Naval Academy because of the quantity of food waste generated by the Academy's midshipmen, the academic mission of the institution, and the opportunity to engage midshipmen in the project. While the Academy's galley (King Hall) operates efficiently, if each of the Academy's 4,000 midshipman produces just three ounces of food waste per meal, the amount of total waste accumulates very rapidly. So the quantity of food available for anaerobic digestion makes the Academy an ideal location to test the Waste to Watts model.

In addition, there is significant intellectual capital at the Academy that we can leverage by involving midshipmen in the project through senior design projects, class lectures and site visits. So we are collaborating with Associate Professor Patrick Caton from the Academy's Mechanical Engineering Department to fully explore these options.

Reaching out to the younger generation is really important. Every Sailor who reports to their first command identifies some issue where they know they can have an impact. But it's a matter of feeling empowered to make a difference. Ultimately, that's the objective of Waste to Watts—to not only provide a renewable energy resource for the Naval Academy and other naval facilities but also serve as a mechanism to empower junior Sailors. We want to help them implement their own ideas through exposure to the CRIC—the organization that afforded me the opportunity to explore the Waste to Watts project.

U.S. DEPARTMENT OF THE NAVY ENERGY SECURITY

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Pacific Northwest Growler Training Essential for 21st Century Battles

Navy Analyzes Environmental Impacts, Shares Data

THE NAVY'S PREMIER electronic attack aircraft is the EA-18G Growler, an increasingly essential piece of our country's defense systems. For the past several years, pilot training for the Growler has been conducted in the Pacific Northwest according to the Navy's strict environmental compliance standards.

The Department of Defense identified a need for additional Growler aircraft to enhance the nation's electronic warfare capability. To accommodate training requirements and the additional aircraft, the Navy is proposing to continue and increase Growler operations at Naval Air Station (NAS) Whidbey Island, Washington and to study the distribution of operations between the base's two airfields. The Navy has proposed to home base up to 36 additional Growler aircraft at NAS Whidbey Island—the only home base in the United States for Navy and Air Force tactical electronic attack squadrons.

The Navy is also analyzing the potential impacts on the environment and the community from the proposal, and is studying the distribution of operations between the base's two airfields. The analysis and findings will be documented in an Environmental Impact Statement (EIS), which is anticipated to be completed and made available for public review and comment in the spring of 2016.

About Electronic Warfare

Militaries around the world rely heavily upon electromagnetic energy to operate their communication, navi-

An EA-18G Growler flies over NAS Whidbey Island, Washington.

gation or defense-related systems. Without electromagnetic capability, these systems become inoperable.

Electronic warfare involves the use of electromagnetic energy to control or impede an adversary's access to and ability to use its systems, thereby creating vulnerabilities in the enemy's operations. It also aids in preventing enemy interference with the Navy's own electromagnetic spectrum during military operations.

Electronic warfare has unquestionably saved the lives of U.S. service members. For example, in 2011's Operation Odyssey Dawn, electronic measures were used to locate and disable Libyan radar and anti-aircraft sites, essentially eliminating the threat of Libya's air and missile defense systems and allowing North Atlantic Treaty Organization forces to destroy equipment and communication centers. Today, Navy aircrews are able to remotely disable enemy land mines and improvised explosive devices using electronic measures.

The Growler aircraft plays a critical role in the electronic warfare mission and is currently flying missions against Islamic State of Iraq and Syria (ISIS) targets.

Training for Electronic Warfare

In combat, aviators are required to make split-second, life-or-death decisions while in flight, which is why training is so critical. Training in electronic warfare allows Navy pilots to practice the skills needed to identify signals and deny an adversary access to and use of the electromagnetic spectrum in real-life situations. However, training is extremely challenging for aircrews because they must learn to detect, identify and locate a specific signal among all the other existing electromagnetic signals present in the area. Electronic warfare is so complex that Captain Scott Farr, deputy commodore of the Electronic Attack Wing at NAS Whidbey Island, said "Electronic warfare training is not like looking for a needle in a haystack. It's more like looking for a needle in a pile of needles."

Because the nature of electronic warfare training and the science behind it is so complex, the introduction of new or additional aircraft such as the EA-18G Growler to an air station can create confusion and raise questions on the need for the aircraft. Some misinformation has circulated about the potential impacts from electronic warfare training and the Growler on human health and the environment. The Navy has taken steps to correct the misinformation, provide accurate information, answer questions and discuss issues with concerned citizens.

About the Growler

The mission of the Navy's electronic attack (EA) aircraft is to restrict, eliminate and counteract enemy air defenses and communications systems. These aircraft are indispensable for American and coalition forces when engaged in combat operations overseas, significantly contributing to mission success and saving service members' lives.

The EA-18G Growler is the most modern, state-of-the-art tactical aircraft in the U.S. Department of Defense inventory for conducting electronic warfare missions. The Growler replaced the EA-6B Prowler as the Navy's electronic attack aerial aircraft, and began operations at NAS Whidbey Island in 2008. The Growler has an advanced electronic system that allows it to identify targets and

The Basics About Naval Air Station Whidbey Island

NAS WHIDBEY ISLAND in Washington State has been in operation since the 1940s and is a key Navy asset and an integral part of the region. It is home to the Navy's electronic warfare training community and to all Navy electronic attack squadrons in the United States.

NAS Whidbey Island and the Pacific Northwest are critical locations for the Growler aircraft because as home to the Navy's electronic warfare community, they have the associated training facilities and substantial infrastructure established during four decades of operation.

The area is ideal for conducting naval aviation training due to relatively uncongested airspace, varied and mountainous terrain, and conducive weather patterns, including a temperate climate. Additionally, the proximity to coastal regions and existing military training routes and special use airspace makes for more efficient training, shorter transit times, and reduced fuel costs, emissions and wear and tear on aircraft.

The Navy manages two airfields on NAS Whidbey Island–Ault Field in Oak Harbor and Outlying Landing Field (OLF) Coupeville. Both are often used simultaneously to safely and effectively handle air traffic. OLF Coupeville's sole mission is to provide the most realistic training environment for aircraft carrier landing training.

OLF Coupeville is the most realistic and efficient training environment in which to master the technically demanding and dangerous task of landing on a carrier before an aviator actually goes to an aircraft carrier at sea.

–Vice Admiral Mike Shoemaker

protect itself and other aircraft from those targets. It also has advanced communication capabilities that allow it to interact more effectively with personnel on the ground and in the air, compared to the older Prowler aircraft.

Flying a Growler

Landing on an aircraft carrier is perhaps the most difficult task in military aviation, particularly landing at night. It is a highly complex and perishable skill, and requires intense periods of training before pilots deploy. A Navy training activity called Field Carrier Landing Practice (FCLP) teaches proper carrier-landing techniques on land before conducting similar activities on an aircraft carrier. FCLP is critical for Navy pilots to learn to safely conduct landing patterns in as realistic conditions as possible.

Although the Navy uses flight simulation extensively in training, there is no substitute for a Navy pilot practicing on an airfield before landing on an aircraft carrier. Over the years, the Navy believes it has achieved the right mix of simulated and live training to prepare pilots for the demanding task of landing on an aircraft carrier.

According to Captain Benjamin Hewlett, commander of Carrier Air Wing One based at NAS Oceana, the Growler is essential to mission success, and training is critical. "Field Carrier Landing Practice training provides Growler pilots with the necessary training that they need to safely land on a carrier after flying demanding missions, sometimes multiple times a day," he said.

Currently at NAS Whidbey Island, there are nine carrier-based Growler squadrons, four land-based or expeditionary Growler squadrons, and one training squadron for new Growler pilots to become proficient in the aircraft prior to assignment in a carrier or expeditionary squadron. Currently, there are five Growlers in each operational squadron. All of the squadrons, with the exception of the expeditionary squadrons, conduct FCLP training at NAS Whidbey Island.

Outlying Landing Field Coupeville

The Navy manages two airfields on NAS Whidbey Island—Ault Field in Oak Harbor and OLF Coupeville.

Ault Field in Oak Harbor.

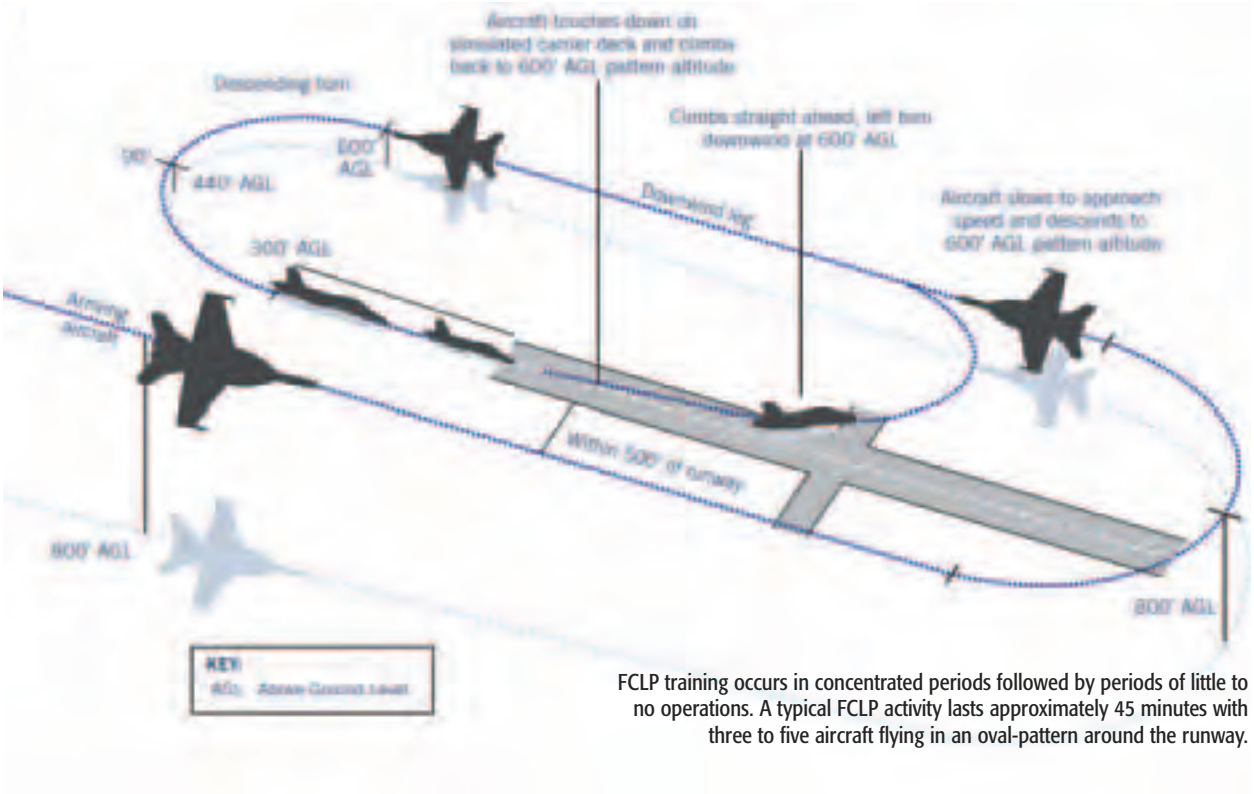
OLF Coupeville.

OLF Coupeville is a critical national training asset and provides the most realistic environment for FCLP training in the Pacific Northwest. The field was built in 1943 and has been used almost exclusively for FCLP training since 1967.

According to Vice Admiral Mike Shoemaker, Commander, Naval Air Force, U.S. Pacific Fleet, "OLF Coupeville is the most realistic and efficient training environment in which to master the technically demanding and dangerous task of landing on a carrier before an aviator actually goes to an aircraft carrier at sea." He adds that "OLF Coupeville provides the most efficient environment we can replicate on land to simulate the demanding and extremely dangerous conditions at sea."

OLF Coupeville is an ideal training location due to its proximity to NAS Whidbey Island, allowing for more efficient training, shorter transit times, reduced fuel costs, emissions and wear and tear on aircraft. As it is in a low-density population zone, there is also little impact on the surrounding community. The low ambient lighting conditions also more closely replicate nighttime conditions onboard an aircraft carrier.

In contrast, Ault Field is a busy, multi-mission airfield. Conducting FCLP training at Ault Field increases overall activity around a more populated



FCLP training occurs in concentrated periods followed by periods of little to no operations. A typical FCLP activity lasts approximately 45 minutes with three to five aircraft flying in an oval-pattern around the runway.

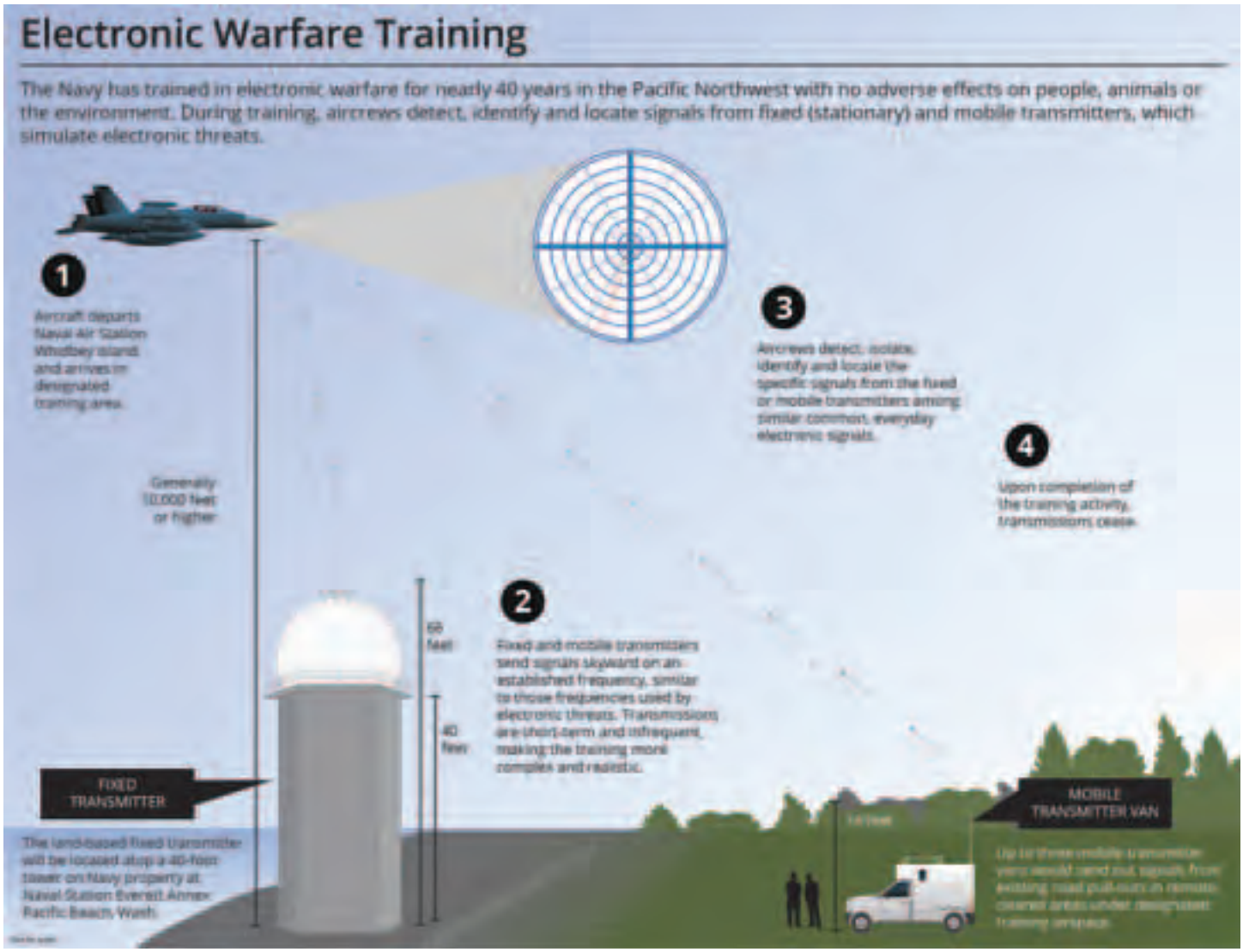
area, interferes with other base operations, and causes delays or restrictions on other training activities. Conducting FCLP activities at OLF Coupeville reduces congestion and allows the Navy to conclude daily operations in less time, reducing overall community impacts.

Assessing Potential Environmental Impacts

The Navy prepared an Environmental Assessment in 2005 to determine whether the transition from Prowlers to Growlers would have significant environmental effects requiring the preparation of an EIS. After extensive review, the Navy determined that there would be no significant effects and that the preparation of an EIS was therefore not required. In 2013 however, Congress authorized more Growlers, so the Navy began the process to start an EIS which is slated to be finished in 2016.

The 2005 Environmental Assessment analyzed 57 Growler aircraft replacing 72 Prowler aircraft. Based on interim directives by the Department of Defense, the 72 legacy Prowlers were ultimately replaced with 82 Growlers, an overall increase of 10 aircraft. Due to this increase, a second Environmental Assessment was prepared in 2012.

The Northwest Training Range Complex prepared its own Environmental Impact Statement/Overseas Environmental Impact Statement analyzing the initial concept to improve ongoing electronic warfare training, along with other Navy training activities. This was completed with community input in 2010.



An EA-18G Growler participating in a training exercise overseas.

MC2 Shannon Heavin

Subsequently, more information and technology became available regarding the transmitters, and a design concept for siting the fixed and mobile transmitters was proposed, after which the Navy prepared an Environmental Assessment discussing all the potential impacts of the transmitters and the new Growler aircraft. (Note: Fixed and mobile transmitters on the ground send signals skyward for the aircraft to detect.) The assessment was completed and a Finding of No Significant Impact was issued on August 28, 2014.

How Loud is the Growler?

Though the sound may seem different, noise levels for the Growler and its predecessor, the Prowler are comparable in most flight profiles. The noise study conducted for the Environmental Assessment does acknowledge that the Growler is 1 decibel (dB) Sound Exposure Level (SEL) louder during arrival than the Prowler but 2 to 8 dB SEL quieter in other flight profiles. Generally, a change of less than 3 dB is not perceptible. (Noise exposure varies depending on where you are in relation to the flight path.)

While the Growler is not louder, it has a slightly higher potential to cause noise-induced vibrations. The Growler is recognizable by the low frequency "rumble" of its jet engines, whereas the Prowler's engines are associated with a higher frequency sound.

About Noise Assessment & Modeling

Noise modeling is the most accurate and comprehensive method for estimating aircraft noise and evaluating potential noise mitigations, including working with the community on land-use compatibility. As part of the EA-18G Growler Airfield Operations EIS, a thorough noise assessment of current and proposed operations will be conducted for Ault Field and OLF Coupeville.

The U.S. Environmental Protection Agency, Federal Aviation Administration and Department of Defense measure aircraft operational noise levels in decibels using two common

Determining Aircraft Noise Profiles

THE EA-18G GROWLER'S noise profile was developed based on the existing F/A-18F Super Hornet's profile because of the similarities between the two aircraft. The Growler and the Super Hornet share the same airframe, same engine, and have approximately the same in-flight weight. The difference between the two aircraft is the mission-related electronics inside each aircraft.

In 1997, acoustic data for the F/A-18E/F Super Hornet was collected at NAS Patuxent River, Maryland using a microphone array at the airfield. These acoustic data were validated with a second series of measurements conducted at NAS Lemoore in November 2000. The acoustic data were then incorporated into the Department of Defense database for future use in noise modeling. To support the upcoming Growler acoustic analysis, operational flight profiles were developed based on numerous pilot interviews regarding flight parameters (e.g., engine power settings, aircraft speed and altitudes) for different flight procedures (e.g., normal flight, departures, arrivals, and field carrier landing practice). These profiles were validated with data from F/A-18E/F aircrews at NAS Lemoore.

MC3 Siobhana R. McEwen

MC2 Scott Fenaroli

MC2 John Philip Wagner, Jr.

CLOCKWISE FROM TOP LEFT: Conducting realistic electronic warfare training with the EA-18G Growler is vital to save U.S. service member lives in combat; An EA-18G Growler launches from the flight deck of an aircraft carrier; An EA-18G Growler, the Navy's electronic attack aircraft, flies over the Pacific Ocean; An EA-18G Growler on an aircraft carrier; Simulators are critical in electronic warfare training and are used extensively, but they cannot replace the feel and physiological conditions experienced through live training; Aircrews from NAS Whidbey Island practice detecting, identifying and locating the kind of electronic signals they can expect to encounter when deployed into hostile territory.

metrics—the Day-Night Average Sound Level (DNL) and the SEL.

The DNL represents the average sound energy of events over a 24-hour period, with a penalty added for night operations conducted between the hours of 10:00 p.m. and 7:00 a.m. The DNL takes into account all of the factors that influence our perception of noise, including loudness, number and duration of events, and time of day.

The SEL represents the total noise energy of a single event. This can be represented by a single flyover. This metric takes into account the loudness of the flyover, as well as the time of the flyover. SEL is useful in determining sleep disturbance and speech interference.

Noise is modeled using a computer program called NOISEMAP, which factors in the number and type of flight operations planned over the course of a year. It should be noted that noise modeling data are based on sound measurements of actual aircraft, both in flight and on the ground. The NOISEMAP program uses computerized simulation of aircraft activity at an installation and reflects airfield-specific data, such as the type of aircraft, number of flights, flight tracks, altitude, power settings, speed of the aircraft and environmental factors, such as temperature, humidity and terrain. Engine maintenance testing and surface types for touch down are also included. The final results are presented on land use maps in the form of noise contours.

The map below depicts DNL for OLF Coupeville and Ault Field. These contours are not expected to change with the phase-in of Growler aircraft.

Supplemental tools and metrics are also used to provide another measure of noise exposure by evaluating community annoyance, potential hearing loss, sleep disturbance, and interference with indoor speech or classroom learning. The Navy's noise assessment as part of the EA-18G Growler Airfield Operations EIS will also include an analysis of non-auditory health effects based on peer-reviewed literature studies.

It is important to keep in mind that many of the studies that have been conducted on this subject have focused on very busy commercial airports, conducting 300,000 annual operations or more annually, unlike a Navy OLF that conducts far fewer operations, with busy periods followed by times with little or no activity.

It is also important to remember that the Navy has been flying the Super Hornet aircraft—an aircraft with the same airframe and the same engines (and therefore, the same noise impacts) as the Growler—at air stations throughout the nation for well over a decade. At many of these installations—NAS Oceana in Virginia Beach, Virginia, is one example—the population density in the area is far greater than that of either Oak Harbor or Coupeville.

The Navy is not aware of any documented impacts to the health of individuals in the Virginia Beach community resulting from aircraft noise, even though this installation conducts far more operations annually than those conducted at NAS Whidbey Island. The OLF serving aircraft based at NAS Oceana, Naval Auxiliary Landing Field Fentress, is located in Chesapeake, Virginia. Nearly 100,000 FCLP operations are conducted annually at Fentress.

More About Training

Electronic warfare training has been an instrumental part of military training for decades with no

Public Health & Safety

ONE OF THE concerns voiced by the public in this instance has to do with exposure to electromagnetic energy. In the case of the Navy's electronic warfare training, there is no exposure to electromagnetic energy and therefore there is no health risk. The public is not exposed to electromagnetic energy from the fixed or mobile transmitters because the signal is pointed skyward as a narrowly focused beam toward the aircraft, and the transmitters are at least 14 feet off the ground. Birds flying through the signal would not be affected because they would not be in the path for an extended period of time. The transmitters would also be located in remote, cleared areas, and there would be a 100-foot safety zone around the mobile transmitters. If a person or animal enters this safety zone, transmission would cease.

The fixed transmitter would be located atop a 40-foot tower at Naval Station Everett Annex Pacific Beach, Washington, a Navy-owned and operated site. The surrounding area would be fenced for security purposes.

These precautions ensure there is virtually no chance that anyone would come near the transmitters while in operation without the operators knowing about it.

The power output levels of the Navy's fixed and mobile transmitters are comparable to the levels of a television news satellite van or navigational radar found on many recreational boats. For example, the power output from the fixed transmitter would be about 90 to 100 watts. The output of the mobile transmitters can vary from 100 to 300 watts, but is expected to be about 100 watts. For comparison, people commonly use 60 to 100-watt light bulbs at home, and many commercial radio stations in the Puget Sound area have antenna power output levels of 100,000 watts or more.

Low power output from the fixed and mobile transmitters makes training more realistic and challenging for aircrews because they need to detect, identify and locate these specific signals among all the other existing electronic signals produced by everyday devices. This training is critical because it enables Navy aircrews to learn and practice the steps needed to safely and successfully counter enemy defenses before going into harm's way.

Mobile transmitter vans are similar to television news satellite trucks in that they broadcast a signal skyward, but rather than broadcasting to a satellite, signals are aimed at the aircraft.

Navy personnel in the mobile transmitter vans do not need to wear protective gear because they are underneath the signal transmissions, which would start at least 14 feet above the ground.

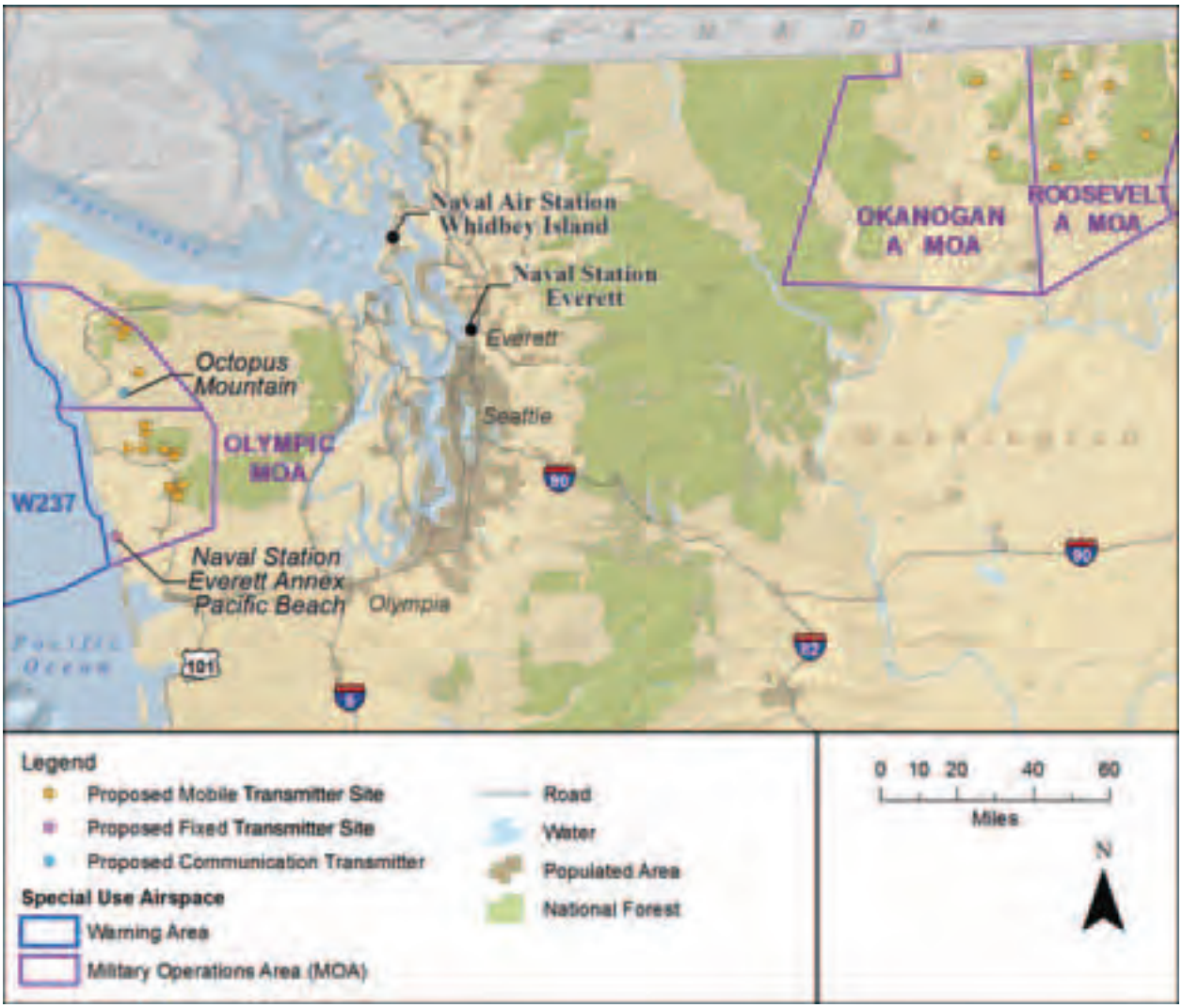
adverse effects on people or the environment.

The training is conducted with the aircraft at 10,000 feet above sea level or higher and does not involve the use of any weapons. Fixed and mobile transmitters on the ground send signals skyward for the aircraft to detect. The aircraft does not send signals to the transmitters. The transmitters' frequencies, which are similar to common civilian communication and radar systems, do not harm people, animals or the environment.

When training, transmitters on ships or on land send electromagnetic signals skyward using frequencies that are similar to those used for some satellite communications, Wi-Fi and Bluetooth devices, and weather radar systems. The frequencies used by the Navy are approved and licensed for Navy training, and are similar to other frequencies used for commercial or recreational purposes. Mobile transmitters (affixed to vans) present real-life testing challenges and locations of these transmitters can be altered with each training activity. "Fixed and mobile transmitters would challenge aviators and their systems with a more complex threat for training scenarios," states Captain Farr.

Due to insufficient ground-based transmitters and instrumentation, electronic warfare units currently homebased at NAS Whidbey Island must commute more than 400 miles to Mountain Home Air Force Base in Idaho, which takes 50-60 minutes each way, to complete required training.

To increase training efficiencies, improvements and additions to the Navy's systems are proposed, to



include land-based fixed and mobile transmitters under existing military airspace above the Olympic Peninsula and north-central Washington State. The proposal includes a land-based fixed (stationary) transmitter at Naval Station Everett Annex Pacific Beach, Washington, and the operation of up to three mobile transmitter vans, similar to television news satellite trucks, on fire access roads in remote, previously cleared areas underneath existing military airspace. The Navy is pursuing appropriate property access to lands managed by the U.S. Forest Service and other landowners to use the areas proposed for driving the vans.

The proposed enhancements would allow aircrews to train more effectively closer to home, reducing fuel costs, air emissions and flight-hour expenses. Conducting this training within an upgraded Pacific Northwest Electronic Warfare Range would save the government and taxpayers about five million dollars each year.

Flight Activity

The Navy has been training in Military Operations Areas in the Pacific Northwest for decades. While flight requirements and actual flight training activities fluctuate yearly, the average number of flights in the Military Operations Area above the Olympic Peninsula has averaged about 1,250 annually for the past two years. Improving existing electronic warfare training by adding land-based mobile and fixed transmitters would not significantly change the amount of training runs currently conducted.

The Navy has estimated a 10 percent increase in the current average number of flights for electronic warfare training activities. This 10 percent increase amounts to less than one additional flight per day.

It is important to note that the Navy's planning documents generally use conservative overestimates of required training and actual airspace usage and training activities may not be as extensive as what was analyzed. The Navy is not anticipating an increase in electronic training activities for the Military Operations Areas in north-central Washington State (Okanogan and Roosevelt counties).

Vice Admiral Shoemaker sums up the importance of electronic warfare training by saying, "I consider the continued use of the Pacific Northwest

The Electromagnetic Spectrum

ELECTROMAGNETIC ENERGY IS energy that is reflected or emitted from objects in the form of electrical and magnetic waves. Electromagnetic waves create patterns as they travel through space, and each wave has a certain shape and length. The distance between peaks, or high points, of a wave is called wavelength. It is the difference in wavelengths that distinguishes between the various types of electromagnetic energy.

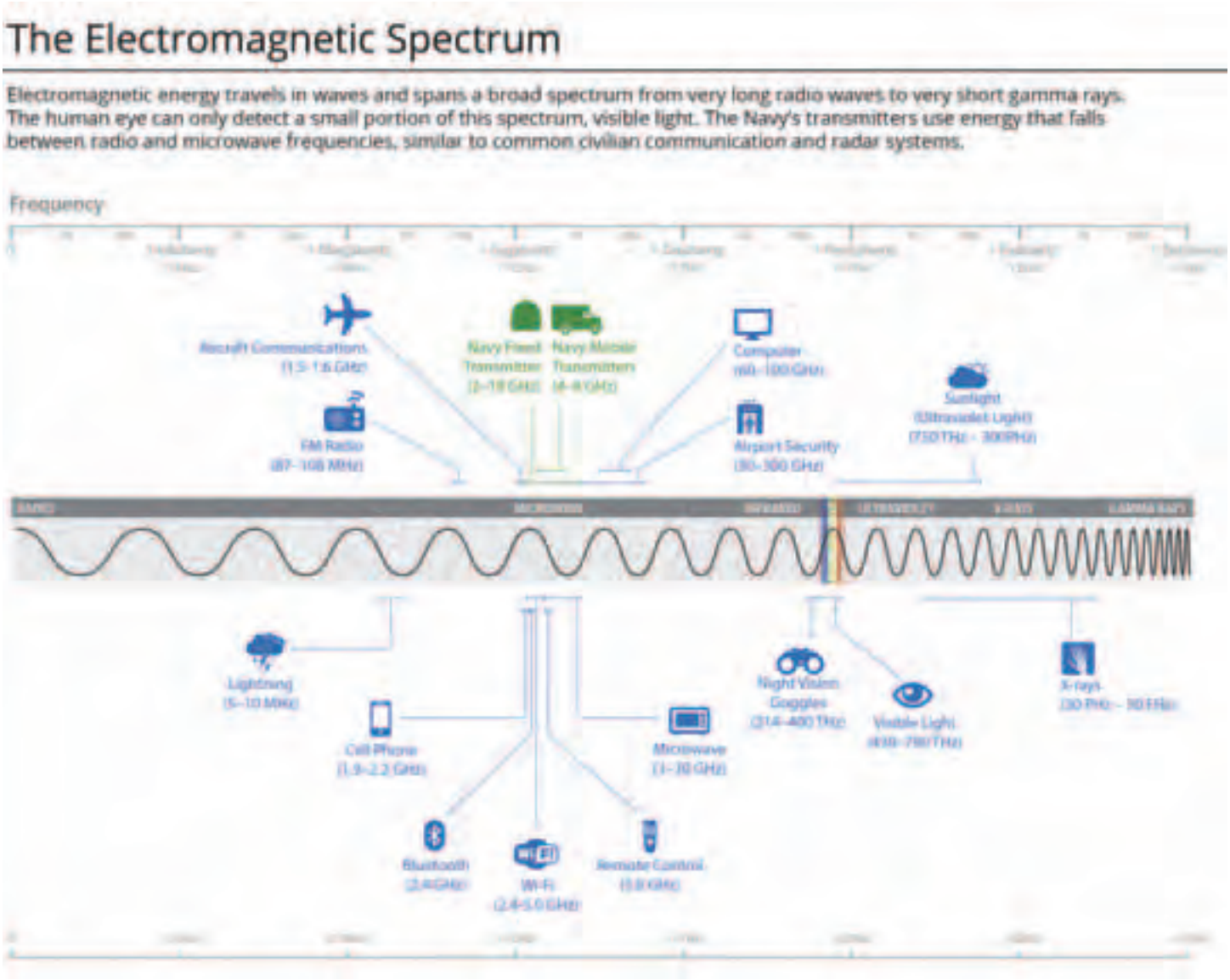
The electromagnetic spectrum represents the range of all types of electromagnetic energy, from very long, low-energy radio and microwaves, to visible light, to very short, high-energy X-rays. The human eye can only detect a small portion of this spectrum, visible light. There are seven categories of electromagnetic energy that make up the electromagnetic spectrum:

1. Radio
2. Microwave
3. Infrared (heat)
4. Visible (light)
5. Ultraviolet light
6. X-rays
7. Gamma-rays

People regularly experience various forms of electromagnetic energy that exist all around us every day when we tune in to our favorite radio station; use a remote control, cell phone or other electronic appliance; stand in the sunlight; go through security screening at airports; or undergo X-rays for medical purposes. We benefit from this energy through improved communication, convenience, safety and health. In general, this energy is not harmful, unless overexposure to higher-energy rays occurs.

When conducting electronic warfare training in the Pacific Northwest, the Navy's use of electromagnetic energy falls between radio and microwave frequencies, similar to common civilian communication and radar systems, such as Wi-Fi devices, cordless phones, Bluetooth devices, and weather radars.

"Electromagnetic radiation" is a phrase that has been used to describe the transmission of electronic signals during electronic warfare training. Electromagnetic radiation is a general term used to describe the energy output of all kinds of electronic devices. Electromagnetic radiation is electromagnetic energy; it is not the same thing as nuclear radiation. There is no nuclear radiation associated with electronic warfare training.



Electronic Warfare Range key to aircrews' ability to accomplish their missions as they deploy around the world."

Public Information & Involvement

The Navy continually strives to minimize impacts on the community from its activities, and recognizes the importance and value of public involvement. Navy personnel make a concerted effort to notify, inform and involve the community in the environmental analysis processes for projects proposed in the Pacific Northwest and across the globe.

In 2014, the Navy began sharing the weekly flight schedule for OLF Coupeville with the media and posting it on the Navy's website and Facebook page. Also, a telephone call-in line was established to better monitor and track noise issues and to improve the Navy's responsiveness to community concerns.

Additionally, the Navy has established a website to provide accurate information directly to the public about electronic warfare training and the Growler aircraft. This site (http://go.usa.gov/3B4Mk) contains fact sheets, a downloadable copy of the Environmental Assessment, and more. ⚓

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First Kemp's Ridley Sea Turtle Nests at Dam Neck Annex

Productive Nest Generates 85 Eggs & 72 Hatchlings

A KEMP'S RIDLEY sea turtle that nested at Naval Air Station Oceana's (NASO) Dam Neck Annex was the northern-most nest of this species ever documented. It demonstrated the value of the installation's sea turtle protocols and added a new species to its list.

When two campers walking the beach at NASO Dam Neck Annex found a sea turtle nesting, they notified staff at the Sea Mist campground, where they were staying, who then notified staff at the Virginia Aquarium Stranding Team (VAST). The calls set into action the procedures for protecting endangered sea turtles, which brought together professionals from partnering agencies. After analyzing the campers' photos and marks left by the nesting turtle, they concluded they had a rare visitor—a Kemp's ridley sea turtle (*Lepidochelys kempii*). This was the farthest north the species had been known to nest. Protection of the nest and hatchlings helped 72 turtles make it to the ocean.

While most of the NASO shoreline is not ideal for sea turtle nesting, the roughly four-mile stretch at Dam Neck Annex (DNA) does provide suitable habitat bordering the Atlantic Ocean. Five species of sea turtle are known to frequent these waters at some point during their development:

1. Green (*Chelonia mydas*)
2. Hawksbill (*Eretmochelys imbricata*)
3. Kemp's ridley (*Lepidochelys kempii*)
4. Leatherback (*Dermochelys coriacea*)
5. Loggerhead (*Caretta caretta*)

Until the Kemp's ridley sighting in 2012, only two of these species were known to have nested successfully along the southeastern Virginia coastline—Loggerhead and Green.

While not the first Kemp's ridley to nest along the Atlantic coast, it was the first in Virginia and an unusual event for the species. Kemp's ridley sea turtles typically nest along beaches in the western Gulf of Mexico in a mass nesting event called an arribada, with many females coming ashore at the same time in the same area.

All sea turtle species are federally listed under the Endangered Species Act

An adult Kemp's ridley sea turtle making a nest and laying eggs. Obvious signs of old damage to the sea turtle's shell are likely due to shark bite.

Doug and Yvonne Gilbert

(ESA) as threatened or endangered. The Kemp's ridley was listed as endangered in 1970. As part of its responsibility to protect endangered species, NASO maintains Standard Operating Procedures (SOP) for sea turtles to address how to patrol for and respond to turtle crawls, nesting and/or strandings on installation beaches.

The NASO-DNA sea turtle program is managed in cooperation with the U.S. Fish and Wildlife Service's (USFWS) Back Bay National Wildlife Refuge (BBNWR). During sea turtle nesting season, NASO staff and authorized individuals conduct daily patrols to look for nests, signs of turtle crawls and stranded turtles. They patrol at both NASO-DNA and Virginia Army National Guard-Camp Pendleton. The trained patrollers begin their work at least 30 minutes before sunrise, first scouting along the water's edge then proceeding to mid-beach to look for signs of turtles and turtles themselves.

In mid-June 2012, NASO's Natural Resources Manager Michael Wright had completed her morning patrol with no signs of nesting. Later that day, she was contacted because campers at the Sea Mist campground reported a nesting turtle. Wright and her colleagues from VAST, BBNWR and Virginia Department of Game & Inland Fisheries (VDGIF) initially were skeptical because the sea turtles that typically nest on the installation nest at night. After inspecting photos the campers had taken and distinctive crawl marks left by the turtle, the group determined that the nest was that of a Kemp's ridley, the only turtle known to nest during the day. According to the campers who saw the turtle nesting, she spent less than two hours on the beach from the time she left the water until she re-entered.

A Kemp's ridley sea turtle nest with nest predator guard cage installed and posted with signage (Sea Turtle General Information and National Wildlife Refuge/USFWS signage).
NASO Environmental Staff

The Basics About the Kemp's Ridley Sea Turtle

THE KEMP'S RIDLEY sea turtle has been on the endangered species list since 1970. A few of its unique characteristics include being the smallest of the sea turtles, typically nesting in mass nesting events and nesting during daylight. The relatively diminutive Kemp's ridley reaches only about two feet in length and about 100 pounds. Compare that to one of Virginia's more frequent nesters, the loggerhead turtle, which can average three feet long and weigh about 300 pounds.

Habitat information provided by the USFWS notes the following: Outside of nesting, the major habitat for Kemp's ridleys is the nearshore and inshore waters of the northern Gulf of Mexico. Adult and sub-adult Kemp's ridleys primarily occupy nearshore habitats that contain muddy or sandy bottoms where prey can be found. Kemp's ridley hatchlings and small juveniles inhabit a very different environment than adults. After emerging from the nest, hatchlings enter the water and quickly swim offshore to open ocean developmental habitat where they associate with floating Sargassum seaweed. They passively drift within the Sargassum, feeding on a wide variety of floating items. Some of these juvenile turtles remain within Gulf of Mexico currents while others are swept out of the Gulf and into the Atlantic Ocean by the Gulf Stream. This developmental period is estimated to last approximately two years or until the turtles reach a carapace length of about eight inches, at which time these sub-adult turtles return to neritic zones of the Gulf of Mexico or northwestern Atlantic Ocean where they feed and continuing growing until they reach maturity.

Source: www.fws.gov/northflorida/seaturtles/turtle%20factsheets/kemps-ridley-sea-turtle.htm

When nests are located, NASO and USFWS biologists determine if the nest can remain in place or will need to be relocated. Factors considered include:

- Height on the beach (preferably close to the toe of the dunes)
- Location relative to average high tide line (regular inundation by water will result in embryonic mortality)
- Width of the beach
- Amount of public use
- Location relative to a military training area
- Susceptibility to erosion
- Proximity to a sloughing escarpment (susceptible to being buried too deep).

Nests at risk, as determined by the NASO Natural Resources Manager and the USFWS biologist, are relocated to a safer location. Nest relocation follows exacting steps to protect the eggs.

In the case of the Kemp's ridley nest, it was safe to leave it in place. After USFWS personnel collected one egg for a genetic study, the team implemented nest protection steps, including:

- Installing a wire cage to keep out predators
- Placing informational signs, wire, flagging, and reflectors to educate the public, deter human disturbance and alert permittees driving on the beach
- Checking daily to ensure no unauthorized disturbance of the nest had been made, to determine if hatching had commenced, and to document any signs of predatory disturbance and plant or pest invasion.

(For more information on the genetic study, see the our sidebar "Tracking the Genetics of Nesting Turtles")

Having exact nesting time data helped the team know when to begin nest monitoring and sitting procedures, including two daytime checks and overnight "sitting." Regular presence is needed overnight because most nests hatch at night. It is important to have individuals present during hatching to protect the hatchlings from predators (including gulls, raccoons and foxes) and to help guide them to the water.

The Kemp's ridley nest hatched within one week of the time estimated by NASO and USFWS biologists. Individuals on hand during the hatch estimated that 71 hatchlings reached the ocean. Because hatchlings can continue to emerge for up to two weeks following the initial hatch, monitoring continues. When no addi-

Michael Wright (in the background) aiding a USFWS biologist in the excavation of the 2012 Kemp's ridley sea turtle nest located at NASO Dam Neck Annex. This was the first Kemp's ridley sea turtle to nest in Virginia and the most northern known location of a nesting Kemp's ridley sea turtle in North America. The nest was deemed successful with a total of 85 eggs, of which 72 hatched.

NASO Environmental Staff

Michael Wright holding an endangered Kemp's ridley sea turtle hatchling. The hatchling was found during the excavation of the nest after the nest had successfully hatched. Mrs. Wright and a number of volunteers, in coordination with the USFWS and the VDGIF, released the sea turtle later that evening and watched it successfully make its way into the Atlantic Ocean.

NASO Environmental Staff

tional hatchlings emerge, it is standard practice for the biologists to excavate the nest to study any remaining eggs or dead hatchlings. In this nest the biologists discovered 13 unhatched eggs, one live hatchling (released that night) and one dead hatchling. Ultimately the team determined a surprisingly high hatch success rate of 86 percent.

Despite multiple false crawls (a turtle coming onto the beach but not nesting), this was only the third confirmed sea turtle nest in the last 30 years at NASO-DNA. The two previous nests, in 1992 and 2002, were loggerhead sea turtles. Another Kemp's ridley nest was confirmed in Virginia, south of NASO-DNA, in 2013.

Sea turtle experts are uncertain why these Kemp's ridley nesting events are occurring in such unexpected places. Possibilities proposed include some combination of effects of oil spills in the Gulf of Mexico, climate change, natural territory expansion, interspecies breeding between Kemp's ridleys and loggerheads, and releases of Kemp's ridley hatchlings along the Atlantic coast.

The sea turtle patrols at NASO-DNA will continue, now with a new turtle to watch out for.

NASO's sea turtle program, managed cooperatively with USFWS BBNWR personnel in Virginia, maintains SOPs that clarify the respective roles of all participants in the program and detail all activities related to sea turtle strandings, crawls, nests and nest hatches.

Annual training and refresher training is required of all program participants, including those who patrol and nest-sit. Environmental staff have the primary role in daily turtle patrols. The nest-sitting program is staffed largely by trained volunteers who have necessary installation access approval.

A Kemp's ridley sea turtle (*Lepidochelys kempii*).
Adrienne McCracken

Tracking the Genetics of Nesting Turtles

ONE PIECE OF endangered sea turtle recovery would benefit from understanding more about nesting habits including:

- How many individual females are nesting?
- How many nests does one female lay in a season?
- Do they return to the same spots to nest?
- Do their daughters return to those locations?
- What can be known about the nesting populations?

While tagging has been tried, its results can't answer all of these questions.

Scientists at the University of Georgia's (UGA) Warnell School of Forestry and Natural Resources have developed genetic testing tools that can analyze maternal DNA from viable turtle eggs. Working with USFWS personnel, researchers from UGA have been conducting analyses of loggerhead turtle eggs. Initially focused in three states of the species' Northern Recovery Unit (Georgia, South Carolina and North Carolina), the effort has expanded to Virginia.

To secure the maternal nuclear DNA, the scientists need material from between layers of the inner shell membrane, extracted within 24 hours of egg-laying. This allows them to identify the female that deposited the eggs, rather than her offspring.

While this effort is focused on loggerhead turtle nests, the more common turtle to nest in the study states, one egg was collected from the NASO-DNA Kemp's ridley nest and from a subsequent nest at False Cape, Virginia. Based on visual observations of the nesting turtles it is known that these two nests were from two different females. Additional information regarding whether the two females are related, however, might become available through the genetic testing.

For more information on the Northern Recovery Unit DNA Project, visit www.seaturtle.org/nestdb/genetics.shtml.

Training covers a wide range of topics that range from knowing what to look for to how to use and maintain the patrol equipment. Turtle-specific training includes:

- When, where and how to patrol
- What to do if there are signs of a turtle, signs of turtle crawl and/or signs of a nest
- Who to contact and the role each partner plays
- How to protect a nest
- How to monitor nests
- How to protect hatchlings on their way to the ocean.

The trainings use the current knowledge of standard practices and legal requirements.

In addition to training individuals, NASO widely distributes informational brochures about sea turtles and about the beaches and dunes of the Navy Mid-Atlantic Region, where sea turtles might nest. Sea turtle information is also published in the local Navy newspaper (the *Jet Observer*) and the installation's Officer In Charge provides notices during the weekly installation tenants meeting in advance of and during nesting season. The brochures include the USFWS's "You Can Help Protect Sea Turtles" and the VDGIF's "Where Sea Turtles Roam."

The specific information, comprehensive training and public information efforts are critical to supporting a successful nest and protection of an endangered species. ⚓

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ONE OF MY Best Shots

I captured this image of a sunrise looking east from San Clemente Island in January 2015 as we headed toward the Southern California Anti-Submarine Warfare Range for a marine mammal survey. Researchers from Cascadia Research and the Naval Undersea Warfare Center Newport, Rhode Island are studying the behavior of Cuvier's beaked whales in the region as part of the Navy's program to understand the impacts of training on the different species of marine mammals that inhabit the area. The calm seas help the survey work, making it much easier to visually locate and tag these cryptic animals.

The photo was taken with a Canon EOS 7D, with a 100-400mm f/4.5-5.6 lens, ISO-320 at f/6.3, and shutter speed of 1/1250.

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

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