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Marine Protected Areas

Sustaining benefits | Meeting challenges | Seizing opportunities

PROCEEDINGS

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Marine Protected Areas

Applications and Tools

Economics, Policy, and Law

Living Marine Resources

On Deck

Nautical Queries

On the Cover: Lori Mazzuca, a Coast Guard PACAREA marine protected species manager and fine art photographer, captured this image of a humpback whale in the waters off the Hawaiian Islands. She also photographed the Hawaiian monk seal on the back cover, who seems to be warning readers not to skip articles. In reality, the seal was rescued from the wild to treat a virus that can cause temporary blindness.

Ms. Mazzuca's photos "Killers in the Mist" and "New Life" also accompany Mr. Brian Corrigan's article in this issue.

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Assistant Commandant's Perspective

by Rear Admiral Anthony J. Vogt
Assistant Commandant for Response Policy
U.S. Coast Guard

The Coast Guard has a long and storied history of protected resource conservation and enforcement that continues today through the Living Marine Resources and Law Enforcement missions. In this edition of *Proceedings*, contributors discuss various aspects of marine protected areas, including sanctuaries and marine national monuments, and the challenges and opportunities presented when monitoring human uses and enforcing federal laws.

From a global perspective, Target 11 of the Aichi Accord establishes the goal to conserve at least 10 percent of coastal and marine areas. Subsequent to that, the International Union for the Conservation of Nature approved a motion at the 2016

Champion's Point of View

by CAPT Jay Caputo
Chief, Living Marine Resources
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Everyone is a stakeholder when it comes to the sea. John F. Kennedy said, "We are tied to the ocean, and when we go back to the sea, whether it is to sail or to watch, we are going back from whence we came."

Unfortunately, we are falling short when it comes to protecting this valuable resource. International law requires a minimum of 10 percent of marine and coastal areas to be effectively protected by 2020,[1] yet today, only 4 percent of marine and coastal areas are protected by law, and less than 1 percent is fully enforced.[2] This issue of *Proceedings* explores the many ways in which marine protected areas (MPAs) can help to preserve our oceans.

What is an MPA? Some people argue it is a means to preserve an area to prevent the overharvesting of fish, corals, and other natural resources. To this end, these areas act as reserves to replenish what humans remove from the ocean. Many others believe MPAs should be "no-take," meaning you cannot remove any

World Conservation Congress to protect 30 percent of the global oceans by 2030. This emphasis on the management and use of ocean resources spans well beyond the conservation communities. Commercial and industrial sectors with equities in the ocean environment are also at the table to share their needs, perspectives, and expertise.

Here in the United States, we recently observed the 45th anniversary of the Marine Protection, Research, and Sanctuaries Act that established NOAA's National Marine Sanctuary Program. Since the program's adoption, the Coast Guard, NOAA, and other government and commercial partners have worked together to support multiple, compatible uses of federal marine protected areas and safeguard the underlying resources from damage caused by prohibited activity.

While the need to continue this work in the near term is clear, we have a long way to go before we fully understand the resource requirements, programs, policies, and legal frameworks needed to sustain ocean ecosystem health and productivity. Sustaining a system of marine sanctuaries, monuments, and other specially designated areas is one of many strategies needed to effectively manage human uses of the ocean. However, many of the characteristics that make good candidates for designation as marine protected areas—namely, substantial tracts of largely intact marine habitat and remoteness from hubs of commercial activity that offer default protection from exploitation—also make these areas difficult to monitor and protect.

The Coast Guard has vast authorities within marine protected areas and the responsibility to exercise them. We will continue to support and build robust policy and programs that are well-grounded in scientific research. We will support these efforts through enhanced enforcement capabilities such as remote sensing technologies, the National Security Cutter, and the planned Offshore Patrol Cutter—a new surface asset that will serve as the Coast Guard's workhorse in these vast, remote operating areas.

I would like to extend my thanks to the authors who provided their viewpoints through the articles on the pages that follow and hope that you will share your thoughts about the Coast Guard's efforts to protect and govern our oceans.

resources or they should be left completely undisturbed by mankind to preserve their pristine wild ecosystems. Thus, fishing, aquaculture, transportation, energy extraction, essential fish habitats, and recreation come into conflict with MPAs and require planning for the effective use of ocean space.[3]

The creation of an MPA comes down to what a community values and their relationship with the ocean. There are many different non-use values. For example, *option value* is preserving an area for future use, thus not disturbing it. The *quasi-option value* protects an area for unknown future benefits; for example, organisms that could be used to make medicines or industrial materials. The *bequest value* is based on the belief that we have a responsibility to pass along our natural heritage for future generations. *Existence value* is the appreciation of the inherent value of marine wildlife and healthy ecosystems. *Terra incognito* is the preservation of submerged cultural resources. All are valid reasons for preservation, because the ocean itself doesn't care one way or another.[4]

Understanding the relationship between marine reserve design and performance is essential to decision making about enforcement and monitoring systems for ensuring success and desired outcomes.[5] In December of 2016, the action plans for both the Northeast[6] and mid-Atlantic ocean planning[7] were certified by the president. There will undoubtedly be more in the future, and the U.S. Coast Guard will remain an integral part of this process as we regulate these plans or provide protection to people using the sea for various purposes.

Please consider this issue a journey into the different types of MPAs and the issues that surround them. I would like to thank the many authors who provided outstanding perspectives on this topic, and I hope you will find yourself asking difficult questions about how marine protected areas can be best used to benefit mankind.

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3. National Ocean Council, National Policy for the Stewardship of the Ocean, Our Coasts, and the Great Lakes, https://obamawhitehouse.archives.gov/administration/eop/oceans/policy
4. Bradley W. Barr, et al., 2003, "Non-use Value of Marine Protected Areas"
5. Michale B. Mascia, "Social Dimensions of Marine Reserves"
6. Northeast Regional Planning Body, http://neoceanplanning.org/
7. Mid-Atlantic Regional Council on the Ocean, http://midatlanticocean.org/

Paper Parks, Paper Tigers, and Paper Trails

Marine protected area designation and enforcement

by Steven Tucker
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Intensifying and proliferating uses of offshore waters challenge existing frameworks for managing varied ocean uses, and for avoiding undue impacts to ocean resources. The fields of marine policy and applied ocean management are evolving in response. It is abundantly clear that decisions made in the coming years carry heavy implications for the ocean, and human dependence on the resources found there. Calls to action are emanating from the daises of countless ocean conferences and multinational meetings, and a flurry of consensus statements and proclamations raise targets for marine protected area (MPA) coverage. These include the Aichi Target to protect 10 percent of marine and coastal areas by 2020 and the International Union for Conservation of Nature (IUCN) target of 30 percent by 2030, which might best be described as a stretch goal.

In addition, the United Nations General Assembly has endorsed multinational efforts to explore frameworks for managing activities on the high seas, and global interests in the marine environment were recently codified in the United Nations Sustainable Development Goals (Goal 14). The urgency underlying these efforts to better align multinational efforts is wholly warranted.

Lion's mane jellyfish floats through California's Monterey Bay National Marine Sanctuary. NOAA photo by Kip Evans

However, the designation of vast and remote areas as MPAs raises the question of whether unenforced protections are a step forward, or are instead detrimental to sound maritime governance and improved environmental outcomes: "the establishment of very large MPAs in the last five years has far outpaced research on the ecological effectiveness of these MPAs."[1] Vast designations raise the prospect of "**paper parks**" that risk failure because they are inadequately supported to accomplish their intended purpose. As noted by Simon Upton of the Organization for Economic Cooperation and Development:

> ***Progress in expanding the coverage of marine protected areas is underway. With a push from the Sustainable Development Goals, their global coverage is expected to increase even further. But their effectiveness is uneven. It is one thing to draw a line on a map—it is another to effectively design, site, monitor, and enforce them.***

In some instances, it seems the waves of progress for protected area designations are dashed on the rocks of loose rhetoric, undermining implementation. It is as though a collective détente takes shape, a consensus to forego the difficult and time-consuming discussions that establish the footing for effective MPAs and instead, turn to more provocative terms such as:

- piracy
- food security
- territorial sovereignty
- combating illegal fishing
- transnational criminal organizations

Of course, these are very real concerns in some areas. As we will see, the gravity of these challenges should inform decisions about the scale and type of intervention

required, and demands that the terms be used responsibly, precisely, and with restraint. When such terms are misapplied in order to lend urgency to the designation of MPAs, the dialogue is misappropriated. The resulting misalignment of effort and the challenge of focusing on the true threats at hand can render maritime authorities "**paper tigers.**"

In order to manage activities in MPAs in a manner consistent with sound maritime governance and non-use or multiple-use objectives, MPA managers must invest substantial work to build and maintain a credible administrative framework. This investment in "process" is necessary for effective designation and implementation. It should include a well-targeted and properly scaled enforcement and compliance program supported by a robust threat assessment. These "**paper trails**" are the necessary overhead for successful protected area planning and management. They establish the foundation necessary to support adaptive approaches and accommodate future change.

Yellowfin goatfish at Kure Atoll in Papahānaumokuākea Marine National Monument in the northwestern Hawaiian Islands. NOAA National Marine Sanctuaries photo by Claire Flacker

Paper Parks

For nearly a decade, coastal nations have been responding to calls to reach global MPA targets by making sweeping MPA designations. In their zeal to designate marine protected areas and enjoy the economic and environmental benefits derived from them, they sometimes set aside practical considerations—like enforcement and compliance—that bear on the success of MPAs.[2]

In distant waters, and sometimes closer to home, it can be time and cost prohibitive to identify a suspect vessel and then inspect and potentially apprehend it while in the act of violating protected area regulations. Enforcement agencies must constantly prioritize among different threats. They must balance high-effort, resource-intensive operations that target specific high-consequence violators against more proximate, frequent, and routine contacts. In either case, a strategy of gaining compliance through vessel-by-vessel boardings and interdictions may deter a nominally motivated actor, but may be too blunt an instrument to curtail organized operations that engage in persistent, programmatic exploitation of the resource. Field response to violations already taking place is a fundamentally reactive approach and is not, in isolation, the right tool to thwart illegal activities of distant water fleets or to undermine transnational criminal organizations. Administrative investigations may deliver greater impact than pulse operations in the field by striking

Poaching Networks and U.S. Markets

Contemporary examples of organized, networked poaching of protected species or excess harvest of fish stocks are not difficult to come by. By the time these enterprises are interrupted, they may have been in operation for years, exerting control over people, capital, and vessels well beyond the host nation's boundaries. For example, the Bengis case involving a network located in South Africa that profited from overharvest and international distribution of lobster to the United States caused an estimated $46.7 to $61.9 million in damage to South Africa's stock.[1]

More recently in the United States' most lucrative fishing port of New Bedford, Massachusetts, a multivessel fishing corporation amassed rights to a substantial portion of the permitted harvest, engaged in systematic overharvest and mislabeling of product over a span of multiple years. As with Bengis, the Carlos Rafael case violations in the field were amplified when the investigation expanded to business records, revealing a pattern of malfeasance entirely out of scope with the fishing activity represented in log books and other first order reporting mechanisms.

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nearer the upper echelons of a corporation or organization that systematically pursues illegal harvests.

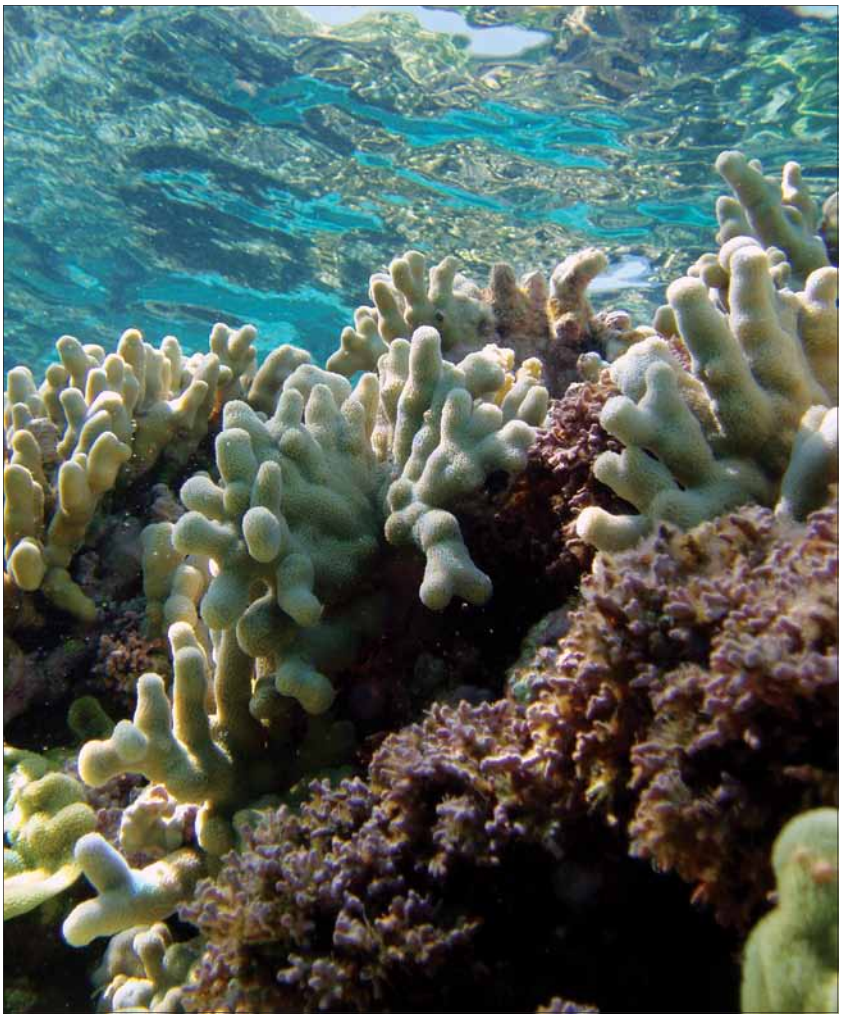
Some nations have designated all or a substantial portion of their exclusive economic zone (EEZ) as a sanctuary in an attempt to stave off incursions by foreign fishing vessels. The United States has taken similar action around some of its island holdings. From an enforcement perspective, large MPAs designated in the absence of adequate monitoring and enforcement dilute the benefit of identifying a geographic region for special protection.

Difficulties policing the ocean are amplified when vast protected areas—such as an entire EEZ, or hundreds of thousands of nautical miles—are created with no provision for increased monitoring and enforcement. In such cases monitoring and surveillance by civilian authorities remains weak, overcome by the tyranny of time and distance. As a result, compliance is dependent upon normative factors that may prompt a higher level of stewardship.[3]

Designation of new or expanded protected areas where there is an enforcement vacuum exacerbates existing shortfalls of maritime governance and may not result in behavior changes sufficient to improve the condition of the resource being protected. This fact seems to be the subject of frequent reacquisition in the cycle of published literature and media coverage related to ocean governance.[4]

New tools may be at hand to help address these shortfalls. For example, protected areas that limit access can generate new revenue by recovering rents that are not captured when activities go largely unconstrained. Innovative uses of such funds to ensure continued historic or traditional use and to mitigate against undue harm are showing success. These funds should also be used to meet the fundamental need for monitoring and for enforcement of protective regulations for the area.

Globally, there are areas that depend on fish as the principal source of dietary protein, and where the collapse of commercial fisheries brings economic or existential consequences.[5] States with weak civil governance structures are bound to be even more fractured when it comes to protecting both national and community-level interests in the marine environment. Weak states, young nations with undercapitalized or faltering governments, or economies and societies in regions with scant natural resources are at greater risk of instability. We might expect that poaching in the marine environment will be more rampant under such circumstances, just as is the case for terrestrial species.[6] Under these conditions, sufficient national interests may be at stake to prompt a decision about the use of "gray-hull" military assets and trained warfighters for natural resource law enforcement. Using such military forces to ward off foreign interlopers who steal resources that are vital to civil stability and subsistence may make sense, but it is important to carefully consider the potential consequences of such a decision. It can trigger or exacerbate diplomatic sensitivities, and can be detrimental to the very interests in need of protection, when "increased levels of military-style enforcement could increase poverty and alienate local communities."[7]



Finger coral reef in the lagoon at Kure Atoll State Wildlife Refuge in the Northwestern Hawaiian Islands Marine National Monument. NOAA National Marine Sanctuaries photo by Claire Flacker

Paper Tigers

Inconsistent treatment of illegal fishing as a crime or a violation or as a matter of sovereignty is problematic. It clouds discussions meant to reach consensus on uniform approaches to enforcement. For large MPAs and for future oversight of the high seas, a standard of conduct that sets expectations for the roles of civilian law enforcement, management authorities, and military forces

Coast Guard members from the USCGC *Kiska* depart a sailing vessel after passing out safety information to mariners operating off Maui in the Hawaiian Islands Humpback Whale National Marine Sanctuary as part of Operation Kahola Guardian 2016. The *Kiska* crew, along with Coast Guard members from Station Maui and officers from the Hawaii Department of Land and Natural Resources, conducted safety and compliance boardings on recreational and commercial vessels to inform the public of the requirements to avoid coming too close to whales or impeding the whales' path. Coast Guard photo by Petty Officer 2nd Class Tara Molle

is essential. Complicating matters is the lack of consensus among nations about the gravity with which illegal fishing in protected areas should be addressed, particularly as it relates to foreign nationals illegally fishing in sovereign waters.

A community of nations is galvanizing in support of harsher penalties and increasing the costs incurred by vessels and operators operating illegally. These parties advocate for treatment of illegal or unreported fishing as a serious crime. Activating criminal procedures triggers judiciary and diplomatic interventions that until now have been difficult to reconcile with the Law of the Sea and, closer to home, with the United States' own tendency to approach fishery and marine protected area violations—absent amplifying factors—as civil matters.

Instead, we need to better map illicit supply chains, dragging key figures and organizations into the daylight and holding illegal actors accountable for the full spectrum of their illegal activities. Furthermore, analytic work to identify the threat that these activities pose to U.S. MPAs and the economic costs to the U.S. seafood market are long overdue. Consider that our own U.S. commercial fishing fleet is estimated to be upwards of 83,000 vessels. In order to make the best decisions supporting U.S. interests, we need to understand the economic benefits that could be derived from improved compliance in the U.S. fishery and the costs of reduced compliance by foreign vessels. Countering either threat by relying on periodic contacts and interdicting individual vessels is a risk management strategy, rather than a solution.

In light of the designation of vast MPAs by nations with modest maritime capabilities, is it time to call for an even greater role for the world's war-fighting apparatus, and particularly for the United States' Department of Defense? The U.S. Navy and other nations' gray-hulled counterparts, despite their might and capabilities, are not built to police marine protected areas and enforce fishing regulations. Naval vessels are often configured to travel in groups, the different vessels complementing one another and presenting a lethal projection of force. While they are versatile, bringing such a force to bear to enforce marine protected areas and international fisheries regulations carries different implications than does the use of law enforcement vessels.

The marine debris discovered in the Northwestern Hawaiian Islands Marine National Monument contains a significant amount of derelict fishing gear. NOAA National Marine Sanctuaries photo by Claire Flacker

In their article "The Non-State Navy: Sea Shepherd as a Case Study for 21st Century Non-State Actors," Chris Rawley and Claude Berube provide an interesting case-in-point. Their paper provides views on the *Sea Shepherd's* anti-whaling tactics and the organization's standing under the piracy provisions of the Law of the Sea. They draw comparisons to criminal organizations, at best, or terrorist organizations, at worst. Importantly, they also contend that operationalization of private, less-than-lethal assets supporting conservation priorities, and the increasing grassroots support for groups adopting such tactics, are a sound proxy for gaps in maritime governance.

In the absence of legal authorities properly governing activities of concern, issue-based organizations may rise to fill the vacuum. Rawley and Berube contend that such action further undermines maritime governance and the rule of law because weakened or absent maritime governance affords criminal networks the opportunity to gain a foothold and shore up traditional activities with black market revenues.[8] Thus, whether for profit or principle, vacuums in maritime governance result in an influx of independent actors.

The article provides a useful stepping off point—describing the organizational structure of non-state groups taking action in ocean basins, and comparing their tactics with military doctrine. We can borrow their approach and turn from anti-whaling groups to instead focus on illegal fishers and others that would exploit the resources within designated protected areas in a persistent, programmatic manner for the sake of profit. For these actors, we know the operational assets are broadly dispersed, they operate with a degree of independence, having received general instruction from the organizing command, and they prefer to stay in the shadows. While it may be an uncomfortable analogy, organized smugglers and illegal harvesters share these characteristics with other unconventional combatants in the world's conflict areas seeking to gain advantage by subverting the rule of law.

Rather than looking to bring to bear additional military personnel and assets, we might look to military strategies as models for defeating networks and their success countering terrestrial poaching operations. Effective field enforcement for natural resource violations when the threat is suspected to be an organized entity depends on the ability to gain sufficient advantage, get beyond the field operators, and hone in on the coordinating entity.

For example, the International Fund for Animal Welfare has incorporated elements of the U.S. military's approach to defeating networked threats into its counter-poaching efforts in terrestrial protected areas. Their tenBoma initiative cultivates ties with existing authorities and affected communities.[9] This approach integrates operational and intelligence capabilities, places information collection near the forefront of operational priorities, and emphasizes efforts to fully use information gathered from the field. Accordingly, operations are targeted and conducted in such a manner to optimize that information and to enlist other users of the information to create a network of forces that can more effectively counter the networked threat.[10]

Paper Trails

Is there an argument to be made that earnest investment in "mere process" produces better outcomes? There is—and it turns on, among other things, the tenets of sound management and governance. This includes the need for local advocate and stakeholder acceptance, and to maintain good faith with skeptics and opponents in the interest of long-term success.

Guidance on the establishment of marine protected areas and sound ocean planning tends to highlight the centrality of civil process and public participation in the designation process. First, designations must give weight to the enforcement component of management efforts.

A proper threat assessment should be conducted in advance and inform decisions about the scope and extent of the protected area. The enforceability of protections that will be put in place and the spatial extent of the area subject to them are likely to be key factors determinative of enforcement effectiveness.

With greater clarity than ever before, nations now acknowledge that ocean resources are themselves finite, and vested with bounded capacity to renew themselves. It is also abundantly clear that, left unguarded, many nations possess the means and inclination to take these resources as their own. In response, the global community is moving toward the laudable goal of building a framework for managing impacts to high seas resources. As a consequence of that, we draw nearer to making the final cuts that carve up the ocean, assigning her benefits to separate parties. We will be parsing out ocean resources once held in common. As we do so, nations will grow more strident in their actions to protect the resources they lay claim to, and will be even more likely to take an adversarial stance toward others infringing on those claims, be they states or individuals.

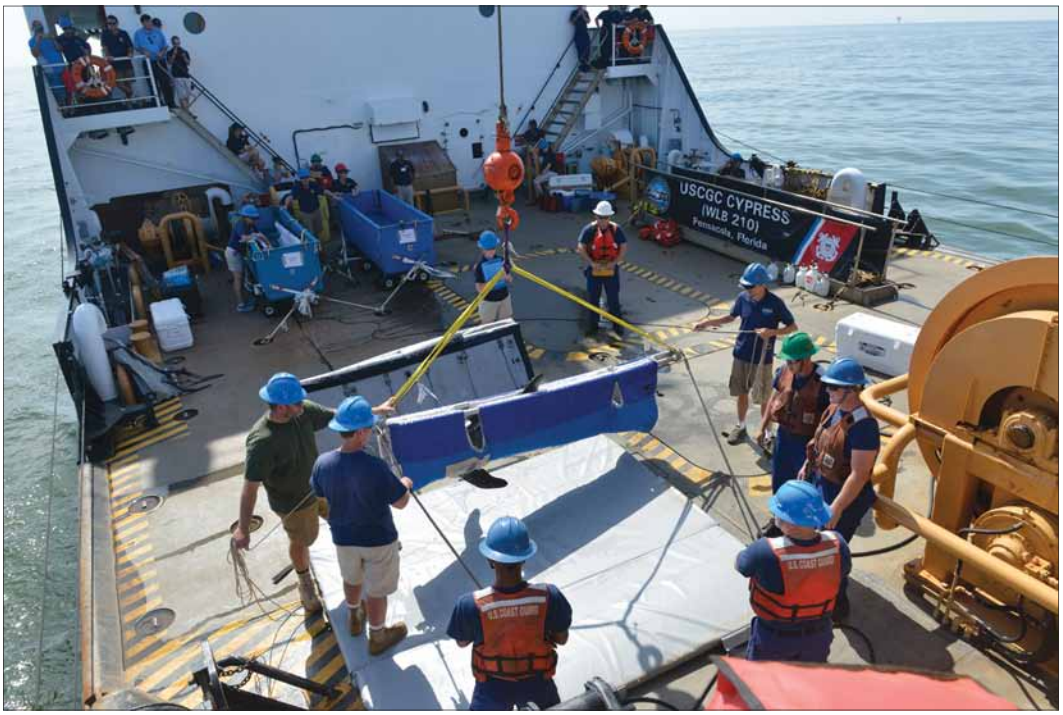
Conclusion

We are seeing a proliferation of tools to identify illicit activity in the maritime environment. The application and leveraging of technology to improve the reach of monitoring and surveillance, and the application of decision science and machine learning[11] to safeguard specially designated areas of the ocean are being brought to bear. Is the next step greater reliance on military assets? This is one of the questions at the root of recent writings and continuing discussions among stakeholders and governments.

Unfortunately, it is far too coarse a question. Related discussions become muddled between the bona fide food security concerns that often arise in the highly productive near-shore waters that support local subsistence and trade, and other interests that are prevalent in more distant waters, where species like tuna and shark are harvested as a commodity catch destined for distant markets. The distinction between subsistence activities and commodity harvest needs to be considered when calibrating a response to illegal activities in marine protected areas.[12]

The waters become murky when a case is made to use nations' gray-hulled assets to police civilian commercial activities in large marine protected areas, because the nexus with subsistence becomes more tenuous. In his book "Sea Power," Navy Admiral James Stavridis puts a fine point on it, saying of the U.S. plan against illegal, unreported, and unregulated fishing, "Neither the Coast Guard, nor the U.S. Navy, has the spare capacity to undertake the kinds of sweeping tasks outlined in the plan."[13]

A local fisherman on Puako, Hawaii Island, resets his net to cast it in Hawaiian Islands Humpback Whale National Marine Sanctuary. NOAA National Marine Sanctuaries photo by Claire Flacker



A pygmy killer whale is hoisted by crew members from USCGC *Cypress*, NOAA, the Institute of Marine Mammal Studies, and the Navy Marine Mammal Program in July 2016. Two pygmy killer whales were taken more than 60 miles offshore to be released. Coast Guard photo by Petty Officer 3rd Class Lexie Preston

Where once fishers and resource managers overestimated the capacity of the sea to replenish harvested resources, we now seem to be at risk of overestimating the capacity of our seagoing services to police access to those resources. Occasional gray-hulled transits through isolated patches of distant waters with law enforcement personnel embarked is not an effective solution for sustained enforcement of marine protected areas or for countering persistent illegal fishing and trans-shipment.

The need is clear: To meet today's challenge of managing protected areas and extractive uses, expanded law enforcement presence on the ocean is necessary. Nations have significant ground to cover in order achieve strong, credible, civil systems of maritime governance and a balanced playing field. The extent of protected waters and the scope of regulated activities will only increase as more MPAs are designated; more fish stocks are marginalized, requiring closer management through more complex or numerous regulations; and other measures are brought to bear to govern our use of the ocean.

While there are lessons to be drawn from military strategies, the need for law enforcement should be met with increased investment in law enforcement training and assets. Throwing combat forces into the breach is a perilous and inadequate stopgap measure. Advocating for heightened military involvement, and the application of tools and technologies that facilitate national defense and war fighting, to instead counter violations of fishing and MPA regulations sets the stage for forecasts of increased maritime conflict to become self-fulfilling prophecies.

We might also look to a more widespread adoption of private sector response. Non-state organizations working on behalf of their memberships to advance sustainable ocean management may be part of the solution. Jurisdictions with scant maritime patrol resources and/or vast areas of responsibility should consider whether support from such groups could advance their goals. Calls for public-private partnerships and improved cooperation are commonplace. Using revenue generated by protected areas that limit access or control harvest rights to leverage the capabilities of conservation organizations willing to adhere to appropriate codes of conduct and other controls may be an effective force multiplier for surveillance, monitoring, and information gathering.

In addition, existing investments in training, material, and technical support for U.S. interests in such areas are important. Occasional missions that bring maritime law enforcement assets to remote areas and that vector U.S. law enforcement personnel to areas with weak organic enforcement capabilities are an important contribution to maritime governance. Pulsing such resources into an area makes a strong statement and may help deflect or deter illegal activity, temporarily clearing the area of illegal activity. But occasional law enforcement or military presence does not complete the cycle necessary to ensure sound maritime governance. Adequate training and development of local capability is required in order to achieve sustained compliance. To maintain this capability once it is established, "circuit riders" responsible for training personnel in remote or under-resourced areas should be established to help maintain MPAs and living marine resource law enforcement proficiency. Developing sustainable, organic capabilities sets the stage for developing a network equipped to counter threats from both independent actors and networked operations.

Ultimately, for the United States to continue its leadership of ocean governance, conservation, and sustainable uses, it must demonstrate its commitment by addressing

the problem of inadequate at-sea enforcement by setting fiscal priorities to address that shortfall. The Department of Defense has proven adept at being a force multiplier for partner nations, and the federal government has cultivated strong partnerships with state maritime enforcement agencies to augment existing at-sea enforcement capabilities. Neither of these is a fitting substitute for a fully resourced federal maritime law enforcement entity. As the United States continues to work with the community of nations toward improved ocean governance, it is incumbent on us to ensure that our own national marine sanctuaries, marine national monuments, and parks and refuges with marine components are adequately protected, and that protective regulations are supported by effective robust enforcement programs.

About the author:

Since 2008, Steven Tucker has served as the deputy chief for Marine Protected Resources at Coast Guard headquarters, responsible for program direction, oversight, administration, resource planning, technical leadership, and execution of the Marine Protected Resources [enforcement and conservation] program within the Coast Guard. The program's scope includes conservation and enforcement activities for endangered species, marine mammals, and federally designated marine protected areas in all waters subject to U.S. jurisdiction.

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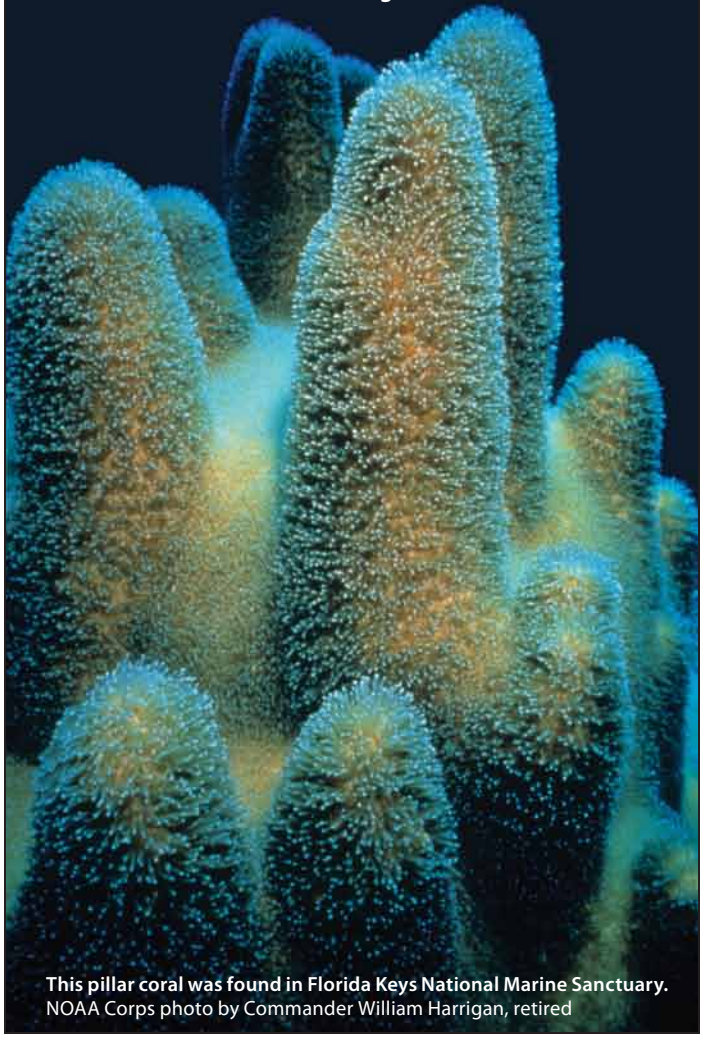
National Marine Sanctuaries Act: Prohibited Activities

The act makes it unlawful for anyone to do any of the following to any sanctuary resource:

- destroy
- cause the loss of
- injure
- possess
- sell
- offer for sale
- purchase
- import
- export
- deliver
- carry
- transport
- ship

Criminal penalties can result for interfering with the enforcement of this act by:

- refusing to permit any officer authorized to enforce [the act] to board a vessel to search or inspect
- "resisting, opposing, impeding, intimidating, harassing, bribing, interfering with, or forcibly assaulting" anyone authorized by the secretary of Commerce, or
- "knowingly and willfully submitting false information to the secretary of Commerce or any authorized officer" relating to a search



This pillar coral was found in Florida Keys National Marine Sanctuary.
NOAA Corps photo by Commander William Harrigan, retired

Guardians of the Sea

Protecting the oceans together

by Emma Skelley
Jennifer Damian
Graduate Student Volunteers
Office of National Marine Sanctuaries
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Last summer, the hit movie "Guardians of the Galaxy, Volume 2" reminded us of the importance of partnerships in tackling big jobs. In the movie, an earthling, a number of aliens, a mutant raccoon, and … well, whatever Groot is, teamed up to save the galaxy yet again.

In real life, the big job is protecting our oceans, and the National Oceanic and Atmospheric Administration (NOAA)'s Office of National Marine Sanctuaries, other NOAA offices, and the U.S. Coast Guard have been close partners in this battle for decades—and even longer.

The Beginning of a Partnership

In fact, we could say this cooperation between NOAA and the Coast Guard is centuries old. The Coast Guard, today a modern steward of resources and enforcer of maritime law, has its roots in the Revenue Cutter Service founded in 1790. NOAA can trace its mission of science, service, and stewardship of our oceans and coasts to the 1807 founding of the Coast Survey.

With three main areas of focus—promoting a safe and sustainable marine environment; enhancing regional collaboration; and fostering innovation in science, technology, and youth education—the 2013 Cooperative Maritime Strategy guides the NOAA-Coast Guard partnership.

The Coast Guard works with various NOAA entities in these activities, such as the Office of Response and Restoration; the Office of Law Enforcement; NOAA Fisheries; and the NOAA Corps, the nation's smallest uniformed service.

The Coast Guard is also one of the National Marine Sanctuary System's oldest partners. Established in 1972,

NOAA's R/V *Shearwater* and the USCGC *Halibut* conduct remotely operated vehicle operations over the USCGC *McCulloch* shipwreck site. NOAA photo by Robert Schwemmer

the sanctuary system covers more than 600,000 square miles of ocean and Great Lakes waters from the Hawaiian Islands to the Florida Keys, and from Lake Huron to American Samoa. It consists of 13 national marine sanctuaries and two marine national monuments that are home to historical shipwrecks, a wide diversity of habitats, and myriad wildlife ranging from whales to shorebirds. Cooperation between the sanctuary system and the Coast Guard takes place in a variety of areas, including enforcement of sanctuary regulations, emergency response, and joint stewardship of maritime heritage resources.

Enforcement

The Coast Guard is the primary enforcement agency for the navigable waters of the U.S. and works with other authorities to ensure enforcement efforts are coordinated and complementary among other federal, tribal, state, and local agencies.

NOAA provides additional support through joint enforcement agreements, which are prepared to help coordinate between NOAA Office of Law Enforcement and state fish and wildlife management agencies to enforce sanctuary regulations and other NOAA laws. The joint enforcement agreements also cross-deputize state officers so they can enforce federal regulations.

A sanctuary advisory council in Key West, Florida, provides a forum for the discussion of issues related to the Florida Keys National Marine Sanctuary. The Coast Guard has a representative on each of the 14 site-based advisory councils.
Coast Guard photo by Petty Officer 3rd Class Michael Hulme

Coast Guard representatives participate in sanctuary advisory councils—community-based groups established to provide advice to the superintendent of a sanctuary—to provide input on a variety of topics. Such coordination allows each partner to be responsive to the management priorities of the other, as well as providing them a more complete picture of what's happening on the water. Issues are addressed more quickly, allowing for resolutions to be made before management problems become bigger issues.

Not all joint activities are regulatory, or even so formal. The sanctuary system and Coast Guard work together in other areas such as outreach and education. For example, boater education has increased in Florida Keys National Marine Sanctuary as a result of a partnership between the U.S. Coast Guard and the sanctuary. Members of the Coast Guard Auxiliary use marked vessels to visit different parts of the sanctuary, inform boaters of its special zones and rules, and promote boating safety.

Vessel Traffic Management

The Coast Guard has the authority to manage vessel traffic in U.S. waters. NOAA has worked with the Coast Guard to help reduce vessel traffic impacts on sanctuary resources, and it also works with the IMO if international traffic is part of the concern. The United Nations' International Maritime Organization (IMO) is a specialized international agency with the authority and responsibility to ensure safe and secure shipping and protect marine environments from the harmful effects of international shipping. The Coast Guard is the official United States representative to the IMO. NOAA provides scientific and technical expertise to the Coast Guard in this role.

Working together, the Coast Guard and the National Marine Sanctuary System have established a number of IMO-approved vessel traffic management measures to help safeguard the natural and cultural resources protected by sanctuaries. One example is the designation of Particularly Sensitive Sea Areas, which allow protective measures to be put in place in specific geographic areas. The U.S. has two Particularly Sensitive Sea Areas, both of which are in the sanctuary system—the Florida Keys National Marine Sanctuary and Hawaii's Papahānaumokuākea Marine National Monument.

A voluntary Area To Be Avoided, which moves vessel traffic away from sensitive habitats, surrounds Olympic Coast National Marine Sanctuary as well as Flower Garden Banks and Cordell Bank national marine sanctuaries. The latter two—both sites of impressive coral growth—are internationally recognized as no-anchoring zones.

The Coast Guard and the National Marine Sanctuary System have also worked to shift traffic lanes in various sanctuaries to help protect vulnerable habitats and species and increase operational safety.

To protect endangered whales in Massachusetts' Stellwagen Bank National Marine Sanctuary, sanctuary researchers studied whale concentrations and shipping traffic and discovered that the threat of ship strike was highest in the Boston shipping lanes, which cut through the sanctuary. In collaboration with the Coast Guard, NOAA partners, and the maritime industry, the sanctuary proposed narrowing and moving the lanes to areas the whales used less frequently. The proposal was accepted, went into effect in 2007, and the new lanes reduced the risk of whale strike for all great whales by as much as 81 percent.

Shifting shipping lanes can also help protect resources in other sanctuaries. California's Cordell Bank and Greater Farallones national marine sanctuaries collaborated with NOAA, the Coast Guard, the maritime industry, and other partners to recommend adjustments to historic traffic lanes leading into San Francisco Bay to reduce the risk of ships encountering endangered whales. In 2013, the same approach was employed within the Santa Barbara Channel to help reduce the risk of ship strikes involving endangered whales, especially blue whales.

In 2010, funded with a special congressional appropriation, NOAA created the Remediation of Underwater Legacy Environmental Threats (RULET) project, which identified the location and nature of potential sources of oil pollution from sunken wrecks. There are more than 20,000 shipwrecks in U.S. waters, most a result of more than a century's worth of natural events, human error, and war. These wrecked vessels were a concern, as many were "potentially polluting wrecks," defined as wrecks and cargo that might release oil and hazardous waste into the environment. These concerns led to the formation of the RULET project team, consisting of NOAA's Office of Response and Restoration, the National Marine Sanctuary System, and the Coast Guard. The project brought together the team's skills and expertise to conduct a tiered risk assessment approach that resulted in a prioritized list of 87 potentially risky shipwrecks still containing oil. Of these, the list was narrowed down further to 18 wrecks identified for additional in-water assessment and potential pollution remedy.

Emergency Response

The Coast Guard leads emergency responses to help prevent and minimize damage to sanctuary resources, including partnering to ensure safety and marine pollution response measures. Hands-on simulation drills build the skill sets needed for time-sensitive, effective response and management. These drills are held on a rotating routine basis year-round all over the country, involving various partners as required by each training scenario.

Occasionally, more elaborate drills are conducted by the sanctuary system and Coast Guard to provide training to sanctuary staff and volunteers on how to respond to potential pollution threats within a sanctuary. Safe Sanctuaries 2005 and Safe Seas 2006 were NOAA-led emergency response exercises designed to build long-term partnerships. The integrated efforts across multiple programs both within and outside of NOAA worked toward the goal of protecting NOAA's trust resources and improved the relationship between state/federal resource trustees and the spill response community.

A NOAA member attempts to safely remove a large electrical cable from the mouth of a sub-adult humpback whale while off the coast of Maui in March 2017. The Coast Guard assisted responders from the Office of National Marine Sanctuaries, Maui Ocean Safety, Kahoolawe Island Reserve Commission, and NOAA's West Maui response team by providing an additional platform to work from and enforcing a safety zone in the area. Coast Guard photo by Petty Officer 2nd Class Rob Lester

A rehabilitated Hawaiian monk seal is loaded onto a USCG plane in March 2015 to be returned to Midway Atoll. The Coast Guard crew members work regularly with NOAA, U.S. Fish and Wildlife Service, and the Hawaii Department of Land and Natural Resources to transport rehabilitated Hawaiian monk seals to Midway Atoll, where they can be returned to Papahānaumokuākea Marine National Monument. Coast Guard photo by Petty Officer 2nd Class Tara Moelle

Stewardship of Maritime Heritage Resources

The sanctuary system and the Coast Guard occasionally share stewardship of maritime heritage resources protected in sanctuaries. The wreck of the Lightship *LV-71,* now also known as the *Diamond Shoal Lightship,* is just one example. This floating lighthouse, the only lightship sunk by enemy fire, went down in 1918 off the coast of North Carolina during World War I. The crew not only escaped the ship as it was being fired on by the German U-boat *U-140,* but warned more than 25 friendly vessels away from the attack. The wreck, protected by a joint agreement between NOAA and the Coast Guard, has been added to the National Register of Historic Places.

More recently, in October 2016, the Coast Guard Cutter *McCulloch* was found during a remotely operated vehicle training mission in Channel Islands National Marine Sanctuary off the coast of Southern California. The *McCulloch,* which had served in the Battle of Manila Bay during the Spanish-American War, sank after colliding with the steamship *Governor* in 1917. A century after her loss, the Coast Guard, National Marine Sanctuary System, and National Park Service announced the discovery of the wreck and paid tribute to the historic vessel.

In going to watch *Guardians of the Galaxy*—or any of the action blockbusters released every summer—we enjoy the derring-do and brave deeds of the heroes. In a span of about two hours, they get to save the galaxy, and we get a break from real life. But in real life, the important work of safeguarding our seas is a longer, harder, more important job that takes many hands and hearts to accomplish. The partnership between NOAA and the Coast Guard is—and will continue to be—an important component of that job.

About the authors:
Emma Skelley and Jennifer Damian served as graduate student volunteers at NOAA's Office of National Marine Sanctuaries during the summer of 2017. Both will resume their studies this fall.

Marine Protected Area Networks

Tools to promote resilience of Arctic marine ecosystems

by Lisa Speer
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The Arctic Ocean is undergoing rapid physical, chemical, and biological change as a result of rising carbon dioxide in the Earth's atmosphere. These changes include ocean warming and declines in sea ice as well as acidification, altered salinity, declining oxygen levels, and altered circulation patterns. Most of these changes are occurring in other oceans of the world, as well, but they are amplified in the Arctic. For example, while the world as a whole warmed one degree Celsius over the past century, the Arctic warmed by two degrees (Figure 1).

The consequences of these changes for Arctic marine ecosystems are likely to be profound, particularly for those species that rely on sea ice for all or part of their life cycles. Shifts in distribution and abundance of Arctic marine wildlife in response to warming and loss of ice are already affecting the people of the Arctic who depend on these animals for sustenance and cultural survival.

The loss of ice in the Arctic Ocean also means that previously inaccessible areas are rapidly opening up to potential development such as oil and gas extraction, shipping, and fishing. Shipping accidents, oil spills, air and water pollution, invasive species, underwater noise, and a host of other impacts related to industrial development pose major threats to the region, much of which is very remote, often difficult to access, and lacks roads, ports, or basic response infrastructure.

Just 7 percent of the Arctic Ocean is charted to modern standards. The presence of ice, darkness, and subzero temperatures for much of the year means that any emergency response would likely be slow and difficult, as Coast Guard Commandant Admiral Paul Zukunft noted last July.[1]

Networks of marine protected areas (MPAs)—essentially parks in the ocean—and other area-based conservation measures provide an important means of helping to maintain biodiversity, bolster resilience of Arctic marine ecosystems, and help the people who depend on them as they face these changes. A short window of opportunity exists to ensure that accelerating industrial development does not undermine the ecosystem services upon which the people of the Arctic and the global community depend.

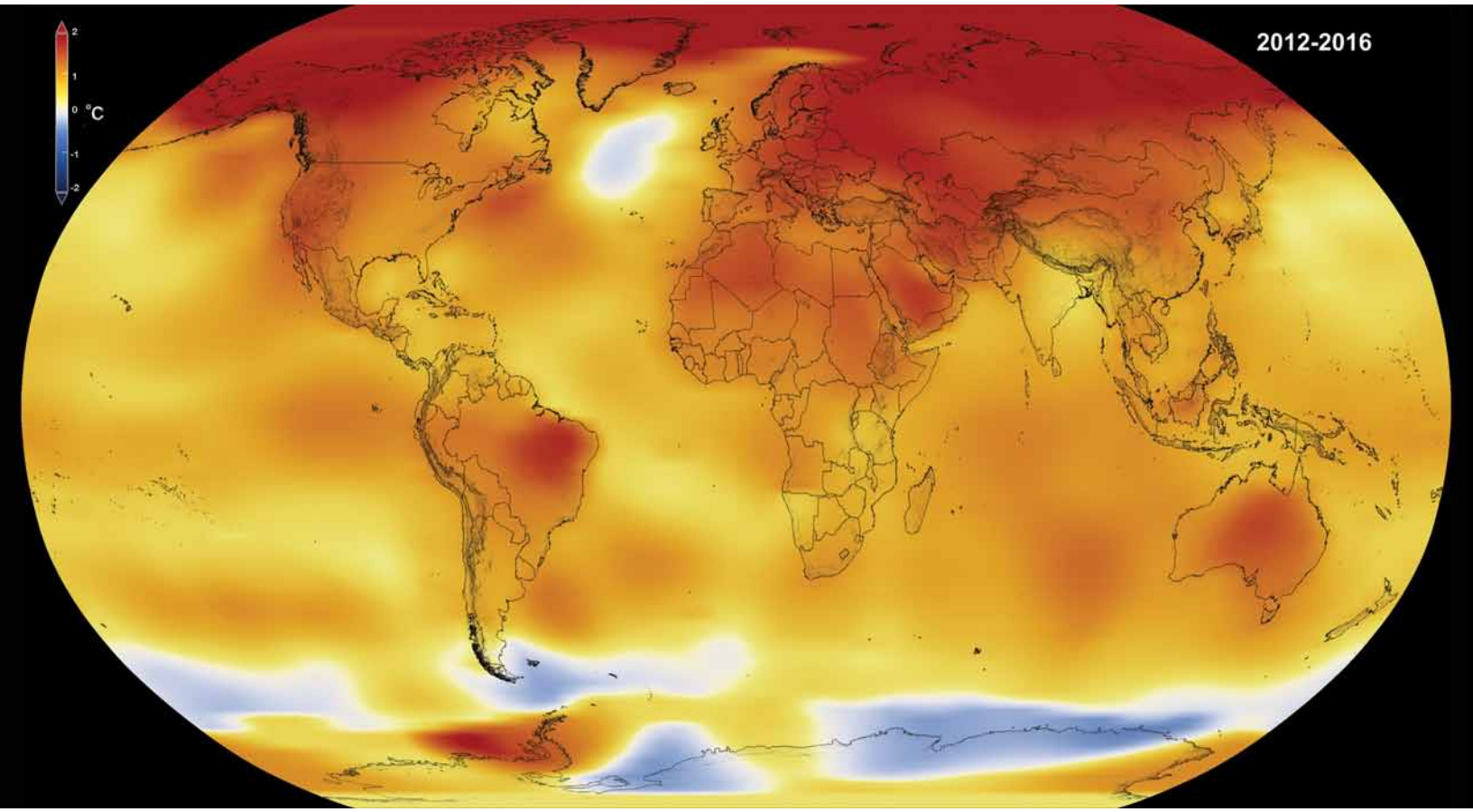
An ecologically connected network of MPAs in the Arctic Ocean would help conserve biological diversity, secure sustainable use of Arctic marine living resources for coming generations, and increase the region's resilience to various changes. Because many species of whales, fish, birds, seals, and other Arctic marine wildlife are highly migratory and do not stay within the waters of one country, coordinated international action is needed for effective regional conservation.

Role of Area-Based Management in Promoting Resilience

"Marine protected area" is a general term for a type of area-based management tool used for long-term conservation of the marine environment. As defined by the International Union for the Conservation of Nature (IUCN)/World Commission on Protected Areas, an MPA is "a clearly defined geographical space recognized, dedicated, and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values."[2] National parks, national wildlife refuges, and national marine sanctuaries, as well as areas established at the state or provincial level, are all examples of MPAs.

Based on increased scientific understanding of the ways ocean currents and other processes connect marine ecosystems, global marine conservation targets over the past decade have focused on the establishment of effective

Figure 1



Global temperature anomalies from 1880 to the period 2012–2016 (five-year average) in degrees Celsius. NASA Goddard Institute for Space Studies graphic

MPA networks. An MPA network is a collection of individual MPAs operating cooperatively and synergistically at various spatial scales, designed to meet conservation objectives that a single MPA cannot achieve alone.[3] These networks are a key tool in promoting ecosystem resilience to rapid changes in the ocean.

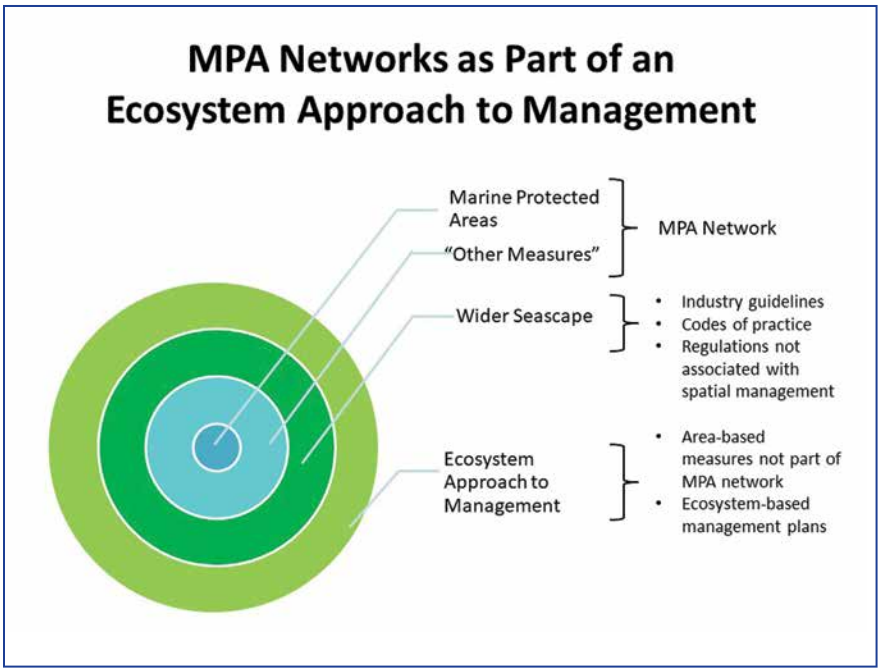
Ecosystem resilience is the capacity of an ecosystem to resist degradation from a perturbation or disturbance and recover quickly. A pan-Arctic MPA network can strengthen the ecological resilience of the Arctic by protecting important species, habitats, and features; connecting and protecting spatially separate habitats essential to the life cycles of transboundary marine species—feeding, breeding, nursery grounds, and migration corridors. They provide refuge for marine species by protecting multiple locations of important habitat features in the event one area is devastated, and protect and connect features and habitats that support the ability of species to be resilient to climate change with forecasted persistence.[4]

In a changing climate, MPA networks serve to protect refugia—areas relatively buffered from climate change that enable the persistence of valued physical, ecological, and socio-cultural resources.[5] These refugia exist because of locally unique combinations of physical characteristics—like climate variables, oceanography, or topography—that influence, among other things, habitat stability or species persistence at specific locations like areas of persistent multi-year ice that sustain ice-dependent ecosystems.

Well-designed networks should include the following characteristics, including how well certain features like habitats are represented in the network, how well those features are protected, and how well the protected sites are ecologically linked to one another.[6] Additionally, area-based conservation measures that are not formal MPAs can contribute to conservation outcomes. These "other measures" can include sector-based protection measures, such as areas to be avoided by commercial shipping, areas excluded from oil and gas leases, and areas where fishing is restricted or prohibited. "Other measures" can play a role in contributing to the effectiveness of MPA networks by facilitating appropriate and sustainable uses, including those for local communities.

Figure 2 illustrates how MPAs and "other measures" operate within the context of ecosystem-based management.[7] MPAs are the backbone of an MPA network—forming important conservation areas that protect species, habitats, and ecosystem services.

Figure 2



How MPA networks align as part of an ecosystem approach to management. MPAs are the backbone of an MPA network, forming important conservation areas that protect species, habitats, and ecosystem services. NOAA graphic by Lauren Wenzel

In MPA networks, area-based conservation measures are located within a broader framework that includes other management measures, both area-based (shipping lanes that are not part of an MPA network) and non-area based (regulations and practices that apply everywhere). For example, some fisheries regulations provide area-based protection by limiting or requiring certain fishing gear to reduce bycatch in a particular location, while the dumping of radioactive waste in the ocean is prohibited everywhere through international treaties.

MPAs in the Arctic and an MPA Network Toolbox

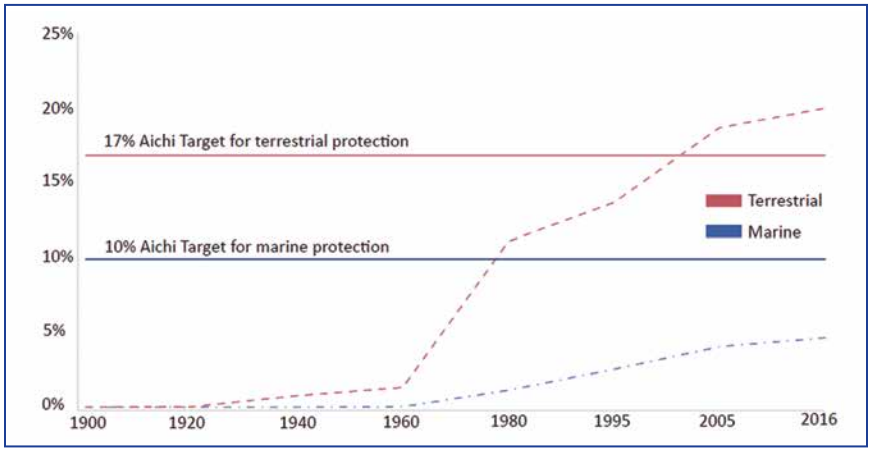
In the Arctic, progress in establishing MPAs lags behind that of protected areas on land. The Convention on Biological Diversity has established a global target for 2020—Aichi Target 11—of protecting 17 percent of terrestrial and inland water areas and 10 percent of marine and coastal areas.[8] As of 2016, this target has been met for terrestrial/inland water areas in the Arctic, with 20.2 percent protected, but has not yet been met for marine areas, with 4.7 percent protected (Figure 3).[9] Less than 1 percent of Arctic marine areas are fully protected.[10] Protected areas are those reported by countries to the World Commission on Protected Areas Database, and fully protected areas are those in IUCN Categories 1A and 1B.

In light of this, since 2012 Arctic states have worked together through the Arctic Council[11] to develop a common framework for a pan-Arctic MPA network,[12] and to build the scientific knowledge and tools to support Arctic states as they further develop their own national networks. In 2017, the Arctic Council's Protection of the Arctic Marine Environment working group produced an MPA Network Toolbox that describes different types of MPAs, other area-based management tools, and the ways in which they can contribute to ecosystem resilience in the Arctic.

The objective of the toolbox is to support decision makers and practitioners in developing and managing marine areas, as some countries are already moving ahead with the development of MPA networks. For example, Canada has committed to meeting the 10 percent target by 2020, with an interim target of 5 percent by 2017.[13] Russia is currently designing an MPA network, and in 2016 announced the expansion of the Russian Arctic National Park. Now at 35,000 square miles of land and water, it's Russia's largest protected area.[14]

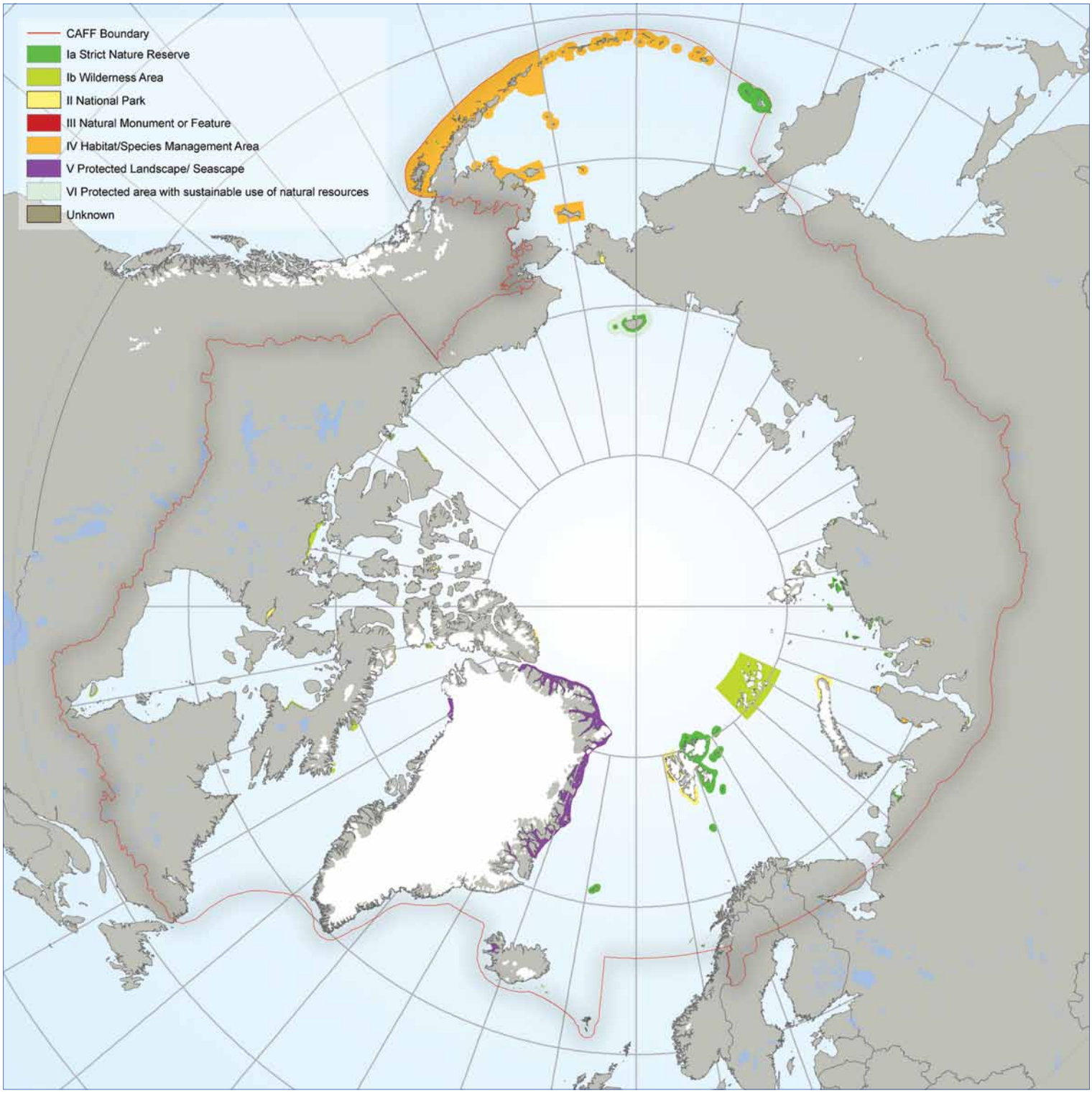
The toolbox also aims to add to the dialogue around the development of Arctic MPA networks by providing examples of different types of area-based management tools currently being applied in the Arctic, and in particular, explaining the ways in which measures other than MPAs can contribute to conservation goals and MPA

Figure 3



Trends in terrestrial and marine protected area coverage within the CAFF boundary, 1900–2016. Graphic from "Arctic Protected Areas: Indicator Report, 2017: Conservation of Arctic Flora and Fauna and Protection of the Arctic Marine Environment, Akureyri, Iceland" courtesy of Protection of the Arctic Marine Environment (PAME)

Figure 4



Marine protected areas in the Arctic. Graphic from Arctic Protected Areas: Indicator Report, 2017: Conservation of Arctic Flora and Fauna and Protection of the Arctic Marine Environment (CAFF and PAME, 2017) courtesy of Protection of the Arctic Marine Environment (PAME)

network objectives. For example, by including appropriate "other measures" managed by communities or industry sectors, managers can more actively engage them in discussions about MPA networks and their conservation objectives.

These measures may have different primary goals, such as safety or food security, but also provide important conservation benefits. Some types of "other measures" may also be more flexible and responsive to changing conditions and ocean uses than MPAs. These include

measures like seasonal or emergency fishery closures and shipping regulations like establishment of lanes, areas to be avoided, or speed limits.

Examples of Area-Based Management in Promoting Arctic Resilience

MPA Network Analysis in Russia[15]

In the Russian Arctic, there are more than 100,000 km^2 of MPAs, and their total area is about 2.4 percent of the Russian exclusive economic zone in the Arctic. All these protected areas were created at different times via an *ad hoc* approach, and they do not form a representative ecologically connected network. To increase the effectiveness and ensure a thoroughly integrated system of MPAs, a systematic conservation planning exercise was conducted in Russia from 2014–2016. The goal of the research was "to design a geographically and ecologically connected and representative network of conservation areas that protects and promotes the resilience of the biological diversity and ecological processes of the Russian Arctic marine environment, taking into account economic development and ongoing climate change, and act as a whole, complementing each other."

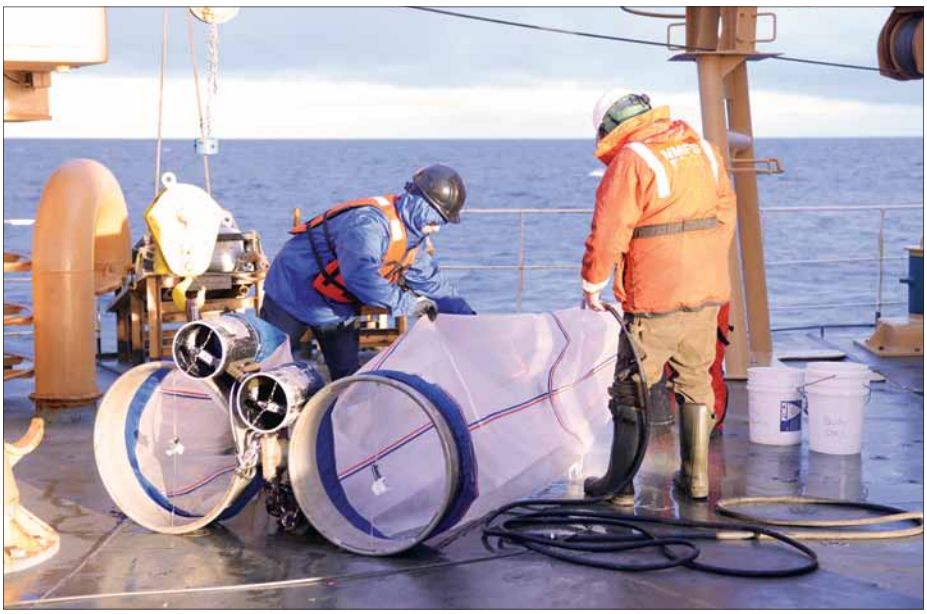
The resulting proposed network covers nearly 25 percent of the Russian Arctic seas, guarantees proportional representation of their biodiversity, and allows for geographical and ecological connectivity. This first attempt to apply systematic conservation planning to a selection of protected areas in the Russian Arctic seas revealed that even under variable data conditions, it is possible to identify a network of marine areas that meet criteria for ecologically or biologically sensitive areas and promote resilience in a rapidly changing region.

Co-Management for Long-Term Resilience in Canada

In August 2017, the governments of Canada, Nunavut, and the Qikiqtani Inuit Association (QIA) announced the boundary for the Tallurutiup Imanga National Marine Conservation Area in Lancaster Sound. Recognized internationally as one of the most productive areas in the circumpolar Arctic, this is an area of critical ecological importance to a rich variety of marine life and a significant traditional hunting ground to Inuit who are strongly tied to the land and sea. At 109,000 km^2, this area is the largest protected area in Canada, representing about 1.9 percent of Canada's marine estate.

The governments and QIA signed an agreement that confirms this will be the final boundary, subject to minor modifications, and provides interim protection for the area, such as declaring no mining and no exploration or development for hydrocarbons. The agreement also commits Parks Canada and QIA to begin negotiations for an Inuit Impact and Benefit Agreement and commits the parties to develop an interim management plan with public consultations. Once these steps are completed, Canada will move to permanently protect the area under the Canada National Marine Conservation Areas Act.

Public consultations, particularly in the local Inuit communities, played a key role in the final boundary recommendations, with Inuit knowledge contributing to the same degree as contemporary science to a better understanding of the Tallurutiup Imanga region and to making better decisions about its protection.



Royhon Agostine (left), an intern with the Ship-based Science Technical Support in the Arctic team, and Morgan Busby, a research fisheries biologist with the National Oceanic and Atmospheric Administration, rinse off bongo plankton nets on the fantail of the USCGC *Healy* in August 2017, while conducting research in the southern Chukchi Sea. The bongo nets were deployed along distributed biological observatory region three, which is one of eight regional hotspots that exhibit high productivity, biodiversity, and overall rates of change. Coast Guard photo by Petty Officer 3rd Class Amanda Norcross

Precautionary Approach to Fishing in the U.S. Arctic and Beyond

In 2009, the United States announced a moratorium on fishing in all marine waters of the U.S. EEZ of the Beaufort and Chukchi Seas, where retreating sea ice may open up new fishing grounds, until there is enough scientific information on the area to support effective fishery management.[16] This zone begins at three nautical miles from the coast of Alaska. Shortly thereafter, the United States initiated discussions with the other four Arctic coastal States—Canada, Denmark, Norway, and Russia—toward applying a similar precautionary approach in the region's high

seas, namely the Central Arctic Ocean. The objective of those discussions was to develop a legally binding agreement to prevent unregulated commercial fishing in the Arctic high seas.

Those discussions concluded in July 2015 with the signing of a non-binding declaration committing those five states to refrain from authorizing their vessels to conduct commercial fishing in the high seas area until there is sufficient science and a regional or subregional fisheries management regime in place to sustainably manage any such fisheries. The signatories also stated their intention to establish a joint program of scientific research and monitoring to improve understanding of Arctic ecosystems and associated fisheries, as well as to invite other states with fishing interests in the area to join discussions in consideration of a binding agreement.

Subsequently, China, Iceland, the European Union, Japan, and the Republic of Korea have joined the original five states in a series of ongoing negotiating sessions toward a legally-binding agreement and have made significant progress. It is possible the 10 parties to these negotiations may finalize a legally binding agreement to prevent unregulated commercial fishing in the Arctic high seas in 2017.

The Way Forward

Networks of marine protected areas and other area-based conservation measures provide an important means of promoting ecological, cultural, and social resilience by protecting key species and habitats that play essential ecological, social, and/or cultural roles. Because these habitats and species can range over large areas of the Arctic Ocean, international cooperation is essential to establishing an effective regional network of MPAs.

The Arctic Council is the principal regional forum where countries cooperate to advance their shared interest in the conservation and management of the Arctic Ocean. A number of Arctic Council reports and assessments[17] have called for an international, ecologically connected network of marine protected areas in the Arctic. While some progress has been made to identify important marine areas for protection on a pan-Arctic scale, a recent review of current protections for Arctic marine biodiversity and habitats found that:

> ***[E]xisting marine protected areas in the Arctic Ocean offer little or no protection to many habitats … [that]are globally unique, hosting Arctic species within pristine environments that are currently undergoing rapid adjustment to climate-induced changes … The existing Arctic marine protected area network needs to be expanded in order to protect these habitats … and ensure any uses of Arctic marine or subsea resources are sustainable.***[18]

A number of pan-Arctic scientific workshops have identified globally significant biological or ecological hot spots in the Arctic marine environment.[19] These reviews provide a good scientific basis for starting to develop a regional MPA network.

Simultaneously, research is needed to fill out our understanding of lesser-explored areas of the Arctic Ocean, particularly deep water ecosystems. Additionally, more work is needed to identify culturally or socially significant marine areas in the Arctic Ocean.

In light of these considerations, a recent series of workshops and consultations under the auspices of the Arctic Council discussed and synthesized perspectives and knowledge on MPA networks in the Arctic. A number of ideas emerged from these workshops for next steps to support the development of a pan-Arctic MPA network:[20]

Engage with Indigenous and Local Communities and Ocean Users

- Work closely with indigenous and local communities to identify ways to 1) further integrate traditional and local knowledge into guidance on MPA network development, aiming to consider livelihoods, food security, and cultural values into MPA network design, and 2) to enhance sustainable indigenous management practices through MPA networks.
- Explore how best to promote and facilitate the multiple values of protected areas—areas conserved and managed to meet the goals of multiple sectors and communities—as part of an ecosystem approach to management.
- Support public outreach and education efforts on the impacts of a changing climate on biodiversity and the role of protected area networks in conserving biodiversity and its social and economic benefits.

Identify Additional Important Areas

- Building on the solid basis that already exists for starting to build a regional MPA network, identify additional important species, habitats, ecosystems, and ecosystem services that would benefit from collaborative approaches to MPA network design, also considering threats, connectivity, range shifts, and refugia in a changing Arctic.
- Identify areas of the Arctic marine environment that are important for cultural and/or social values.

Continue to Build Our Scientific Understanding

- Continue to build our scientific understanding of Arctic marine ecosystem function and resilience, particularly in offshore slope and deepwater regions.
- Develop robust models capable of modeling ecological connectivity and potential shifts in

location of ecologically or culturally significant areas.

Develop and Distribute Data and Tools to Inform Network Planning

- Synthesize and distribute data on Arctic biodiversity to inform MPA network planning. For example, synthesize habitat and ecological community mapping and coordinate habitat classification systems, especially of benthic habitats. Also, synthesize studies of identified keystone species to serve as a starting point for identifying areas important to Arctic connectivity.
- Identify, through Arctic science and indigenous and stakeholder communities, observation and monitoring needs and tools available to support area-based conservation measures, including dynamic measures. This should also include practices and tools for monitoring and assessing the effectiveness of area-based conservation measures.
- Integrate emerging tools and guidance that could support countries' identification of important areas for ecological connectivity into the toolbox.

Support Implementation and Effective Management of Marine Protected Areas

- Move forward expeditiously to establish MPAs and/or other area-based management tools in areas that have been identified as important for the ecological functioning and resilience of Arctic marine ecosystems, based on the best scientific information available.
- Improve collaboration between MPA managers in different regions to share experiences.

Decision makers and local communities are increasingly aware of the rapid changes in the Arctic and the need to protect ecologically important areas for conservation, sustainable development, and climate resilience. Marine protected areas and other measures are key tools to achieve these goals, and many Arctic countries have the added impetus of the desire to meet the Aichi 11 Target to protect 10 percent of their coastal and ocean areas by 2020.

Marshalling existing science and engaging indigenous and local communities and other ocean users as active partners in this effort will be essential to the success of an Arctic MPA network.

About the authors:

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Laura Strickler is an international affairs specialist for NOAA's Office of International Affairs, on contract with Calhoun International. She works on a range of international policy issues for NOAA, with an emphasis on Arctic affairs, biodiversity, and sustainable development.

Martin Sommerkorn is the Head of Conservation for the World Wildlife Fund Global Arctic Programme. He leads work on resilience approaches to nature conservation and resource management. He had a first career as an Arctic ecosystem scientist and is the author of about 30 publications in leading international journals.

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Endnotes:

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The Future of Marine Protected Areas in the Northern Latitudes

Marine protection in a changing Arctic

by LCDR Courtney Sergent
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Arctic ice is receding every year due to warming temperatures. This reality is potentially changing marine ecosystems as living marine resource populations, including migrating marine mammals, look for continued access to desirable habitats and food sources.

At the same time these marine inhabitants are trying to adapt to a new climate, maritime traffic is increasing significantly throughout the Arctic area. The commercial shipping industry is aiming to shorten transit times by using the Northwest Passage and Northern Sea Route. Adventure and tourism enthusiasts are aspiring to experience new frontiers, and opportunities are arising for those seeking to explore the region for oil and gas resources, as well as future commercial fishing stocks. Furthermore, while all of these changes are occurring, many Alaskan coastal communities are now, and for the foreseeable future, dependent on subsistence fishing and hunting to ensure their survival and way of life.

In response to this changing Arctic, many believe marine protected areas (MPA)[1] are a practical and important management tool for protecting marine ecosystems

The USCGC *Healy* crew views a group of walrus huddled together on the ice in the Chukchi Sea, Alaska. Coast Guard photo

A polar bear rests while the USCGC A*lex Haley* patrols in the Beaufort Sea, Alaska. Coast Guard photo

and helping them adapt to their transforming environment. During its meeting in 2015, the Arctic Council charged its member states—including the United States—to develop a network of MPAs in their Arctic jurisdictional waters in an effort to preserve cultural and subsistence resources for future generations, and protect and restore marine biodiversity and ecosystem function.[2]

Advisory committees, working groups, and stakeholders alike are discussing, planning, and coordinating for the possible inclusion of MPAs in the Arctic.[3] As the federal and state governments work with managers, industry, and community leaders to develop these MPAs, a realistic and dedicated approach to conducting law enforcement is needed in this region, where enforcement resources are constrained.

A Snapshot of Alaskan Fisheries

There are multiple fishing sectors putting pressure on Arctic living marine resources, including commercial, subsistence, and sport fishing sectors. U.S. waters surrounding Alaska support a healthy commercial fishing industry, contributing more than $6.2 billion to the nation's economy. More than 60 percent of commercially harvested fish caught in the U.S. are taken from Alaskan waters.[4] Federally managed marine fisheries in Alaska are separated into five subregions: Southeast Alaska, Gulf of Alaska, Bering Sea, Aleutian Islands, and the Arctic. This article specifically addresses the Arctic subregion.

Subsistence fishing, the harvest of animals for direct consumption by an individual or community, is a highly valued part of the native Alaskan culture, and in many rural communities, subsistence harvests are essential contributions to the local economy. Subsistence fishing in Alaska encompasses the noncommercial, customary, and traditional use of fish by Alaskan residents. It is a vital means of self-support in remote regions with limited economic opportunity, and where transport of groceries and commercial goods is logistically difficult and exceptionally expensive.[5] A vibrant sport and recreational fishing industry also exists in Alaska, drawing thousands of participants from in and out of the state.

Through the Magnuson-Stevens Act, the U.S. has adopted a complex regulatory scheme to manage and enforce these industry sectors.[6] Fisheries management and enforcement is critical to adequately conserve and sustain the many fish stocks in Alaskan and U.S. waters. The Alaska Department of Fish and Game manages coastal state fisheries—commercial, sport, and subsistence—within 3 nautical miles of the shoreline. Pacific halibut, which is managed under the tenets of the Halibut Convention of 1923, is the exception.

Commercial fisheries for the state include salmon, groundfish, shellfish—crab, scallop, and shrimp—herring, and several dive fisheries. Primary sport fisheries harvested within state waters are halibut, salmon, and rockfish. Subsistence fisheries include halibut, salmon, herring spawn, shellfish, and some groundfish. State fisheries are enforced by the Division of Alaska Wildlife Troopers (AWT) of the Alaska Department of Public Safety.

The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) manages federal fisheries—commercial, sport, and subsistence—in waters from 3 nautical miles to 200 nautical miles in the U.S. exclusive economic zone (EEZ) off of Alaska. Commercial federal fisheries include Pacific halibut, sablefish, and groundfish such as walleye pollock, Pacific cod, and several flatfish species. The federal sport and subsistence fisheries target Pacific halibut. Federal fisheries, including Pacific halibut in federal and state waters, are enforced by the NOAA Office of Law Enforcement (OLE) Alaska Division primarily via dockside inspections and vessel monitoring, and the U.S. Coast Guard via at-sea patrols, aerial patrols, and with law enforcement boardings.

Within the U.S. EEZ, the North Pacific Fishery Management Council developed an Arctic Fishery Management Plan (FMP) under the authority of the Magnuson-Stevens Act. This Arctic FMP covers the U.S. Arctic EEZ waters off Alaska, the Arctic Management Area. This area is defined as all marine waters of the Chukchi and Beaufort Seas from 3 nautical miles to 200 nautical miles offshore within the U.S. EEZ, north of the Bering Strait and westward to the Maritime Boundary Line between the U.S. and Russia. Within the Arctic FMP, all federal waters will be closed to commercial fishing except for subsistence or recreational fishing or State of Alaska-managed fisheries in the Arctic. Kotzebue Sound supports a state-managed commercial salmon fishery, while most of the coastal marine fisheries within the Arctic Management Area are subsistence fisheries of salmon, Arctic cisco, broad whitefish, Dolly Varden, and Arctic grayling.

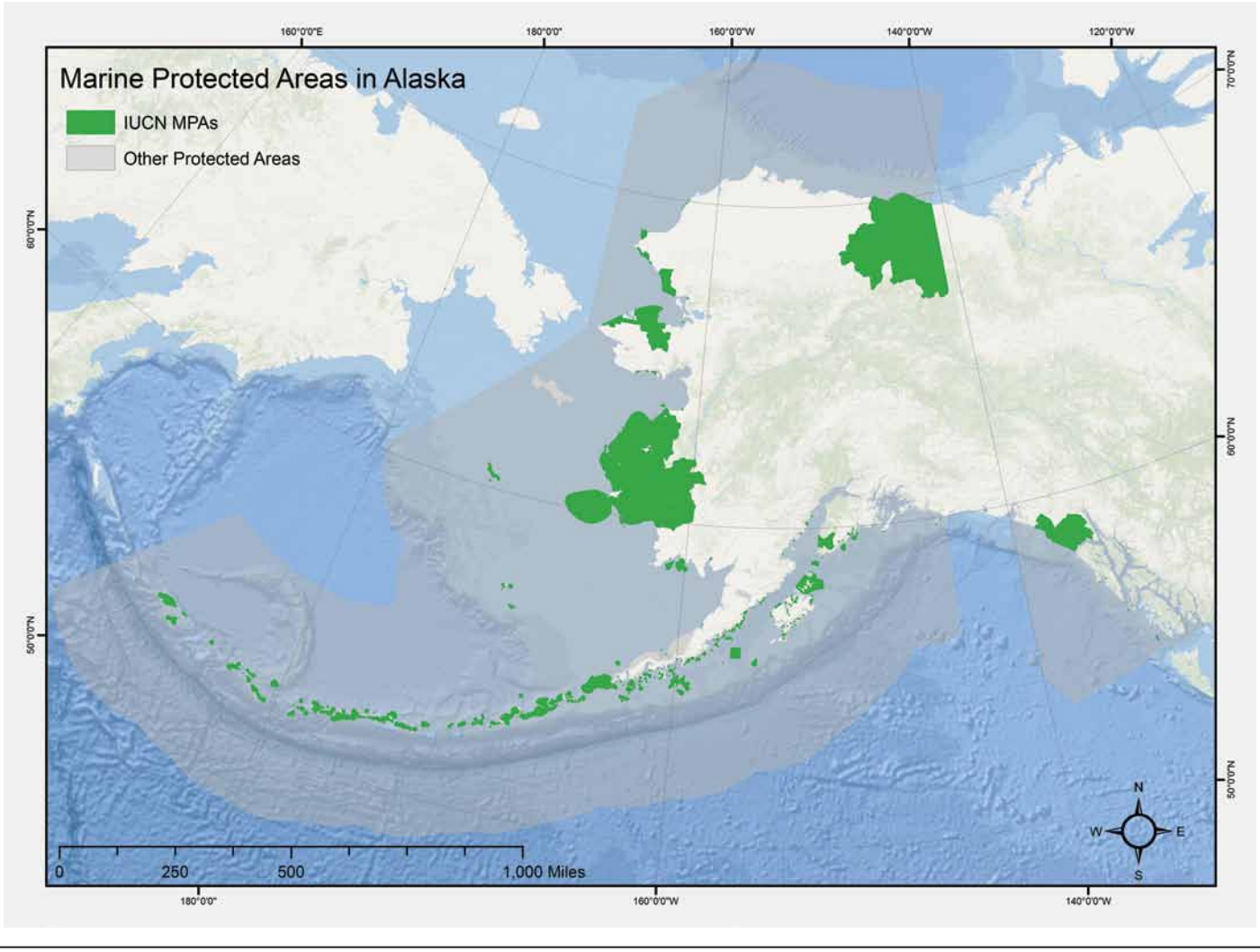
Marine Protected Resources in Alaska and the U.S. Arctic

Marine protected resources (MPR) include those species listed as threatened or endangered in the Endangered Species Act (ESA). Responsibility for managing species listed under the ESA and the Marine Mammal Protection Act (MMPA) is shared by NOAA and the U.S. Fish and Wildlife Service (USFWS). In Alaska, the National Marine Fisheries Service is responsible for implementing marine mammal conservation and recovery programs under the MMPA, and whales, ice seals, harbor seals, northern fur seals, and Steller sea lions under the ESA. The USFWS is responsible for the conservation and recovery of the Northern sea otter, Polar bear, Pacific walrus, and several bird species, including the Steller's eider, spectacled eider, and short-tailed albatross.

The Coast Guard, along with NOAA's OLE, has the responsibility to enforce federal regulations pertaining to the conservation and protection of MPR, which includes species, critical habitats, and federal protected areas. In addition, if applicable in your area of responsibility when warranted, and when resources allow, the Coast Guard can support state and local enforcement by sharing information, providing transportation for surveillance, and providing other requested assistance to the responsible agencies.

Both the conservation of the marine mammal species and the ensured sustainable subsistence use of them by rural Alaskans are vitally important. Subsistence hunting occurs throughout Alaska all year and is often critical to

A boarding officer from the USCGC *Alex Haley* examines the vessel monitoring system aboard a commercial fishing vessel during a federal fisheries law enforcement boarding in the Bering Sea, Alaska. Coast Guard photo



This map illustrates all current marine protected areas in Alaska, as defined by the International Union for Conservation of Nature.* The other protected areas depicted are fishery management areas in U.S. waters. Graphic developed by the NOAA National Marine Protected Areas Center, September 2017.

* Guidelines for Applying the IUCN Protected Area Management Categories to Marine Protected Areas, International Union for Conservation of Nature (IUCN), 2012.

the nutrition, food security, and economic stability of many rural Alaskan residents, not to mention the cultural significance of the hunt. Subsistence hunting for marine mammals is common in western Alaska, with seals, sea lions, whales, and walrus the most frequently targeted animals.

Federal accountability for managing the subsistence harvest of seals, sea lions, and whales falls to the NMFS, while the USFWS manages the subsistence harvest of sea otters and walrus. In many cases, the stock assessment and harvest regulations are developed through a formal "co-management" process with indigenous communities and associated governance structures. This ensures that management efforts will have the benefit of traditional knowledge as it relates to stock distribution and abundance. It also ensures that those affected by management decisions have a means of direct participation in the process—a characteristic that can foster improved compliance with harvest controls.

Status of Marine Protected Areas

Numerous MPAs are in effect in Alaska. A majority of these MPAs are established with the purpose of supporting "sustainable production." Sustainable production is the continued extraction of renewable living resources that live within the MPA or depend on the protected area's habitat for essential aspects of their ecology or life history.

A handful of MPAs are established as "natural heritages" to sustain, conserve, restore, and understand the natural biodiversity, populations, communities, habitats, and ecosystems.[7] These areas typically restrict all fishing—commercial and/or recreational—fishing by specific gear type (e.g., trawl gear), or restrict entry altogether. The Coast Guard, along with the NOAA OLE, is responsible for the enforcement of MPAs in the U.S. EEZ surrounding Alaska. The AWT is responsible for the enforcement of MPAs within state waters.

Enforcement of Fisheries and Marine Protected Areas

The Coast Guard's primary law enforcement role in Alaska is protecting natural resources within the U.S. EEZ, which covers more than 950,000 square miles of ocean. The Coast Guard uses both aerial and at-sea patrols in order to enforce federal fisheries regulations and monitor MPAs in the U.S. EEZ, all while conducting its other missions.

Within the regions of Southeast Alaska and the Gulf of Alaska, the Coast Guard typically has one patrol boat conducting at-sea law enforcement and response operations in each area at a given time of the year. A rotation of major cutters are deployed throughout the year as the primary search and rescue and law enforcement assets within the Bering Sea and the Aleutian Islands, areas with extremely high fishing activity and marine commercial traffic.

The NOAA OLE has minimal afloat resources suitable for extended patrols, although enforcement officers and special agents often deploy aboard Coast Guard cutters and AWT vessels to assist in law enforcement activities. From June through September, when the ice flow diminishes to allow vessel transits, the Coast Guard deploys one major cutter in the Arctic region to serve primarily search and rescue and law enforcement functions.

Given the vast expanse of federal waters, the number and wide spatial distribution of MPAs in Alaska, limited enforcement resources, and the Coast Guard's multiple missions, monitoring and enforcement of MPAs is limited throughout all five subregions. The required use of a Vessel Monitoring System (VMS) satellite transmitter on fishing vessels participating in specific fisheries and regions is one critical enforcement tool in Alaska.

For example, a fishing vessel is required to use VMS when operating in the Aleutian Islands due to the presence of Steller sea lion protection areas, which are designated MPAs. A NMFS-approved VMS transmitter automatically determines a vessel's position and transmits it to a NMFS-approved communications service provider, which relays this to NMFS and NOAA OLE.[8]

Access to this data has been provided to the Coast Guard for the purposes of law enforcement. The use of VMS has significantly increased the ability of NOAA OLE and the Coast Guard to monitor and enforce MPAs that serve to restrict vessel activities and movements within their boundaries. However, only one-third of fishing vessels operating in Alaskan waters are currently required to use VMS, thus limiting the number of vessels whose positions and activities are available to enforcement personnel.

Marine Protection in a Changing Arctic

In order for a marine protected area to fully meet its management objectives, the physical boundary and the users operating in and around it must be monitored and its regulatory controls enforced. Monitoring and enforcement can occur at multiple levels, including at the operator level (e.g. self-monitoring). That is, vessels that will operate in or transit through U.S. waters of the Arctic region can—and should—be adhering to an Arctic Code of Conduct. All vessel operators are to pursue responsible Arctic stewardship, with an understanding of where MPAs exist, what restrictions are in place, and more importantly, what vital living marine resources are present in the area.

Given the current law enforcement posture of state and federal government in the Arctic region, the implementation of a network of MPAs will be challenging. The Coast Guard will not have the resources to directly and consistently enforce MPAs in the Arctic region; therefore, leveraging technology to police such vast protected areas is critical. Advances in satellite positioning technology, such as VMS geo-fencing, for example, have the great potential to act as a force multiplier for federal enforcement.

In addition to ensuring that the development of an MPA includes the best available science and collaboration among all appropriate stakeholders, an MPA proposal should consider a realistic approach to enforcing restrictions. This includes an Arctic Code of Conduct and the requirement of electronic vessel monitoring, like VMS or an Automatic Identification System, among potential vessels transiting or operating in the region.

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4. The Economic Value of Alaska's Seafood Industry, McDowell Group, December 2015.
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Expanding the Reach of the Monitor National Marine Sanctuary

Protecting more wrecks and increasing public awareness

by CDR Kevin Saunders
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In a time period when the United States is wrestling with proposals to remove several Civil War monuments, there is one monument the federal government and charitable investors are struggling to preserve. It is a symbol of that historic internal conflict, and of the valiant service of those brave men who fought and served within her iron hull.

However, it is also a symbol of American ingenuity that prompted a new era of sea-fighting technology. Over the past 150 years, the USS *Monitor* has bridged the gap between military and civilian cultures, carrying the mantles of strategic innovation and tactical advantage on one hand, and of cultural and historic touchstone on the other.

USS *Monitor,* Civil War Ironclad

The USS *Monitor,* designed by John Ericsson, a Swedish-American engineer, was built at Greenpoint, New York, at a total cost of $275,000. The *Monitor* was the prototype for a new class of American ironclads. She claimed a revolving gun turret, an anchor that could be raised or lowered from below deck, forced-air ventilation, and a flushing shipboard toilet among her unique features.

Her first battle on March 9, 1862, at Hampton Roads, Virginia, was with the Confederate ironclad ram CSS *Virginia,* formerly known as the *Merrimac.* The four-hour engagement ended in a draw, but marked the first time ironclad ships clashed in naval warfare, signaling the end of the era of wooden war ships. It forever changed the course of naval warfare, setting a new standard in both naval architecture and ship design.

Eleven months after its launch, the *Monitor's* promising career was cut short. The *Monitor* and 16 of her crew were lost while being towed by the USS *Rhode Island* off Cape Hatteras, North Carolina, an area long considered to be the "Graveyard of the Atlantic." The ironclad, unable to weather the heavy gale-driven seas, foundered and sank on December 31, 1862. William Keeler, an officer aboard the ironclad, wrote "The *Monitor* is no more … what the fire of the enemy failed to do, the elements have accomplished." Her final resting place in the Atlantic Ocean remained unknown for over a century.

In August 1973, scientists conducting a research project using side-scan sonar aboard the R/V *Eastward* located the *Monitor's* remains about 18 miles southeast of Cape Hatteras. Using remotely operated still and video cameras, these scientists obtained the first images of the wreckage. In April 1974, the R/V *Alcoa Seaprobe* verified the ship's identity and produced the first photo mosaic of the wreck.

Making international headlines, Duke University and the North Carolina Department of Archives and History jointly announced the discovery of the *Monitor* on March 7, 1974. Verification that the wreck was indeed the USS *Monitor* created significant concern over how the United States could protect an archaeological site that was, at a time prior to the Law of the Sea Convention, lying in international waters.

USS *Monitor,* America's First National Marine Sanctuary

Title III of the Marine Protection, Research, and Sanctuaries Act of 1972 established the National Marine Sanctuary Program. Under this act, the U.S. Secretary of Commerce

The deck of the USS *Monitor.* NOAA National Marine Sanctuary Program photo

was granted the authority to designate national marine sanctuaries that "possess conservation, recreational, ecological, historical, scientific, educational, cultural, archaeological, or esthetic qualities which give them special national, and in some cases international, significance." Given this definition, the remains of USS *Monitor* and a column of water one mile in diameter surrounding the vessel was formally designated by the Secretary of Commerce as the nation's first national marine sanctuary on January 30, 1975.

At the time of its designation, NOAA had no existing historical or cultural resources management policy. Since the *Monitor* was one of the most significant historic shipwrecks in U.S. waters, it was imperative that a comprehensive historical context study and resources policy was established. This has since been named "Fathoming our Past" and addresses the historic and cultural resources of all national marine sanctuaries.

The highest-priority management goal for the Monitor National Marine Sanctuary (MNMS) is resource protection through comprehensive and coordinated conservation and management of the wreck and its surroundings. The objectives of the resource protection program are to encourage responsible public access to the wreck site, enhance public awareness of sanctuary regulations and the permitting process, ensure compliance with sanctuary regulations, and ensure re-engagement of access and permitting policies of the MNMS management plan based upon changing site conditions. Continued education and outreach through public forums, images of the wreck online, and an extensive display of artifacts at the Mariners Museum in Newport News, Virginia, are crucial to ensuring the *Monitor* site's protection. The sanctuary staff works in concert with the National Oceanic and Atmospheric Administration (NOAA)'s Office of Law Enforcement, the Coast Guard, and other federal, state, and private organizations to provide adequate site surveillance and enforcement, and to maintain active cooperative programs in research and education. In this manner, authorities and stakeholders work together, by sea and by air, to stave off both inadvertent and deliberate actions that can disturb the wreck of the *Monitor.*

Despite being protected under the Antiquities Act, Sunken Military Vessel Act, and by the National Marine Sanctuary Program, the USS *Monitor* is still susceptible to damage by well-intentioned boaters. In 1991, the U.S. Coast Guard sighted a recreational fishing boat anchored within the sanctuary. NOAA inspections of the wreck showed damage to the wreck, including evidence that an anchor had snagged the *Monitor's* skeg and ripped it loose from the lower hull.[1] This type of damage demonstrates the importance of regulation, monitoring, and enforcement in the protection of this historic wreck.

Some threats to the site are intractable, and the passage of time combined with corrosive and oceanographic processes will continue to affect the wreck, underscoring the need to acquire available knowledge and to deter impacts from inappropriate human activity. Archaeological work at MNMS sheds light on ways to make optimal use of the sanctuary's resources and maritime landscape through inventorying, locating, documenting, assessing, managing, and interpreting the sanctuary's archaeological, historical, and environmental resources.

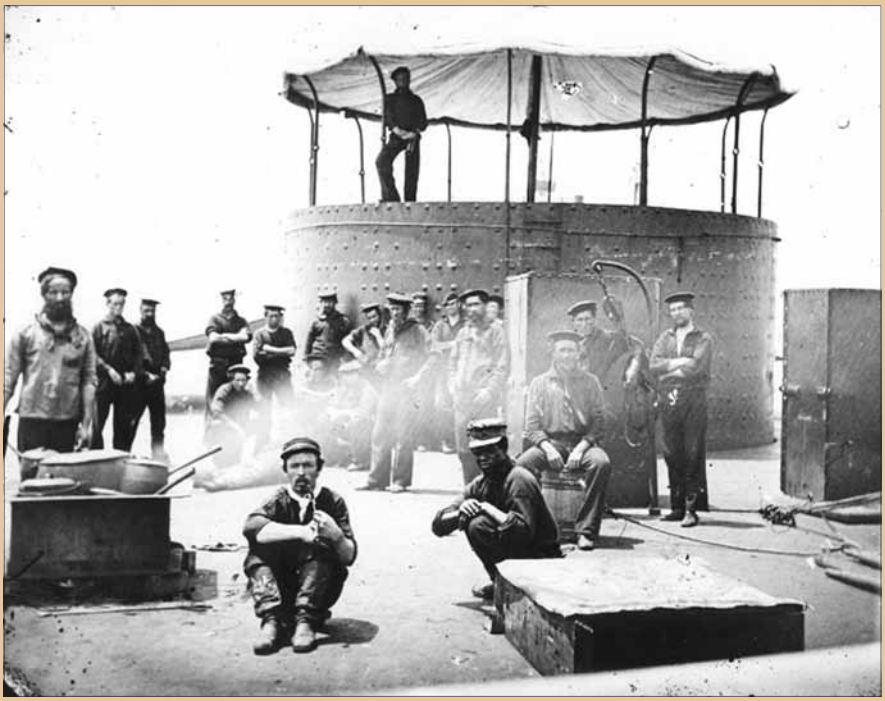
In 2002, when NOAA archaeologists and U.S. Navy divers worked to raise the *Monitor's* turret, the skeletal remains of two sailors were found. On December 31, 2012, the 150th anniversary of their deaths, the sailors' remains

Bring History to Life

Technology has brought the USS *Monitor* and other sunken artifacts like it into the classroom. Thanks to the hard work of the Monitor National Marine Sanctuary's (MNMS) staff, students from all over the country can explore the remains of the ironclad and understand the lives of the men who served on her.

In fact, the MNMS program undertook a project to apply facial reconstruction software to the remains of the sailors recovered from the wreck. The results allow students and visitors to see a representation of how those men may have appeared in their final days of service to our nation. They can look through the porthole of history and better understand the maritime roots that shaped American grit.

The USS *Monitor* did her duty preserving the Union in the Battle of the Ironclads. Now we have a duty to continue to preserve her.



The USS *Monitor* in 1862 (left) and the facial reconstruction of the two recovered skeletons. NOAA National Marine Sanctuary Program photos

were interred at Arlington National Cemetery. NOAA continues working to identify these men and to establish a protocol for dealing with human remains if additional remains are found at other underwater archaeological sites in the future.

The sanctuary's current research program continues to ensure the scientific recovery and dissemination of historical and cultural information from the site, and to preserve and manage the remains of the *Monitor* in a manner that appropriately enhances the significance and interpretive potential of the warship. Additionally, resource monitoring programs help NOAA better understand the living and natural resources within the sanctuary and in the surrounding waters.

Expanding the Sphere of Influence

In 2013, after several years of scientific and archaeological assessment and in coordination with the public, NOAA proposed to expand the MNMS to include additional maritime heritage resources. The proposed expansion would protect a nationally significant collection of shipwrecks that currently have little or no legal protection, including one of America's only World War II battlefields.

For more than 40 years, MNMS honored the iconic Civil War ironclad and the memory and service of Civil War sailors. The proposed sanctuary expansion provides the opportunity to honor another generation of mariners that helped defend the nation during World War I and World War II. Expansion of MNMS would elevate the maritime legacy of coastal North Carolina, preserve important historic sites for future generations, promote increased access and stewardship, and provide economic benefits to coastal communities.

Coastal North Carolina serves as a uniquely accessible underwater museum and memorial to the nation's rich maritime history. It is also an ideal location to study and preserve historic wreck sites dating back to the Age of North American Exploration, the Revolutionary War,

the Civil War, and perhaps most prominently, World War II's Battle of the Atlantic. With preservation, these resources offer historians, maritime enthusiasts, recreational divers, fishermen, beachgoers, and outdoor adventure seekers the ability to experience this unique region and celebrate the nation's maritime heritage.

The Monitor National Marine Sanctuary Advisory Council and the public were presented four possible expansion models on June 5, 2014:

- The first model only restricted boundaries around select wreck sites, similar to that of MNMS' current boundary.
- The second model established a small area centered around the waters off Cape Hatteras. Boundaries were established to include several wrecks and adjacent waters and culturally significant features in the landscape.
- The third model consisted of a large area centered off Cape Hatteras that included many historically significant wrecks in federal and potentially state waters. This model included sanctuary boundaries around individual sites, and designates a non-regulatory study area.
- The fourth model consisted of three designated areas, each capturing both a representative collection of wrecks of many eras and vessel types in federal and potentially state waters, and the primary historically significant wrecks off of most of the Outer Banks.

The Coast Guard advised the council that if expansion were to occur, the easiest models to use to conduct surveillance and enforcement operations would imitate that of the second model. Receiving enough positive feedback to move forward, the council voted to move forward with expansion.

To date, no further action has been taken to determine what boundary models would be used for the expansion. As an ex-officio member of the Monitor National Marine Sanctuary Advisory Council, the Coast Guard can work directly with the sanctuary superintendent and council stakeholders to balance the objectives of regulations under consideration and the degree to which adopted regulations can be enforced at sea. Once regulations are adopted, this same venue also affords the opportunity to compare the sanctuary's enforcement priorities with the resources that the Coast Guard can bring to bear to address these priorities.

The remnants of historic Naval vessels that lie along the Graveyard of the Atlantic are the greatest links to our naval fighting tradition and our continued pursuit of sea supremacy. Accordingly, given their standing as a war grave, their historical significance in the perpetuation of our nation, and as cultural resources emblematic of times of turmoil and sacrifice, these wrecks are clearly artifacts worth preserving. Expansion of the Monitor National Marine Sanctuary, its effective management, and the dedicated effort of federal, state, and private partners are critical to safeguarding these important resources now and into the future.

The interment of the two crew members' remains. Coast Guard photo by Steven Tucker

For more information

Learn more about the Monitor National Marine Sanctuary as well as various historical shipwrecks along North Carolina's Outer Banks at https://monitor.noaa.gov/

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Collaboration, Creativity, Compromise, and Conclusion

U.S. Coast Guard modifies the Port of Miami anchorage area

by Paul D. Lehmann
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American cartoonist Rube Goldberg became well known for depicting complicated devices that performed simple tasks in indirect, convoluted ways. While federal rulemaking can appear to be like a Rube Goldberg machine to the public and participants alike, if done correctly, it is a well-choreographed, thoughtful process with opportunities for public input.

The Port of Miami anchorage area was reduced into two smaller anchorage areas in July 2017 as a result of a multi-year process with no specific funding mechanism. Since there were no dedicated funds and protected coral species were present, a group of representatives from nonprofits, industry and associated agencies, and the broader public had to think creatively and ultimately compromise on a solution. While it wasn't easy, and flexibility was necessary, the newly designed anchorage areas protect more than 600 acres of coral reef without negatively impacting the reasonable needs of navigation.

Winston Churchill was credited with saying, "We have no money—we shall have to think." This concept perfectly summarizes this project and the challenges we faced.

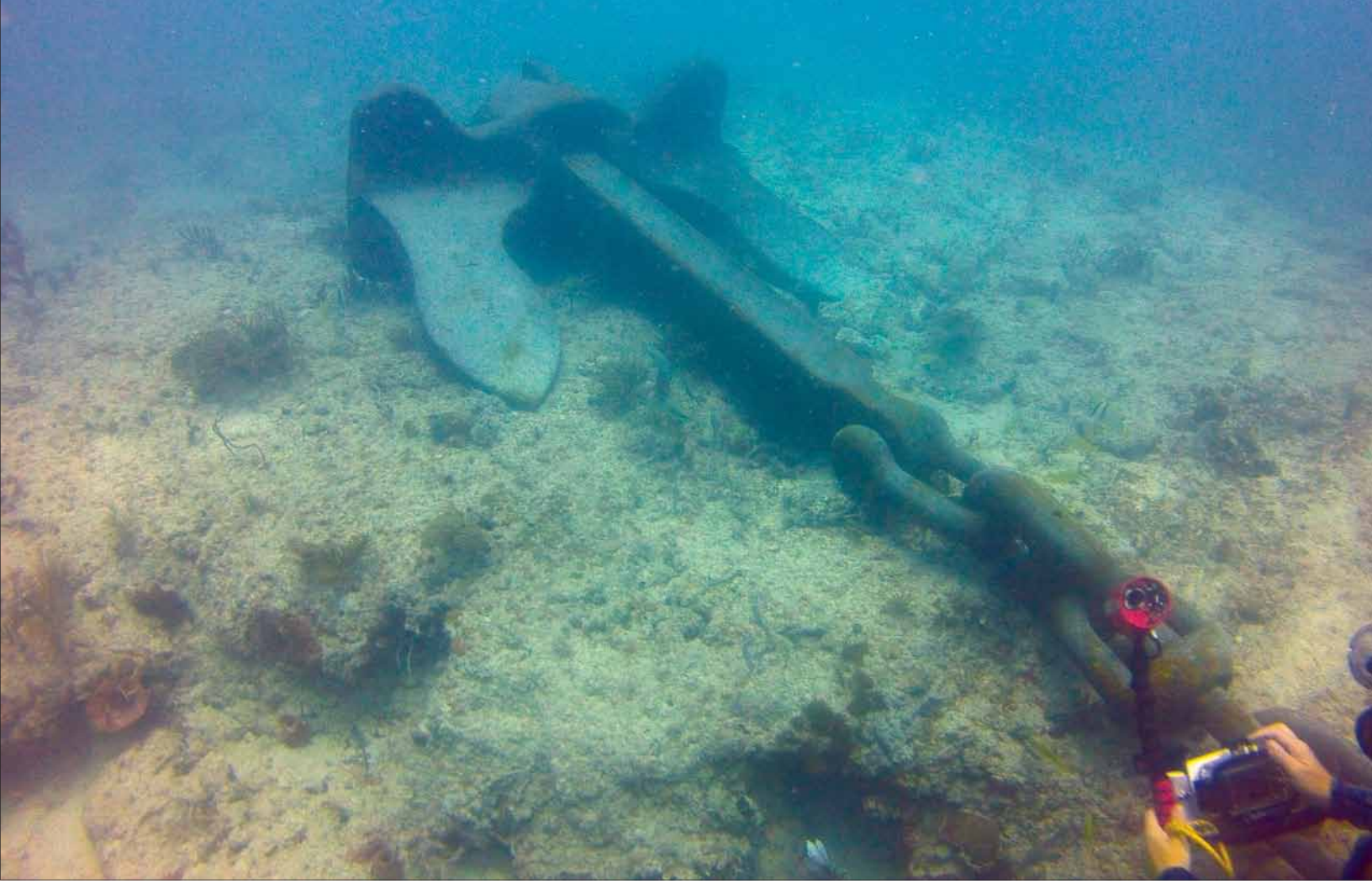
Background

Miami is a unique city, and while it can be many things to many people, life here has never been dull. In the mid-2000s, the Coast Guard's Seventh District (D7) was heavily involved with several events of national significance—agency reorganizations, immigration and drug smuggling prosecutions, and implementing improved post-9/11 security protocols, to name a few. D7 was also monitoring the National Oceanic and Atmospheric Administration (NOAA)'s review regarding elkhorn and staghorn corals and whether those species should be protected pursuant to the Endangered Species Act (ESA).

NOAA Fisheries Service photo

In 2006, elkhorn and staghorn corals were listed as "threatened" pursuant to the ESA, so we evaluated the impacts of that decision on Coast Guard operations as well as on those engaged in maritime transportation. In 2014, five additional species of coral in the D7 area of responsibility were listed as threatened pursuant to the ESA, adding to the complexity of this project.

Without delving too deeply into the nuances of the ESA, a species is considered threatened if it is likely to become an endangered species



A diver examines an anchor on the seabed. Florida Department of Environmental Protection photo

within the foreseeable future.[1] Elkhorn and staghorn corals are of the genus *Acropora*.[2] The most abundant group of corals in the world, Acropora once represented the most dominant reef-building species throughout Florida and the Caribbean.[3] They are typically found on shallow-water reefs, live in high-energy zones with a lot of wave action, and are in water temperatures from 66 to 86 degrees Fahrenheit.[4] In sum, the elkhorn and staghorn habitat exists almost everywhere in the southern D7 area of responsibility.

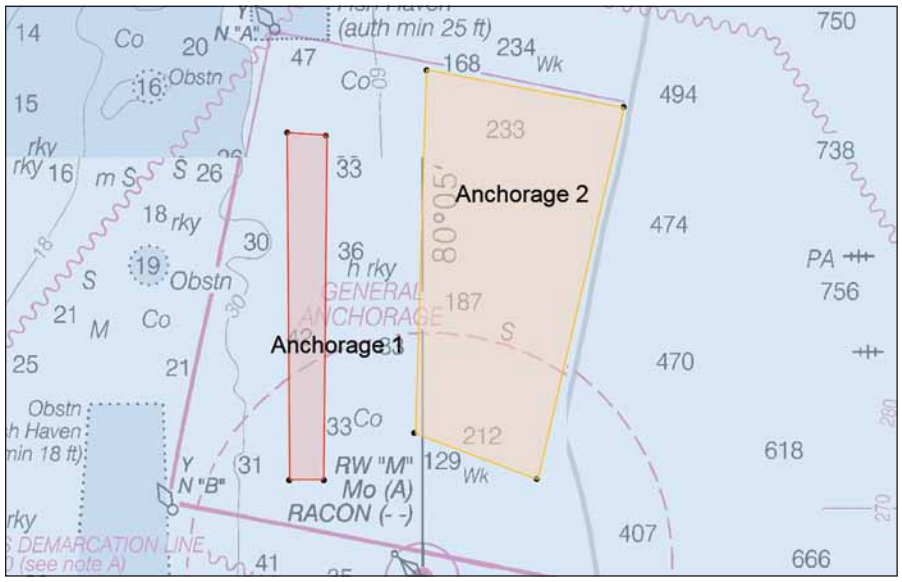
Following the first listing in 2006, and over the next few years, we had several meetings with the Florida Department of Environmental Protection (FDEP) and Nova Southeastern University (NSU) on whether these species and their habitats existed in the Port of Miami Anchorage. Without specific funding to conduct a survey, the FDEP and NSU provided data and identified 700 acres of hard bottom (coral habitat) within the anchorage. In addition, they suggested options to reduce anchoring impacts to coral habitat.

This was just one part of the puzzle, as the Coast Guard, FDEP, and NSU had to study and collect data on how the anchorage was actually being used by vessels. In short, we analyzed anchoring events to ensure safety would not be impacted at the expense of protecting the coral habitat. All involved parties understood that a major marine casualty could have severe impacts on the entire community, which helped set expectations among the group.

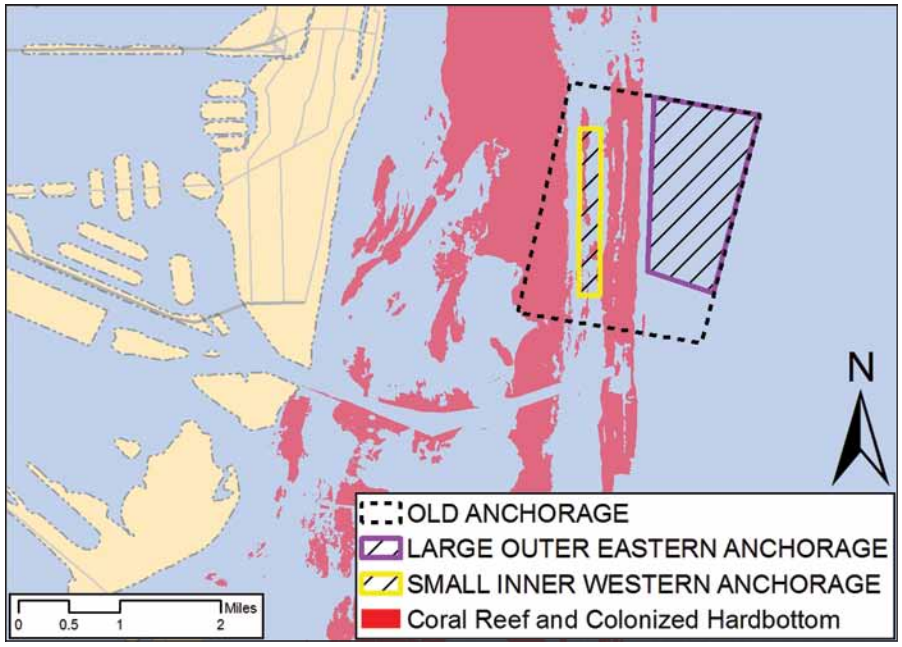
This is when we started to flesh out ideas with the Port of Miami pilots, Caribbean cargo vessel operators, and other waterway users. The needs of individual vessels/companies vary considerably, and federal rulemaking requires agencies to review the impacts of their actions through a variety of regulatory mechanisms.

For example, if we were to move the anchorage into deeper water and outside the coral habitat, as suggested by some, the smaller Caribbean vessels would be impacted. They would be required to handle and add more anchor chain, adding considerable weight to the vessels, impacting their operations, and ultimately impacting the communities those vessels serve. This is just one example demonstrating insight into the concerns we had regarding unintended consequences.

Suffice it to say, there are a variety of niche industries and facets that exist in any situation, so collaboration and public outreach is key. We routinely used the mantra "You don't know what you don't know" throughout this process and continued to gather more data in order to make thoughtful, sound decisions for all involved.



2016 slide utilized during stakeholder meetings showing current anchorage, reef habitat, and proposed anchorage. This information was designed and presented in conjunction with FDEP and NSU. Coast Guard Sector Miami graphic



2017 image developed in conjunction with FDEP and NSU from joint press release to inform public of the change. FDEP Coral Reef Conservation Program graphic

Given the sensitive environmental habitat in the area, we reached out to federal resource agencies to gauge the likelihood of success regarding this project. We knew a number of approvals, recommendations, and opinions would be needed before the project could be completed and felt it was important to include representatives from those agencies, sharing the FDEP/NSU data and developed biological survey protocols in advance of federal rulemaking. This approach allowed us to highlight major obstacles beforehand and increase the likelihood that federal rulemaking would be successful.

Seeking Public Input and a Broad Consensus

Since we had enough data and a framework for a reasonable proposal, we turned to industry, the public, and other interested parties for their thoughts. That process began on December 1, 2015, when the Coast Guard published a notice in the Federal Register indicating we were evaluating the Miami Anchorage because of the coral reefs off the Florida coast.

The notice stated that the Coast Guard was evaluating whether to divide the anchorage into two smaller anchorage areas. It also described the information that led to this proposal and provided it in the regulatory docket, both online and in hard copy. We also reached out to potential interested parties through a variety of means to ensure the broadest possible exposure.

Four initial comments were received and addressed in a Notice of Proposed Rulemaking (NPRM) on May 10, 2016. Another four additional comments were received in response to the NPRM. Two of the comments, one by the local nonprofit Miami Waterkeeper and the other by a private citizen, supported our planned modification of the Miami Anchorage. The third and fourth were submitted by the Biscayne Bay Pilots Association (BBPA).

BBPA requested that the Coast Guard evaluate changes in the proposed anchorage, including shifting the outer anchorage west and shifting the southern boundary of the outer anchorage north. In response to these comments, the Coast Guard discussed the request and how we arrived at the current anchorage configuration with the BBPA. During the meeting, the Coast Guard agreed to shift the western boundary of the outer anchorage about 300 feet to the west to provide more room for large anchoring vessels. This change did not have any effect on the coral reef, since the sea floor in that area is composed of sand.

BBPA also mentioned that the eastern outer anchorage could expose vessels to increased current and waves that could increase the chance a vessel would drag anchor. To properly assess environmental conditions and the risk

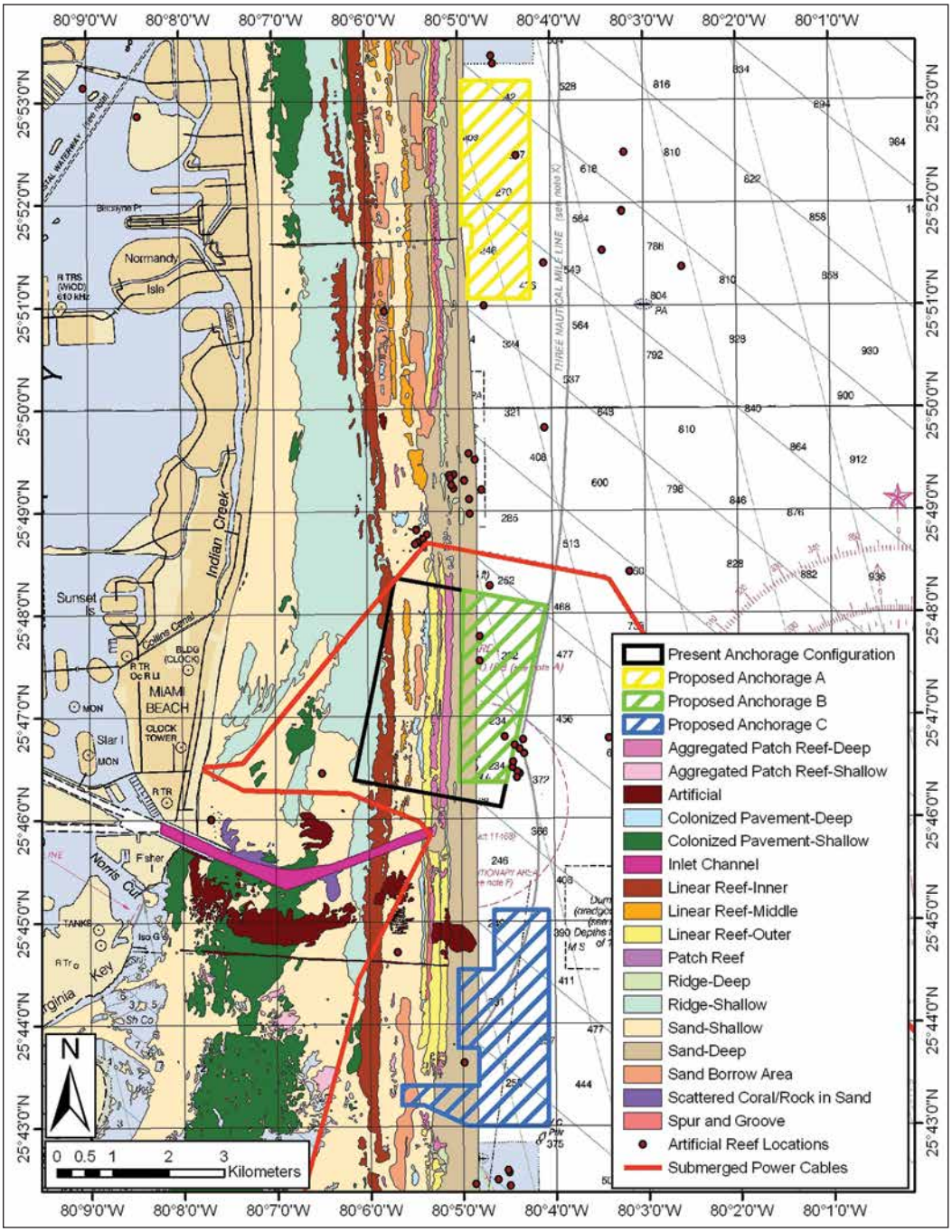
continued on page 38

Excerpts from USCG and Florida Department of Environmental Protection press releases:

The two areas include an inner western anchorage, ideal for smaller vessels, and an outer eastern anchorage, best for larger vessels. These new anchorages total to a combined area of approximately 1.5 square nautical miles, which will reduce the current anchorage area by close to 3 square nautical miles. The new anchorages save over 600 acres of coral reef from future impacts. Additional benefits include decreased shipping hazards because the new anchorages separate anchoring by vessel size, which ensures adequate depth for the safe anchorage of new, larger, post-Panamax shipping vessels that may now utilize Port Miami.

Several studies by Nova Southeastern University and the Florida Department of Environmental Protection showed that anchorage modification was necessary to reduce reef damage to the ecologically and economically important northern portion of the Florida Reef Tract. Ranging from the northern boundary of Biscayne National Park to the St. Lucie Inlet in Martin County, this reef system provides over 70,000 jobs and $6.4 billion annually to Florida's economy. It is also home to approximately 45 coral species and over 305 fish species, some of which are listed on the Endangered Species Act. These corals and fish communities attract tourists both regionally and globally for fishing, diving, and other purposes. As a member of the United States Coral Reef Task Force and the United States National Action Strategy to Conserve Coral Reefs, the USCG has acted to fulfill their commitments to protect, restore, and sustainably use United States coral reef ecosystems.

Yellow elkhorn coral is part of the *Acropora* genus. *Acropora* once represented the most dominant reef-building species throughout Florida and the Caribbean. Elkhorn and staghorn habitat currently exists throughout the southern D7 area of responsibility. Photo by Oliver S / Shutterstock.com



Florida Department of Environmental Protection graphic

of an anchor drag, the Coast Guard consulted with the National Weather Service and a Maersk training center. The National Weather Service conducted a study to analyze the previous year's current in the vicinity of the anchorage and found that the average current in the area of the outer anchorage over the previous year was approximately 1.2 knots, with currents ranging plus or minus half a knot from the mean current 70 percent of the time.

This information was provided to the Maersk training center in Svendborg, Denmark. Subject matter experts at the training school indicated the conditions posed no significant hazard, and that captains would have the training and experience to set an anchor in the deeper waters of the outer anchorage.

In addition to the assistance from Maersk and the National Weather Service, the National Marine Fisheries Service Habitat Conservation Division (HCD) and Protected Resources Division (PRD) advised us on what to do with a few small threatened corals located within the anchorage. A permitted individual was able to relocate the small corals at no cost.

We were nearing the home stretch.

Following these events, the Coast Guard again sought public input. Through continued cooperation and research with stakeholders, the USCG amended the original locations and other provisions stated in the NPRM. All comments and changes were then published in a Supplemental Notice of Proposed Rulemaking (SNPRM) on February 22, 2017. There were five written submissions on the SNPRM in support of the proposed rule, citing the desire to protect natural resources while acknowledging perceived minimal impact to industry and commerce.

We completed our economic impact analysis and found the proposal to have no significant economic impact to industry, nor would it negatively affect small businesses. Shortly thereafter, we obtained a biological opinion from the National Marine Fisheries Service Protected Resources Division and finalized our National Environmental Policy Act analysis, finding no significant impact to the human environment.

All the hurdles had been cleared and we were ready to draft a Final Rule.

I think it is safe to say that all members involved with this project came away with a greater awareness of the interconnected world in which we live.

Habitat landscape on outer reef. NOAA Fisheries Service photo

A grouper swims close to the seabed. NOAA Fisheries Service photo

Conclusion

On June 19, 2017, the Final Rule was published in the Federal Register. It became effective 30 days later. We submitted nautical chart corrections, updated the Local Notice to Mariners, and coordinated enforcement with FDEP to ensure enforcement actions would be phased in over time. We also directed an Aid to Navigation Cutter to remove two buoys marking the prior anchorage.

About the author:

Paul D. Lehmann has served in the U.S. Coast Guard for 23 years in many capacities. Since 2013 he has been the chief of the environmental section for the Seventh District's Waterways Branch. In addition to his civilian position in Miami, he is a commander and Judge Advocate in the U.S. Coast Guard Reserve.

Endnotes:

1. See NOAA press release, Elkhorn and staghorn corals listed in threatened status, dated May 5, 2006.
2. Ibid.
3. Ibid.
4. Ibid.

Detecting Illegal Fishing Activity with Acoustic Technology

Passive acoustic methods help USCG fight illegal fishing

by Hady Salloum, Ph.D.
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Combating illegal, unreported, and unregulated (IUU) fishing is a top international priority. IUU fishing involves fishing activity that does not respect rules adopted at either the national or international level, and is a worldwide problem estimated to cost the global fishing industry billions—possibly tens of billions—of dollars a year.[1]

In June 2014, the White House released a Presidential Memorandum entitled "Establishing a Comprehensive Framework to Combat Illegal, Unreported, and Unregulated Fishing and Seafood Fraud."[2]

Impacts of IUU Fishing

Illegal, unreported, and unregulated (IUU) fishing threatens the sustainable management of fish stocks and the economic health of U.S. fishing communities, the National Oceanic and Atmospheric Administration said in "Leveling the Playing Field: NOAA's plan to combat illegal fishing in 2012." Also known as pirate fishing, IUU fishing threatens fair marketplace competition and opportunities for legitimate U.S. fishermen. Illegal fishing can also impact these specific areas:

- **Biological**—impacts on the stock or resource base
- **Environmental**—impacts on the environment/ecosystem
- **Social**—impacts on communities related to the fisheries sector as well as those wider afield
- **Economic**—impacts on the national economy
- **Revenue**—impacts on a state's ability to generate income from selling licenses

The actions to address these issues fall under four general themes:

- combating IUU fishing and seafood fraud at the international level
- strengthening enforcement and enhancing enforcement tools
- creating and expanding partnerships with non-federal entities to identify and eliminate seafood fraud and the sale of IUU seafood products in U.S. commerce
- increasing information available on seafood products through additional traceability requirements

The United States Coast Guard plays a key role in the second theme by protecting the U.S. exclusive economic zone (EEZ) and key areas of the high seas. The Coast Guard has four overall objectives in its living marine resources mission,[3] including preventing illegal encroachment of the U.S. EEZ by foreign fishing vessels; ensuring compliance with U.S. laws and regulations; monitoring compliance with international agreements; and developing viable enforcement schemes to support marine resource management plans.

Areas most often subject to incursions:

- the U.S./Mexico maritime border
- the western Pacific around U.S. territories
- the Bering Sea at the U.S./Russia maritime boundary

Current Methods of Illegal Fishing Monitoring, Control, and Surveillance

The term monitoring, control, and surveillance (MCS) encompasses more than just detection of illegal fishing activity. A guidebook[4] describing various elements of MCS includes a review of the different components for detection of unlicensed vessels/fishers and points out that the most effective methods are patrol vessels, patrol planes, helicopters, and satellite imagery. The most extensive review of monitoring and surveillance technologies for fisheries[5] also includes a brief review of passive acoustic methods.

The development of passive acoustic methods of ship and submarine detection started at the beginning of the 20th century.[6] It was reasonable to extend the application of acoustic systems developed for Anti-Submarine Warfare (ASW) to the detection of boats involved in IUU activities. The most powerful passive acoustic system, the Navy's Sound Surveillance System (SOSUS), was investigated for the detection of fishing boats.[7] SOSUS is a network of underwater hydrophone arrays deployed throughout the oceans of the northern hemisphere. Though the system was built for submarine detection, the Navy allowed testing for civil purposes. It is a relatively old system and was operated at 30 undersea surveillance sites around the world during the Cold War. Today, the Navy has operational systems in only three deployments[8] where possible applications of such systems for IUU could be geographically limited and expensive.

Though SOSUS is a very large, expensive system, passive acoustic monitoring can be conducted using much smaller hydrophone systems than SOSUS uses. Many organizations are developing acoustic systems for mammal and fish activity measurements and ocean ambient noise control applications, with acoustic autonomous recorders being the most popular tool. These devices, as well as their applications, vary greatly in capabilities and costs. They range from small, hand-deployable units for detecting dolphin and porpoise clicks in shallow water, to larger units that can be deployed in deep water and record at high-frequency bandwidths for over a year, but must be deployed from a large vessel.[9]

The majority of these systems provide sound recording, where the recorded data is processed after being retrieved from the systems, not in real time. There are, however, several acoustic buoys that provide onboard signal processing and send information about any detected mammal and fish activity to a command center. These systems are applied mainly for the detection of marine mammals, but can be adapted for IUU detection. They include:

- the East Carolina University system, the ECU instrumented tripod[10] that was applied for monitoring the acoustic environment in coastal waters
- a passive digital acoustic monitoring instrument (DMON) capable of recording and processing audio aboard a variety of autonomous platforms developed by the Woods Hole Oceanographic Institute[11]
- the Passive Acoustic Listener, developed by the Applied Physics Laboratory in Washington and the Hellenic Center for Marine Research in Anavissos, Greece[12]

One of the most suitable systems for boat detection is the Remote Hydrophone Buoy developed by the French company RTsys Marine Technologies.[13] RTsys offers moored or drifting buoys that are able to store recorded acoustic data or to transmit them if they are within range of Wi-Fi or a radio transmitter.

Stevens Passive Acoustic Detection System and Portable Acoustic Recorder System

The passive acoustic methods of surface and subsurface threat detection research have been investigated in the Maritime Security Center (MSC), a DHS Science and Technology National Center of Excellence for maritime and port security. The goal of the Stevens Institute of Technology, the MSC's lead institution, is to examine basic science issues and emerging technologies to improve the security of ports as well as coastal and offshore operations. The acoustic research of the MSC is aimed at the investigation of passive acoustic methods and their applications to surface and underwater threat detection, classification, and tracking in coastal zones. Acoustics is the only tool that provides detection of underwater threats. Initially, the focus was on threats posed by subsurface intruders, including SCUBA divers.[14] Later it was extended to small boats using passive acoustic techniques.[15]

> The RTsys Marine Technologies BA-SDA14 Wi-Fi remote acoustic buoy has a range of up to 3km. The RB-SDA14 model has a radio transmitter and a range of more than 10km.

The acoustic research at Stevens led to the development of the Stevens Passive Acoustic Detection System (SPADES). SPADES consists of two—or potentially more—moorings, each of which has four highly sensitive wideband hydrophones deployed on a collapsible frame. A data acquisition system that captures the signals with a frequency content up to 100 kHz is installed at the center of the mooring. The frame has one of the four hydrophones in the center, while the others are separated by collapsible

legs, with a radius of 2.4 m and 120 degrees between each leg. A fiber optic cable is used to transmit data from the mooring to the shore equipment (see Figures 1 and 2). Two or more nodes, together with onshore equipment, are capable of localizing and tracking the targets by triangulating the direction of arrival. The system has been demonstrated to be able to detect targets including divers using SCUBA equipment, small and large vessels, and other targets that produce underwater noise.

SPADES can detect, track, and classify surface vessels. Stevens conducted intensive tests in the Hudson River, New York Bay, Port of Miami, Den Helder in the Netherlands, and San Diego area. Tests in controlled conditions with six different boats were also conducted at Lake Hopatcong in New Jersey. This resulted in the development of a library of acoustic signatures that is being used to develop methods for boat detection, tracking, and classification.

Stevens also developed and built the Portable Acoustic Recorder System (PARS), which is a modular system that consists of an enclosure, battery module, payload, and frame. It is designed to digitally record precisely time-stamped signals acquired by interchangeable sensors, like hydrophones or microphones. The PARS is low-cost and provides continuous recording for at least 15 days. The system has three hydrophones that provide bearing to an acoustic target; two or more systems can then provide target localization. This system does not provide real-time detection, but it can be used for investigating IUU activity and patterns in remote areas.

Software and Signal Processing

For boat detection and classification, the signal from one hydrophone is sufficient; systems with three or more hydrophones are required for finding a target-bearing direction. The application of two or more systems provides localization of a suspicious boat. In our tests, the detection distance of fishing boats reached 15 miles in the open sea.

The majority of passive acoustic systems calculate target positions from bearings received in two or more locations. Beam-forming arrays are used for bearing finding in many ASW systems that are too expensive for most non-military applications.

One of the main advantages of acoustic methods is the ability to classify by vessel type based on an acoustic signature. For the classification, we used a practical approach based on the findings of the mechanical characteristics of vessels from their acoustic signatures.[16]

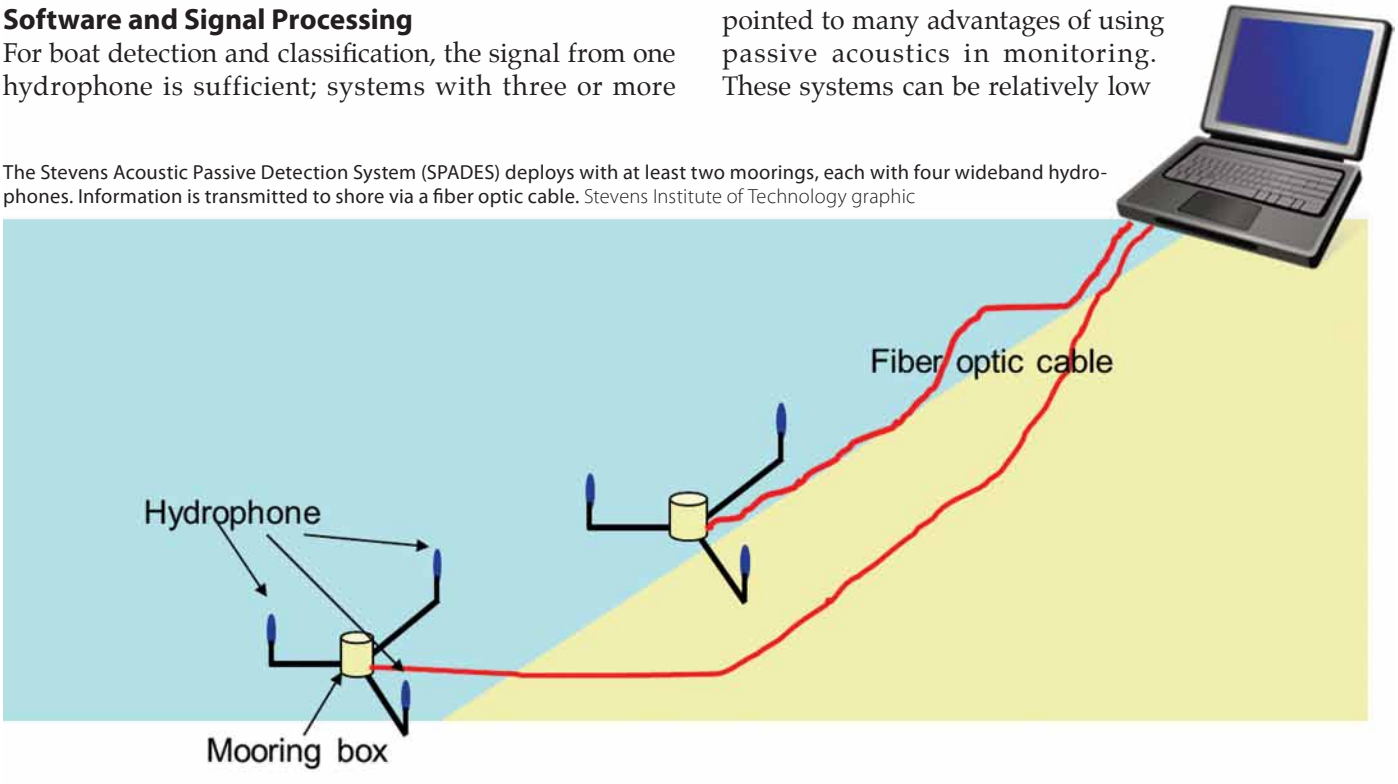
The developed algorithms allow us to determine:

- number of engines
- number of propeller blades
- gear ratio between the engine and propeller
- engine stroke type
- number of engine cylinders
- engine type

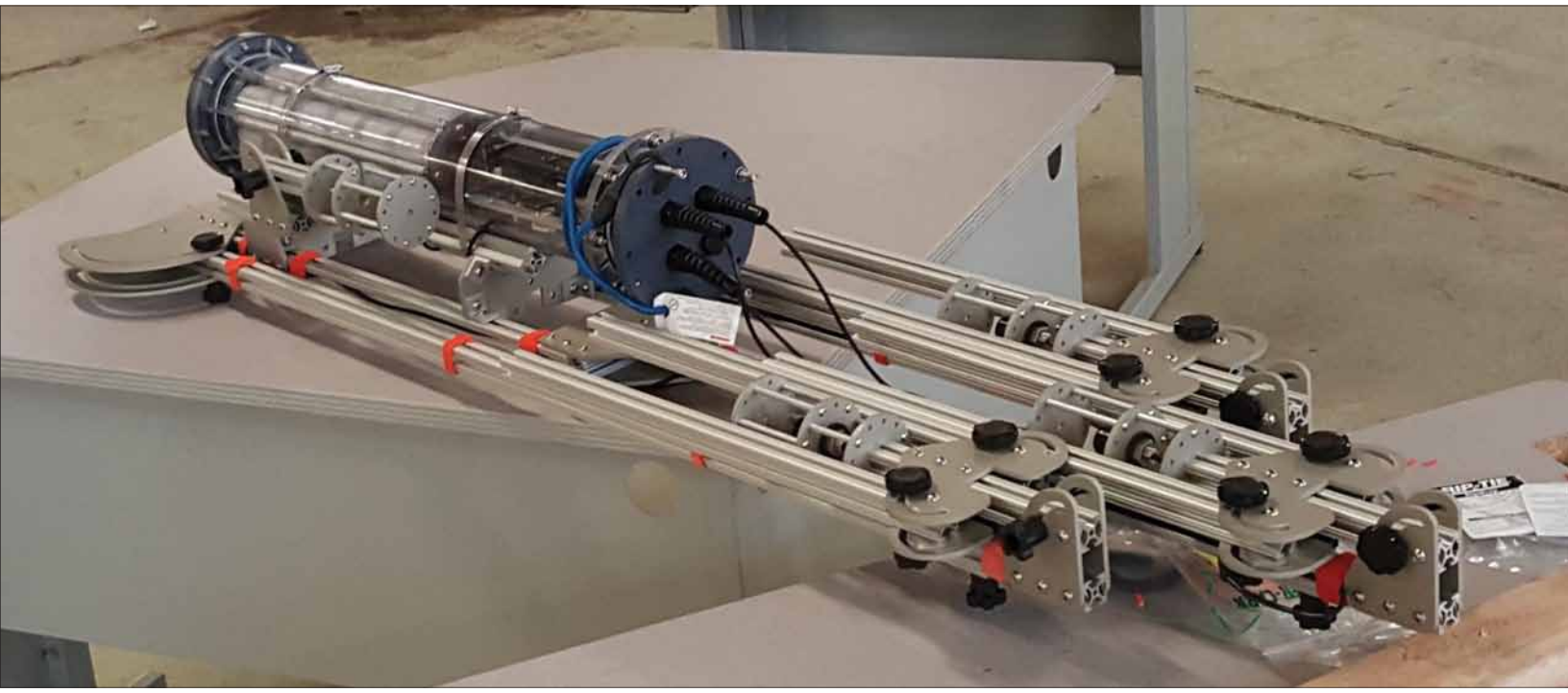
Our algorithms even allow for determination of specific characteristics of separate vessels for use in vessel forensics. For example, recorded acoustic signatures reflected the malfunction of some small vessel engines as well as the extensive wear of some propellers.

Prospective Acoustic Sensors and Required Work

A detailed review of prospective applications of acoustic sensors for IUU boat detection[17] pointed to many advantages of using passive acoustics in monitoring. These systems can be relatively low



The Stevens Acoustic Passive Detection System (SPADES) deploys with at least two moorings, each with four wideband hydrophones. Information is transmitted to shore via a fiber optic cable. Stevens Institute of Technology graphic



The Stevens Passive Acoustic Detection System (SPADES) can detect, track, and classify surface vessels. Stevens Institute of Technology graphic

in cost, very simple, and easy to use. The estimated cost of a Stevens custom-made PARS is about $10,000, similar to the cost of commercially available recorders.[18] The PARS has three hydrophones that allow finding the bearing of the detected ship, whereas the application of two or more systems provides localization of a suspicious boat.

Acoustic sensors are particularly effective in situations where silent, undetectable monitoring of IUU activity is required. The IUU fishers would be unaware of the surveillance, and therefore not inclined to modify their behavior, as would happen with visible forms of surveillance. Data collected could also be used in connection with Vessel Monitoring System (VMS) information to identify non-VMS equipped ships, which could indicate IUU fishermen who typically do not use VMS or automatic identification system information on larger vessels. Acoustic monitoring schemes are also effective in that they do not require the buy-in and action of multiple stakeholders—only those of the funding and monitoring bodies.

Disadvantages and Required Work

"Disadvantages come in the initial capital costs, as there needs to be enough coverage area for it to be effective. There is also a potential for vandalism or theft if they are mounted on a buoy or USV," Dr. Selbe said.[19]

Based on our limited system deployment experience, theft is a large concern. Two of our PARS systems were lost in different areas—New York Bay and California off the coast of Los Angeles—within a few weeks of deployment, possibly due to theft of the surface buoys.

For possible USCG applications, we can use two possible systems, including a simple acoustic recorder or a system with onboard signal processing, allowing near real-time alerts to law enforcement agencies about the presence of legal and illegal boats. Several proposals for use by the USCG are pending.

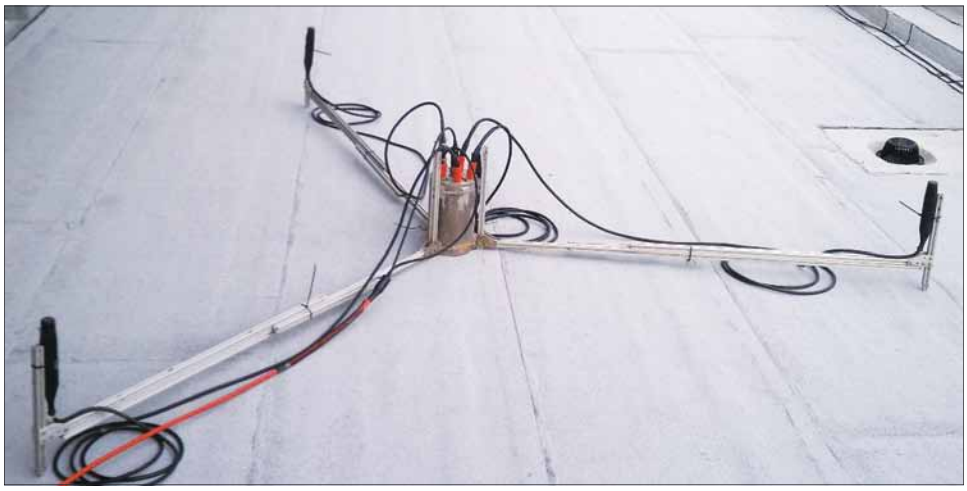
We plan to use the acoustic recorders with time-release or acoustic-release systems. This allows the system to be hidden on the bottom and programmed to surface at predetermined times, or after the acoustic command is sent. The recorded acoustic signatures can be used for vessel identification and may be considered proof of IUU activity during forensic analysis for possible legal actions.

Other more advanced systems providing near real-time information need to have a communication antenna on a surface buoy connected to the bottom hydrophone system through a cable. This cable cannot be made strong enough to take the system to the surface. The buoy and antenna are not expensive, and theft is not a concern. The extraction of the system itself may be accomplished using another buoy that can be released at a predetermined time or through an acoustic release.

Dr. Selbe also states that "While the concept has been proven, there are not a lot of commercially available systems that can perform this function. As a result, there may be some development work necessary. They would also have to be effective enough to detect only the

intended vessels without giving an unmanageable number of false positives."[20]

The Stevens team conducted intensive work in the development of automated methods of vessel detection, tracking, and classification.[21] The developed algorithms can be implemented in commercially available passive acoustic systems, like the BA-SDA14 Wi-Fi Remote Hydrophone Buoy, or Stevens can build an acoustic system customized for various maritime applications.



A Portable Acoustic Recorder System (PARS) is set up on shore before deployment. Stevens Institute of Technology graphic

About the authors:

Professor Hady Salloum is a professor and the associate dean for research at the Stevens Institute of Technology, as well as the director of the DHS S&T National Center of Excellence for Maritime Security. He has been leading key border and maritime security initiatives, including Integrated Maritime Security Sensing using acoustics, radar, and IR sensors; information security; and other related projects. He has over 30 years of experience in industry and academia, running large-scale, complex research and development projects.

Alexander Sutin is a research professor at the Stevens Institute of Technology. He has many years of experience in physical and underwater acoustics and has conducted a large number of experiments, from crack detection and ultrasonic microscopy to detection, tracking, and classification of large ships, small vessels, submersibles, divers, and aircraft.

Alexander Pollara was a Ph.D. student at the Stevens Institute of Technology and has recently completed his Ph.D. thesis "Characterization of Small Vessels from Acoustical Signatures."

Acknowledgment:

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How To Improve Your "Climate-Smart IQ" Using the Adaptation Design Tool

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Suppose you are leading a project to protect coastal infrastructure from storms using natural habitats like coral reefs and wetlands. Because you know that sea level rise and more powerful storms will negatively affect the coastal protection both habitats provide, you want to incorporate these and other climate change effects into your project's planning assumptions. Furthermore, you want to ensure that how you deal with climate change is documented, transparent, and follows clear logic.

What can you do to rigorously include climate change effects in your coastal protection actions, or make them "climate-smart?" How can you develop coastal management actions that should be effective not only now, but also as climate change intensifies?

Regardless of whether you are managing coastal protection, ports, marine protected areas, navigation channels, energy extraction, or another sector, the basic process for incorporating climate change is the same. There are three broad questions to address:

- How will climate change affect the system stressors about which you are concerned? In the case of coastal protection using wetlands, stressors would include sea level rise and storm intensity.
- How will the stressors that are altered by climate change affect the management actions you are considering taking? For wetland coastal protection, this might be that wetlands will be flooded more often from sea level rise and physically destroyed by larger waves.
- How can you alter potential management actions to respond to the anticipated climate change effects? For wetland coastal protection, this might entail using alternative wetland species or sloping the land differently.

Answering these questions and then adjusting your management actions accordingly makes them climate-smart.

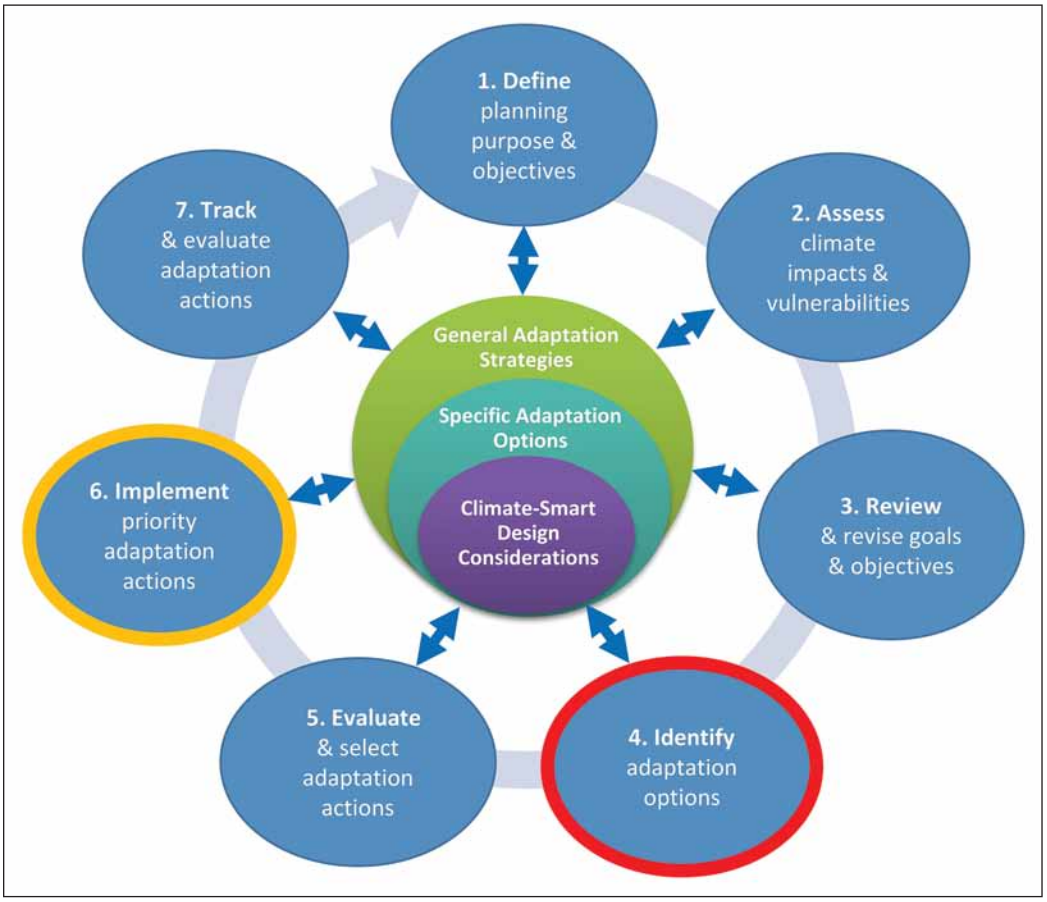
Bringing Climate Change into Decision Support Tools

The Adaptation Design Tool can help you work through these steps. It is a systematic, standardized method for incorporating climate change into resource management actions. The tool was developed under the auspices of the Climate Change Working Group of the U.S. Coral Reef Task Force—an interagency, intergovernmental task force established by Executive Order 13089 to, among other things, identify the major causes and consequences of the degradation of coral reef ecosystems—as part of the Corals & Climate Adaptation Planning project. This project is a partnership of the U.S. Environmental Protection Agency, the National Oceanographic and Atmospheric Administration, the Department of the Interior, and the Nature Conservancy, with input from collaborators in Hawaii, Puerto Rico, the Chesapeake Bay program office, and Florida.

The project's two main activities include making potential management actions climate-smart and helping to identify additional adaptation actions that address gaps in the resource management plan. Depending on what stage of planning you are in, one or both activities may be relevant. Furthermore, the Adaptation Design Tool can be applied to a range of potential management actions before final selection, to inform prioritization, or it can be used after priority actions have been selected, to inform implementation. (Figure 1)

Using the Adaptation Design Tool to incorporate climate change into management actions has four benefits beyond ensuring such actions are climate-smart.

Figure 1



The climate-smart cycle (outer ring) and Adaptation Design Tool framework (center). The Adaptation Design Tool can be used in Steps 4 and 6. Adapted from NOAA reference material

First, the design tool may alter users' perceptions of which actions will be the most effective over the long term. Actions that are tried-and-true without climate change could become much less effective once climate change effects are factored in, while actions that seemed less useful without climate change may have greater potential once climate change effects are considered. Thus, using the design tool could change how users prioritize management actions for implementation.

Second, the design tool can help counteract the potentially overwhelming uncertainty involved in climate change adaptation by encouraging users to write down both what is known as well as important information gaps. This foundation can always be updated as new information becomes available.

Third, the design tool has users consider only technical constraints, remaining agnostic to the myriad other nontechnical constraints on adaptation like financial, staffing, or political constraints that restrict implementation. By focusing on the technical merits of adaptation actions, the design tool can highlight the nontechnical challenges that might be worth overcoming because of the value delivered by the technical advantages of the adaptation action.

Fourth, the design tool aids transparent decision making, improves institutional memory, and builds connections within the managed system and otherwise potentially disparate actions. Generally speaking, it supports structured decision making, and writing down the steps involved in making an action climate-smart makes it easier for future decision makers to understand the basis for decisions made by their predecessors.

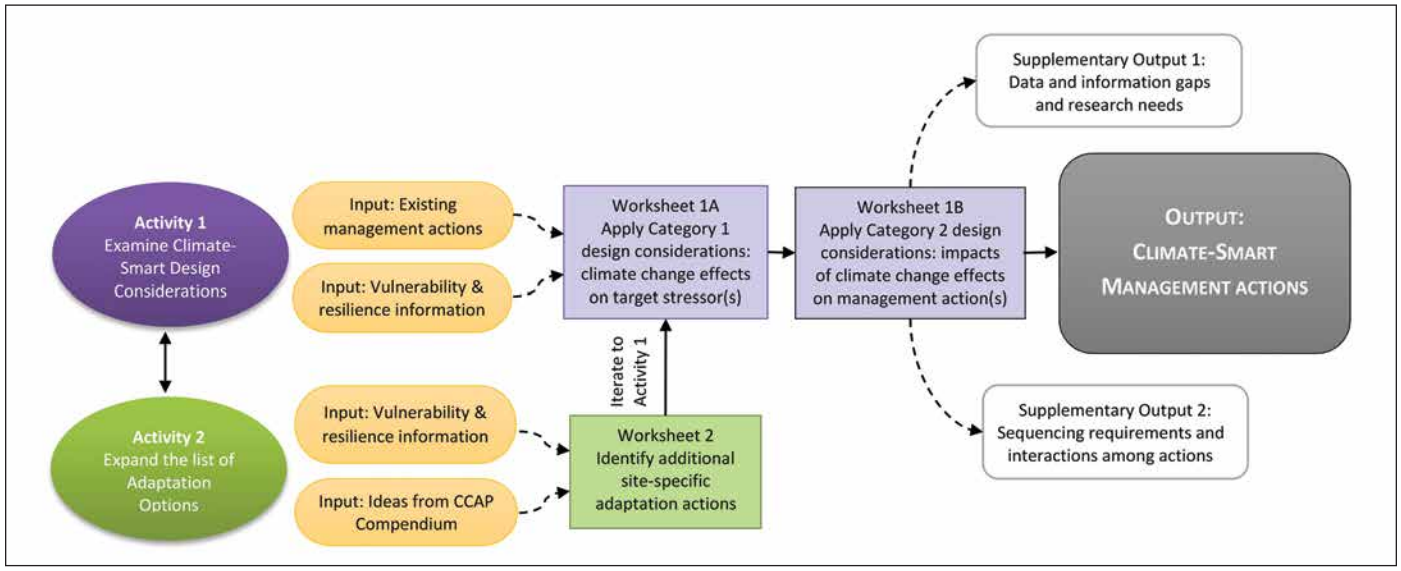
How Do You Use the Adaptation Design Tool?

The general flow of the design tool is shown in Figure 2. At a minimum, you will need a climate change vulnerability assessment for the area of interest as an input to the tool. Existing vulnerability information for your region can be collected and summarized many different ways, but whichever form works for your organization is fine for using the design tool. If you are trying to make potential actions climate-smart—Activity 1—you will also need your list of potential management actions. The only other materials you will need are the design tool worksheets.[1]

Activity 1 is used to make a list of potential management actions climate-smart. It is comprised of two worksheets, which together walk users through a series of climate change design considerations. The first worksheet focuses on how climate change will directly and indirectly affect how the stressors of concern impact the system. The second worksheet focuses on how climate change will affect the functionality of the management action—through its effects on the stressors and/or its effects on the action directly—and, as a result, how the action will need to be adjusted in terms of location, timing, or engineering design.

The worksheet columns build on each other and are completed sequentially, yet it is natural to also return to and add information to columns you have already filled out as insights emerge from working on later columns or even later actions. Both worksheets also have notes

Figure 2



The Adaptation Design Tool workflow. Users can begin with Activity 1, then go to Activity 2, then return to Activity 1, or they can start with Activity 2, then go to Activity 1. NOAA graphic

columns for documenting questions, information gaps, additional concerns, resources, etc.

At the end of this activity, you will have developed a climate-smart version of each action you started with, plus supplementary information in the notes columns of both worksheets. Table 1 provides an example of an Activity 1 result for one action.

The information mentioned above from the "notes" columns of Activity 1 can be used to generate two important supplementary outputs (SO1 and SO2), each with its own worksheet. (Figure 2) The SO1 worksheet documents information gaps and research needs for each action. The SO2 worksheet documents information on interactions among management actions—for example, which actions are synergistic with or conflict with each other—and the order in which actions must be taken.

These supplementary outputs can help drive the research agenda for the management area and assist with implementing actions by suggesting which actions should or should not be used together, and in what order they should be used. Generally speaking, the supplementary outputs promote a systems approach to management, rather than addressing stressors with individual management actions operating independently of each other.

After putting your list of management actions through Activity 1, you can use Activity 2 (Figure 2) to search for adaptation actions that fill gaps in your management plan, i.e., those that address remaining aspects of vulnerability. A compendium of adaptation ideas from the literature is provided in the Adaptation Design Tool user guide[2] as a starting point for brainstorming. Any actions identified in this process can then be put through Activity 1 and added to your list of climate-smart actions. The ultimate output of the combined activities, then, is a wide range of potential climate-smart actions that can be evaluated in terms of their relative effectiveness in light of climate change. This can help with final selection of priority actions for implementation in a climate-smart plan.

Application of the Adaptation Design Tool

The design tool can be used at two junctures in the management cycle (Figure 1):

- Step 4—Identify adaptation options
- Step 6—Implement priority adaptation actions

In the first case, Step 4, the manager is considering multiple management actions and has not yet selected which ones to proceed with. In order to make the selection step—Step 5—climate-smart, as many potential actions as possible should be put through Activity 1 of the design tool. As previously mentioned, this allows selection from a pool of climate-smart actions, which may yield different results from a pool of actions without climate change incorporated into them. Because using the design tool on many actions can be time-consuming, a low level or "rough cut" of climate-smart detail is recommended at this stage.

In the second case, Step 6, management actions have already been selected, and implementation plans are being developed. At this point, the design tool can be used with a group of subject matter experts for each action to add much greater detail to the climate-smart design.

You may also find that using the design tool informs steps of the climate-smart cycle besides Steps 4 and 6. For example, design tool results might indicate:

- you need to gather more information on climate impacts and vulnerabilities (Step 2)

continued on page 49

Table 1

A1	A2	A3	A4	A5	A6	A7
Action number	Existing management action	Target stressor(s)	Climate change effects on stressor(s): direction, magnitude, mechanism, uncertainty	Timing of climate change effects	Implications for effectiveness metrics and how to measure them	Notes
1	Outplant aquarium-grown corals on reefs surrounding the bay mouth	• Warmer ocean water • Lower pH ocean water • Terrestrial sediment and nutrients • Sea level rise (SLR) • Disease	• Warmer waters may increase bleaching episodes and disease outbreaks. High magnitude, low uncertainty. • Stormwater plumes may extend further into the ocean, impacting more coral reefs. High magnitude, low uncertainty. • Storms of sufficient intensity to release levels of sediment and nutrients exceeding reefs' tolerance may occur more frequently. High magnitude, medium uncertainty. • Sea level rise may occur faster than reef accretion, leading to "sinking reefs". Medium magnitude, low uncertainty. • Ocean acidification may decrease colony growth rates, reproduction, and successful recruitment if corals cannot chemically cue to settlement sites, put energy into gamete production, or calcify (due to acidic conditions). High magnitude, medium-high uncertainty.	• Temperature effects have already occurred, with increasing magnitude through mid-century. • Increasingly violent storms are already occurring. • Storm intensity will likely continue to increase over coming decades. • Acidification beyond coral optima may have already occurred for some taxa and is expected to worsen.	• **Effectiveness metrics:** Survival and growth rates of outplanted colonies, including genetic diversity. Sexual and asexual reproduction of colonies. • **Implications for effectiveness metrics:** Survival rates over longer time periods (multiple years) may decrease due to episodic events, like storms or bleaching events. Growth rates may decrease and time until sexually reproductive may increase due to acidification. • **Implications for how to measure effectiveness metrics:** Monitor survival for longer after outplanting because of more episodic climate change-associated events, like bleaching or storms. Monitor longer for reproduction because of delayed sexual maturity.	• Is a certain level of rugosity of outplants desirable? • Some micro-fragmenting is being used to "re-sheet" dead boulder colonies. • It will be important to adjust coral nursery rearing practices in response to outplanting results.

B1	B2	B3	B4	B5	B6	B7	B8
Action number	Existing management action	Changes in effectiveness of management action due to: climate impacts on target stressor	Changes in effectiveness of management action due to: climate impacts on management action	Time frame or constraint for using the action and implementation (e.g., urgency, longer or shorter term)	What changes are needed to adapt the action (place, time, and engineering design)	Climate-Smart Management Action	Notes
1	Outplant aquarium-grown corals on reefs surrounding the bay mouth	• Areas suitable for outplanting colonies may change due to extended sediment plumes from rivers. • Decreased growth and reproduction rates of outplants from ocean acidification. • Above stressor effects may reduce the genetic diversity of outplanted colonies below the intended level. • Increased death of outplanted colonies from bleaching and diseases.	• Fewer boat days available for outplanting corals due to an increase in storms • Methods and materials for attaching corals to substrate may not withstand stronger storms • Preferred outplanting season may shift	• The sooner this is done, the better. • Outplanting will have to be a sustained, long-term effort.	• Focus on outplanting coral strains with a variety of types of tolerance to climate-change effects, including being bred to tolerate multiple stressors. • Cement may need to be used more often to attach colonies to substrate due to increased risk from storms. • Time outplanting to avoid periods with more runoff and land-based pollution. • Factor changes in sediment plume location and direction into outplanting site selection. • Monitoring may need to be extended longer after outplanting to include how outplants handle extreme events and to what extent they reproduce.	Outplant colonies that are heat-, disease-, sediment-, and low pH-tolerant. Outplanting during high sediment or precipitation periods should be avoided to reduce initial stressor exposure to outplants. Colonies in shallower sites may need to be affixed to reefs using cement more frequently due to larger storms. Site selection may also be affected by shifting plumes of land-based pollutants from the bay. Because survival through extreme events is an important part of the nursery program, colonies should be monitored through extreme events such as high temperatures and large storms. Monitoring periods for outplants may need to be extended to do this.	• Need to focus on other activities that are important for improving the outplanting environment. • How can multiple colonies be attached to the bottom at once?

Example output from the Adaptation Design Tool using a coral outplanting action. Graphic courtesy of David Gibbs

- your goals and objectives may need to be re-examined (Step 3)
- the metrics and methods for tracking results of your actions may need adjustment (Step 7)

Anyone from an individual to a group of experts can put actions through the design tool. Who should do so depends on the context in which it is being employed. If you are using the design tool to identify adaptation options—Step 4—you might consider using one or two people with more general knowledge who can put many potential actions through relatively rapidly for a "rough cut." On the other hand, if you are using the design tool to generate detailed climate change-related implementation information (Step 6), it is preferable to have a group of between three and eight experts work through the more intensive design process in person or virtually.

A free, self-paced course on the Adaptation Design Tool is available on The Nature Conservancy's conservation training website. The course introduces principles of climate-smart planning and the Adaptation Design Tool. It is available at www.conservationtraining.org/enrol/index.php?id=295 and takes about two hours to complete.

Though engagement with the public throughout climate change adaptation is important, the design tool is not meant to be an instrument for public engagement because it focuses on technical design aspects only. During public engagement sessions, however, its technically oriented output can be weighed alongside other criteria of interest to the public.

Adaptation Design Tool: A Framework for Being Climate-Smart

Climate change is a pressing concern for maritime activities. It is already occurring and expected to intensify. Although the general course of climate change is fairly well understood, there are many uncertainties associated with specific aspects of future climate change, our understanding of how natural systems will respond to resulting impacts, and how effective our management actions will be in counteracting these impacts.

Nevertheless, maritime activities must continue with as much preparation as possible for climate change, using the best information currently available. The Adaptation Design Tool can help assemble this information and make it actionable now. At the same time, it provides a conceptual framework and information record that can be revisited and continuously refined through time as new scientific advances emerge. The Adaptation Design Tool empowers you to do what you can now, incorporate new information as it becomes available, and make better and better decisions in the future.

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Endnotes:

1. The Adaptation Design Tool user guide and worksheets can be found in B.A. Parker, J.M. West, A.T. Hamilton, C.A. Courtney, P. MacGowan, K.H. Koltes, D.A. Gibbs, and P. Bradley, 2017, Adaptation Design Tool: Corals and Climate Adaptation Planning. Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 27. 58 pp. www.coris.noaa.gov/activities/CCAP_design/

2. Ibid.

Graphic references:

Figure 1: West, J.M.; Courtney, C.A.; Hamilton, A.T.; Parker, B.A.; Julius, S.H.; Hoffman, J.; Koltes, K.H.; and MacGowan, P. 2016. Climate-smart design for ecosystem management: A test application for coral reefs. Environmental Management. DOI: 10.1007/s00267-016-0774-3

Figure 2: B.A. Parker, J.M. West, A.T. Hamilton, C.A. Courtney, P. MacGowan, K.H. Koltes, D.A. Gibbs, and P. Bradley. 2017. Adaptation Design Tool: Corals and Climate Adaptation Planning. Silver Spring, MD: NOAA Coral Reef Conservation Program. NOAA Technical Memorandum CRCP 27. 58 pp. www.coris.noaa.gov/activities/CCAP_design/

Fathoms Deep in Salt Water

The wealth of ocean parks

by Elizabeth Moore
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In 1911's "Book of Buried Treasure," author Ralph D. Paine sums up the enduring appeal of finding lost treasures:

> ***The language has no more boldly romantic words than pirate and galleon and the dullest imagination is apt to be kindled by any plausible dream of finding their lost treasures hidden on lonely beach or tropic key, or sunk fathoms deep in salt water.***

Indeed, pirates and their treasures have fired our imagination for well over a century, from Robert Louis Stevenson's "Treasure Island," to Disney's "Pirates of the Caribbean" movie franchise, to today's news stories of gold doubloons found on rediscovered Spanish shipwrecks. While we can all relate to the exciting image of tumbled piles of gold coins gleaming underwater, we've also come to understand that the true sunken treasures of our ocean are not precious metals and gems, but what the ocean and its ecosystems and wildlife provide us.

Ocean Capital

Since humans arrived on the North American continent, there has never been a time they didn't survive and prosper from the ocean. From eating fish, crafting currency

California's Bowling Ball Beach overlooks Greater Farallones National Marine Sanctuary. NOAA photo by Matt McIntosh

The National Marine Sanctuary System includes 13 national marine sanctuaries and two marine national monuments. NOAA graphic

from seashells, and using furs as trading goods, our distant forebears weren't all that different from us today—eating fish, extracting energy and minerals, and guarding the resources of our exclusive economic zone.

What's different today is how many more of us there are, the voracious demands we place on our ocean, and the ruthless efficiency with which we fulfill those requirements for food, energy, medicine, minerals, shipping, and recreation. At a June 2017 Capitol Hill briefing on ocean wealth, scientists warned that we are on the brink of an industrial revolution for the ocean, and we need increased protection, better planning, and more knowledge to understand and manage the full picture of our ocean wealth to avoid the problems of the industrial revolution on land in the 18th and 19th centuries.

Ocean parks are one solution to those needs, providing long-term protection and planning for important marine and Great Lakes areas of our nation and serving as a kind of "savings account" for our marine capital. We have 1,200 underwater parks in the U.S. today, an institution we've had longer than most people realize. The first official ocean park in the country was likely a fur seal reserve declared in 1869 around Alaska's Pribilof Islands.

Our ocean parks protect single species and shipwrecks to entire ecosystems, range from the very small to the immensely large, and are managed by authorities at all levels of government. Together they protect about a quarter of our exclusive economic zone—an area 1.4 times as large as our land mass—but only 3 percent is considered "no-take," meaning all extractive uses are prohibited. The National Marine Protected Areas Center, housed in the National Oceanic and Atmospheric Administration's (NOAA) Office of National Marine Sanctuaries, is responsible for serving as a resource for, and building partnerships among, the many federal, tribal, state, and local agencies involved in managing ocean parks.

One of the oldest and largest ocean park systems in the U.S. is the National Marine Sanctuary System, a network of important underwater areas that together cover more than 600,000 square miles of the ocean and Great Lakes. The network consists of 13 national marine sanctuaries and Papahānaumokuākea (Hawaii) and Rose Atoll (American Samoa) Marine National Monuments, which protect America's most iconic natural and cultural marine resources. Sanctuaries are managed, studied, and protected with the help of formal and informal partners, including tribes, state agencies, and federal partners such as the U.S. Coast Guard, National Park Service, and other parts of NOAA. The sanctuary system also works with diverse partners and stakeholders to promote responsible, sustainable uses that ensure the health of our most valued ocean places.

Benefits of Sanctuaries

Like other ocean parks, national marine sanctuaries provide numerous benefits to our communities, nation, and planet. The benefits easiest to quantify are direct economic contributions. Sanctuaries protect the things that make our coasts so important and valuable—amazing

Marine Sanctuaries vs. Marine Monuments

The National Marine Sanctuary System comprises 13 national marine sanctuaries and Papahānaumokuākea and Rose Atoll Marine National Monuments. Though they sound similar, national marine sanctuaries and marine national monuments are actually two different types of protections.

National Marine Sanctuaries

Under the National Marine Sanctuaries Act, the National Oceanic and Atmospheric Administration (NOAA) or Congress can designate a national marine sanctuary. The National Marine Sanctuaries Act is the only federal law written specifically to protect ocean areas ranging from discrete geographies to entire ecosystems. The National Marine Sanctuaries Act provides the authority to issue regulations for each sanctuary and the system as a whole.

These regulations are developed and updated through a public process. NOAA takes nominations for potential new national marine sanctuaries from local communities and, if they meet certain criteria, accepts the nomination for a new national marine sanctuary to the inventory. Once NOAA decides to move forward with the designation process, it consults with Congress, other federal agencies, state and local government entities, fishery management councils, and the public. This process, based on requirements in the National Environmental Policy Act and the National Marine Sanctuaries Act, provides multiple opportunities for public engagement and official public comment.

Marine National Monuments

Marine national monuments are designated by presidential proclamation under the Antiquities Act of 1906, which authorizes the president to establish national monuments on federal lands that contain "historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest."

Marine national monuments are typically managed by multiple government agencies, which may include NOAA, the Department of the Interior, and other federal and state partners. The specific management partnerships vary depending on the details of the management arrangement established in the presidential proclamation. Moreover, although no public process is required under the Antiquities Act, designation of Pacific marine national monuments by former President George W. Bush, and the expansion of one of those monuments by former President Barack Obama, were all preceded by some level of public engagement. Additionally, the development of marine national monument management plans and regulations is carried out through a public review process.

But one thing remains the same: Monuments and sanctuaries protect our nation's underwater treasures. These special places are sources of national pride, and when we take care of them, we strengthen our nation—now, and for future generations.

A visitor to Florida Keys National Marine Sanctuary fly fishes in bright, shining waters. NOAA photo by David J. Ruck

wildlife and wondrous habitats, beautiful coastal vistas, fascinating indigenous cultures thousands of years old, and maritime traditions that have been with us for centuries. Just in sanctuary gateway communities, about $8 billion is generated annually and 140,000 jobs supported in fields as diverse as commercial fishing, tourism, hospitality, recreational activities, research and science, and filming and photography.[1]

Commercial fishing is an old and lucrative use of the ocean, worth $5.2 billion in commercial landings in the U.S. in 2015.[2] Many sanctuaries, including several with no-take areas, support valuable commercial fisheries. Stellwagen Bank National Marine Sanctuary off the coast of Massachusetts is an area of concentrated commercial fishing effort, with about 300 commercial fishing boats landing a total commercial catch annually valued between $15–23 million. The four California marine sanctuaries—Channel Islands, Monterey Bay, Greater Farallones, and Cordell Bank—together include more than 1,000 commercial fishers who generate more than $100 million in sales annually.

Recreational fishing—valued at $60.6 billion in sales in the U.S. in 2014[3]—is another lucrative use of sanctuary waters. About 75 party and charter boats operating in Stellwagen Bank National Marine Sanctuary generate a direct annual sales value of about $2.5 million. Several major sport fishing tournaments occur off the coast of Georgia every year, with Gray's Reef National Marine Sanctuary being a premier target for participants. An estimated $700,000 is spent annually by tournament fishermen targeting Gray's Reef. Recreational fishers spend $274 million annually in and around Florida Keys National Marine Sanctuary, and about 11,000 recreational fishing trips are taken each year in Olympic Coast National Marine Sanctuary off the coast of Washington.

Wildlife watching is big business in the U.S., as birders and other wildlife watchers buy gear and take tours and trips to get closer to their objects of devotion, to the tune of about $30 billion annually.[4] Whale watching in Hawaiian Islands Humpback Whale National Marine Sanctuary, conducted by about 50 operators statewide, has an annual total economic impact of up to $74 million. Nearly all whale watching off the coast of Massachusetts occurs in Stellwagen Bank National Marine Sanctuary, generating about $24 million a year. Wildlife viewing and nature study engage over 620,000 visitors and residents in Florida

Keys National Marine Sanctuary, resulting in almost 2.7 million days of such activity each year. Kayaking and sightseeing charters and rentals in Channel Islands National Marine Sanctuary generate about $1 million in annual spending.

Like these other activities, recreational diving and snorkeling rely on healthy, attractive habitats and wildlife. This diving/snorkeling business is a profitable one in the U.S., worth about $11 billion to the American economy.[5] Each year there are approximately 2.8 million days of diving in Florida Keys National Marine Sanctuary, with participants spending about $54 million on diving and snorkeling operations. Despite its distance offshore—about 115 miles—Flower Garden Banks National Marine Sanctuary gets up to 2,000 divers a year.

Sanctuaries as Members of Communities

Sanctuaries are invested in the prosperity of their gateway communities, and work both with and as part of those communities to support diverse, healthy economies. Small business owners and operators, including those of charter boats and dive shops; representatives of local civic and use associations; and local elected officials sit on sanctuary advisory councils to offer their expertise and opinions to sanctuary superintendents.

Sanctuaries are members of and/or work with nearly 20 chambers of commerce or visitor bureaus across the country, and engage with national use associations to work with recreational fishers, divers, and other recreators. Sanctuaries support small businesses in some sites by developing recognition programs, like the Blue Star program in Florida Keys National Marine Sanctuary, or in others by placing volunteer naturalists on charter boats and wildlife viewing tours, like Channel Islands National Marine Sanctuary's Naturalist Corps.

Sanctuaries are sometimes even able to work with local officials to recruit new businesses and expand existing ones. For example, the Great Lakes Maritime Heritage Center, the visitor center for Thunder Bay National Marine Sanctuary, is a major tourist destination for the region, hosting eight times more visitors annually than the entire population of its host city of Alpena, Michigan.

Protected status helps raise the profile of an area to a national audience. Stellwagen Bank has been voted as a favorite recreational fishing spot in the northeast, and the sanctuary has been named the best place to see ocean wildlife in the United States.

More than 33,000 jobs in the Florida Keys, an area surrounded by a sanctuary, are supported by ocean recreation and tourism, accounting for 58 percent of the local economy and $2.3 billion in annual sales. Finally, the coral reefs of American Samoa provide for subsistence fishing, traditional nearshore commercial fishing, recreation, and non-use values, for a value that might reach $10 million a year.

Because sanctuaries and other ocean parks are permanent, managed institutions, they serve as a safe investment for agencies, universities, NGOs, and other organizations to invest in science and education. For example, dozens of partners contribute to the SIMoN (Sanctuary Integrated Monitoring Network) project to help assess resource conditions in the four California sanctuaries. Every dollar the sanctuary system spends on education activities is matched by partners, doubling the reach of education and interpretive efforts.

Besides purely economic value, there are other benefits to national marine sanctuaries and other ocean parks. They help preserve the places we love to play, so that the generations who beachcomb and surf cast and swim today will give way to generations who can enjoy the same pleasures tomorrow. Sanctuaries spread the word about ocean conservation by engaging all types of audiences and working with partners to teach communities, the nation, and the world. They provide opportunities for citizen scientists and other volunteers who help us study and protect everything from seals to shipwrecks. They are democracy in action, engaging citizens through public hearings, public comment periods, and advisory councils, and encouraging communities to nominate their waters for consideration as a future sanctuary. Sanctuaries preserve the history of lives spent working the ocean and defending the nation.

While we might daydream about finding buried treasure—or winning that mega lottery—chances are we never will. But real wealth is available to us every day in our ocean parks and beyond in the beaches we walk, the waves we surf, the coral reefs and kelp forests we dive, the fish we eat, the air we breathe, and the energy we need.

And we don't even have to be pirates to enjoy it!

About the author:

Elizabeth Moore is a senior policy advisor at the National Marine Sanctuary System. Her current role includes developing strategic projects and partnerships on behalf of the system, including support of its 50th anniversary in 2022.

Endnotes:

1. All socioeconomic information and supporting references regarding national marine sanctuaries can be found at: http://sanctuaries.noaa.gov/science/socioeconomic/.
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Rethinking MARPOL Enforcement

by CDR John T. Dewey
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Recognizing the need to protect the environment as early as 1972, the nations of the world drafted a number of conventions aimed at preventing pollution from ships. On October 2, 1983, Annex I of the International Convention for the Prevention of Marine Pollution from Ships (MARPOL Convention) entered into force. Annex I prohibits discharging oil[1] or oily mixtures[2] from ships.[3]

Over the intervening 34 years, international enforcement of the MARPOL Convention has matured unevenly, which is, perhaps, an inevitable consequence of primary reliance on flag state[4] enforcement. The international community should ameliorate inadequate flag state enforcement by expanding coastal and port state authority to take enforcement action. The international community should also extend powerful regulatory requirements to smaller vessels.

This latter effort should be taken domestically, with or without the international community. Finally, enforcement and penalty provisions in overlapping U.S. laws should be unified. Taken together, these actions promise to improve the effectiveness of the MARPOL Convention by closing existing enforcement gaps and furthering the ultimate goal of protecting the marine environment.

The enforcement scheme in the MARPOL Convention protects and limits sovereignty by dividing responsibility among flag states, coastal states, and port states. The authority of coastal and port states to take enforcement action, while distinct, is almost always concurrent. Coastal states may take enforcement action against ships in their territorial sea, and port states may take enforcement action against ships arriving or departing their ports.

Flag states, on the other hand, are responsible for enforcing marine pollution prohibitions on their vessels everywhere. Viewed differently, only flag states have authority to enforce marine pollution prohibitions in international waters.[5] Given uniform effort by flag states, this enforcement scheme would work perfectly, but unfortunately, even reasonably uniform effort may be unattainable. Many flag states simply lack the resources, if not the will, to enforce the marine pollution prohibitions. Our globalized economy exacerbates this problem, especially because of the propensity of the merchant fleets of the world to avoid more onerous regulation by registering in, and flying the flag of, states where regulations—or at least the ability to enforce them—are more lenient.[6]

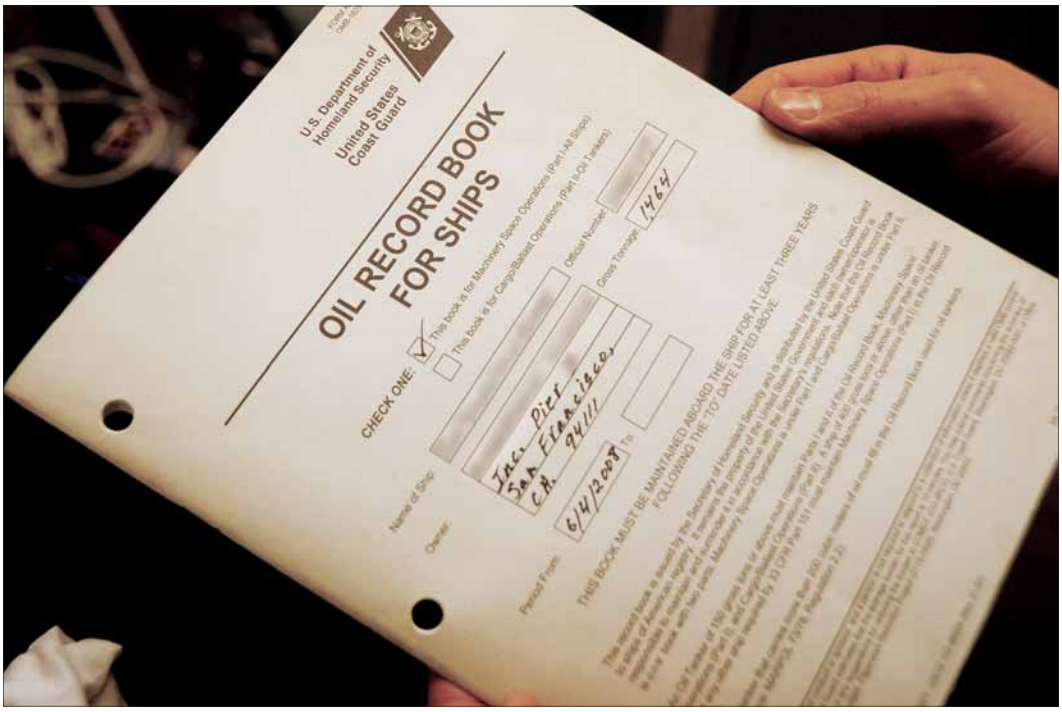
After 34 years of spotty flag state effort, a logical adjustment would shift more enforcement authority to coastal and port states. Extending coastal and port state authority, under Annex I of the MARPOL Convention, to the outer boundary of the exclusive economic zone (EEZ) would enable coastal states to better protect the marine resources over which they have sovereign authority. Compellingly, the extension of authority would comport with the United Nations Convention on the Law of the Sea (UNCLOS),[7] which recognizes coastal states' "rights for the purpose of exploring and exploiting, conserving, and managing the natural resources."[8]

More pertinently, this extension of authority would increase the ability of able and willing states to enforce marine pollution prohibitions, furthering the worldwide goal of protecting the marine environment. Such an effort would, however, require the international community to disturb the long-standing MARPOL Convention. Consider this a call to action for a logical, measured improvement.

Perhaps a more effective improvement would extend powerful regulatory requirements in the MARPOL Convention to more vessels. As a signatory to the convention, the United States enacted domestic implementing legislation called the Act to Prevent Pollution from Ships (APPS),[9] which closely mirrors the convention. Both the convention and APPS prohibit all vessels from discharging oil or oily mixtures into the sea. Both also require ships of at least 400 gross tons, and tank vessels of at least 150 gross tons,[10] to track oil from cradle to grave, meaning all petroleum products brought onto the ship, transferred about the ship, consumed by the ship, and removed from the ship (including oily waste) must be recorded in an Oil Record Book (ORB).

This powerful regulation enables port states to take enforcement action against foreign-flagged ships that pollute in international waters, subsequently enter port, and present an ORB that fails to document the illegal discharge. Just as the murdering crime boss Al Capone was imprisoned for tax evasion, these foreign-flagged, high seas polluters may be prosecuted by the port state, not for the pollution that occurred beyond port state jurisdiction, but for the false ORB presented within port state jurisdiction.

To some extent, the sovereignty limits of the convention are overcome by this enforcement strategy, but it's not enough. Many states do not use this jurisdictional hook, a deficiency that may be greatly bolstered if expressly incorporated into Annex I of the MARPOL Convention, and the strategy does not foreclose avoidance, at least until the strategy is used by a majority of states. Until then, polluters will continue to register vessels in flag states and call in port states that lack the will or resources to adequately regulate and enforce marine pollution prohibitions.



Chief Warrant Officer Allan Roth looks through an oil record log book during an inspection on a commercial passenger vessel moored to a pier in San Francisco in September 2012. Coast Guard inspectors routinely board and inspect vessels to ensure the ship and its crew are in compliance with all federal maritime laws. Coast Guard photo by Petty Officer 2nd Class Pamela J. Boehland

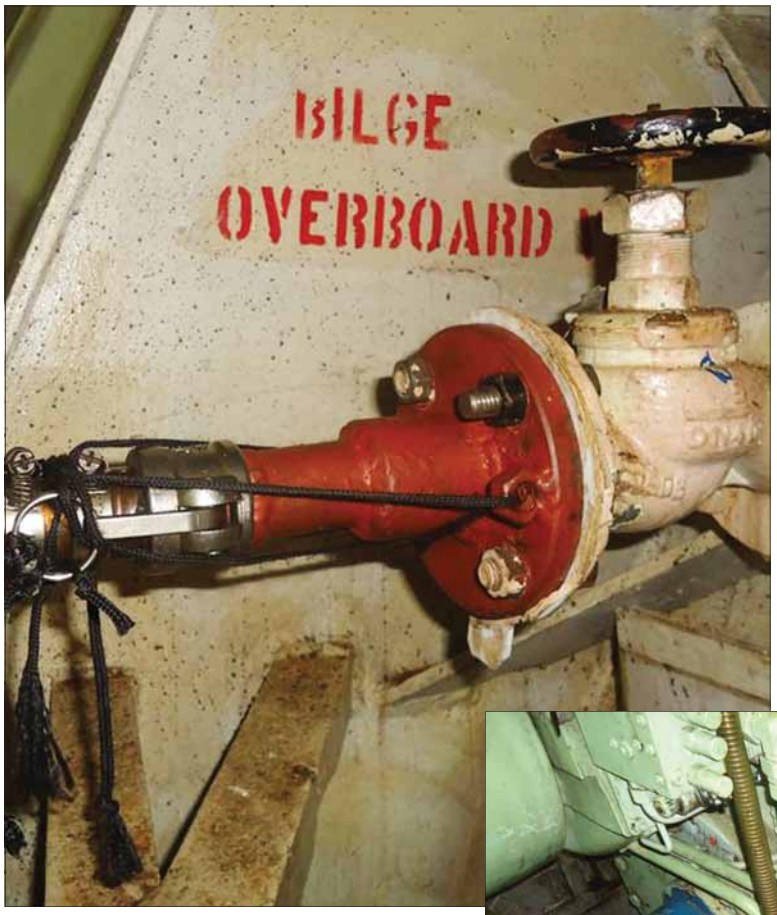
A recent series of cases in the Fourteenth Coast Guard District illustrates the strategy. On February 7, 2016, marine inspectors from Sector Honolulu conducted a Certificate of Compliance renewal and several other routine examinations on *B. Sky*, a Korean-owned, Vanuatu-flagged, 3,978 gross ton, 321-foot-long tank vessel. *B. Sky* regularly calls in Hawaii and provides fuel to the distant water fishing fleets operating in the Central and Western Pacific Ocean.

During the inspections, the chief engineer proved unfamiliar with the oily water separator (OWS) equipment. The OWS equipment is used to remove oil from oily mixtures before the remaining water is discharged into the ocean. Inspectors also identified evidence of recent tampering of the flange adjacent to the OWS overboard discharge valve. The first engineer subsequently stated the OWS was being bypassed and provided the marine inspectors with photographic evidence showing a system rigged to bypass the OWS, often referred to as a "magic pipe," spurring a more in-depth examination followed by a criminal investigation. Crew members of *B. Sky* rigged the illegal bypass shortly after leaving Panama, used it to regularly and illegally discharge oily mixtures throughout the 2,800-mile voyage, and dismantled the bypass before calling in Honolulu, Hawaii. Needless to say, the chief engineer made false entries in the ORB in an attempt to conceal the illegal discharges.

The chief engineer ultimately admitted directing some of the engineering staff to set up the bypass. Both Doorae Shipping Co. Ltd., the Korean company that owned the vessel, and the chief engineer pleaded guilty in federal court on April 5, 2016, less than two months after the Coast Guard discovered the violations. The sentence against the company included a total fine of $950,000 and a two-year, court-monitored environmental compliance plan for the *B. Sky* and its two sister ships, *B. Ace* and *B. Pacific*.[11]

On April 6, 2016, the sister ship *B. Pacific,* to which the terms of the environmental compliance plan now applied, attempted to pump out oily waste that had been illegally stored in a bottom void before beginning its voyage to Honolulu. Despite several attempts, they could not get enough head pressure to pump out the oily waste and left it in the bottom void. The compliance auditor in Honolulu discovered the illegally-stored oily waste and reported it to the Coast Guard. The subsequent criminal prosecution resulted in another guilty plea, a $250,000 fine, and an additional year under the environmental compliance plan for all three ships.[12]

Without the requirement to maintain an ORB, these prosecutions may not have happened. The corollary is even more relevant—had these ships been smaller, these prosecutions may not have happened, because the requirement to maintain an ORB does not apply to ships or tank vessels below a certain gross tonnage. The lack of an ORB significantly increases the difficulty of enforcement and limits prosecution strategies, yet smaller ships are just as likely to pollute. Large ships may individually



These images were part of the evidence submitted in the *B. Sky* case. Above: the bypass connection; Right: the bypass pump. Coast Guard photos

represent a greater pollution threat, but there are many more small ships, and their collective pollution threat is comparable. Therefore, closing this enforcement gap should be the next step in the global effort to prevent pollution from all ships.

Regardless of whether the international community takes this action, the United States should require smaller U.S.-flagged vessels to maintain an ORB or similarly track oil from cradle to grave. Taking this step independently of the international community, with respect to U.S.-flagged vessels only, does not run afoul of the notions of sovereignty in the MARPOL Convention. Rather, the Convention and UNCLOS both recognize the breadth of coastal state authority over its waters[13] and flag state authority over its vessels.[14]

This is an opportunity for the United States to take another step forward in environmental stewardship and lead the international community by example. In this effort, difficult policy questions raised by the burden of maintaining an ORB or similar requirement cannot be ignored and must be addressed to maintain the health and competiveness of U.S. commercial fleets. However these problems are managed, smaller vessels need to be better regulated to protect the environment.

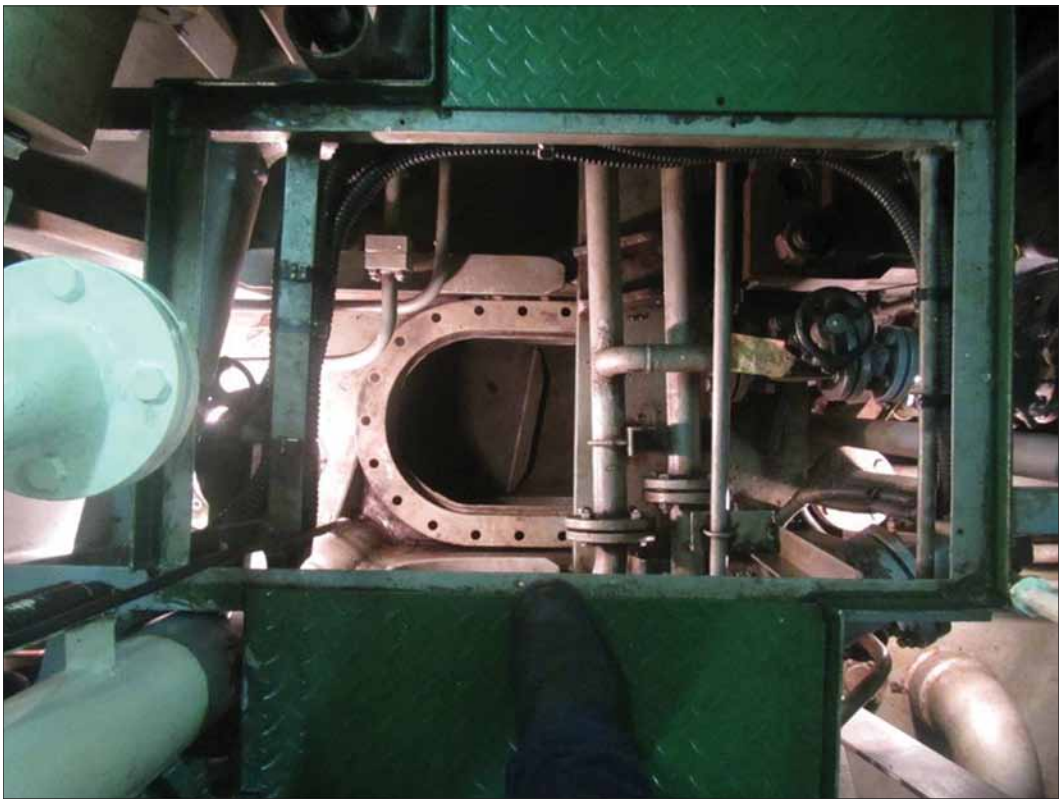
A third improvement in marine pollution enforcement would eliminate inconsistencies across the patchwork of U.S. environmental laws. APPS and the Clean Water Act (CWA),[15] which also prohibits discharges of oil and oily mixtures, have different jurisdictional reach, enforcement, and penalty provisions. The CWA, which applies to all vessels in U.S. waters and the EEZ, under limited circumstances, contains a powerful enforcement option called a judicial civil penalty. Additionally, APPS, which applies to U.S. vessels everywhere, does not have this enforcement option. As a result, enforcement options against U.S.-flagged vessels are limited, depending on their location.

A pollution case involving the commercial fishing vessel *Capt Vincent Gann* ran afoul of this problem. The *Capt Vincent Gann* is a large, U.S.-flagged distant water fishing vessel operating in the Western and Central Pacific. On October 16, 2014, the vessel was in Pago Pago Harbor, American Samoa. While shifting berths, a mechanical malfunction caused a collision with another large fishing vessel, tearing a hole in the bow of the *Capt Vincent Gann*.

Unfortunately, the *Capt Vincent Gann* illegally stored fuel oil in the bow, causing an oil spill in the harbor. The CWA applied to the oil spill in the harbor with moderate

monetary penalty exposure, but APPS applied to the illegally stored fuel, commanding a per-day penalty scheme with significantly higher monetary penalty exposure.

For a number of reasons not pertinent here, the United States pursued the judicial civil penalty enforcement provision under the CWA. Ultimately, the corporations that owned the *Capt Vincent Gann* settled the case for $1.05 million and agreed to stringent environmental compliance provisions and regular inspection audits for its fleet of 10 vessels, including modifications that inhibit the storage of fuel oil in the bow.[16]



The *B. Pacific's* access hatch to the bottom void as found by Coast Guard investigators during expanded MARPOL exams. Coast Guard photo

The gap caused by differing jurisdictional reach combined with differing enforcement provisions is senseless. The differing jurisdictional reach may be harder to fix, but the enforcement provisions can be easily duplicated with a simple legislative change—copy the judicial civil penalty enforcement provision from the CWA into APPS.

By expanding coastal state authority under the MARPOL Convention, extending to smaller vessels the requirement to track oil from cradle to grave—internationally, domestically, or both—and unifying enforcement and penalty provisions across the patchwork of U.S. environmental laws, we can improve upon 34 years of progress in maritime environmental stewardship. We can move closer to achieving the convention's ultimate goal: "the complete elimination of intentional pollution of the marine environment."

About the author:

CDR John Dewey has served in the Coast Guard for 20 years, beginning as a cutterman operating ships before serving as an intelligence officer. He currently serves as a judge advocate (attorney) and has prosecuted dozens of marine pollution cases.

Endnotes:

1. Defined as petroleum in any form in Regulation 1 of Annex I of the MARPOL Convention.
2. Defined as a mixture with any oil content in Regulation 1 of Annex I of the MARPOL Convention.
3. Annexes II through VI prohibit other types of pollution from ships but are not discussed here.
4. The flag state is the state in which a ship is registered.
5. Jurisdiction under the convention is a convoluted matter that may be further complicated by domestic implementing legislation. Under the U.S. interpretation, enforcement of Annex I by coastal states, for example, is limited to internal waters and the territorial sea (i.e., navigable waters of the coastal states), and flag states have exclusive jurisdiction in international waters (i.e., beyond the territorial sea of any state). By contrast, Annex V is enforceable out to the EEZ boundary by coastal states, and flag states have exclusive jurisdiction on the high seas (i.e., beyond the EEZ of any state). 33 U.S.C. § 1902.
6. Also derivative of globalization, a lack of adequate reception facilities exacerbates the marine pollution problem. Providing reception facilities where ships can offload oily waste for treatment in port is a coastal or port state responsibility. This facet of marine pollution is beyond the scope of this article.
7. *See* United States Oceans Policy, Statement by the President, March 10, 1983. Even though the United States is not a signatory, the United States recognizes UNCLOS as largely a reflection of customary international law.
8. Proclamation 5030 of March 10, 1983; UNCLOS Article 56.
9. 33 U.S.C. § 1901 *et seq.*
10. Regulation 9 of Annex I of the MARPOL Convention; 33 U.S.C. § 1907; 33 C.F.R. § 151.25.
11. www.justice.gov/usao-hi/pr/korean-company-fined-750000-and-make-200000-community-service-payment-illegal-discharge
12. www.justice.gov/usao-hi/pr/korean-company-fined-275000-second-violation-act-prevent-pollution-ships
13. *See* UNCLOS Parts II and V; MARPOL Convention Article 6.
14. *See* UNCLOS Part VII; MARPOL Convention Article 6.
15. Federal Waterway Pollution Control Act (FWPCA), a.k.a. the Clean Water Act (CWA), 33 U.S.C. § 1251 *et seq.*
16. www.justice.gov/opa/pr/tuna-fleet-companies-pay-over-1-million-civil-penalties-and-perform-fleet-wide-compliance

Reducing Noise from Large Commercial Ships

Progress and partnerships

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Increasing ensonification of our oceans by human sound sources has been identified as an important environmental concern, spurring intensive study by marine scientists during the past few decades. Guidelines and mitigation measures have been developed by regulators, and various sectors have sought ways to reduce noise in the ocean and its effects on marine life. Scientific research and recent national and international efforts continue in their attempts to quiet commercial ships, one of the leading contributors to noise in the ocean.

Radiated Noise from Individual Vessels

Ships generate various noises during normal operations. Modern-powered vessels produce low-frequency sound from hydrodynamic flow noise, onboard machinery, and primarily propeller cavitation. Wenz (1962) provided early characterization of natural and anthropogenic ocean ambient noise, including typical low-frequency noise spectra from differing levels of shipping activity. Many subsequent measurements of different classes of large vessels (e.g., Wales and Heitmeyer, 2002) have informed broad characterizations of vessel noise (e.g., McKenna et al., 2012).

Ship noise is predominately low-frequency—<1000 Hertz [Hz]. Source level and frequency spectrum depend on factors such as vessel size, speed, load, condition, age, and engine type. Larger vessels (exceeding 100m)

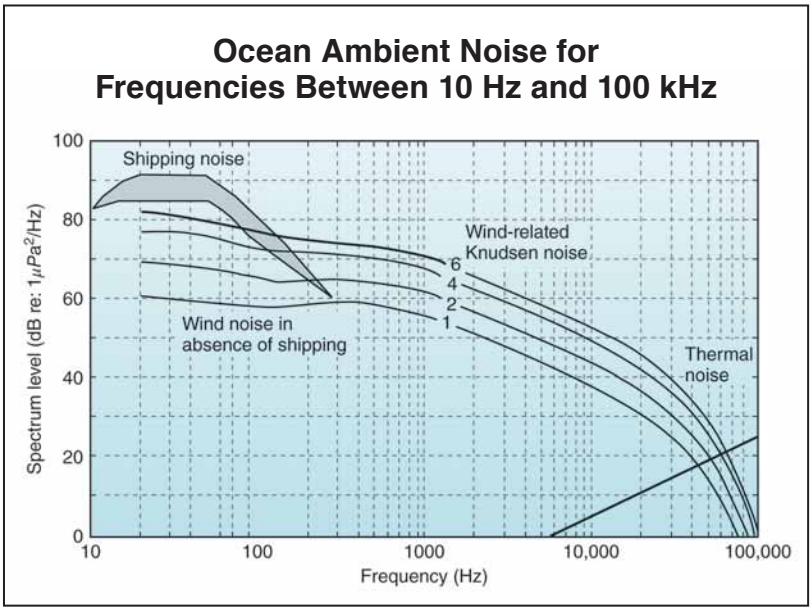

Figure 1. This figure shows typical underwater noise profiles developed by Wenz (1962), but has been modified to reflect modern levels of shipping noise (shaded area), which exceed natural wind noise, even for high sea-states (numbered curves). Figure adapted from Hildebrand (2009), reprinted with permission of J. Hildebrand.

typically produce louder, lower-frequency sounds than smaller boats, and faster vessels are typically louder. Reviews by Hildebrand (2009) and McKenna et al. (2012) discuss typical noise spectra and source level characteristics of different commercial vessel classes.

Commercial Vessels and Low-Frequency Underwater Noise

Vessels add noise to environments filled with natural sounds from waves, wind, animals, and other sources. Broad-scale longitudinal increases in low-frequency ambient noise have been associated with increased shipping traffic in some areas (e.g., Andrew et al., 2002; McDonald et al., 2006).

Low-frequency noise is not increasing throughout the ocean, but changes in low-frequency ambient noise in areas of increased commercial vessel presence (Figure 2) demonstrate that shipping activity can broadly affect low-frequency ambient noise levels on decadal time scales. Such increases may be expected to continue as global trends in commercial shipping suggest the total amount of cargo transported by large commercial ships may double or triple from 2005 to 2025 (USDOT-MARAD, 2006).

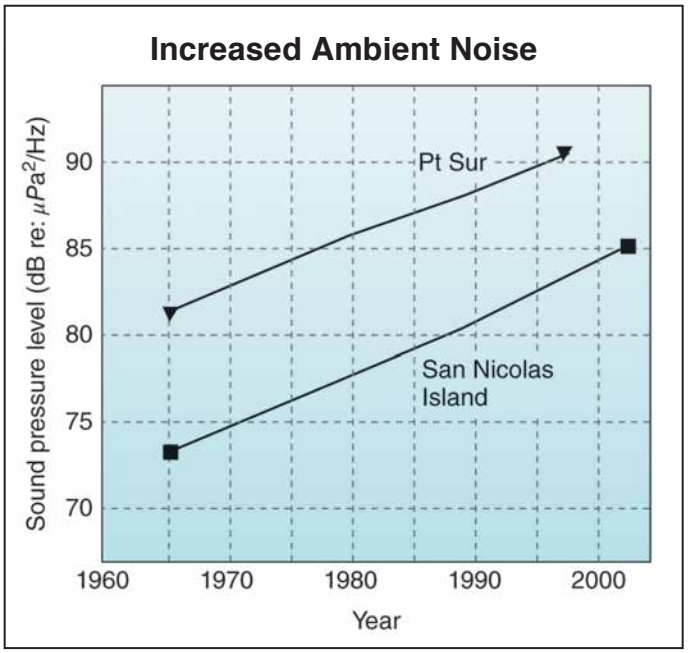

Figure 2. Low-frequency ambient ocean noise increased by about 3 dB/decade at two sites off the coast of California by comparing U.S. Navy data from the 1960s (Wenz, 1969) with more recent measurements below 100 Hz. Graphic created using data from Wenz (1969), Andrews et al. (2002), and McDonald, Hildebrand, and Wiggins (2006).

Such data have led noise modelers to predict that continued growth in the number of ships, the quantity of goods carried, and the distances traveled could increase the maximum noise capacity of the global shipping fleet—by as much as a factor of 1.9—by 2030, with major growth in the container and bulk carrier segments (Kaplan & Solomon, 2016). Further, underwater noise from maritime transportation is likely to become an even broader concern as previously inaccessible areas like the Arctic become accessible.

Consequences of Ship Noise on Marine Life

Sound is centrally important for most marine animals, including all marine mammals. Sound serves key biological functions, including communication, foraging, reproduction, navigation, and predator/hazard avoidance. Some species—dolphins and porpoises—use high-frequency biosonar in feeding and orientation. Others, notably baleen whales, use low-frequency sound for longer-range communication.

Predominately low-frequency sounds associated with large commercial vessels directly overlap these communications, and thus most effectively interfere with low-frequency signals used by baleen whales and some seals and sea lions (Figure 3). Many fishes, and some invertebrates, also rely on low-frequency sound in their natural history and may also be particularly affected.

Acoustic Communication and Hearing

More is known about marine mammal sound production than their hearing, given the relative ease of recording animal sounds compared with the challenges of directly measuring hearing. Direct hearing measurements are available for less than half of the approximately 125 marine mammal species. It should be noted that this includes none of these being low-frequency oriented whales and almost all studies involve only one or a few individual subjects.

Dolphins, porpoises, and other toothed whales use various whistles and other calls ranging from a few hundred hertz (Hz) to tens of kilohertz (kHz), but their high-frequency echolocation clicks can extend above 100 kHz. Potential interference from ship noise is thus relatively limited for these animals and restricted to the lowest frequency signals.

Baleen whales lack specialized high-frequency echolocation, but use sounds for important social and spatial orienting functions. Hearing in baleen whales remains completely untested, but has been estimated by studying a combination of sound production, anatomical characteristics, and behavioral responses to sound. Based on this indirect evidence, some may hear into the tens of kHz range, but most of their signals occur at "very low," "low," and "intermediate" frequency ranges between about 10 Hz and 10 kHz. It is at these low frequencies, where these species' communication signals overlap shipping noise, that they are most susceptible to negative effects from noise interference.

Other marine mammals, including seals and sea lions, also make and listen to sounds for important life functions. Like the large whales, they lack specialized high-frequency echolocation signals, but their communication sounds, produced largely in social contexts, generally occur from about 100 Hz to several tens of kilohertz, thus directly overlapping the predominantly low-frequency energy of vessel propulsion noise.

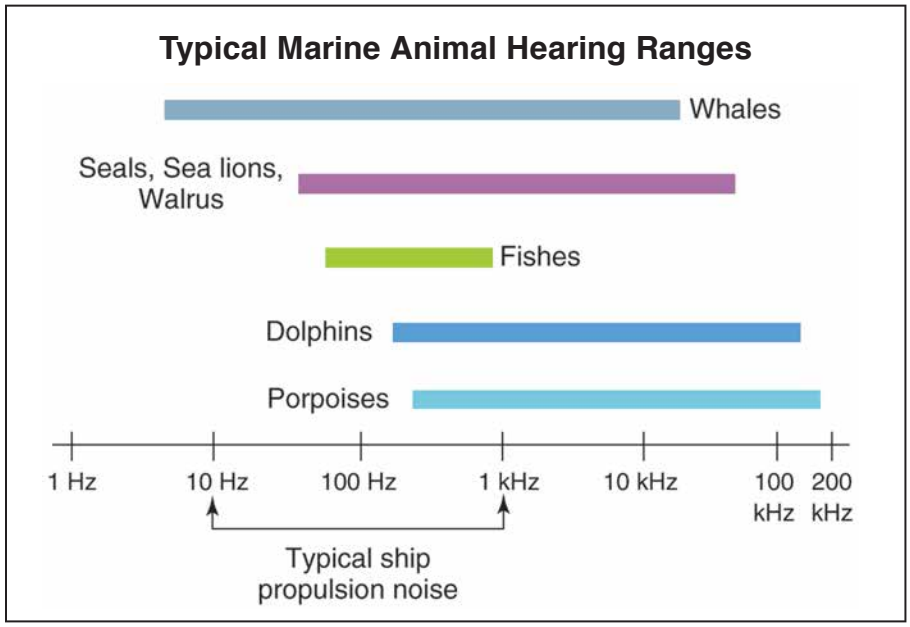

Figure 3. Typical hearing ranges for various groups of marine animals shown relative to the typical predominant frequencies of commercial shipping. Graphic created based on data from Southall et al., 2007.

Effects of Noise on Marine Life

Noise can adversely affect marine life by causing altered behaviors, like reduced communication ranges for social interactions, foraging, and predator avoidance. It also can temporarily or permanently reduce hearing sensitivity and have other physiological consequences (see: Southall et al., 2007; 2017).

Numerous studies have shown that noise from vessels can cause marine mammals to modify or cease sounds used to communicate, forage, avoid predators, or assess their environment. For example, North Atlantic right whales (*Eubalaena glacialis*) and North Pacific blue whales (*Balaenoptera musculus*) adjust vocalizations in the presence of vessel noise (Parks and Clark, 2005). However, such alterations may have biological costs and be constrained by physical and environmental factors.

A key consideration in terms of broad-scale potential impacts is the masking of biologically significant sounds. Such interference with hearing important signals may interfere with key functions, like breeding and navigation. The greatest masking occurs where signals and noise overlap in frequency. These effects have thus been considered explicitly for baleen whales and shipping noise. For example, shipping noise has been found to severely mask communication for North Atlantic right whales more than 70 percent of the time in some conditions (Hatch et al., 2012). Recent laboratory and field experiments have evaluated vessel noise impacts on fishes, examining whether vessel noise is masking detection of the soundscape and/or biologically relevant sounds (e.g., Simpson et al., 2016).

Underwater noise is widely recognized as an important environmental factor for marine species, and the potential effects of noise have been the subject of numerous consultations required under Section 7 of the U.S. Endangered Species Act. For the U.S. Coast Guard, the effects of underwater noise on endangered or threatened marine species have been considered in consultations with the U.S. National Oceanic and Atmospheric Administration (NOAA) and U.S. Fish and Wildlife Service. Impacts from sources including high and ultra-high frequency sonars, liquefied natural gas deep-water port construction and operation, and maintenance of fixed aids to navigation have been addressed.

International Collaborations to Reduce Vessel-Radiated Noise

Scientists, environmental managers, and conservationists are increasingly studying and considering many types of human noise that may impact marine animals. Much of the focus has been on loud, acute point sources, including military sonars and seismic air guns used in oil exploration, but there is increasing appreciation of potentially broader issues associated with chronic noise from, for instance, aggregate commercial vessel operations (e.g., Southall et al., 2007; 2017; Hatch et al., 2012).

A 2004 NOAA-hosted international stakeholder symposium, "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology," was one of the first events to bring together regulatory and scientific communities with the shipping industry. Uncertainties and complexities regarding the potential effects of ship noise were acknowledged, and large vessels were clearly identified as significant contributors to low-frequency ambient noise levels. Recommended actions included evaluating whether existing vessel-quieting technologies for military and fisheries research vessels could be feasibly and economically applied to large commercial vessels.

A 2007 follow-on NOAA symposium, "Potential Application of Quieting Technology on Large Commercial Vessels," focused specifically on technical aspects,

costs, benefits, and potential incentives for various noise reduction options (see Southall and Scholik-Schlomer, 2008). Various technological design and retrofit options, as well as operational measures and the relative costs and benefits associated with these proposed quieting options, were considered.

A recommendation was made to prepare an informative paper on shipping noise and marine mammals for the International Maritime Organization (IMO). Shortly thereafter, the U.S. delegation to the IMO, led by the United States Coast Guard, submitted such a document to the Marine Environment Protection Committee (MEPC) entitled "Shipping noise and marine mammals" (MEPC\57\INF-4). This document, composed by NOAA scientists involved in the 2004 and 2007 symposia, was a broad introduction regarding shipping noise and its potential adverse impact on marine life. This paper opened the door for future collaboration within the IMO, which would be enhanced by new discussions and partnerships among environmental groups, scientists, regulators, and the industry.

Cross-Sector Partnerships Emerge

Building on the collaborative efforts of the NOAA symposia, Okeanos-Stiftung für das Meer [Foundation for the Sea] convened a 2008 workshop in Hamburg, Germany (see Wright, 2008). The workshop sought to expand awareness of the issue, engage different sectors of international maritime transport—particularly ship builders, marine architects, and classification societies—and call for specific action by the IMO. Participants agreed on an ambitious objective, calling for "… initial global action that will reduce the contributions of shipping to ambient noise energy in the 10–300 Hz band by 3 decibels in 10 years and by 10 decibels in 30 years, relative to current levels. This goal [will] be accomplished by reducing noise contributions from individual ships."

Formal consideration of this issue within the IMO began at the 58th session of the MEPC in June 2008, with a U.S. petition to establish a correspondence group to consider potential vessel quieting technologies. The proposal was accepted, and the U.S. chaired a correspondence group within which subject matter experts, ship owners, naval architects, and design model basins began assessing feasibility and developing technical recommendations. The MEPC sent draft guidelines to the IMO's Ship Design and Equipment (DE) Subcommittee (now the Ship Design and Construction Subcommittee) for further consideration and additional technical expertise. A DE correspondence group and later a drafting group, chaired by the United States, were formed.

The correspondence groups' combined efforts focused on propeller design and modification to reduce cavitation, but considered hull design, on-board machinery, and operational modifications. In 2014, the MEPC formally adopted the resulting vessel-quieting guidelines (see: MEPC, 2014; and Southall et al., 2017 for more on these processes). Because the guidelines are voluntary and underwater noise is not yet the subject of mandatory code, successful implementation will require commitment from shipping lines, ship classification and green certification societies, port authorities, and member states. Subsequently, the IMO has considered additional proposals that the DE identified to quantify underwater noise output and direct management effort.

Humpback whale tail while diving in Glacier Bay, Alaska. Photo by Andrea Izzotti / Shutterstock.com

Recent Initiatives—North America and Europe

A number of significant international developments regarding shipping noise and marine life have occurred in parallel with the IMO processes.

From 2012–2016, NOAA worked to develop its forward-looking Ocean Noise Strategy to provide long-term direction to NOAA's management and research activities associated with ocean noise impacts to marine life. The final roadmap for this initiative, released in September 2016,[1] highlighted the need for NOAA to broaden its focus to address the need to protect the quality of marine acoustic habitats in addition to minimizing more direct adverse physical and behavioral impacts to specific species. As part of the Ocean Noise Strategy initiative, NOAA has already deployed a Noise Reference Station Network to provide a standardized, calibrated monitoring system with which to characterize status and trends in low-frequency underwater noise and the contributions of various sources, including shipping.

Canadian ocean management and science efforts, with significant investment from Ocean Networks Canada since 2007, have spearheaded the integration of noise

monitoring with advancing ocean observation capabilities. Many initiatives have focused on characterizing shipping noise contributions to Canadian waters.[2] The most directed efforts thus far have taken place at the Port of Vancouver, where in 2014 the Vancouver Fraser Port Authority instituted the Establishing Cetacean Habitat and Observation[3] (ECHO) program to better understand and manage the impacts of shipping underwater noise and ship-strike risk on British Columbia's endangered southern resident killer whales in their legally designated critical habitat. Since then, ECHO's mandate has expanded to include other at-risk cetaceans as well as its initiatives on underwater noise.

Establishing Cetacean Habitat and Observation

Researchers on a National Marine Fisheries Service vessel observe a "spy hopping" southern resident killer whale near the San Juan Islands, Washington, in 2006. NOAA photo

ECHO's numerous initiatives on underwater noise include:

- a program to measure and analyze ambient underwater acoustic levels
- acoustically identifying noise contributors to the underwater soundscape
- sharing information with industry on noise reduction technologies
- collecting vessel noise data from a calibrated underwater listening station
- testing an in-water propeller and hull maintenance facility
- an incentive program for vessel quieting compliance (EcoAction)

The Port of Prince Rupert, at the northern end of the British Columbia coast, is anticipating major increases in commercial vessel activity and is following suit with a program modeled on Vancouver's ECHO. Three Canadian federal agencies—Transport Canada, Environment Canada, and the Department of Fisheries and Oceans—are exploring how to manage shipping noise in both the Salish Sea and in the St. Lawrence estuary, where noise presents a recognized threat to a small, endangered population of belugas.

Green Marine, a leading green certification society for the North American shipping industry, has added underwater noise to its voluntary environmental certification program, adopting noise performance indicators for ports, terminals, and shipping companies.[4] Participants include ship owners, ports, terminals, St. Lawrence Seaway corporations, and shipyards based in Canada and the United States. Their compliance with specified noise criteria is voluntary in 2017, and compulsory in 2018.

New tools to address cumulative and chronic noise effects over wider spatial scales have continued to emerge in the European Union, including implementation of the Marine Strategy Framework Directive (MSFD).[5] The EU MSFD defines its objective, "Good Environmental Status," to include the requirement that "Introduction of energy (including underwater noise) does not adversely affect the ecosystem." In 2010, the European Commission produced a set of detailed criteria and indicators to help member states implement the MSFD. Two criteria address the noise energy requirement (Van der Graaf et al., 2012):

- the proportion and distribution of days in which anthropogenic sound sources exceed levels that are likely to entail significant impacts on marine animals
- trends in ambient noise levels in specific low-frequency bands (63 and 125 Hz)

The latter criterion considers frequencies dominated by vessel contributions and has led to the development of regional monitoring programs and heightened focus on ship noise characterization and modeling. The European Commission has supported collaborative research programs, like Achieve QUieter Oceans (AQUO),[6] to assess noise impacts and provide practical and achievable noise control measures.

Such initiatives continue to emphasize the need for international standards in noise measurement and monitoring. In 2009, the Acoustical Society of America and American National Standards Institute issued guidelines for measuring underwater noise from ships (ANSI/ASA S12.64-2009). The UK National Physical Laboratory followed in 2014 with a "good practice" guide for underwater ship noise measurement (NPL Good Practice Guide No. 133). In 2016, the International Organization for Standardization (ISO) published its requirements for deep-water measurement of underwater ship noise (ISO 17208-1:2016), with a shallow-water measurement presumably to follow. Three major ship classification societies, Det Norske Veritas (2010), Registro Italiano Navale (2014), and Bureau Veritas (2014), have used these measurement

Technical Progress Needed

A Great White shark swims under a ship propeller. Photo by Andrea Izzotti / Shutterstock.com

Additional progress is needed in many areas to better understand the relationship between marine life and shipping and other noise sources.

- better understanding of the relationship between noise and propeller cavitation, including vessel noise signatures for different ship classes and sizes under various operating conditions
- coordinated noise measurements for vessels with means of tracking movement and other operational conditions (e.g., automatic identification system)
- implementation, efficacy testing, and cost/benefit analyses of quieting measures for individual ships, including those recommended by IMO
- quantitative evaluation of ship noise reduction and regional ambient noise levels

protocols as the basis for new "quiet ship" notations which have been applied by the ports of Vancouver and Prince Rupert to grant substantial reductions in berthing fees for ships bearing one of these notations.

Finally, dialogue surrounding multilateral Arctic marine environmental protection continues to highlight concerns with shipping noise impacts due to the sensitivity of many Arctic species to sound and changing densities and distributions of human activities that produce noise. For example, the January 2017 meeting of the Arctic Council workgroup for Protection of the Arctic Marine Environment (PAME) considered a World Wildlife Fund proposal for "Developing Guidelines for Reducing Underwater Noise from Ship Operations in the Arctic."

Research Needs and New Directions

Scientific and technical progress has and will continue to advance in parallel with action to address the impacts of shipping noise on marine life. Clearly, additional science is needed to better understand the scope and biological significance of disturbance and masking from shipping noise. Efforts are also needed to sustain recent U.S. federal agency initiatives to better understand marine species distribution and density relative to temporal and spatial patterns of shipping and other noise sources.[7]

The scope of potential environmental implications of, and solutions to, shipping noise is substantial and will require concerted and sustained international efforts. Regulatory mechanisms such as nation-specific requirements by port and/or flag states may become part of how the issues are addressed internationally. However, challenges in their implementation and enforcement argue strongly for additional industry engagement. Building on the NOAA ship noise symposia, the Okeanos workshop, and the international progress that has occurred through IMO, proactive involvement of industry can constructively contribute to tangible progress. Moving forward, approaches to motivate this engagement could include government incentives (e.g., incentive-based regulations or tax breaks) and market incentives (e.g., fuel efficiency and "green" company certifications) in addition to regulation. Additionally, coordinated efforts with other environmental issues, like ship-strike mitigation, should be considered, including areas for speed reduction or vessel traffic avoidance that may simultaneously reduce noise *and* reduce the risk of vessel collisions.

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Portions of this article are adapted from Southall et al. (2017) that include nearly all of the same authors; more recent developments are considered here. We thank J. Hildebrand for his assistance in adapting and updating Figure 1.

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Understanding and Addressing the Effects of Shipping Noise in MPAs

Lessons from U.S. National Marine Sanctuaries

The Office of National Marine Sanctuaries, part of the U.S. National Oceanic and Atmospheric Administration (NOAA), manages a system of 14 marine protected areas (MPAs) in U.S. waters.

NOAA's Ocean Noise Strategy Roadmap[1] recently highlighted national marine sanctuaries within the agency's efforts, encouraging enhanced monitoring of ocean noise and development of innovative methods for addressing noise impacts within these sites. Driven by such interests, passive acoustic monitoring capacity within national marine sanctuaries is becoming more systematic and coordinated. Beginning in 2014, NOAA deployed Noise Reference Stations within Olympic Coast, Channel Islands, and Stellwagen Bank National Marine Sanctuaries, adding a fourth to Cordell Bank National Marine Sanctuary in 2016. These are long-term—1- to 2-year sequential deployments—low-frequency and mostly deep-water listening stations that are part of a 12-unit network deployed throughout U.S. waters. Data from this network will inform NOAA's understanding and management of ocean noise impacts (Haver et al., in review).

In 2016, a second program was started to coordinate shallow-water acoustic monitoring in Stellwagen Bank, Gray's Reef, Florida Keys, and Flower Garden Bank National Marine Sanctuaries along the East Coast of the United States and in the Gulf of Mexico. These broadband acoustic recordings are providing standardized and calibrated insights regarding temporal peaks in the spawning activity of fish, feeding and reproductive activity of baleen whales, small and large vessel activity, and offshore energy exploration variability among and within sanctuary soundscapes (J. Stanley, personal communication).

Stellwagen Bank National Marine Sanctuary (SBNMS), off the coast of Massachusetts, has become a hub of research focused on evaluating the potential impacts of noise from high levels of human activity on marine species and habitats co-occurring within its boundaries. The International Maritime Organization-approved Traffic Separation Scheme (TSS) for the Port of Boston routes the daily transits of container ships, tankers carrying oil and liquefied natural gas, and cruise lines directly through the sanctuary in an east-west pattern (Figure 1).

In addition, the sanctuary is a regional hot spot for biological productivity and has supported nationally important commercial fisheries, including those for groundfish like Atlantic cod and haddock. Cod and haddock are among many fish species in the sanctuary that are vocally active, particularly when spawning. Male cod produce low-frequency calls associated with spawning that are overlapped by noise produced by ships (Stanley et al., 2017). The sanctuary is also an important seasonal feeding ground for endangered and threatened marine mammals like North Atlantic right, humpback, and fin whales. These baleen whales also communicate using vocalizations in frequencies that are overlapped by noise produced by ships (Hatch et al., 2012).

For more than a decade, researchers from SBNMS and NOAA's Northeast Fisheries Science Center have been collaborating with a diverse group of academic and industry-based partners to:

- characterize the contribution of shipping noise to sanctuary waters
- document the calling activity of species in the sanctuary
- develop methods to quantify the risk of noise impacts to vulnerable species
- evaluate possible management options to address those risks

Many different types of underwater recording technologies have been used, and acoustic data are integrated with high-resolution ship tracking information available from land-based automatic identification system receivers. This research found that noise generated by commercial shipping contributes significantly to noise levels in the sanctuary, with high-traffic locations experiencing double the acoustic power of less-trafficked locations for the majority of the time period analyzed (Hatch et al., 2008). Methods were developed and applied to quantify the risk that these species' sounds are "masked" by shipping noise, which leads to a decrease in the distance over which calling animals can hear each other in biologically important contexts, like group feeding and mating (Hatch et al., 2012; Stanley et al., 2017).

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Such methods can also examine the possible gains in listening capacity resulting from changes in the quantity, distribution, or operation of ships. For example, NOAA and the USCG have worked to reduce the risk of lethal collisions between large ships and North Atlantic right whales, including within the sanctuary. This resulted in shifting and narrowing the Boston TSS and reducing ship speed within the TSS during time periods of high risk.

These mitigations have been evaluated for their indirect effects on reducing peak exposures of large whales and spawning fish groups to noise from ships transiting the sanctuary. However, because of the long-distance propagation of ship noise, efforts to design and implement quieter designs, as discussed in this article, will be necessary to reduce the contributions of both nearby and distant shipping to chronic background noise conditions within the boundaries of national marine sanctuaries and other protected areas (Hatch et al., 2016).

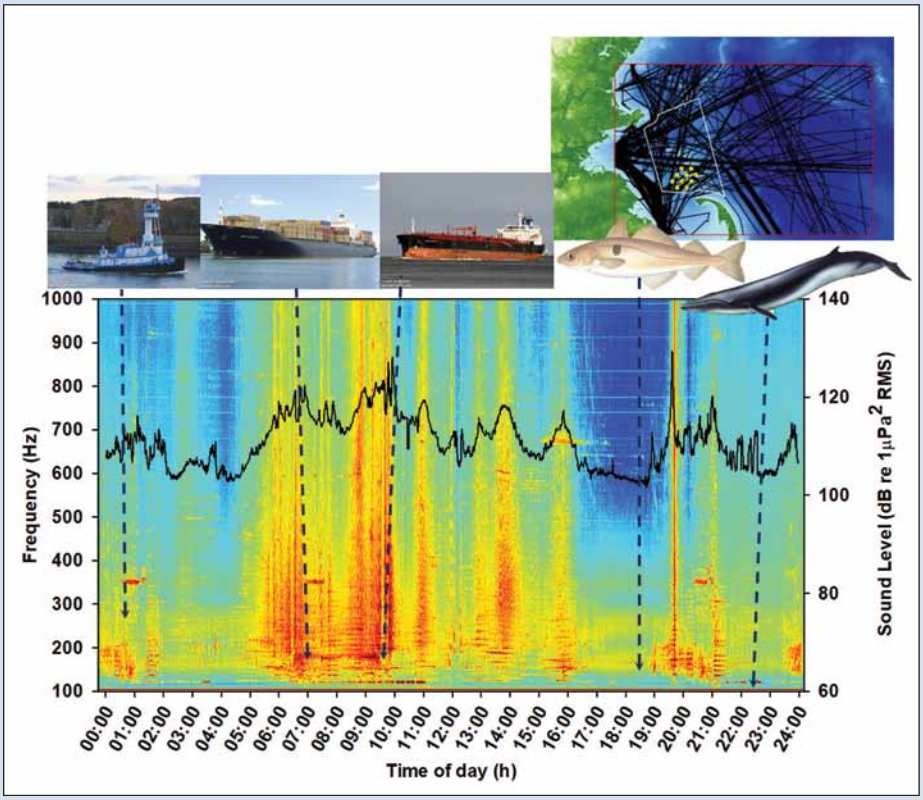

Figure 1. Map of coastal Massachusetts off the U.S. East Coast (upper right) showing one month of shipping traffic (black lines) in areas surrounding the Stellwagen Bank National Marine Sanctuary (white boundaries) and example placement of underwater recording equipment (yellow dots). 24-hour spectrogram showing example of contributions to low-frequency recordings from multiple vessel types as well as fish and baleen whales (dashed arrows). Sound intensity is indicated as both redder color and broadband levels (right axis) in the spectrogram. NOAA Stellwagen Bank National Marine Sanctuary image

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Strengthening Environmental Rule-of-Law to Reinforce Marine Protected Area Stewardship

by Xiao Recio-Blanco
Director, Ocean Program
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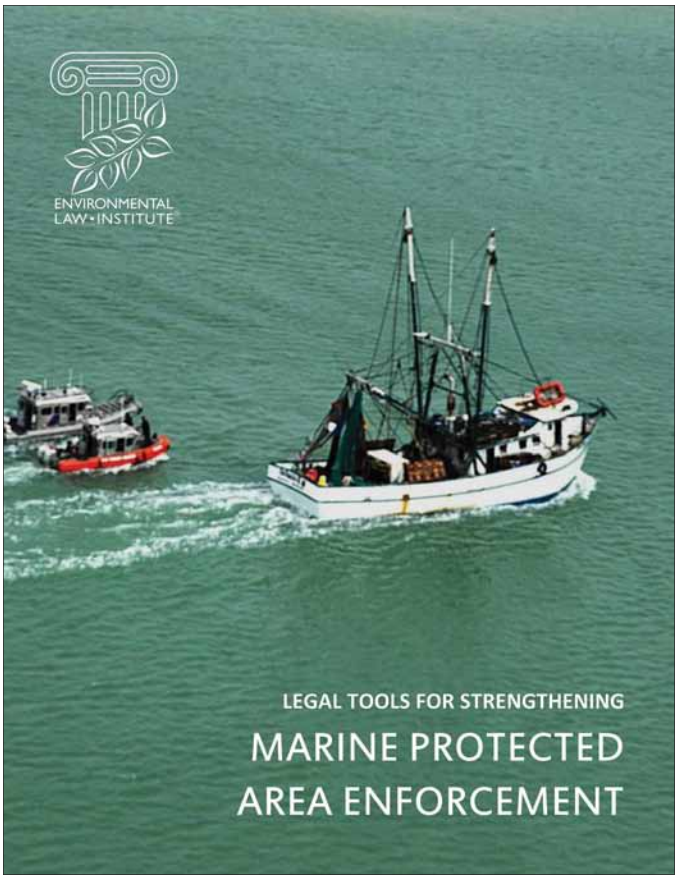
In 2016, the Environmental Law Institute (ELI)'s Ocean Program engaged in a research project[1] aimed at identifying the best regulatory practices for the implementation of marine protected area (MPA) laws. The main result of the project was ELI's publication of *Legal Tools for Strengthening Marine Protected Area Enforcement*. In addition to proposing several legal tools for strengthening MPA enforcement and compliance, it provides the reader with several sample enforcement provisions that would supplement and amend existing MPA laws, or assist in drafting new ones.



Environmental Law Institute photo

A marine protected area, as defined by the International Union for Conservation of Nature, is "any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical, and cultural features, which has been reserved by law or other effective means to protect part, or all, of the enclosed environment."[2] While each country has its own specific MPAs, all MPAs generally include habitat biodiversity protection, fish and fisheries productivity, and maintenance or enhancement of other ecosystem services.

Most MPAs can fall into one of two major categories: large-scale and offshore, or small-scale and near-shore. As human activity continues to cause increased threats to the same biodiversity MPAs seek to protect, there is a growing trend toward the creation of more expansive, elaborate MPAs.

The very nature of MPAs makes them difficult to enforce. Because offshore MPAs are usually extremely far offshore and large, they face threats from illegal, unreported, and unregulated (IUU) fishing activities undertaken by distant water fishing vessels (DWF) that can easily go undetected. As for near-shore MPAs, while it may be easier to spot a violation with the naked eye, protected areas are often misused by domestic fishers and other coastal water users. In addition, near-shore MPAs are more directly affected by other factors like coastal development and pollution, unsustainable recreational uses, and agricultural or industrial runoff.

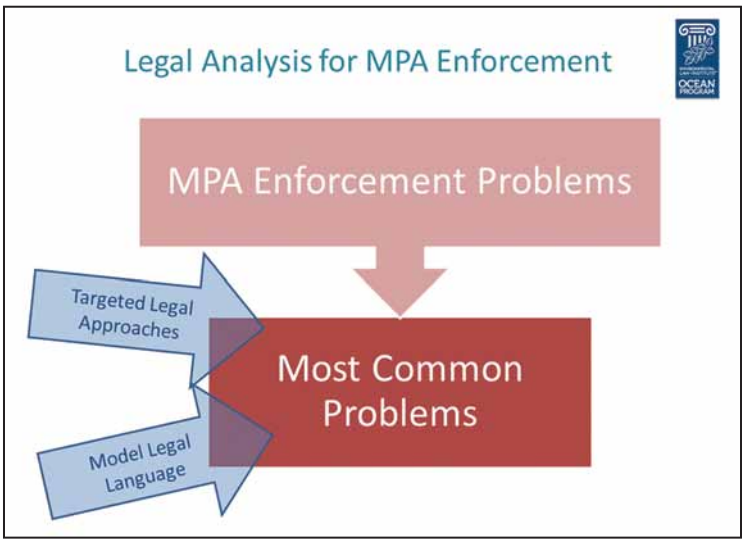
These challenges can be confronted, however, by making stronger, more enforceable MPAs through the amendment of existing MPA regulations or the outright creation of new ones. The first step toward improving compliance through enforcement begins with an understanding of common threats and problems affecting MPAs. In order to reach this full understanding, an individual or government charged with the task of strengthening or creating a marine protected area must speak to those charged with enforcing one as well as those who are forced to comply with it. In doing so, it will become easier for a country

to see where their specified problems lie and, as a result, realize how to best combat them.

Strengthening Rule of Law in MPAs

Thanks to the guidance of an ad-hoc expert committee, the project research team was able to identify a list of 12 topics or areas in which MPA practitioners should focus to support enhanced MPA enforcement:

1. designing MPAs for enforcement
2. enforcement powers
3. detection
4. adjudication of MPA violations
5. penalties
6. requirements pertaining to international vessels/fishers
7. detection and adjudication of other violations
8. sharing enforcement powers
9. sharing information
10. other cooperation
11. role of community
12. other mechanisms



Environmental Law Institute graphic

Designing MPAs for Enforcement

The purpose behind the creation and implementation of MPAs is to conserve marine biodiversity. To be successful, MPAs need to deter illegal behavior through encouraging compliance and imposing enforcement measures. Compliance and effective enforcement begins with the initial drafting of the MPA, which involves the actual design of the document as well as designation of the area the MPA will cover.

In regards to area designation, those tasked with the creation of an MPA need to undergo a careful consideration of what boundaries the MPA will cover. Their decision directly affects the efficiency and success of an MPA. For example, the designation of an MPA with straight lines is the most easy to follow, and thus has a greater chance at compliance. On the other hand, the creation of boundaries based on ecosystems may fulfill the purpose of the MPA, in that it would protect specific flora, fauna, and historical features, but these types of boundaries pose additional enforcement challenges.

As for the design of the MPA, the main question is whether activities will be prohibited, unless expressly allowed; or whether activities will be allowed, unless expressly prohibited. At present, the latter is more common but constitutes greater difficulties for enforcement. A switch to the former makes for better, simpler MPA enforcement.

Another way to make enforcement easier from a design standpoint is the designation of a single point of access. This designation facilitates control and allows for the creation of a singular common office used for collecting fees and applying for permits.

The creation of no-take zones is another option. Within these zones, any vessel found within the area that has not stowed its fishing gear would be presumed to be fishing illegally.

Enforcement Powers

Law enforcement at sea entails many challenges not present on land. As a result, those charged with strengthening MPA enforcement or compliance must use all the tools available in his or her arsenal to empower enforcement officials.

Within the MPA itself, the law should specify which agency has the authority or jurisdiction to take enforcement action and indicate which has prosecutorial authority. The MPA law or regulation should not make it difficult for interagency collaboration because enforcement can and will be difficult, and any extra assistance from another agency through staffing or funding is paramount. This assistance can also come from the MPA's expansion of enforcement authority to cross-deputization arrangements, allowing administrators to appoint new officers when necessary. In writing an MPA to include these suggestions, an officer's enforcement powers and tools available will be expanded in a way that makes enforcement easier and more successful.

Because the basic enforcement options include detention, search, investigation, seizure, and arrest, MPAs implicate general laws of civil and criminal procedure outside the scope of MPA law, and should be updated to make sure MPA enforcement officials are allowed to use modern remote technologies.

Detection

Much of the problem that lies with the enforcement of MPAs is the fact that the probability of a violator being detected at sea, seized, and successfully prosecuted is

incredibly low. As a result, those involved in the enforcement process, from detection to prosecution, must gain as much information as possible about potential violations from as many sources as possible.

Effective management and enforcement of an MPA unequivocally needs some form of recordkeeping and reporting. This type of recordkeeping and reporting includes examples like electronic reporting, logbooks, onboard departmental observers, video monitoring, scales to determine catch weights, and environmental DNA testing of a catch to evaluate MPA compliance. Additionally, the use of emerging technologies like Global Positioning Systems (GPS) or automatic identification systems (AIS) should be encouraged.

Adjudication of MPA Violations

A violation of a marine protected area can result in either a civil or criminal enforcement action against the offender. However, regardless of the type of MPA, the biggest issue regarding adjudication of these actions is holding the responsible party accountable. This is difficult for reasons previously given—the difficulty of detection, enforcement, etc.

One way to combat this is a stipulation that the master, crew, and owner all be held accountable for a marine protected area violation, regardless of whether the owner was aboard the vessel or not. By broadly defining who is considered liable under the regulation and expanding it to owners and other individuals, this stipulation would create a catch-all clause and eliminate any questions as to who can be held responsible for any MPA violation.

Admissible evidence is another issue that arises with MPA adjudication. To combat this, evidentiary rules should allow for the admissibility of any type of reliable evidence, and general standards regarding the liable party should be expanded. Lastly, a country's legal system should encourage avoidance of the costly adjudication process altogether by allowing for a ticketing system regarding minor violations, or a settlement system that gives government officials the right to negotiate a resolution for larger violations. All of the above would make the adjudication process much easier—and in some cases, entirely avoidable—all while holding the violator responsible.

Penalties

In order to deter negative and illegal behavior, successful MPAs need to have a penalty system in place, which makes it more expensive to conduct illegal fishing activities. Within the MPA, the penalty system must be drafted to provide clarity to the nature of the violation as well as how much a violation will cost. In doing so, potential violators will know the consequences of a breach, and illegal actions can swiftly and fairly be punished. Of these penalties, warnings are the least serious, with a limited deterrent, but can become more successful when recorded.

For example, if a vessel violates a marine protected area and has a history of breaches in the past, but was only issued warnings, a good penalty system would require a heftier fine than from a vessel that didn't have any warnings against it. Fines are the most common type of penalty, done through ticketing systems, settlements, or ruling by a judge or magistrate. A country can require fines or payments be paid to repair the damage done to a marine protected area. Such a system requires the party to either restore the damaged resource or pay for the cost of doing so. This option helps the community in a way that cannot be monetarily quantified, in that those who depend on the natural resource destroyed or harmed will not go without.

Almost 350 dead sharks were discovered caught in a 5-mile-long gill net floating 4 miles off the south Texas shore in December 2012. The crew of a Coast Guard Station 109 bonnet, and 11 bull sharks. Coast Guard photo

Temporary or permanent permit sanctions can be placed on vessels, individuals, or entire operations. Permits can also be revoked or suspended for non-industrial activities like ecotourism or other recreational activities. To date, permit sanctions represent the most effective penalty, both in terms of cost and compliance. Similarly, forfeiture, either permanent or temporary, has also proved effective. Imprisonment offers another form of penalty, though it should only be used in the most extreme of cases. Additional penalties include restoration, monitoring, management activities, or requiring that any individual who breaches a marine protected area help with public education regarding its intricacies, potentially transforming a violator into an advocate. In order for an individual penalty or combination of them to be successful in deterring violations, however, a country should widely publicize that a penalty has occurred to show others the consequences of a violation and the readiness of the government response.

Requirements Pertaining to International Vessels/Fishers

Because many off-shore MPAs deal primarily with larger, international fishing vessels, it can become difficult for those charged with enforcement to hold a violator responsible due to jurisdictional issues and the vessels successfully avoiding capture. To contest these potential issues, a government can adopt bond measures, which would help to secure the appearance of an international crew hoping to avoid the fine by not appearing. If a bond is not complied with, the addition of an "in absentia" clause within a marine protected area would allow for adjudication to commence and continue without the defendant present, helping the government to recuperate any loss resulting from the breach.

Detection and Adjudication of Other Violations

As a result of the interaction with MPA law and other laws, such as a criminal or civil code, when an individual or vessel violates a marine protected area, they are often also violating one of these other laws. Examples include a violation of recordkeeping or the crime of falsehood or deception when trying to cover up a breach. By making MPA enforcement part of an overall, more recognized law enforcement plan; such as immigration, drug trafficking, or human rights issues; the crafter would help to make the MPA more successful.

Sharing Enforcement Powers

Many coastal countries struggling with their MPA enforcement are in such a position because they cannot afford efficient implementation. As a result, management of industrial fishing in most nations' exclusive economic zones is usually characterized by a great imbalance. However, according to the United Nations Convention on the Law of the Sea (UNCLOS), "all states are obligated to cooperate for the conservation of the marine environment."[3] Countries can engage in joint enforcement activities including ship rider agreements, in which an enforcement officer from a host country rides with a vessel from another country; or bilateral and multilateral agreements for monitoring and controlling fisheries and conservation measures.

Co-managing an area or regional agreements can also be written into a marine protected area to help with enforcement. With regional agreements, countries can coordinate the efforts of enforcement vessels and personnel to create a more efficient execution strategy. Co-managing also increases information sharing, transparency, and efficiency, all while cutting down on the cost of implementation procedures.

South Padre Island response boat spotted the illegal gill net about 17 miles north of the U.S.-Mexican maritime border. Among the sharks seized were 225 black tip,

Cooperation to protect near-shore MPAs can take shape in several ways, including, but not limited to:

- the use of local citizen councils that explain the regulations and benefits of following the MPAs
- the deputization of local authorities to make up for lack of enforcement staff in smaller towns and less populated areas
- self-regulation through education and understanding of MPA rules
- the assignment of local fishing rights, which leads to voluntary compliance
- the moral obligations and social peer pressure a local community can impart on violators

Sharing Information

Similar to sharing enforcement powers, the sharing of information also has a strong impact on the effectiveness of an MPA. In the sharing of enforcement powers, there obviously needs to be reciprocity of information in order for the enforcement to be a success. However, even in cases where enforcement powers are not communal, information sharing remains hugely important. For one thing, this sharing results in the continued cleanliness of the ocean. For another, it helps other countries hold violators responsible.

There are several options a state can take to improve its information sharing capabilities. One example is through a common, updated registry of fishing facilities, target species, and authorized fishing vessels. Through this, a country could know immediately upon seeing a ship, despite never having seen it before, whether or not they are in violation of their MPA. Additionally, a country can ratify the Food and Agriculture Organization Port State Measurements Act (PSMA), which helps to increase transparency and further the exchange of information on port measures.

Other Cooperation

Similar to a co-management strategy of enforcement is the idea of transboundary MPAs. Transboundary MPAs are those that have been created through the enactment of domestic laws that connect on either side of the maritime boundary. These MPAs increase coordination, information sharing, scientific cooperation, and harmonized monitoring. To further this international cooperation, countries can also ratify agreements that go toward coordinating vessel registry procedures, distributing allowable catch rights, and information sharing.

Unfortunately, many of the countries struggling with MPA enforcement also struggle with corruption, affecting small-scale and industrial facilities. In order to combat this corruption, countries should establish sustainable finance mechanisms specifically for MPAs that could only be allocated and used by MPA officials for the implementation or undertaking of specific maritime conservation actions.

Role of Community

Near-shore MPAs, in particular, need to depend heavily on the role and cooperation of their local citizens and fishermen. The more that communities are involved with the drafting process and have implemented their own area-specific rules and regulations, the more invested they will be in compliance with, and enforcement of, an MPA. Additionally, the cooperation of local communities and contribution of officers in regards to inspections can lower the cost of enforcing MPAs.

Other Mechanisms

The tools listed above are only a few of the many in the toolbox that crafters, enforcers, and supporters can use in the strengthening of MPA compliance. There are other mechanisms by which governments, citizens, and nonprofits can approach the complex enforcement and compliance problem. One in particular includes adding a layer of protection to an MPA by introducing an outright prohibition on the trafficking of fish, wildlife, and plants in violation of domestic or international law, cutting directly to the problem of illegal trade. This introduction, modeling on the anti-trafficking approach of the Lacey Act of the United States, would make every individual throughout the process—brokers, importers, processors, and retailers—liable for a marine protected area breach.

Citizen suits also offer another way for individuals, nonprofits, and organizations not involved in the crafting of a marine protected area to make a major impact on its enforcement and compliance methods. Citizen enforcement allows for these types of groups to step in and require compliance when the government either cannot, or will not. Under citizen suit provisions, any person who witnesses illegal activity, whether it be a fisherman on the water, a nonprofit that has done their due diligence, or a beachgoer on the shoreline, can sue the violator. The result of a successful suit is usually injunctive relief, and especially helps in the case of the fishermen. When establishing

a system of exclusive fishing rights, those on the water using those rights every day are the most likely to see a violation, and a citizen suit provision gives them the right to bring a violator to justice.

Introducing Legal Reforms on MPA Enforcement Provisions

Generally, the suggested government actions here can be implemented through legislation, regulation, decrees, executive orders, international agreements, and other measures, depending on the specific laws of each individual state. In addition to MPAs, as previously mentioned, other laws outside of the scope of maritime regulation may have to be amended, such as the criminal or evidentiary code. The following paragraphs introduce a few ideas on how to draft and introduce regulatory reforms for MPA enforcement:

1. A crafter must draft the MPA restrictions as clearly as possible. This means making them relatively simple and easy to understand so it's easier for prosecutors to pursue legal action, for courts to determine whether the law has been violated, and for ocean users to understand whether they are following the law.
2. Drafters must ensure that the MPA they create penalizes the acts and omissions that violate the most important MPA requirements. This means that the law will assign liability when the MPA is violated. It should be clear to anyone reading a marine protected area law what the law prohibits and what the penalties are for violating those prohibitions.
3. The drafter must attempt to strike a balance between making the MPA short and simple enough for enforcement, but detailed enough so that the law in place will meet the local needs. This can be achieved through maintaining clear, simple requirements through the legislative process, allowing for the ease of assigning liability, but also by allowing certain flexibility at the level of regulation and management, so that the law can be implemented in a way that best assists a specific area.
4. When assigning responsibilities under the law, be as plain as possible about who is required to do what.
5. A drafter has to be conscious of existing domestic and international law that may have an effect on his or her MPA—there should be no conflict or confusion.

Petty Officer 2nd Class Chris Parmenter, an aviation maintenance technician from Coast Guard Air Station Barbers Point, Hawaii, looks for illegal fishing vessels in the water using the Casper camera on a C-130 Hercules airplane over the southern Pacific Ocean in May 2017. Operation Tui Moana is a patrol of air and water assets with a goal of detecting, deterring, and apprehending illegal fishing activity. Coast Guard photo by Petty Officer 3rd Class Amanda Levasseur

Conclusion

There are many tools that those drafting a marine protected area can use to create a successful, enforceable MPA, and many mechanisms by which governments can enforce—and individuals can contribute to enforce—compliance. The Environmental Law Institute's MPA enforcement project attempted to sort through all of the options and compile those that have worked best in successful MPAs.

Again, it is important to remember that while not all may apply to a singular state, the most effectively enforced MPAs result from a combination of these tools and suggestions. Furthermore, it is through the creation, promulgation, and enforcement of carefully crafted MPA laws that the areas protected—old and new—will fulfill their purpose.

About the author:

Xiao Recio-Blanco joined the Environmental Law Institute in early 2016, and has conducted research on a broad range of ocean management and conservation topics, including small-scale fisheries, marine spatial planning, maritime boundary agreements, and ocean renewable energy. He holds a Juris Doctor from the Complutense University (Spain) and a Doctor of Juridical Science from Duke University.

Endnotes:

1. This project was made possible thanks to a generous grant from the National Geographic Society.
2. World Commission on Protected Areas, Guidelines for Marine Protected Areas. Best Practice Protected Area Guidelines Series No. 3, at https://portals.iucn.org/library/efiles/edocs/PAG-003.pdf
3. *See* UNCLOS arts. 116–19 (conservation of straddling fish stocks); art. 192 (general obligation to protect and preserve the marine environment). As the vast majority of countries are parties to UNCLOS, its provisions have become customary international law.

Operation Kohola Guardian, 2017

Maui, Hawaii

Each year, the Coast Guard works with the National Oceanic and Atmospheric Administration's Office of Law Enforcement and the Hawaii Department of Land and Natural Resources to conduct Operation Kohola Guardian. The sustained multiagency pulse operation is intended to safeguard the humpback whales that visit the waters off of Maui.

Kohola Guardian focuses on the Hawaiian Islands Humpback Whale National Marine Sanctuary, where the state of Hawaii and the federal Office of National Marine Sanctuaries monitor and manage human activity more closely. The agencies' shared objective is to safeguard the humpback whales and protect the public from inadvertent encounters with them. This sustained joint operation leverages the resources, expertise, and priorities of each partner. Cooperative planning work by the participating state and federal agencies delivers the best possible outcomes from related operations in the field.

The Coast Guard's support includes work by District Fourteen, Station Maui, and Air Station Barbers Point focused on safeguarding humpback whales and the boating public. During Kohola Guardian, and throughout the year, units respond to requests for assistance with marine mammal entanglements and, when circumstances demand and resources allow, transporting high-risk animals that pose a threat to public safety—or protected species—for rehabilitation or release.

Now entering its second decade, Operation Kohola Guardian demonstrates the benefit of increased field presence by law enforcement and natural resource agencies. It's also a strong example of the value of advance planning and cooperation to ensure optimal outcomes for the public and the resources they value.

—by Steven Tucker
Deputy Chief for Marine Protected Resources
Office of Law Enforcement, U.S. Coast Guard

Petty Officer 1st Class Sean Hill of Coast Guard Station Maui provides a copy of a completed boarding form to a mariner during a recreational vessel boarding near Maui in February 2016. Station Maui crew was on patrol in the Hawaiian Islands Humpback Whale National Marine Sanctuary with the Hawaii Department of Land and Natural Resources teams conducting safety and compliance boardings in conjunction with Operation Kohala Guardian. Coast Guard photo by Chief Petty Officer Sara Mooers

A History of the New England Marine Resources Trinity

Fisheries, sanctuaries, and monuments

by CDR Eric Johnson
Deputy Chief, Enforcement Branch
U.S. Coast Guard, First District
in partnership with the Northeast Regional Fisheries Training Center

Commercial fishing throughout New England has a long, rich history dating back hundreds of years. Established as one of the first Colonial industries of the 1600s, the Atlantic Ocean and its bountiful marine life have sustained and employed generation after generation of New Englanders. However, a growing population increased the demand for fish, prompting the development of more efficient fishing—and, for a time, whaling—techniques, which led to some stocks being overfished.

While the concept of fisheries management might seem like a relatively recent initiative, efforts have been in place for well over a century. In 1871, former President Ulysses S. Grant appointed Spencer Fullerton Baird as the first commissioner of the newly formed U.S. Commission of Fish and Fisheries. As commissioner, one of Baird's first actions was the establishment of a fisheries laboratory located in Woods Hole, Massachusetts.

Soon after being established, the laboratory issued a report detailing the status of the New England fisheries, highlighting multiple issues based upon the results of numerous studies that had been conducted to ascertain the status of the region's fish stocks. These issues included depleted bait stocks for native fish species, migration of certain species to other geographic areas, and overfishing by the commercial fleet.

Despite the publication of these findings, which arguably illuminated the need for more aggressive management of the fish stocks, the health of fisheries throughout the region continued to decline. From the 1930s through the 1970s, fish stocks declined at a historic rate. This decline can be attributed to a combination of factors, not the least of which was the continued development of more efficient fishing methods and equipment. The growing fleets, encroachment into the area by foreign fishing fleets, and the innovation of offshore commercial fish processing vessels also contributed to this depletion. With catch numbers consistently increasing, it was simply a matter of time until harvests outpaced natural replenishment of the stocks.

In one of the first attempts to proactively manage the stocks, end overfishing, and rebuild groundfish stocks, the Magnuson-Stevens Act, now referred to as the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA), was enacted in 1976. The MSFCMA established a fishery conservation zone of 200 miles, but this language was later changed to establish the area of coverage as the exclusive economic zone (EEZ).[1]

The MSFCMA also established eight regional fishery councils charged with managing fisheries throughout their respective regions through the use of Fisheries Management Plans (FMPs). FMPs are required to comply with comprehensive requirements in order to ensure efficiency. Throughout the following years the Magnuson-Stevens Act was amended twice, first in 1996 through passage of the Sustainable Fisheries Act, and again in 2006 with the Magnuson-Stevens Fishery Conservation and

Dolphins escort a small boat from USCGC *Legare* back to the ship after a living marine resource boarding. Dolphins are known to approach bow waves of their own accord. Coast Guard photo by Petty Officer 3rd Class Kaitlin Bearden

A whale breaches near USCGC *Legare* as the ship enters Block Island Sound. Coast Guard photo by Petty Officer Angel Claudio

Management Reauthorization Act. The reauthorization of the MSFCMA solidified the United States' commitment to the effective management of fisheries stocks.

A Whale of a Story

The establishment of the Stellwagen Bank Marine Sanctuary in 1992 was another effort to preserve an area representative of the marine ecosystems of New England. Stellwagen Bank is an underwater plateau formed by the same glacial processes that formed Cape Cod. The sanctuary—the 12th of 13 created under Title III of the Marine Protection, Research, and Sanctuaries Act of 1972—was established to help protect the marine life in the area as well as the plant and sea life contained therein.

The designated sanctuary is a 638-square-nautical-mile area at the mouth of the Massachusetts Bay, with rectangular boundaries starting 3 miles southeast of Cape Ann, Massachusetts, and extending to 3 miles north of Cape Cod. It is about 25 miles east of Boston, situated wholly within federal waters. It encompasses all of Stellwagen and Tillies Banks, along with the southern portion of Jeffrey's Ledge.

Today, Stellwagen Bank is home to a multitude of marine species, including lobster, Atlantic bluefin tuna, and Atlantic cod. However, Stellwagen Bank is probably best known for its robust and vibrant humpback and North Atlantic right whale populations.[2]

A Monumental Task

Northeast Canyons and Seamounts Marine National Monument

In September 2016, former President Barack Obama designated the first marine national monument in the Atlantic Ocean. Located about 150 miles southeast of Massachusetts, this monument is thought to have been created by extinct undersea volcanoes and seabed sediment erosion. Now known as the Northeast Canyons and Seamounts Marine National Monument, this area is a hot spot for rare and endangered species.

The monument is an area of 4,913 square miles that is home to four distinct underwater seamounts named Bear, Mytilus, Physalia, and Retriever. In addition, there are three undersea canyons located within the boundaries of the monument, and all three—Oceanographer, Lydonia, and Gilbert—extend into the continental shelf.

This location has been subject to extensive underwater research and discovery for decades because of its unique ecosystem and rich biodiversity. The continued protection of this area will ensure the sustainment of, and critical protection for, important ecological resources and marine species, including endangered sperm, fin, and sei whales, Kemp's "ridley" turtles, important deep-sea coral, numerous fish species, and other marine mammals and birds.[3]

Frank R. Lautenberg Deep-Sea Coral Protection Area

Deep-sea coral beds are vital to the preservation and ability of numerous fish species and invertebrates to flourish. The protection of existing deep-sea coral habitats is vital to preserving these extremely fragile ecosystems, which can take centuries to recover from damage sustained by disturbances on the sea floor.

The Frank R. Lautenberg Deep-Sea Coral Protection Area was named for the late New Jersey senator who was dedicated to ocean resource conservation. The protection area was created in December 2016 as an amendment to another fisheries management plan, with the goal of

protecting the delicate coral formations from potential damage due to bottom-tended fishing gear.

The protection area lies off the coast of the mid-Atlantic states of Virginia, Maryland, Delaware, New Jersey, New York, and Connecticut and encompasses an area of about 38,000 square miles. The area enveloped by the protection area is either known or likely to have a high concentration and presence of deep-sea coral in the underwater canyons and sloping areas that extend out from the continental shelf. Because of the likely presence of coral in these areas, commercial fishing vessels are prohibited from using most types of bottom-tended fishing gear, yet recreational fishing in the area is not affected.[4]

Something's Fishy Around Here

Fisheries enforcement in the Northeast region is an extremely complex business. New Bedford, Massachusetts, is the home port for the country's most profitable fishing fleet, bringing in about $369 million dollars' worth of catch and generating a multi-billion dollar economic impact every year. The northeast fishery bio mass is a critical national resource, key to our economic sustainment and independence.

To ensure preservation of the resource and adherence to laws and regulations from the National Oceanic and Atmospheric Administration, living marine resources enforcement activities are governed by two Coast Guard doctrines—*Ocean Guardian* and *Ocean Steward*. *Ocean Guardian* is a Fisheries Enforcement Strategic Plan that contains effective and professional at-sea enforcement of federal fisheries regulations strategy. This strategic plan also advances national goals for the conservation and management of living marine resources and their environment. *Ocean Steward* focuses on another aspect of maritime strategy by providing guidance on the elimination and mitigation of environmental damage and natural resource degradation associated with all maritime activities.

Within the guidelines of these two strategic documents, operational directives have been developed to further guide the implementation of these strategies and ensure that effective enforcement is coupled with education and outreach efforts.

In the First Coast Guard District, units execute Operation Atlantic Venture. This long-standing operation balances the protection and stewardship of our natural resources by leveling the playing field within the fishing industry to prevent overfishing, curtail environmental degradation, and enforce protections for species vital to the country's economy.

One of the most important lines of effort for Coast Guard living marine resource enforcement (LMRE) is to ensure a level playing field for everyone. Because of

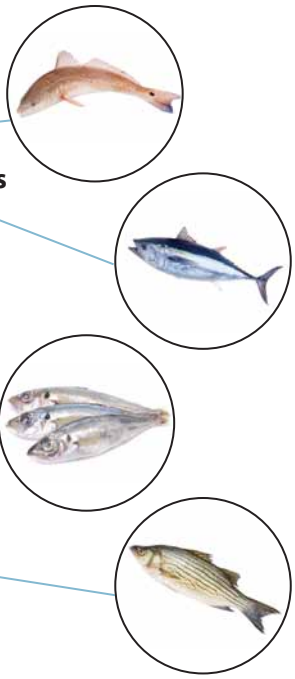
USCGC *Legare* approaches a deceased right whale on Georges Bank. Coast Guard photo by Petty Officer Angel Claudio

Species Regulated in Accordance with Management Plans

Northeast Multispecies
- Haddock
- Atlantic cod
- Redfish

Highly Migratory Species
- Atlantic bluefin tuna
- Shark
- Swordfish

Other Species
- Atlantic sea scallops
- American lobster
- Monkfish
- Atlantic mackerel
- Squid and butterfish
- Herring
- Striped bass
- Summer flounder
- Black sea bass
- Scup



Redfish by IrinaK; bluefin tuna by holbox; fish horse mackerel by Julia_Lelija; striped sea bass by Alexander Image| all Shutterstock.com

How Irresponsible Fishermen Thwart the Law

- Making false statements
- Improper and deceptive use of the Vessel Monitoring System for the purpose of hiding vessel incursions into closed areas
- Intentional fishing inside areas closed to fishing
- Retaining prohibited catch
- Significant catch overages
- Using undersized net mesh
- Employing net liners and choking mechanisms to increase catch potential
- Using hidden compartments to conceal illegal catch

the potential for profitability within the fishing industry, there will always be some who will attempt to get ahead by any means necessary. Unfortunately, those who subvert regulations to gain an advantage over their competitors may not comprehend, or simply disregard, the impact their actions have on the fragile ecosystem. The Coast Guard has encountered myriad tactics irresponsible fishermen have adopted in attempts to gain unfair advantage.

Preserving the Trinity

Living marine resource enforcement within the USCG First District is the bread and butter—or fish and chips—of its law enforcement program. As the geographic point of origin for the nation's efforts to manage marine resources and establish marine resource protection, and as the home of America's number one fishing port, New Bedford, the Northeast Region serves as the touchstone for the nation's fisheries enforcement.

Coupled with the acute environmental awareness of the population in the Northeast Region and the prominent role of the marine environment as a cultural icon, enforcement of fisheries harvest regulations is only one piece of the puzzle. Preservation of the fragile marine ecosystem is also achieved by effective implementation, education, outreach, and enforcement. For Coast Guard LMRE, education and outreach efforts run the gamut, from everyday interactions between Coast Guard law enforcement personnel and the fishing industry, to displays set up by the New England Fisheries Management Council, and meetings that are open to the public.

Regardless of the forum, personnel of the First Coast Guard District; along with various local, state, and federal partners; work diligently to ensure the preservation of the New England marine resources trinity, and to ensure the public is aware of how best to protect our valuable resources.

About the author:

CDR Eric Johnson is a native of Missouri, where he grew up on a farm near a town of 460 people. After enlisting in 1987, he advanced to chief in 1997, attending Officer Candidate School in 2000. He became a permanent cutterman in 1994, and his most recent assignment was as executive officer of USCGC Reliance. *He has served in the Coast Guard for 31 years.*

CDR Johnson worked on this article in partnership with the Northeast Regional Fisheries Training Center (NRFTC). The NRFTC was established in Cape Cod, Massachusetts, in 1994 to educate Coast Guard boarding officers on the regulations, policies, and procedures governing the East Coast's most complex and diverse fisheries and marine protected species.

The NRFTC's area of responsibility spans the Northeast and Mid-Atlantic regions, consisting of Coast Guard units from Maine to North Carolina. The training center delivers 12 living marine resource boarding officer courses per year, training nearly 200 Coast Guard boarding officers as well as enforcement partners from the National Oceanic and Atmospheric Administration and state agencies. Additionally, the NRFTC conducts specialized living marine resource enforcement action training and familiarization for pilots, air crews, and shoreside enforcement personnel throughout the year.

Endnotes:

1. Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service, available at: www.fws.gov/laws/lawsdigest/FISHCON.HTML
2. https://stellwagen.noaa.gov/about/faq.html
3. https://obamawhitehouse.archives.gov/the-press-office/2016/09/15/fact-sheet-president-obama-continue-global-leadership-combatting-climate
4. www.greateratlantic.fisheries.noaa.gov/stories/2016/december/13_deep-sea-coral-protection_area.html

SeaSketch for Safe Passage

Collaborative mapping helps conflicting marine interests work toward shared goals

by Grace Goldberg
Marine Science Institute
University of California Santa Barbara

Sean Hastings
Channel Islands National Marine Sanctuary
National Oceanic and Atmospheric Administration

Will McClintock, Ph.D.,
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The process of collaboratively mapping out ideas and overlaying layers of data can help diverse groups come to a common understanding of an area. By overlaying map data describing the distribution of human activities, natural resources, and infrastructure, stakeholders can use these data to discover conflicting uses and explore potential solutions.

In 2015–2016, a working group including shipping industry members, whale biologists, military representatives, resource managers, air quality managers, environmental interests, and the U.S. Coast Guard used SeaSketch, a novel mapping platform, to discuss local solutions to manage marine traffic more sustainably in the Channel Islands region. Like its predecessor, MarineMap, SeaSketch is built to help such groups communicate about existing uses and management options across coastal waters, allowing diverse stakeholders to link their opinions and ideas to shared maps and come to a common understanding of competing needs and perspectives.

Process Context

In September 2007, the National Oceanic and Atmospheric Administration (NOAA) received reports of five blue whale carcasses between Santa Cruz Island and San Diego. On October 11, 2007, NOAA's National Marine Fisheries Service (NMFS) designated the blue whale deaths as an "unusual mortality event." In response to these deaths, the Channel Islands National Marine Sanctuary (CINMS) Advisory Council has been working to develop both short- and long-term management measures to reduce the ship strike threat to large whales in CINMS and the Santa Barbara Channel region listed on the Endangered Species Act.[1]

One such measure is their ship strike subcommittee, which produced recommendations adopted in 2009. As a result, the shipping lanes through the channel were modified in 2013 to decrease traffic overlap with areas of observed high whale concentrations. In addition, a

Members of the CINMS Advisory Council working group, stakeholders, and the general public attend a meeting where SeaSketch is used to present map data, sketch prospective management zones, and record feedback on options. Photo by Will McClintock, Ph.D.

Sanctuary Advisory Council Marine Shipping Working Group

Primary Goals:

- Reduce the risk of ship strikes on endangered whales.
- Decrease air pollution and greenhouse gas emissions.
- Improve navigational safety and promote efficient maritime shipping throughout the region.
- Manage ship traffic to minimize naval operation interruptions and reduce conflicts with other ocean users (e.g. fishing and whale watching concessionaires)

general call for voluntary speed reduction in the Coast Guard's weekly Local Notice to Mariners bulletin has evolved into a trial financial incentives program to reduce vessel speed.

A marine shipping working group of the CINMS Advisory Council was convened to build upon this previous and ongoing work, and to provide a collaborative forum for local stakeholders and experts to share knowledge and generate solutions. They came together to produce recommendations addressing four primary goals to broaden the scope of the working group's charge. Beyond just ship strikes, these goals incorporated a holistic look at how marine shipping affects marine resources and the broader maritime community in and around the sanctuary.

The working group members and support staff participated in five all-day meetings as well as multiple supplemental remote webinars. These meetings included expert presentations to inform the process as well as the facilitation of discussions to design spatial and non-spatial management recommendations. The final report offers more detail about the process and resulting recommendations.[2]

SeaSketch for Geodesign in Marine Spatial Planning

The working group's integrated approach aligns well with best practices for marine spatial planning:

- examining existing and potential use of ocean space comprehensively to identify conflicts between user groups and sustainability goals
- designing plans to reduce these conflicts

Geodesign, the iterative sketching and analysis of spatial designs, provides a useful framework for shaping the collaborative process.[3] To support this process, mapping tools allow decision-making participants to view relevant data and information, express ideas on the map, evaluate prospective plans, and discuss these ideas with other participants throughout the process. The features of the SeaSketch platform were developed to meet these specific needs common to a geodesign process for collaborative, data-driven marine spatial planning. Because SeaSketch is web-based, participants have access to a central planning hub where they can continue work and interact remotely between in-person meetings.

Decision support tools for area-based planning are wide-ranging. Some are sophisticated models that may be, but aren't necessarily, parameterized and vetted in a participatory process and run by skilled technicians like Marxan, InVest, etc. Other tools may be more like web-based atlases that democratize geographic information, making it accessible for participants and the general public. SeaSketch provides facilities for the evaluation of plans, including some integration with popular modeling tools, as well as easy-to-use map visualization that allows non-technicians to dive into science and information relevant to a planning decision.

The Software as a Service (SaaS) architecture allows every group implementing SeaSketch to leverage out-of-the-box features common to all projects and customize the platform to meet their specific needs in an administrative dashboard. Every planning process is unique and evolves, making use of different features and tools in different phases of the process. A few of the tasks common to configuring SeaSketch for a specific planning context include:

- gathering information and curating maps to populate the data layers of a project
- configuring sketching tools tied to analytics specifically relevant to that planning context
- managing user groups and discussion forums

Project leads work with a user-centered design approach to create a platform that intuitively meets the needs of multiple user groups.

Developing Safepassage.seasketch.org

The remainder of this article will describe how the CINMS Advisory Council working group process specifically configured and made use of the SeaSketch tools.

Data Layers

The first step involved creating a SeaSketch project site with a unique URL—safepassage.seasketch.org—and populating it with some publicly available data layers we anticipated would be useful for the working group

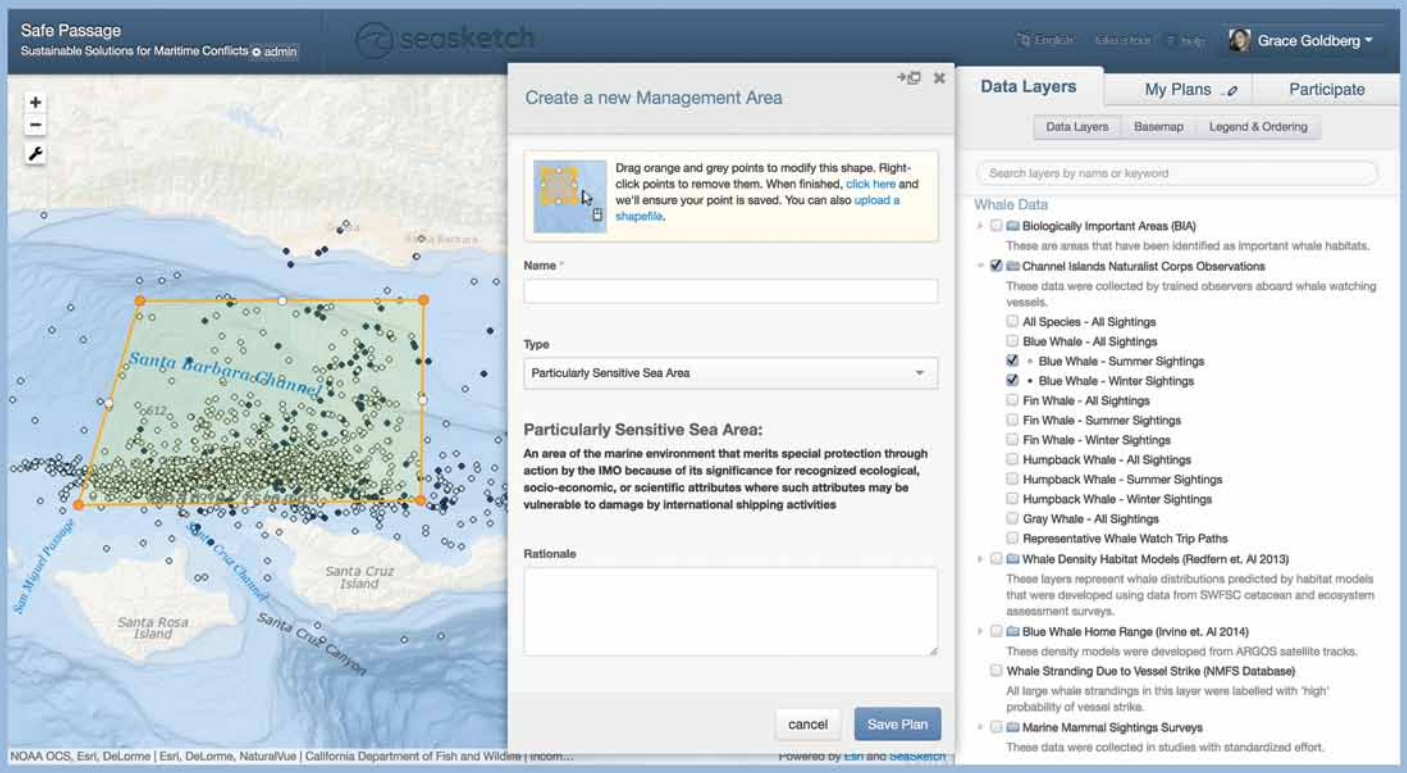
ahead of their first meeting. The distributed architecture of SeaSketch allowed us to leverage existing investment in data infrastructure from state and federal agencies in addition to publishing new map and analytical services, per project request. When the working group members were introduced to SeaSketch, the site already included authoritative boundaries and reference layers as well as some relevant biophysical layers pulled directly from the California Department of Fish and Wildlife servers and the NOAA/Bureau of Ocean Energy Management Marine Cadastre.[4]

At their first meeting, the working group discussed their charge, reviewed the work already completed on the issues, and were introduced to the SeaSketch platform and available information. This was the beginning of an iterative process soliciting data needs from working group members and working with them to build an authoritative data set based on their diverse expertise.

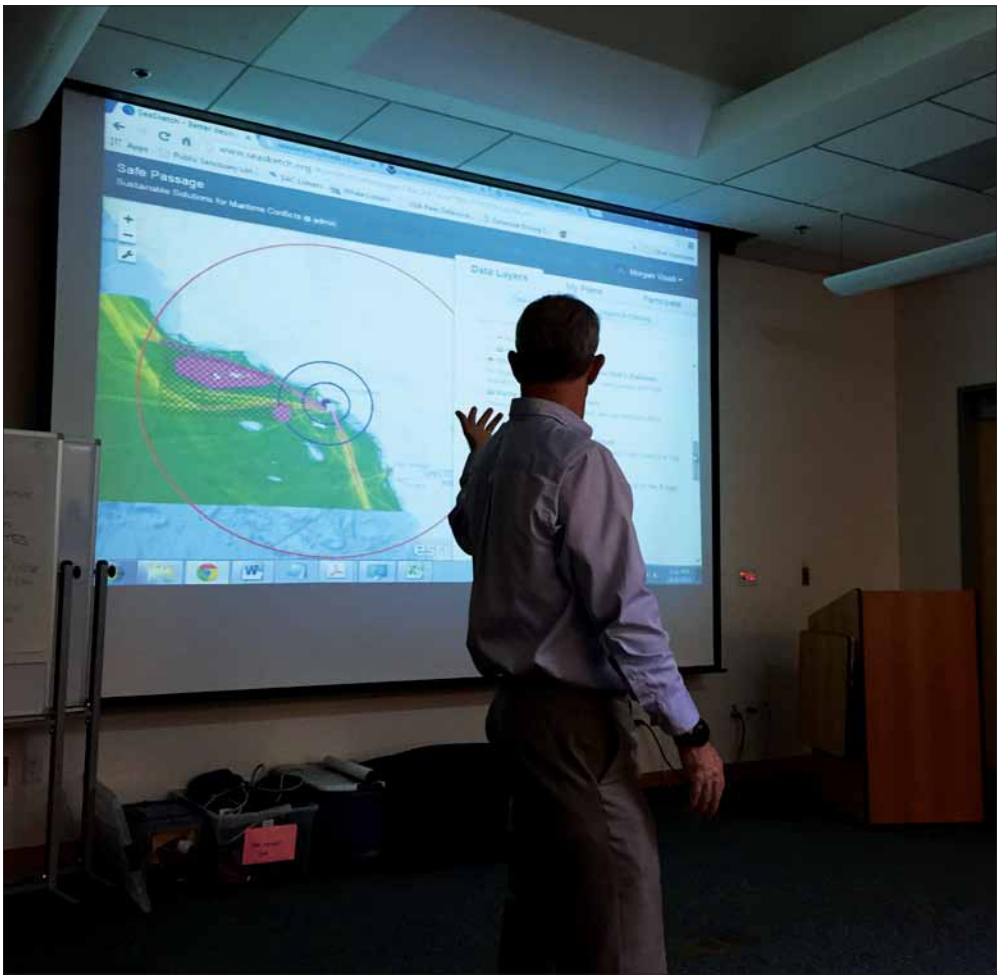
For the tool to be effective, it needed to provide the resources they saw as important for informing their process. For example, a representative from the U.S. Navy was able to provide a more detailed map of military use across the region. The Coast Guard provided automatic identification system data summaries for the region specifically applicable to the group's needs, allowing them to look at traffic density and speed patterns between vessel types, between months, and also interannual variation.

These data sets about the distribution of human uses were overlaid with a wealth of information about the distribution of whale populations. Marine mammal experts from the NMFS and other whale biologists engaged in the process created an exhaustive list of the data that could potentially be used. The spatial data sets were mapped, brought into SeaSketch, and provided the basis for a dedicated webinar on the topic.

In this remote, collaborative webinar meeting, the group members viewed SeaSketch on a shared screen and discussed the merits and limitations of various data sets, identifying five that would remain in the platform through the process. Some data sets offered better coverage in the area of interest, some described one species better than others, and some synthesized products that gave a continuous *prediction* of whale density over space rather than simply point out observations. This group also curated custom "metadata" documents to help the remaining participants use the data sets appropriately.



A screenshot of SeaSketch is used to view map layers depicting the distribution of whale sightings and then sketch a management zone to be designated as a Particularly Sensitive Sea Area. Graphic by Grace Goldberg



A meeting facilitator uses SeaSketch to present map data and record working group ideas for managing ship speed in the Santa Barbara Channel. Photo by Will McClintock

Sketching and Analysis Tools

As the process progressed, the working group needed to determine what types of management tools they might want to consider when building their recommendations. They roughly knew that routing measures might be appropriate, and the creation of no-go and slow-down zones might become a part of the proposal.

They received presentations from experts on what could be achieved through existing International Maritime Organization frameworks, such as traffic separation scheme shipping lane designation and Areas to be Avoided (ATBAs), as well as presentations on how Seasonal and Dynamic Management Areas (SMAs and DMAs, respectively) were being used around major ports of the Atlantic coast to reduce ship strikes on North Atlantic right whales. The working group used these discussions to create a list of what they might want to sketch out in their subsequent planning conversations.

In SeaSketch, we created three primary sketching tools, or "sketch classes." The "shipping lane" tool allows a user to sketch a multi-segment line on the map, designate the width of the lane, and automatically produce a traffic separation scheme along the sketched route. A "management zone" tool allows users to create a polygon, select from many zone types as attributes (i.e., SMA, DMA, ATBA, etc.) and, depending on which type is selected, fill out additional attributes (see page 79). In addition, users could place multiple shipping lanes and zones in a folder, creating a cohesive, multi-part plan to be analyzed together.

Similar to the iterative process to bring together authoritative data sets described above, we worked collaboratively with working group members to create analytical tools that would be helpful as they compared prospective plans. These informal, first-cut analyses were designed to help users with little specific technical knowledge make science-based decisions. For example, some simple feasibility flags alerted users when a shipping lane was sketched too close to existing infrastructure or no-go zones. Analytics co-developed with industry representatives and the Santa Barbara Air Pollution Control District staff allowed users to roughly compare potential emissions reductions based on routing and slow-down zones they had drafted.

Remote Collaboration

In addition to exposing easy-to-use mapping features online, SeaSketch provides discussion forums and survey tools to promote remote participation. Project leads can create private user groups and give them a space to iterate on plan ideas, share sketches and other documents, and link their conversation to relevant data layers.

In other SeaSketch projects, these same features provide space for public engagement rather than internal planning. In this case, the discussion forum allowed working group members and support staff to create new topic threads and post announcements throughout the process.

Using the Platform for Map-based Facilitation

The process of creating the tools in collaboration with users continued, with adaptations and modifications

added concurrently throughout implementation. In-meeting activities relied on SeaSketch for map visualization, design tools, and to capture ideas as notes in dedicated forum threads. Remote access to the tool built continuity between the in-person process steps.

Where information gathering and knowledge sharing dominated the initial working group activities, the second and third in-person meetings held the meat of the idea generation and negotiation around possible management recommendations. A professional facilitation team gave these meetings structure and guided the conversation.

SeaSketch was projected on a screen, with a dedicated individual using SeaSketch to display maps relevant to group member comments and capturing ideas as sketches in real time. For example, participants posed questions about the spatial extent of existing slow-speed incentive programs at the Ports of Los Angeles and Long Beach, California, which could be quickly answered by bringing up those boundaries. Members could then smoothly proceed to designing management recommendations to complement the existing program based on a shared understanding of the authoritative maps.

These seemingly small map interactions add up over the course of an all-day meeting. Where every question posed could add uncertainty to the decisions being discussed, and perhaps would not have been answered until a follow-up email or subsequent meeting, SeaSketch helped participants build a common understanding and more productively explore where their opinions and perspectives diverged. Members could walk up to the projector and point to an area where a zoning measure would be appropriate, and the SeaSketch driver could capture that as a polygon that could be edited through the continuing conversation.

Interestingly, even participants who never took the time to create an account and sketch out an idea themselves stressed the value of having the platform as an anchor during and between meetings, keeping the conversation tied to specific places and meaningful negotiations.

In addition to the in-person facilitation, SeaSketch was used to engage the participants remotely at key process junctures. For example, leading up to the second meeting, working group members were asked to submit straw-dog spatial plans—either routing or zoning measures—anonymously. These sketches provided a valuable foundation for the initial planning meeting as concrete fodder to debate the pros and cons of various management tools and places that might have been recommended. Later in the process, working group members were asked to comment in a discussion thread leading up to meetings, providing ideas on draft recommendation ideas to be discussed in more detail in person.

Conclusion

The first step to reducing complex spatial conflicts is empowering diverse voices to co-develop the possible solutions—but collaboration requires they develop a shared understanding of the space. The members of the CINMS Advisory Council working group represented conflicting perspectives ready to work collaboratively toward shared goals; some saw the region primarily as a shipping highway, or a missile testing area, or an ecologically important area for whales.

At the end of the process, the Safe Passage SeaSketch project held dozens of ideas, comments, and supporting documents contributed by the participants. Through their work, rather than coming to a consensus on next steps, they provided a suite of education, research, and management recommendations—including context about management options that had been considered and rejected. Their final report captured the nuance of why various participants supported some aspects of the recommendations over others that had been captured and fleshed out in map-based discussions over the course of the process.

By sharing knowledge and interacting with information in the SeaSketch mapping platform, the working group members were able to leverage their diverse expertise and come to a common understanding of the geography, allowing them to collaborate productively.

About the authors:

Grace Goldberg implements SeaSketch and other technologies developed in the McClintock Lab at the University of California Santa Barbara's Marine Science Institute using marine planning and ecosystem-based management projects globally. Her master's degree from Stanford University focused on marine systems and conservation.

Sean Hastings serves as the resource protection coordinator at the Channel Islands National Marine Sanctuary, where he develops policies and programs to address industrial, military, commercial, and recreational uses and impacts in and around the sanctuary. Sean has a Master of Marine Affairs from the University of Washington.

Will McClintock, Ph.D., is the director of the SeaSketch program at the Marine Science Institute at the University of California Santa Barbara. He is also a senior fellow at the National Center for Ecological Analysis and Synthesis and has worked in more than a dozen countries to support marine spatial planning with stakeholder-friendly decision support tools.

Endnotes:

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Living With Orcas

Protecting a vital resource—Puget Sound southern resident killer whales

by Brian Corrigan
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Orca (*Orcinus orca*), also known as killer whales, are one of the most well-known and studied cetaceans, and an iconic species inhabiting the Pacific Northwest. The coexistence of these socioeconomically vital animals with the region's broadening human population and robust maritime activity presents many extraordinary challenges.

Killer Whales

Killer whales are toothed whales belonging to the *Delphinidae* family, and are the largest of the dolphins. Found in every ocean, they are the most widely distributed of all whales and dolphins, yet the status of most populations of killer whales is unknown. These complex, highly social animals live within matriarchal societies and rely on underwater sound for orientation, feeding, and communication. They produce whistles and pulsed calls, used to communicate, maintain group cohesion, and hunt.

Killer whales are apex predators with the most varied diet of all cetaceans, tackling prey of all shapes and sizes. Various killer whale populations specialize in fish, some in seals, and some in sharks and rays, while others are foraging generalists. They often use a coordinated hunting strategy, working as a team like a pack of wolves.

Scientific studies have revealed many different populations, or ecotypes, displaying genetic variation and differences in their appearance, behavior, acoustic dialect, and prey choice. There are 10 documented ecotypes, yet more may exist. Three of the most well-studied of these ecotypes—resident, transient, and offshore—occur in the eastern North Pacific Ocean. Transient and offshore ecotypes also spend a portion of their time in Puget Sound's internal waters. Transients are mammal eaters, and offshores feed on sharks and rays.[1] The Puget Sound southern resident killer whales (SRKWs) will be the focus of this article.

Resident killer whales primarily eat fish and appear morphologically different from transient and offshore forms. Residents' dorsal fins are rounded at the tip and curved. They also display a variety of saddle patch pigmentations, with five different recognized patterns. They have been documented in a range spanning from California to Russia.

An orca breaches near the Alaskan coastline. In recent years, members of the southern resident killer whale population have been documented as far south as central California and as far north as southeast Alaska. Martin Prochazkacz | Shutterstock.com

Famous and commonly known to Pacific Northwest locals as the J, K, and L pods, or families, the SRKWs are the most well-studied killer whales. Southern residents are also the only known resident population to occur in the United States.

Individual members of the J, K, and L pods are identified by a number based on pod membership and birth order. Their range during the spring, summer, and fall includes the inland waterways of Washington State and the transboundary waters between the United States and Canada. Relatively little is known about their winter movements and range. However, in recent years, they have been regularly documented as far

south as central California during the winter months, and as far north as southeast Alaska.[2]

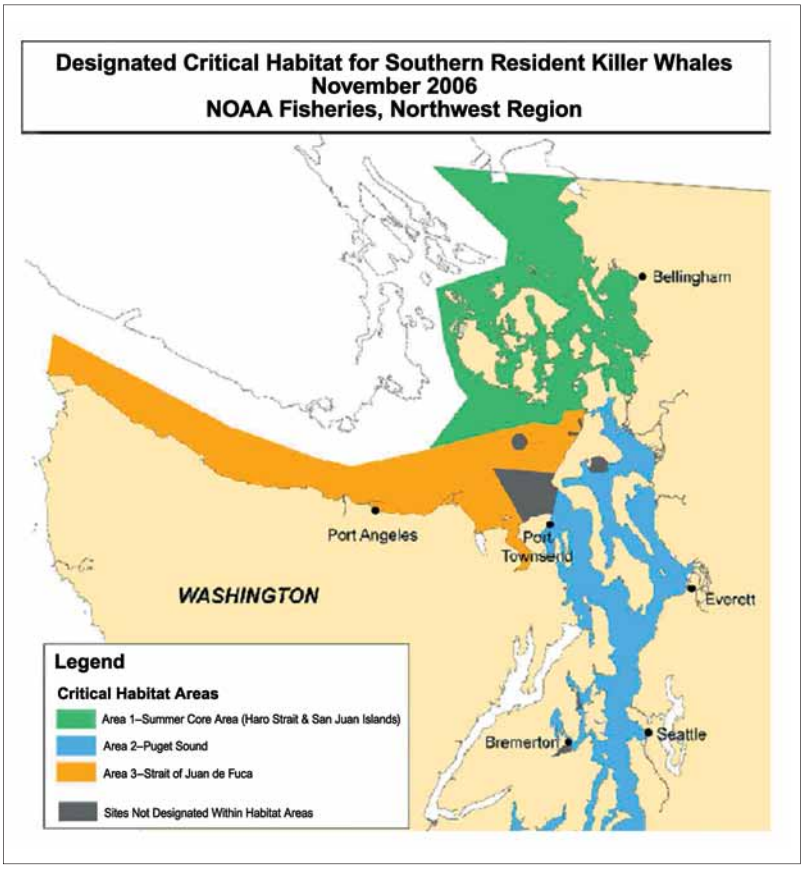
The SRKW population is currently estimated at about 80 whales, a decline from its historical level of about 200 during the late 1800s. Beginning in the late 1960s, live-capture fisheries for oceanariums (capturing killer whales for research, display, or education) removed an estimated 47 whales and caused an immediate decline in southern resident numbers. The population fell an estimated 30 percent, to about 67 whales, by 1971. By 2003, the population increased to 83 whales. Due to its small population size, the National Oceanic and Atmospheric Administration (NOAA) listed this segment of the population as "endangered" under the Endangered Species Act (ESA) in 2005 and designated as critical habitat in 2006.[3]

A new life: a baby killer whale swims beside its mother. Photo by Lori Mazzuca

Protecting a Vital Resource

All killer whale populations are federally protected under the Marine Mammal Protection Act (MMPA). Though they are considered depleted under the MMPA, Puget Sound SKRWs are one of only two killer whale populations receiving special protections under the ESA.[4]

SRKWs are a distinct population segment (DPS) of killer whales, meaning the three family groups making up the J, K, and L pods are a discrete population of killer whales and significant in relation to the entire species. The ESA's use of distinct population segments is a benefit to species conservation, as well as being advantageous to people whose activities may be affected by the ESA's prohibitions. Conservation efforts are deemed more effective and less costly if they are started early, and a DPS listing assists in making earlier listings possible.[5]



SRKW Critical Habitat map. NOAA graphic

During 2011, as part of the SRKW ESA listing's recovery plan, NOAA's West Coast region implemented vessel regulations throughout Puget Sound and most of its surrounding waters. These areas were designated as critical habitat for protection of the J, K, and L orca pods. The regulations are applicable to all types of vessels, including motorboats, sailboats, and human-powered vessels, including kayaks. They also apply to foreign flag vessels boating in the inland waters of Washington State—waters east of Cape Flattery, comprising the Strait of Juan de Fuca, Haro Strait, and Puget Sound.

Applicable vessels in the regulated area are prohibited from coming within 200 yards of killer whales. Regulatory provisions also require those vessels to not park within 400 yards of the whales' path. Parking in the path includes interception—positioning a vessel so whales surface within 200 yards, or so wind or water currents carry the vessel into the path of the whales.

Development of the specific regulations followed a lengthy regulatory rulemaking process, including extensive public outreach and participation, as well as collaboration with other federal, state, and local agency partners, including the United States Coast Guard. As part of their rationales, the ESA listing decision and NOAA's recovery plan for SRKWs identified three major threats to the whales' continued existence, all of which likely act in unison:

- prey availability
- contaminants
- vessel effects and sound

Acknowledging that salmon recovery and mitigation of contamination efforts in Puget Sound are likely to take many years to benefit killer whales, NOAA decided that threats posed by vessels could be reduced most efficiently and effectively through regulation.

Non-government organization monitoring groups, which contributed substantially to the data incorporated into the regulatory decision making process, reported the mean number of vessels following a given group of SRKWs within a half-mile averaged about 15–20 boats in 2010. That was up from a mean of five boats in 1990.

At any one time, the observed numbers of commercial and recreational whale watch boats around the killer whales was often much higher. Observations also included several years of data on incidents when vessels did not adhere to guidelines in the presence of killer

Photo by Lori Mazzuca

whales. The guidelines preceded the ESA regulations and were administered through NOAA's *Be Whale Wise* program. The most common incidents reflected a pattern involving private boaters and Canadian commercial whale watch vessels.

The four most commonly observed incidents leading up to the implementation of the ESA regulations include:

- parking in the path of whales
- vessels motoring inshore of whales—between whales and nearby land
- motoring within 100 yards of whales—the approach distance in the *Be Whale Wise* guidelines and Washington State regulations before implementation of the 200-yard federal regulation
- vessels motoring fast within 400 yards of the whales

NOAA also identified the following specific threats these incidents present to SRKWs as:

- the risk of strikes, causing injury or mortality
- behavioral disturbance, increasing energy expenditure and reducing foraging opportunities
- acoustic masking, interfering with echolocation, foraging, and communication

It has been well documented that killer whales in the Pacific Northwest respond to vessels, including kayaks, engaged in whale watching activities, resulting in

Assessing Impacts on the Puget Sound Maritime Community

Drafting regulations to protect the J, K, and L pods involved the assessment of impacts on the multitude of other aspects of the maritime community in Puget Sound, including the following:

- access to natural resources by commercial, recreational, and tribal harvesters of fish and other living marine resources
- viewing of marine birds and other marine mammals
- maritime commerce, involving cargo vessels transiting into and out of various ports within the region
- government and research vessel activity
- recreational boating traffic, including those vessels accessing private property adjacent to the regulated area
- other vessels with limited ability to maneuver operating in the area, including Washington State Ferries, the nation's largest—and world's fourth largest—passenger ferry operator, carrying more than 24 million passengers annually

short-term behavioral changes. Behavioral responses include increases in direction changes, respiratory intervals, and surface activity, all of which increase energy expenditure and reduce time spent foraging. The 200-yard approach regulation is intended to reduce the risk of vessel strikes, the degree of behavioral disruption, and the amount of noise masking the whales' echolocation and communication.[6]

Pacific Northwest's Diverse Maritime Roots

Puget Sound SRKW critical habitat encompasses the Strait of Juan de Fuca and its approaches, Puget Sound, the San Juan Island Archipelago, Haro Strait, Boundary Pass, and the Strait of Georgia, regions of the Salish Sea. These involve a vastly complex waterway, a pristine ecosystem, and part of a commercially and economically critical port infrastructure used by myriad vessel types.

In addition to large commercial traffic destined for the refineries and bulk or container terminals, the Salish Sea has historically supported a valuable commercial fishery and a large recreational vessel fleet.[7] While NOAA's West Coast region is principally responsible for the protection of the endangered SKRWs, much support is received from the Washington Department of Fish and Wildlife—the state of Washington changed its existing regulations to correspond with the federal regulations—as well as San Juan County, which enforces a related local ordinance.

The USCG also shares in federal marine protected species enforcement responsibilities. In addition to its living marine resources mission, another major effort by USCG District Thirteen (and more specifically the local captain of the port at USCG Sector Puget Sound) is to ensure the continued safe use of these waters for its many diverse users. This is accomplished through air and surface patrols, operation of the Puget Sound Vessel Traffic Service, maintenance of aids to navigation, and close collaboration with agency partners.

Throughout NOAA's SRKW recovery plan regulatory development process, impacts on the region's dynamic maritime community were among the most critical considerations. While taking into account all of the various users of the local maritime resources, one of NOAA's greatest challenges in crafting the regulations involved working toward benefits to killer whales from an increased approach distance while trying to balance any possible negative impacts on continued whale watch opportunities.

As a result of the balance between protecting the SRKWs with the continued socioeconomic stability of the maritime community in the Pacific Northwest, the following vessels were exempted from the vessel regulations:[8]

- government vessels
- cargo vessels transiting in designated shipping lanes
- research vessels
- commercial vessels actively engaged in fishing
- vessels restricted in their ability to maneuver

Coexisting

Upon the 2011 implementation of the ESA vessel regulations designed to protect the SRKWs, initial efforts to

A NOAA Office of Law Enforcement patrol vessel surveys the area. Coast Guard photo by Petty Officer 2nd Class Melissa E. McKenzie

ensure compliance involved a delicate combination of education and enforcement. After more than six years, the NOAA Office of Law Enforcement, USCG, Washington Department of Fish and Wildlife, and their local enforcement partners spend well over 1,000 hours annually monitoring vessel activity in the vicinity of killer whales in the regulated area.

In addition to considerable public outreach and education over the ensuing years, citations have been issued for the most egregious of violations, many of which involved vessels intentionally operating within the 200-yard approach distance and parking in the paths of whales. Washington State regulations have also been modified in recent years to include prohibitions applicable to aircraft and drones, which have resulted in enhanced protection of the whales as well as additional citations being issued. The education and enforcement efforts over the years have proven to significantly enhance vessel behavior around the whales, but there remains room for improvement in order to foster a high level of compliance.

A southern resident killer whale photographed as part of a three-week winter 2015 killer whale research survey off the coast of Washington and Oregon. NOAA Fisheries' Northwest Fisheries Science Center led the survey on NOAA research vessel *Bell.* Photo by Candice Emmons/NOAA Fisheries

Important Findings About Southern Resident Killer Whales

Much has been learned about Puget Sound SRKWs over the more than 10 years of research contributing to the ultimate adoption of the Endangered Species Act Recovery Plan and six-plus years of the regulations being in effect. Some of the most important findings include:

- **SRKWs favor Chinook salmon.** Chinook salmon, also known as king salmon, make up the majority of their diet, especially in the summer when Chinook from Canada's Fraser River are particularly important. Many runs of Chinook are endangered or threatened, potentially limiting the SRKW food source. Ensuring salmon populations are healthy is an important part of recovery.
- **SRKWs are among the most contaminated marine mammals.** They have high levels of pollutants in comparison to other fish-eating killer whales, and levels are particularly high in young whales. Pollutants are a concern because they are known to cause disease and reproduction problems in marine mammals.
- **When vessels are present, SRKWs hunt less, but travel and vocalize more.** This is true for all types of vessels, including kayaks. They also call louder and increase surface behaviors, like breaches and tail slaps, which can be energetically costly.

Although much has been accomplished to protect these animals, many questions remain to be answered that will guide an effective recovery.[9]

In conclusion, vigorous research continues to move forward in order to answer these important questions. Federal, state, and local protected resources managers and enforcement personnel remain steadfast in their vital role supporting protection and recovery efforts. The United States Coast Guard will continue its vigilant dedication, resolute communication, and active operational coordination to promote sustainability, all of which is imperative to the long-term survival and sustainability of the Puget Sound southern resident killer whales.

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Brian Corrigan is the living marine resources specialist in U.S. Coast Guard District Thirteen's Law Enforcement Office. After graduating from the U.S. Coast Guard Academy, he served as a commanding officer, navigation officer, deck watch officer, and boarding officer on three ships before being assigned to District Thirteen in 1998. He lives in Washington with his wife and their two sons. His interest in orca whales dates back to his experience writing a paper about them (in cursive) in the third grade almost four decades ago.

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2. Ibid.
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6. www.westcoast.fisheries.noaa.gov/publications/frn/2011/76fr20870.pdf
7. www.uscg.mil/d13/psvts/docs/userman032503.pdf
8. Additionally, the regulations are not applicable to aircraft.
9. www.nwfsc.noaa.gov/news/features/killer_whale_report/pdfs/summary.pdf

(Plat)Forms That Function

The Rigs to Reef program in the Gulf of Mexico

by LCDR Jason A. Hopkins
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My personal interest in the offshore oil and gas rigs in the Gulf of Mexico (GOM) started when I was stationed in Galveston, Texas, serving as the operations officer aboard the USCGC *Dauntless* from 2007–2009. I remember many nights while navigating the safety fairway off Galveston, thinking, "Wow—why so many lights?"

If you've never had the opportunity to sail in the safety fairway in or around Galveston, you've definitely missed out on an experience! I liken it to flying into Las Vegas at night and seeing nothing but lights. I was amazed at the number of rigs lighting up the night sky!

This incredible but very intimidating sight made me ponder: *What happens to these rigs at the end of their service life?*

It wasn't until my second tour in Galveston, just four years later as a Texas A&M graduate student, that my co-author Mr. Ron Wooten and I would delve into the question I had previously pondered for so many nights. This article will provide information regarding the environmental policies regulating offshore oil and gas rigs, removal techniques, the impact on certain species, personal observations from Mr. Wooten as a NOAA observer from 2008–2010, and the "Rigs to Reef" program requirements.

A platform removal in place will become a new artificial reef in the Gulf of Mexico.
Photo by Ron Wooten

Overview of BSEE and BOEM Responsibilities

Regulations through the Outer Continental Shelf Lands Act (OCSLA) 43 U.S.C. 1331-1356a authorizes the Secretary of the Interior to lease the Outer Continental Shelf (OCS) for mineral development, oil and gas exploration, development, and production operations. The Department of the Interior (DOI) must comply with environmental regulations, including provisions under the National Environmental Policy Act, Endangered Species Act, Marine Mammal Protections Act, and several others.

These regulations require the DOI to provide an assessment detailing to what extent the oil and gas activity would impact the marine environment. Delegated by the DOI, the Bureau of Ocean Energy Management (BOEM) is responsible for managing development of the nation's offshore resources in an environmentally and economically responsible way. The Bureau of Safety and Environmental Enforcement (BSEE) manages the compliance programs which govern the oil, gas, and mineral operations on the Outer Continental Shelf. The BSEE is responsible for conducting onsite inspections to ensure compliance with regulations, lease terms, approved industry plans, and decommissioning operations.[1]

According to the Gulf of Mexico Foundation, the Gulf is bordered by the United States to the north; Florida, Alabama, Mississippi, Louisiana, Texas, and five Mexican states to the west; and the island of Cuba to the southeast. The Gulf region covers about 600,000 square miles, measuring about 1,000 miles from east to west and 500 miles from north to south.[2] The GOM region is home to 2,996 active offshore oil and gas production facilities in federal waters.[3]

Removing Oil and Gas Rigs in the Offshore Environment

U.S. policy 30 CFR 250.1725 states that when offshore oil and gas structures become dry or unprofitable they must

be removed within one year of the termination of the lease or date the well is determined to be dry or unprofitable.[4] "Idle iron" structures—those on active lease sites that have not produced in five years—must also be removed.

OCSLA regulations require the operator to sever bottom-founded objects and their related components at least 15 feet below the mud line before removal. Decommissioning offshore oil and gas rigs attached to the seabed include two main options—mechanical severance, or explosive severance.[5]

The mechanical severance option—the use of abrasive water jets, sand cutters, diamond-wire saws, carbide cutters, shears, and guillotine saws—normally comprises 35 percent of all platform removals in the Gulf of Mexico. The other 65 percent of offshore oil and gas rigs are removed using up to 500 pounds of explosive charges, which is authorized by OSCLA regulations.

Mechanical severance proceeds at a much slower pace, and may include more personnel and human involvement. Due to the additional personnel required, this method could lead to an increased chance of injuries, additional time required, and more equipment than when using the explosive severance option.

That said, the mechanical severance method has a less drastic effect on the marine environment. The explosive severance method uses charges designed to produce enough stress and detonation to sever the oil and gas rig's bottom components completely. An explosive charge is generally deployed from above the water surface inside the pipe-like material in the rig and set at a depth 15–25 feet below the seabed.[6] This method uses fewer people and takes less time—and, therefore, less money—but it also has a more drastic effect on the marine environment.

According to the Bureau of Ocean Energy Management's 2017–2022 Programmatic Environmental Impact Statement, "Marine mammals are adversely affected by noise and disturbances associated with routine offshore activities, like seismic surveys, vessels, aircraft, drilling, and dredging, during relatively brief periods of time. Marine and coastal birds are adversely affected by noise and disturbances associated with routine offshore and onshore activities.

Unavoidable adverse effects on marine benthic communities and associated organisms could occur from anchoring, drilling discharges, structure emplacement and removal, and discharges would result in temporary alteration of the biological, chemical, and physical composition of sediments surrounding activity areas. Coastal and estuarine habitat alteration resulting from coastal and onshore construction activities could result in a loss of wetlands or modification of the habitat, hydrology, and ecological function if not mitigated. Fishes and essential fish habitat could have an adverse effect on the fish in direct proximity to the decommissioning activity."[7]

To Reef, or Not to Reef?

The National Fishing Enhancement Act was passed in 1984 in response to increased interest in recreational activities—fishing and diving—as well as growing environmentalist concern about the effect of oil and gas rig removals on marine life—especially explosive severance removals. "Fishermen, divers, and coastal states have been concerned with the removal of these structures heavily populated with marine life. BSEE began to work with interested parties and coastal states to address these concerns, creating Rigs to Reefs."[8]

The act recognized the benefits of establishing artificial reefs, provided requirements for the reef program, and facilitated development of a National Reef Plan and a reef permitting system.

BSEE's Interim Policy Directive signed on June 1, 2013, states that BSEE can waive the requirement to remove a rig from the seabed if it meets these conditions:

- It becomes a part of the state reef program.
- It complies with environmental and navigation requirements set by the Environmental Protection Agency and the U.S. Coast Guard (USCG).

Type of Cutter	Expense	Mortality	Time	Reliability	Inside/ outside	Problems
Explosives Used 65% of the time	Moderate	High (90–100%)	Low	High	Inside	Misfires, technician error, cut lines and detonation cord, wet det cord, lost charges (bad), require NOAA observers and helicopter surveys
Explosive Shape/Focus charges	Low–Moderate	Moderate	Low–High	Moderate	Outside/ Inside	Require exact placement, diver placement, diver placement in pipes
Diamond Wire	High	Zero	High	Moderate	Outside	Breakdown, pipes must be clear of concrete grout, team and specialized equipment
Hydraulic cutters	High	Zero	High	Moderate	Outside	Breakdown requires excavation. Pipes must be clear of concrete grout, team and specialized equipment
High Pressure sand or water jet cutter	High	Zero	High	Moderate	Inside	Breakdown, clogging, crimped pressure lines, require high compression, moisture in grit, team and specialized equipment
Experimental	High	?	?	?	Both	?

Figure 1: Different methods of offshore platform removals and their benefits. Chart by Ron Wooten

550 pounds of charges were used in staggered detonations for an explosive severance in the High Island leasing block. About 1,000 fish were estimated to have been killed during this blasting sequence. Photo by Ron Wooten

- It receives a permit from the U.S. Army Corp of Engineers.

There are a couple of reasons a Rigs to Reef request may be denied. For example, the oil and gas rig may not be able to meet environmental requirements and standards, or the area may not be conducive for maintaining the artificial reef. With regard to the latter, areas where sea floor mudslides occur and/or areas with a steep grade on the OCS would not allow for maintaining an artificial reef.

As of March 2016, The New York Times reported, "While the so-called rig-to-reef programs in the Gulf of Mexico have existed for decades—more than 400 rigs have been approved for conversion since 1985—the idea of leaving rigs in place as reefs is controversial in California."[9]

According to a 2015 report by Mark Kaiser of Louisiana State University, more than 4,500 structures in the Gulf of Mexico have been decommissioned in water depths of less than 400 feet.[10] Most of these decommissions would've been conducted via the explosive severance method, due to cost savings, but the Rigs to Reef program is an economic alternative that can save the industry millions off their decommissioning costs.[11]

If a company does plan to participate in the Rigs to Reef program, then it must reinvest a portion of its cost savings back into the state's management program. It also seems some rigs aren't eligible for the Rigs to Reef program because of their inability to meet certain environmental standards; that may account for why so many oil and gas rig removals have employed the explosive severance method.

Oil and Gas Rigs: Environmental Benefit and Impacts of Removal

Between 2008 and 2010, co-author Ron Wooten personally observed and collected data for 27 explosive platform removals in the Gulf of Mexico. He also has many observations from his experiences diving before and after a platform removal assessment study conducted between 1993 and 1995.

Experts report that fish kills at oil and gas rig removals vary greatly, but there appears to be an optimum depth for large numbers of fish, especially red snapper *(Lutjanus campechanus).* Shallow water removals, especially those of less than 30 feet, tend to have very small fish kills with even smaller numbers of red snapper killed. Numbers of red snapper killed, as seen from the red on the surface of the water post-blast, increase as the depth increases, with the optimum depth seeming to be between 100 and 250 feet.[12]

From 1989–1998, National Oceanic and Atmospheric Administration (NOAA) divers conducted a fish kill study at several removal operations throughout the Gulf of Mexico. Divers recovered 100 percent of the surface fish killed, with initial findings suggesting that for every fish on the surface, there were two dead on the bottom.[13] The resulting fish kill on the bottom normally wasn't collected due to being partial remains.

Based on aerial approximations, the average number of red snapper killed per platform removal employing explosives was 515 fish, mostly red snapper. There were 121 total removals by explosives in 2008. Using the 2:1 relationship from the initial results of Gitschlagg's study,[14] the approximate total number of red snapper killed in 2008 due to platform removals was 124,630 fish. The average weight of commercially taken red snapper is about 5 pounds/snapper,[15] yielding a total loss of 623,150 pounds of red snapper.

Turtles and Explosive Removal

Due to a significantly high number of stranded sea turtles seen in 1986 following a heavy period of offshore blasting, the National Marine Fisheries Service conducted an explosives impact study on sea turtles at removal sites. The results of this study implicated offshore explosives used at platform removal sites as the probable cause of the mortality event.

The Platform Observer Program (POP) was created to provide trained observers to watch for sea turtles and marine mammals around removal sites as a mitigating action to allow the oil and gas companies to continue explosively removing platforms. The POP is an activity opening the door to relief for the Gulf of Mexico oil and gas industry to offset incidental harm to sea turtles and/or marine mammals.

The National Marine Fisheries Service has been required to provide trained observers to monitor for sea turtles and marine mammals at every structural removal using more than 10 pounds of explosives in federal waters since that opinion was issued. In an analysis of observer data from 1992, 6,500 hours of monitoring, both at the surface and from helicopters, identified 18 individual turtles in 45 distinct sightings during 106 structure removal operations.[16]

In contrast, from 2008 to 2010, Mr. Wooten's personal observations at 27 platform removals offered 104 sightings of more than 50 different individual turtles—10 times the number of sightings per removal from the National Marine Fisheries Service.[17]

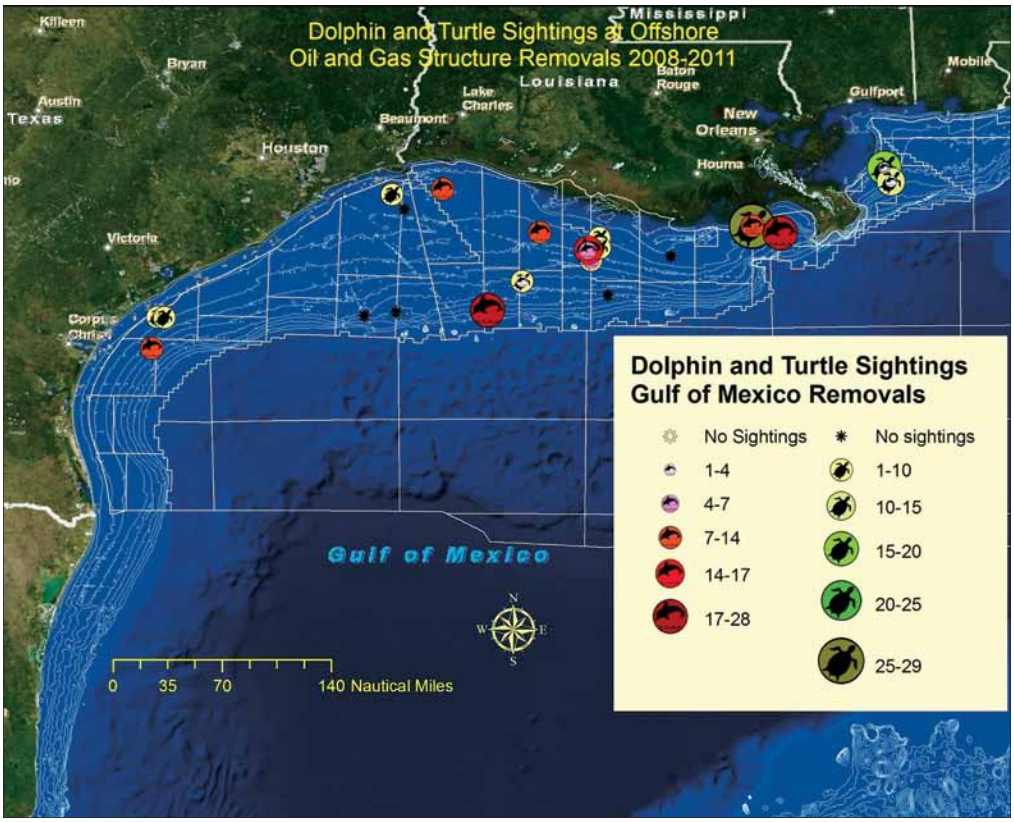
Anecdotal observations during a majority of flights to and from offshore work sites noted sea turtle sightings, with at least one or two turtles seen swimming at the surface on most trips. In 2010, within a period of four weeks, three loggerhead sea turtles at three different removal sites were adversely affected during explosive removals. Observers had conducted the required 1-hour surface surveys and had completed the 30-minute pre-blast aerial survey. At each site, turtles floated to the surface within 20 minutes of blasting. Two of the turtles were dead, while the third suffered a cracked shell. Fortunately, no other turtles were harmed during 2010, but the two deaths equaled the total/only number of turtle fatalities between 1987 and 2008, a period of more than 20 years.

While no truly accurate census data exists by which any comparisons can be made, incidences of live turtle sightings on offshore removals have increased substantially, especially when comparing Gitschlagg's 1994 findings with data from Mr. Wooten's 2008–2010 subset.

Dolphins and Explosive Removals

Both the bottlenose dolphin, *Tursiops truncates,* and the Atlantic spotted dolphin, *Stenella frontalis,* regularly use oil and gas structures as feeding grounds. There are 19 species of whale found in the Gulf of Mexico, along with a variety of pelagic dolphin. Many of these cetaceans

"Pelto" the loggerhead turtle surfaces near a metal ladder leading to a landing platform at the Pelto 19 leasing block. Photo by Ron Wooten



Dolphin and turtle sightings at offshore explosive removals, 2008–2011. NOAA/NMFS Trip Reports for Ron Wooten

feed just off the continental rise near the mouths of the major rivers emptying into the Gulf.

Of the whale species, sperm whales (*Macrocephalus physeter*) run the highest risk of impact from oil and gas operations in deep water. During the three years of data, multiple sightings of dolphins occurred during blasting operations. According to the observer procedures, the helicopters stayed with the dolphins until they either left or appeared to be headed into the impact zone, at which point the pre-blast aerial survey would be aborted and a 30-minute waiting period delay was imposed.

Generally speaking, dolphins were much better about heading away from the platforms, but, just like the turtles, their presence could cause extensive delays. Unfortunately, the occasional dolphin has been known to "slip under the radar." In one instance captured on video by a commercial diver, a bottlenose dolphin was seen 20 yards from the structure just seconds prior to detonation. No one communicated the presence of this dolphin—one of the abundant human errors in this work—and observers were flying half a mile away. Non-lethal injuries are well documented in dolphins coming into range of blast impact zones,[18] but this dolphin's presence within 100 feet of the blast radius almost certainly resulted in a fatality.

Experts have calculated the total volume of the underwater portion of existing platforms as about 127,712,369 m^3.[19] There is an estimated 4,465 acres of reef habitat in the Gulf in the form of oil and gas platforms.[20] To replace the habitat lost during blasting and subsequent removals with an equivalent area of artificial reefs would cost in excess of $17.9 billion dollars.[21]

According to a 2010 CNN Money article, the four largest industries in the Gulf of Mexico are oil, tourism, fishing, and shipping, accounting for about $234 billion in economic activity each year.[22] Offshore platforms have obvious conservation benefits, generating $324 million annually and serving as recreational fishing and scuba diving structures.[23] There may be other uses for these platforms, such as serving as test sites for renewable energy production incorporating wind, currents, waves, geothermal energy, or biofuels; and they can serve as greenhouse gas sequestration stations.[24] Research indicates that properly managed artificial reefs have the potential to create 27,000 jobs for coastal residents, as well.

The research used in these job creation figures factor in industry like aquaculture, fish farms, and other non-recreational uses.[25] Coral reefs are being damaged and degraded by human interaction, including industrial activities like fishing, marine resource exploration and exploitation, and environmental factors like pollution, invasive species, and climate change.[26]

"Oil and gas platforms along the northwestern Gulf of Mexico (GOM) shelf have served as artificial reefs since oil and gas exploration intensified in the 1950s. During the fall of 2012, remotely operated vehicles were used to survey and compare fish communities between artificial reefs and adjacent natural banks in the western Gulf. Surveys suggested that fish communities at artificial reefs were distinct from those at natural banks. Many fisheries species, like the red snapper, were found in both habitat types, with density at artificial reefs estimated to be nearly eight times greater than at natural banks."[27]

Conclusion

Although legislation, regulations, and industry practices related to offshore oil and gas rigs have a potential negative environmental impact on marine life, we do believe

the Rigs to Reef program provides socioeconomic benefits to the region. BOEM and BSEE need to ensure that future lessees in the OCS develop strategies during the initial planning stages that include future decommissioning as participation in the Rigs to Reef program.

Platform removals have a demonstrated economic and marine life impact, and—although debated—it seems the Rigs to Reef program may provide sustainability by leaving the offshore oil and gas platforms in the marine environment. With the demise of coral reefs around the world due to human interactions, the Rigs to Reef program can serve as a positive example that can be duplicated in places where offshore oil and gas leasing areas exist.

A 1989–1998 NOAA study found that for each fish found dead on the surface of the water after explosive detonations, there were two dead on the seabed. Photo by Ron Wooten

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Editors Note: This article (and the graphics included) is an update of a graduate school project completed by the authors. It is not a reflection of their views in their current professional positions or of their respective organizations. These are strictly personal observations and personal opinions based on the authors' experiences.

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Saving the Islands

The USCG's role in rescuing the Marshall Islands

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Tony deBrum, foreign minister of the Marshall Islands, died on August 22, 2017. During his life, he brought the sustainability of the Marshall Islands into the international political arena.

In an era when countries are fiercely grabbing for control over ambiguous islands in the Pacific in order to claim a 200-nautical-mile exclusive economic zone and expand their access to marine resources, the Marshall Islands are instead at risk of drowning. Rising sea levels and residual radiation put these islands in a precarious situation, and the United States and other developed nations are in a position to help them stay above water.

The Aftermath of Nuclear Testing

The Marshall Islands, including the adjacent waters of the Pacific Ocean, are nearly three times the size of Texas. If you remove the area covered by water, the total of all of the islands' land would be about the size of Washington, D.C.[1]

Airman Second Class Paul A. Stiehl, Jr.,[2] was stationed on one of these tiny islands, Eniwetak Atoll, as a weatherman from February 1953 to February 1954. Though he wasn't on the island during Operation Ivy Mike, the blast on Eniwetak from the associated nuclear weapon test occurred just three months prior to his arrival. A month after his departure, a hydrogen bomb was dropped on the adjacent Bikini Atoll during Operation Castle Bravo.[3]

Stiehl remembers a quiet unit with an important mission: Maintain accurate weather calculations so the tests could be conducted as planned. These tests were an outward display of military prowess during the height of the Cold War. The United States claimed the atoll safe for resettlement by civilians in 1970, but people had to be removed again in 1978 when high levels of radiation were detected among those brave enough to return to their former homes.

While under U.S. protection, the water around the Marshall Islands began to show evidence of long-standing nuclear contaminants. The United Nations described the environmental impacts of the 67 nuclear tests that occurred near the Marshall Islands as "near-irreversible environmental contamination."[4] At the time, it seemed logical to some that conducting nuclear testing on a small remote island nation would isolate and minimize environmental impact—especially during a time when the ocean was viewed as a giant solvent. However, as a result of these tests, Plutonium-239 blanketed the ocean in a volume more than 7,000 times the scale of Hiroshima.

At the Hanford Plutonium Uranium Extraction Facility in Washington, where nuclear material from the original Manhattan Project remains, contaminated rail cars were stored in underground tunnels made of wood and concrete and covered with 8 feet of soil. On May 9, 2017, a 20-foot-long section of the tunnel collapsed, raising concern about how the United States disposes of its radioactive material. The cleanup cost for this facility could reach $113 billion.[5] By comparison, the United States spent $604 million dollars to mitigate impacts from nuclear testing on the Marshall Islands.[6] While the Washington area is considered more contaminated than the Marshall Islands, additional cleanup of the contaminated atolls of the islands would likely exceed the small nation's capacity to clean.

Aftermath: Day-to-Day Life and Livelihood

Today, perhaps in deference to impacts from prior nuclear testing, Marshallese people can live and work legally in the United States under a Compact of Free Association.[7] In addition, locals are dependent on supplemental food program funding from the U.S. Department of Agriculture in the form of "processed foods such as Spam, flour, and canned goods."[8] This reduces the likelihood of contaminate transfer, since the food is generally prepared indoors.[9] However, residents have at least one source of food that is still exposed to potential contaminates—the sea. The sea continues to provide a bounty of tuna that is in high demand in the international market.

Those who've lost hope in their home's future due to contamination or constant flooding can join the 10,000 Marshallese accounting for 10 percent of the islands' population who have already moved to the United States.[10]

U.S. Call to Action

Since the U.S. is responsible for the contamination plaguing the sea around the Marshall Islands, it is only fitting that the U.S. continues to provide aid to find an appropriate solution. The Department of Energy and U.S. Coast Guard should partner to ensure that the fish harvested in the expansive waters around these islands are tested for nuclear contaminants. This action would help to ensure that the residents' primary source of protein—and their number one export—is safe for long-term consumption. While monitoring on a large scale will be difficult, samples should be taken periodically from the areas where subsistence fishing is most common.

LTJG Thomas Bondurant, a boarding officer from USCGC *Sequoia,* prepares to board a fishing vessel in the Pacific Ocean. The *Sequoia* crew was participating in a 30-day deployment to promote regulatory compliance of the $7 billion tuna fishing industry in remote areas within Oceania in 2016. Coast Guard photo

Even without nuclear contaminates threatening the health of marine life, the future of Marshall Islands' residents is dependent on the nation's ability to manage its own resources. Most of the fisheries in the area are subsistence fisheries, where people fish to put food on their own plates. Generally, subsistence fishing is conducted with small skiffs, using handlines. While they may cover impressive distances, fishermen are range-limited, have the ability to be highly selective about the species they target and retain, and contend with physical constraints on the amount of fish they can harvest and transport during one voyage. Accordingly, this subsistence fishing does not put nearly as much pressure on the environment as foreign commercial efforts, but if

A USCGC *Sequoia* boarding team aboard a cutter boat-small approaches a fishing vessel in the Pacific Ocean. In 2016, the *Sequoia's* crew and embarked maritime law enforcement officers from the Republic of the Marshall Islands and Australian Fisheries Management Authority conducted seven boardings during a 30-day law enforcement and fisheries patrol in the Pacific. Coast Guard photo

not managed, key reefs could be damaged and fish populations could be adversely impacted if they are caught before they spawn.

Most of these fishermen are traditionally educated on sustainable fishing practices. However, managing the political powers of a regional fisheries management organization poses a different challenge. As a partner in the Western and Central Pacific Fishery Commission, the South Pacific Tuna Treaty, and the South Pacific Regional Environmental Program Regional Fisheries Management organizations, the United States has an interest in lower tropic fish population levels around the Marshall Islands. These populations fuel the more lucrative, commercially exploited highly migratory species in the area, like bigeye and yellowfin tuna.

Crew members from Coast Guard Sector Honolulu stand with port state control officers from the Republic of the Marshall Islands following a 2014 examination aboard the Marshall Islands-flagged tank vessel, ***Spottail.*** Coast Guard photo

Partnerships Call to Action

The Peace Corps, National Oceanic and Atmospheric Administration, and Coast Guard should partner with local fisheries managers to help them inform sustainable and enforceable fisheries regulations and aid local law enforcement with developing enforcement strategies, tactics, and capabilities. Coast Guard units are already solidifying a positive relationship with the Marshall Islands through robust search and rescue governance support, patrols, and even law enforcement courses.

While it may seem controversial, similar nutritional education programs have been established with great success for the Torres Strait Islander communities, helping to mitigate food scarcity.[11] Many of the U.S. comprehensive management plans have specific catch limits on species from cod to red snapper and everything in between. For the Pacific Islands, fisheries management schemes need to be specific enough to address the two primary facets of fisheries activities—subsistence and commercial.

In areas where subsistence fishing is essential to the survival of communities existing in remote outposts and the stability of the nation to which they belong, micro-protected areas—small-scale equivalents to the Phoenix Islands Protected Area—should be reserved for use by local populations for subsistence fishing. In addition, adjacent areas should be set aside for fish spawning and habitat protection to relieve fishing pressure.

While improper subsistence fishing tactics could threaten the reefs in the Marshall Islands, poor monitoring of foreign fishing is one of the biggest threats to offshore fish stocks. The Coast Guard does not have the resources, mandate, or mission to monitor the 2 million square kilometers of ocean that belongs to the Marshall Islands.[12] However, thanks to advances in vessel monitoring systems (VMS), many fishing vessels have been outfitted with devices that allow monitoring from afar, provided that flag states enforce violations of regional fisheries management organization requirements, including VMS usage on fishing vessels, through port state control measures. In addition, infrequent but random overflights help identify vessels not transmitting on the required electronic monitoring systems and act as a deterrent of illegal, unreported, and unregulated (IUU) fishing by vessels. For example, the Marshall Islands-flagged vessel *Koo's 108*, which is owned by a Taiwanese fishing company based in the Marshall Islands, was detected while tuna fishing in a protected area and subsequently fined $4 million USD.[13]

Regulatory Support and Enforcement

While the sea is the number one local food source for residents of the Marshall Islands, it is also a major worry. Sea level rise threatens these islands, where the highest elevation is already less than 10 meters above sea level.[14] To face fears of global warming and melting ice caps, community heroes venture out of their native comfort zone and into the international political arena to plead for help, like Tony deBrum did. They also seek innovative ways to address existential threats.

As the third-largest vessel flag registry in the world, the Marshall Islands has the ability to regulate a significant amount of global shipping, which counts for 3 percent of the world's emission standards—and is expected to rise to as much as 14 percent.[15] Innovative solutions,

such as requiring hybrid power setups that offer lower environmental impact than the standard engine solutions and a lower annual fuel bill, are being explored.[16]

However, the adoption of such a requirement would inevitably send a mass of vessels running to flag states with lower standards, depriving the Marshall Islands of their already miniscule gross domestic product. With international support, unilateral regulations on shipping emission standards would improve shipping efficiency and reduce negative environmental impact from vessel emissions worldwide.

With the life expectancy of a ship averaging 25 to 30 years,[17] in just over one generation the world's shipping industry could be transformed into a low emissions fleet. The Coast Guard's role in this endeavor would be to promote international agreement at the U.N. as the head of the U.S. delegation to the International Maritime Organization. It also must ensure compliance with international emissions regulations once these measures are implemented and enact port state control measures on vessels that fail to meet the minimum emissions standards.

Few rescues are ever accomplished easily. Bold steps are required in the face of adversity. Saving an island will be even more difficult. However, the Marshall Islanders are calling out to the international political arena for help.[18] As the party responsible for much of the nuclear contamination to the Marshall Islands, the United States has an ethical obligation to answer that call. Once the United States accepts this charge, the Coast Guard must be ready to leverage its law enforcement expertise and radiological detection capabilities to save the Marshall Islands, its culture, and its future.

Petty Officer 1st Class Jeremy Langley teaches a Marshallese child how to swim during a Pacific Partnership 2013 basic sea survival course. Pacific Partnership is an annual mission that brings host-nation governments, the U.S. military, partner-nation militaries, and nongovernmental organization volunteers together to conduct disaster preparedness projects and build relationships in the Indo-Asia-Pacific region to allow for better crisis response. U.S. Navy photo by Petty Officer 2nd Class Laurie Dexter

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LT Tanner Stiehl has served in the U.S. Coast Guard for six years, with an operational background in the prevention field. He recently graduated from the University of Florida with a master's degree in fisheries and aquatic sciences with a concentration in natural resource policy.

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From Oral Histories to Fishing Regulations

Defining the importance of the Marianas National Monument to indigenous fishers

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Designating an area of the sea as a national monument with the intent of protecting it, and the ecosystem within it, for future generations to enjoy may seem fairly simple. Resource managers and policy experts, however, understand the complexity of managing that area for use by commercial fishermen and recreational anglers.

All of these things have been done in the waters near the coasts of the continental United States, including California's Channel Islands National Marine Sanctuary and Massachusetts' Stellwagen Bank National Marine Sanctuary.

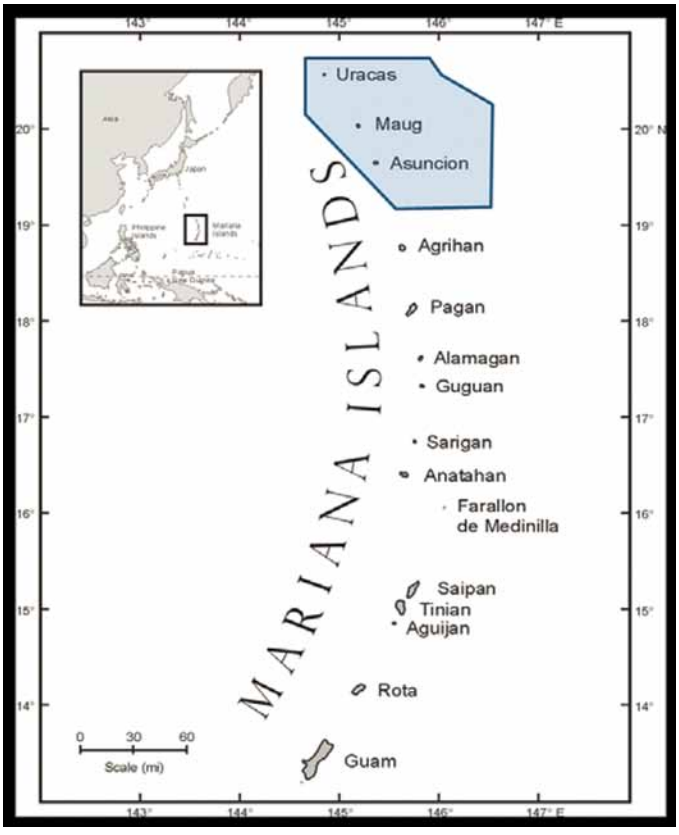

Figure 1: Mariana Islands map with approximate Islands Unit waters denoted. Adapted from Allen and Amesbury 2011, credited to Barry Smith

The task becomes significantly more difficult when it is attempted in the remote reaches of the Pacific Ocean, in places that are difficult to monitor, and where little is known about the fishing activities of people who make their living offshore there.

Traditional indigenous fishing is an activity—alongside commercial and recreational fishing—permitted and regulated within marine national monuments. Unfortunately, within the regulations used to govern these areas, the specific activities covered by "traditional indigenous fishing" had not previously been well-defined, making management of the activity difficult.

On January 16, 2009, Presidential Proclamation 8335 established the Marianas Trench Marine National Monument, which consists of three units—the trench, volcanic, and islands units. The trench and volcanic units include only the submerged lands within these areas. The islands unit consists of the submerged lands and waters to 50 nautical miles surrounding the three northernmost islands of the Mariana Island chain—Uracas (also known as Farallon de Pajaros), Maug, and Asuncion (Figure 1).

Proclamation 8335 authorized the secretary of Commerce, acting through the National Oceanic and Atmospheric Administration and in consultation with the secretary of the Interior, to manage fisheries and fishery-related activities in the monument, which pertains only to the waters of the islands unit. Further provisions in the proclamation prohibited commercial fishing and provided "the Secretary … shall ensure that sustenance, recreational, and traditional indigenous fishing shall be managed as a sustainable activity consistent with other applicable law."

Although commercial, sustenance, and recreational fishing have clear legal definitions and precedent, "traditional indigenous fishing" is a type of non-commercial fishing with no precedent to determine specific definition.

Two of these boats have made the trek to fish in the waters of the Islands Unit (second from left and far right). Photo by Brian Gionfriddo

In an effort to create regulations appropriate to support non-commercial fishing in the waters of the islands unit, the Western Pacific Regional Fishery Management Council requested research be conducted to provide scientific basis for these regulations. The council is a regional fisheries management organization that writes regulations for the fisheries managed by the United States in the waters surrounding Hawaii, American Samoa, Guam, and the Commonwealth of the Northern Mariana Islands (CNMI). Social science researchers sought to document past and contemporary types of trips to the waters of the islands unit by residents of CNMI and Guam. They worked to describe the residents' experiences as well as the historical and cultural connections to the three northernmost Mariana Islands and their surrounding waters, which is now part of the islands unit.

Trips to the Northern Mariana Islands

During two visits to Guam and Saipan in November and December 2011, the researchers reviewed historical records of trips and interviewed 40 residents of CNMI and Guam who lived on the northernmost islands and/or who had traveled to these waters. Although Saipan is about 300 miles away from the waters of the islands unit, and Guam is even further, this research confirmed that residents of these areas traveled there at least 129 times. The information gathered focused on experiences from living memory as a means of supplementing trip and catch records. People contributing their perspectives included boat owners, captains, fishermen, government officials, scientific researchers, and former residents of the island of Asuncion.

The primary purpose of these trips varied from commercial fishing to scientific research, but fishing occurred on 98 percent of these trips. Returning with fish for family

Petty Officer 3rd Class Dylan Hall, a boatswain's mate stationed aboard USCGC *Sequoia*, explains the proper use of a skiff hook to personnel from the Commonwealth of the Northern Mariana Islands Department of Fire and Emergency Medical Services and the Division of Fish and Wildlife in November 2015. Coast Guard photo by Ensign Peter Driscoll

and friends was an important contribution to food security and to maintaining ties to the northern islands of the Mariana Islands. Later trips to the area were rare—averaging 3.8 trips per year from 1979–2010— but important events, providing residents of CNMI and Guam with a sense of connection to these distant islands where indigenous Chamorro and Carolinians fished and lived in the past.

Four commercial fishing operations were identified to have fished in the islands unit, though only two were still in operation and could potentially continue trips at the time of the research. Participants described "commercial" fishing operations in the islands unit waters as not strictly for financial profit, but to ease local fishing pressure and to fish different species from those in the local area, bringing back the catch to residents of Saipan and Guam.

One boat owner/captain noted that he used his large boats to go "fishing up north because [he] was leaving the closest islands for those people that have the small boats."[1]

Based on these interviews, residents' understanding of "commercial" fishing did not align with that defined in the United States governing legislation for fisheries—the Magnuson-Stevens Fisheries Conservation and Management Act. Many people described "commercial" fishing as non-locally based boats, especially those using longline, purse seine, and factory trawl methods to catch fish. This type of fishing was often juxtaposed with the fish-catching practices of local fishermen, who used trolling, rod and reel, and spear guns to sell to island buyers and residents, contributing food locally.

The Importance of Supporting Access to Distant Waters

Many interviewees indicated strong cultural connections to the northernmost Mariana Islands and their waters. Most of the fishermen who fished on trips to the islands unit had family members who had lived on the northern islands of the chain, and they valued fishing there as a way to connect to their familial history.

Fishing the Northern Marianas

Regular fishing trips to the northern waters of the Mariana Islands serve many purposes for the indigenous people of the Pacific island chain, including:

- commercial fishing trips
- maintaining strong historical connections to the northernmost islands
- providing local residents with fish from the northern waters to support food security
- establishing continued access to the distant and well-preserved northern marine ecosystem

While traveling to these waters has served many practical purposes, the place also holds historical and cultural significance for CNMI and Guam residents. In September 1986, 13 fishermen were lost at sea during a trip to the islands unit when the M/V *Olwol* capsized in rough seas caused by a nearby typhoon. Although there was an extensive rescue effort, the only thing found was part of the vessel that had washed up on the island of Maug.

Many people interviewed believed that the fishermen had headed into the inner part of Maug to take cover from the storm, as one fisherman relayed, "'Cause in our minds if there is a typhoon come you can always be safe inside the Maug, that's what we learned from our parents and great-grandparents."[2] An event that touched many people in Saipan, it is memorialized every year.

A researcher/photographer uses aerial photographs to tell of his experience. Photo by Brian Gionfriddo

People associate Maug with the place that houses the souls of the lost fishermen.

Offsetting the costs of the fishing trips to the islands unit waters, which require significant investments in fuel and ice, is another important reason for residential fishermen to sell their catch.

Finally, all accounts from fishermen included descriptions of sharing fish from trips to the islands unit waters with family, friends, and other residents. When one boat owner was asked about how he shared his catch from the islands unit waters, he responded, "Like anybody … when the boat comes in, there are some people that come to the dock. So I just tell them to grab some sheet to wrap [a fish]."[3] The sharing of fish sometimes included monetary exchange, but not at market value. For example, for fiestas, fishermen might provide four large fish, but only be paid for two.

An interviewee shares his early memories living on the island of Asuncion. Photo by Brian Gionfriddo

The interviewees placed a high value on continued access to these distant waters with some type of preservation restrictions. One government official noted the area is "something that we have to conserve for the future. I mean it is like paradise … we don't want it to look like the Caribbean … when they start buying islands and then there's nothing for the future generations."[4] A fisherman noted that he wants his children to be able to see the things he's seen in the northern islands.[5] Another interviewee said he wanted to make sure the indigenous people of the CNMI continue to have access to this area "… and experience fishing up there."[6]

Creating Regulations for Traditional Indigenous Fisheries

At the request of the Western Pacific Regional Fishery Management Council, social science researchers documented CNMI and Guam residents' past and present trips to the islands unit waters. In doing so, they delved deeper into the culture and motives of people who participated in these trips.

In some cases what they discovered was that legally recognized concepts and definitions actually meant different things to the local resource users. Labeling an activity as "commercial fishing," for example, might mean one thing to a resource manager and something completely different to a local fisherman.

Overall, researchers found that the specific reasons for fishing on these trips to the territory within Marianas Trench Marine National Monument varied considerably. The oral histories collected as part of this project helped define the cultural and food security values placed on those waters for the people living in the CNMI and Guam.

Ultimately, in a rare example of social science being directly connected to policy implementation, the researchers' work was cited in the regulations promulgated by the National Marine Fisheries Service and NOAA on June 13, 2013,[7] to manage "traditional indigenous fishing." CNMI and Guam residents were allowed to continue fishing the waters in the area, with restrictions to ensure that the fish were used for food and not commercial benefit.

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Endnotes:

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Under the Ice

Protecting and managing untouched stocks in the central Arctic Ocean

by LT Jessica Conway
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The Arctic is one of the least understood environments in the world. It is remote, with changing ice cover, hostile weather, and rough sea conditions. Even so, Viking settlers and European merchants seeking more direct sea routes have been fascinated by the mysterious Arctic for centuries.

In the mid-1880s, the U.S. Revenue Cutter *Bear* began her career with the rescue of the survivors of the Greely Arctic expedition.[1] Since then, exploratory Arctic voyages for both shipping and scientific research have only increased. Today we have ever-growing technologies that allow us to investigate and operate in the unforgiving Arctic. However, there is much still to be learned.

A Changing Arctic

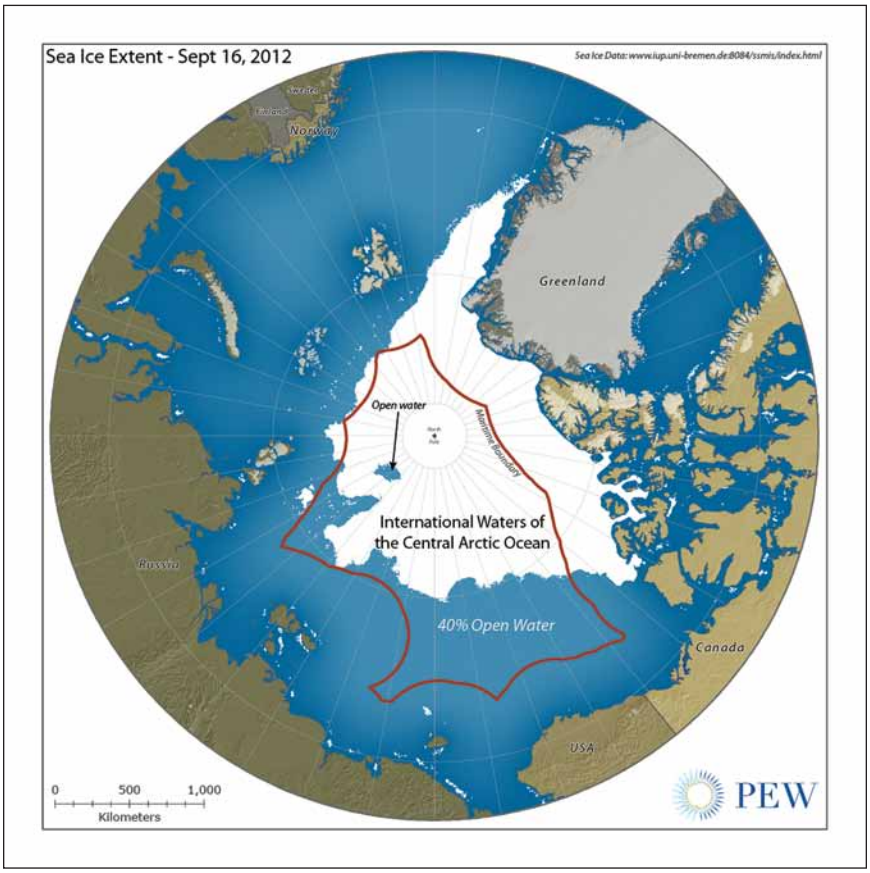
The high seas portion of the central Arctic Ocean was at one point completely ice-covered. Today the arctic sea ice fluctuates yearly, with a maximum extent in March and a minimum amount in September. These seasonal changes can be substantial; the average yearly change during the

A polar bear seen off USCGC *Healy's* stern while underway in the Arctic Ocean in support of its Geotraces mission in August 2015. Geotraces, an international effort to study the distribution of trace elements in the world's oceans, was *Healy's* second science mission of that summer. Coast Guard photo by Petty Officer Cory J. Mendenhall

study years 1979 through 2000 was about 9 million square kilometers, a change of more than 50 percent of the total area.[2]

However, due to warming temperatures and natural variability, the melting season has lengthened and winter ice recoveries have been weak. Ice reflects the sun's rays, while the darker ocean absorbs them. Since the sea surface has been experiencing more direct sunlight, Arctic Ocean temperatures have been increasing. These increasing temperatures delay ice formation in the colder months, meaning that as the average ice content of the Arctic decreases, the rate of decrease will speed up.[3] During the warmest period, about 40 percent of the Arctic Ocean is now ice-free and open to maritime navigation.[4] Many scientists speculate that the entirety of the Arctic Ocean could be clear of summer ice within 20–50 years.[5]

Not all changes in the Arctic have been on the surface. Temperatures in the water column have increased as well, with the top layer increasing at a rate of approximately 0.9 degrees per decade.[6] This leads to speculation that species of fish currently found further south in sub-Arctic regions could migrate farther north to remain in cooler water.



Pew Charitable Trusts graphic

With less ice blocking potential marine transit routes, there will likely be an increase in human activity in the Arctic. Shipping companies will transit available passages; oil and gas businesses will desire to make use of the resources beneath the continental shelves; and fishermen, known for their culture of independence and risk-taking, will venture into the newly open ocean. While there are currently no commercial fisheries in the high seas portion of the central Arctic Ocean, future changes in fish stock migration and advances in technology could motivate fishermen to venture into the northern reaches of the Arctic in search of plentiful fishing grounds.

First Steps: Fishing Moratorium

Since July 2015, the five coastal states surrounding the Arctic Ocean—Canada, Norway, Russia, Denmark in respect of Greenland, and the United States—have been part of a non-legally binding agreement concerning fishing in the high seas portion of the central Arctic Ocean. The agreement places a moratorium on fishing until there is an effective management scheme in place to conserve the stocks.[7] For now, this moratorium is a good precautionary measure and has broad international support. It is pre-emptive, since no commercial fishing has begun, and the agreement highlights the potential importance of Arctic resources to the surrounding states and wider world of fishing nations.

While the cooperation among coastal states to establish this moratorium is positive, interest in the area in question—the high seas outside of the exclusive economic zone (EEZ)—extends well beyond that, to all nations. Any country would be able to access this patch of ocean, and many other nations that do not border the Arctic Ocean have the capacity and incentive to send fishing fleets. Numerous European countries lie in relatively close proximity to the Arctic high seas. Countries like China, Korea, and Japan, while much farther away, have large fishing fleets, depleted stocks in their own EEZs, and a high internal demand for fish. A broader moratorium to include non-coastal states must be considered.

Currently the five states with EEZs bordering the Arctic high seas, along with five other interested parties—China, the European Union, Iceland, Japan, and the Republic of Korea—are developing a binding agreement to prevent unregulated fishing within the high seas portion of the central Arctic Ocean.[8] The last meeting took place in November 2017.

Though as of press time the agreement had not yet been signed or ratified, all 10 parties agreed to ban fishing in the central Arctic Ocean for at least 16 years. After that time, the agreement can be extended for periods of

five years until any of the parties object to continuation. Not only will the area be closed to fishing, but the parties will cooperate on a joint program of scientific research and monitoring. The goal is to have all 10 nations with an interest in the Arctic in agreement on the need to prohibit fishing prior to moving forward with a large-scale management scheme.

Next Steps: Scientific Research

Though there have been exploratory voyages to the far reaches of the Arctic for centuries, there are still broad gaps in current marine ecosystem research and a lack of comprehensive data for the area. Yearly sea ice variability has been meticulously studied for only the last half-century. Nautical charts are being developed for the Arctic, but soundings have only been recorded for a small percentage of the sea floor, mainly in shipping lanes.[9] Information on the species of fish endemic to the area and overall Arctic ecosystems is even scarcer. Since much of the high seas portion of the Arctic has been reliably ice-covered, the opportunity to discover what lies beneath the ice has only recently become realistic.

Many fish species in the world's oceans are found on continental shelves, and it is likely similar in the Arctic. However, scientists are unsure if there are any commercially viable stocks in the Arctic at present. Only three species have been sampled that have potential commercial interest if abundance is high enough—Arctic cod, Polar cod, and Greenland halibut.[10]

Even so, the lack of known stocks is subject to change. With more sunlight reaching the ocean surface, there is an increase in phytoplankton production, which is the base of the food chain for fish and marine mammals.[11] This, when combined with ocean temperature, pH variations, and other factors, could lure or drive species north, shifting or extending their range. Even so, certain parameters must be met for new stocks to flourish:[12]

- water temperatures within a certain range
- available food sources
- suitable bottom topography for benthic species
- access to spawning grounds

Without management based on solid research, the exploitation of fisheries often leads to excessive harvests and catastrophic impacts to the surrounding ecosystem. In 2015, when the five coastal states agreed to the non-legally binding moratorium on fishing in the Arctic, a joint program of scientific research was established.[13] This program has thus far determined that there is a need to establish baseline data on the central Arctic Ocean, given the current lack of scientific knowledge. Questions the program aims to answer include what the current species distribution is as well as what changes are likely to occur in the next 10 to 30 years.[14]

Though more research is being conducted, full pan-Arctic coordination has not yet been established. With more coordination, more research can be shared among scientists and organizations, which will speed up the overall understanding of the ecosystem. Ultimately, the role of science is to provide a baseline from which to establish an accurate management plan.

Final Steps: Development of an Enforcement and Management Regime

We have a unique opportunity to develop and implement a management plan for an area prior to the start of commercial fishing. Virtually every other fisheries management plan in the world has stemmed from the need to rebuild already overfished stocks. Since there has not yet been any historical commercial-scale fishing in these waters, any stocks that exist are not yet overfished. By pre-emptively establishing a moratorium on fishing, conducting extensive scientific research, and—the final step—creating an ecosystem-based management strategy, the high seas portion of the central Arctic Ocean could become a sustainable source of protein for a hungry world.

While protecting a vast section of ocean is a positive gesture towards conservation, it is somewhat superficial without a means to enforce regulations. Though more and more marine protected areas have been established in the past decade, they often fail to achieve their conservation goals due to illegal harvesting, inadequate regulations, or excessive and unenforceable size.[15] There is real potential for an area to become a "paper park," which can

Morgan Busby, a research fisheries biologist with the National Oceanic and Atmospheric Administration, examines plankton taken from an Arctic sample collected while aboard USCGC *Healy* during September 2017 research operations. Coast Guard photo by Petty Officer 3rd Class Amanda Norcross

USCGC *Healy,* a medium icebreaker, sits in the Chukchi Sea off the coast of Alaska during an Arctic deployment in support of scientific research and polar operations in July 2017. The Coast Guard's leadership role in providing a continued Arctic presence is essential to national security, maritime domain awareness, freedom of navigation, U.S. sovereign interests, and scientific research. Coast Guard photo by Petty Officer Meredith Manning

cause a false sense of security for the resources within.[16] Adequate enforcement—achieved by financial investment, regional cooperation, and accurate management plans based on scientific research—is essential to the success of any marine protected area.[17]

Most of the world's oceans are protected by regional fishery management organizations (RFMO). These organizations protect certain species as well as specific areas of ocean. They are established through international agreements by states with a fisheries interest in the RFMO area. Each RFMO is structured slightly differently with regard to the species they manage and how decisions are made; however, all have a scientific committee and measures to promote compliance with determined catch levels.[18]

Though there is not yet an RFMO established in the high seas portion of the Arctic Ocean, individual nations do have management plans in place closer to shore, within their own EEZs. In 2009, the North Pacific Fishery Management Council and National Oceanic and Atmospheric Administration Fisheries implemented a new fishery management plan for resources in the Arctic Management Area.[19]

Of course, fish do not stop swimming at an invisible line. Effective ecosystem-based management would succeed best by considering the Arctic as a whole. Where stocks straddle two countries' EEZs, such as between Norway and Russia, bilateral agreements already exist.[20]

Though most nations already protect fish stocks in their own EEZs, there is no comprehensive management plan in place for the high seas portion of the central Arctic Ocean. Many of these stocks migrate, so species that are found in protected EEZs may also swim into the high seas portion and have the potential to be caught without the protections of EEZ regulations. A larger-scale RFMO is needed for the central Arctic Ocean if legal sustainable fishing is to occur in the future. At a minimum, all five of the coastal states would need to participate for it to be effective, and a joint enforcement program is needed between all nations wishing to fish on the high seas.

Satellite technology can be used to identify a vessel operating in a particular area of the ocean, but it's more difficult to accurately determine whether or not that vessel is fishing. Cloud cover could obscure the image when fishing activity is taking place, and even during periods of

clear skies the images may not be clear enough to show that gear is deployed. Unmanned aerial surveillance systems may provide additional support, but would be limited by weather conditions, as well. Fishing vessels often operate with erratic movements, changing course and speed frequently to set and recover equipment. This movement can be captured by electronic means, satellite, or automatic identification system/vessel management system, but it may not be enough evidence to prove a vessel was fishing in a closed area. It would become even more difficult if the moratorium on fishing were to be lifted in the Arctic. Ideally, at-sea boardings need to be conducted while vessels are actively fishing in the high seas.

With a complete moratorium on fishing—or a moratorium on commercial fishing, while allowing some scientific research—the determining factor is relatively simple: Was the vessel in question engaged in fishing in an illegal area? However, the ultimate goal is not to eliminate fishing altogether, but rather to open the high seas portion of the central Arctic Ocean to sustainably managed fishing. All nations want to be able to use the living marine resources that may be present.

In that case, the task becomes far more complex. A management scheme may prohibit only specific gear or a particular species from being targeted, which electronic surveillance would not be able to detect. While more complicated, a management scheme would be preferable to an outright ban on fishing, since it would allow use of the resource. Nevertheless, it would require considerable cooperation among nations and would demand precision that only at-sea enforcement by surface assets could provide.

Ideally, USCG assets would be used to conduct boardings, and icebreakers would be most effective, given the operating environment. The potential for commercial fisheries in the next decade is yet another factor that comes to the forefront when promoting the construction of additional U.S. icebreakers. Shiprider agreements with other nations that have expansive icebreaking fleets, like Canada or Russia, should not be overlooked when considering alternate enforcement solutions.

A future ice-free Arctic Ocean is definitely a possibility. Without management, any fish species living in the central Arctic Ocean is subject to unsustainable fishing, especially as the world's population demands a consistent source of protein.

The current moratorium has not yet been ratified, so the first step to preserving this as-yet-untouched resource is to sign on to a binding moratorium on fishing until more information can be gathered. As scientific research progresses, commercially viable stocks may be discovered. Once the Arctic ecosystems and stocks are better understood, a management plan can be established for sustainable, continuous use of the resource by all interested nations. Without proper management, the Arctic would become a free-for-all and could be quickly depleted, just as has happened to other stocks that have been aggressively fished without regulation.

As ice in the Arctic withdraws and fish stocks in global oceans are depleted, now is the time to act.

About the author:

LT Jessica Conway is a program and policy analyst for the USCG Office of Fisheries Law Enforcement. She is a graduate of the U.S. Coast Guard Academy and holds a master's degree in marine affairs from the University of Rhode Island. She has served two operational tours on 225' seagoing buoy tenders in support of five of the Coast Guard's 11 missions.

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Life on the Rocks

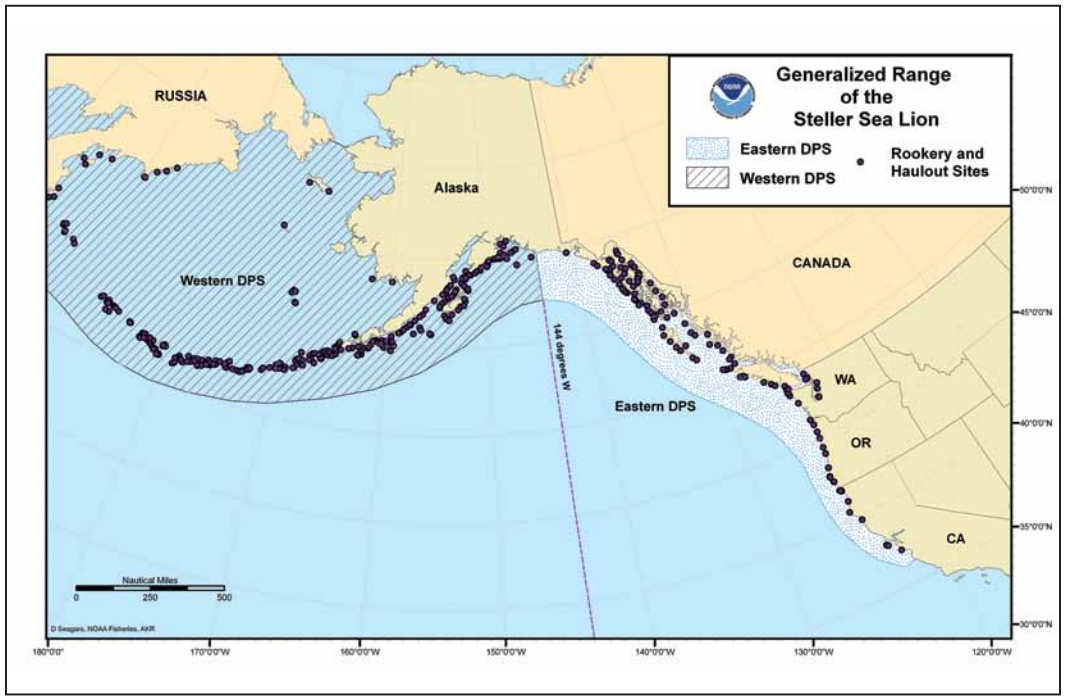
Steller sea lions feel the impact of increased North Pacific Ocean activity

by LT Rebecca Rebar
Commanding Officer
North Pacific Regional Fisheries Training Center

With the notable melting of Arctic ice and increased activities in the maritime domain, the possibilities of commercial use in the North Pacific and Arctic regions are endless. Increased vessel activities in the northern regions will open new opportunities for vessel traffic patterns and even future fisheries. These changes will undoubtedly impact marine life located in areas which were previously undisturbed and rarely frequented.

In particular, one species already impacted by human activities in the region—the Steller sea lion—may take the brunt of these changes. Steller sea lions (*Eumetopias jubatus*) use the rocky shores of the North Pacific Ocean, from central California to Japan, as home.[1] The most significant populations of the species are found in the Gulf of Alaska and the Aleutian Islands, as these areas offer protected breeding grounds and plenty of food. Steller sea lions within the United States are divided into the Western and Eastern Distinct Population Segments (DPS), depending on their location relative to the 144° West Longitude.[2]

A group of Steller sea lions inhabits the Western Aleutian Islands. NOAA Fisheries photo



Range of the Steller sea lion species, including both Western and Eastern Distinct Population Segments. NOAA Fisheries graphic

As early as the 1970s, and more recently in the 1990s, significant decline was noted in the Western DPS in those animals inhabiting the Gulf of Alaska and Aleutian

Islands area. The decline has been attributed mostly to human activity—specifically habitat degradation due to contaminants and pollution, offshore exploration, and fisheries interactions. Contrary to the Eastern DPS in California and Southeast Alaska, the Steller sea lion Western DPS remains listed as "endangered" under provisions of the Endangered Species Act more than 25 years after the species was first listed as "threatened."[3]

Current Status and Protective Measures

Protective measures for the Western DPS are fairly complex and encompass a wide range of living marine resource variants. In general, a 20-nautical-mile buffer zone has been established around "haul-outs," which are major breeding sites for the animals.[4] Included in these zones are specific restrictions for fishing gear types, with additional measures in place for targeted fisheries. Aircraft and terrestrial buffer zones have also been established to limit interactions with people, planes, and helicopters operating on or near critical habitats for the Steller sea lions.

Federal regulations provide more detailed stipulations for maritime operations near Steller sea lion Western DPS. These regulations prohibit vessel operations within 3 nautical miles of more than 30 rookery sites listed in the federal regulations. Some critical habitats are located in transit areas where vessels may continuously navigate through the location, but must remain at least 1 nautical mile from the site itself.[5]

Restrictions on fishing vessel operations within these areas are also very strict. Forty Steller sea lion habitat sites have 3-nautical-mile "no groundfish" regulations in place.[6] This means that no fishing vessel may target any fish species which is regulated by federal laws within these areas. Many of these sites also have "no directed fishing" areas around the location. In these cases, fishing vessels may not target Steller sea lion species' prime food sources of pollock, Pacific cod, or Atka mackerel.

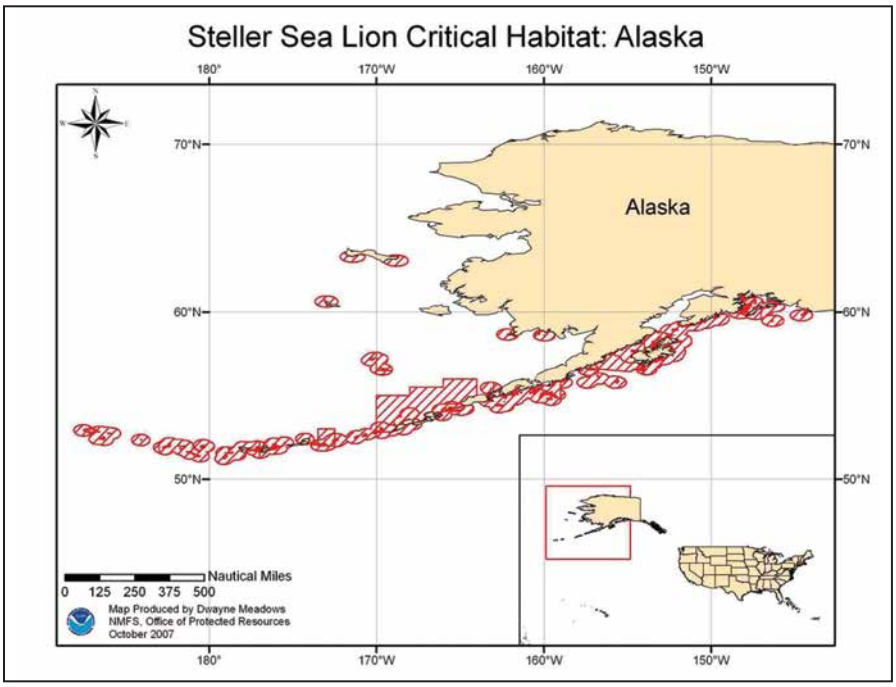
Current methods of enforcing the buffer zones include sighting reports from vessels or aircraft operating near the protected areas and using the Vessel Monitoring System (VMS). Coast Guard cutters and aircraft operating in the Bering Sea and Aleutian Islands monitor rookery sites during routine patrols. Asset operators receive training to detect and report infractions of the federal regulations regarding maritime activities near critical habitats for the Steller sea lion Western DPS. VMS—a real-time, nonstop vessel tracking system—can also be used to identify vessels operating within one of the regulated zones for follow-on enforcement action.

Importance of Protective Regulations

The regulations regarding the Steller sea lion sites, like many of the fisheries in the North Pacific Ocean, are fairly complex. They were developed through a series of studies and discussions with stakeholder groups to create functional, practical, and enforceable regulations for the safety of the Western DPS and the ecosystem on which the species depends. Partnerships with the fishing fleets, conservationists, and federal entities are keys to long-term recovery of the species.

One might ask how restricting zones of 3 nautical miles off small islands spread throughout the North Pacific can have an impact on the viability of the Western DPS food source relative to the scale of the fishery. The total allowable catch allocations for the three main food sources of the Steller sea lion Western DPS for the 2016 season amounted to over 3 million metric tons.[7] This weight is equivalent to about 300 Eiffel Towers.[8] With the average adult Steller sea lion needing to consume 5 percent of its body weight daily—about 63 pounds—and, with about 45,000 animals in the Western DPS, the population consumes more than 1,000 metric tons of food per day.[9] Removing vital food sources in such large quantities shows how effective fisheries management is critical to the survival of the Steller sea lion Western DPS.

Limiting fishing operations near the areas where Steller sea lions breed and forage also reduces the interactions vessels can have with the animals. The



Steller sea lion critical habitat in Alaska. NOAA Fisheries image

National Oceanic and Atmospheric Administration lists several threats to the species, including boat or ship strikes, offshore exploration, and direct and indirect interactions with fishing fleets.[10] Direct interactions include entanglement in fishing gear or with the fishing vessel itself. Indirect interactions include competing for food resources or habitat modifications like fishing equipment that contacts the sea floor—hook-and-line gear and non-pelagic trawl gear. Small buffer zones around Steller sea lion habitats can significantly reduce the likelihood of these threats occurring.

Future of the Steller Sea Lion Population

The future of the Western DPS of Steller sea lions remains unclear. Despite the regulations put in place for the species' continued growth, research has not shown significant rebounding within the population.[11] In 2016, it was found to be only 5 percent of what it was 30 years ago.[12] As the earth continues to warm, the North Pacific Ocean will become a common navigational highway and critical source of seafood around the world. The Western DPS will undoubtedly be affected by these changes.

As Arctic ice recedes at an unprecedented rate, navigable waterways which were once unfamiliar are becoming more popular transit routes. The U.S. Committee on the Marine Transportation System predicts that more than 2,000 Bering Strait transits—a 75 to 430 percent increase from 2013—could be possible before 2025.[13] With Steller sea lions traveling more than 250 miles to find food, the likelihood of increased encounters between the endangered species and vessels transiting through the Aleutian Islands is alarming.

With the world population growing at an accelerated rate, the necessity for food continues to expand, as well. Commercial fisheries conducted within Alaskan waters accounted for 6 billion pounds of finfish and shellfish—63 percent of the total seafood catch around the United States in 2015.[14] With the pressure to not only ensure fish stocks remain viable for the future, but also produce enough revenue and food to remain economically valuable, competition for food resources will only increase in the future. The effects of this competition create an additional challenge for the Steller sea lion Western DPS, which has already been notably impacted by fishery operations.

While recent data shows the Western DPS stabilizing overall, the future projections for impacts to the species' food sources and increased traffic show an ominous future for these Steller sea lions. The efforts of many organizations continue to ensure the future restoration of the species despite the challenges these iconic mammals face.

A rehabilitated Steller sea lion is loaded into a Coast Guard C-130 in preparation for release back into the wild. Coast Guard photo by Petty Officer Christopher D. McLaughlin

About the author:

LT Rebecca Rebar has served in the U.S. Coast Guard for five years, completing two operational tours on Coast Guard cutters in Guam and Southeast Alaska prior to her current assignment in Kodiak, Alaska. She is also a licensed commercial mariner.

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Chemical of the Quarter

Understanding Seed Cake

by LT Andrew Murphy
Staff Engineer, Hazardous Materials Division
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What is it?

Seed cake is a broad term that identifies the byproducts of vegetable oil production. Vegetable oils are produced either through the crushing or pulverizing of seeds and vegetables or through a solvent extraction process that removes the oil. The leftover residue is seed cake, and is derived from numerous sources, including cottonseed, palm kernel, peanut, rapeseed, soya bean, and linseed. Seed cake is primarily used in farming, either as feed for animals or as fertilizer.

Why should I care?

➤ *Shipping Concerns:*

Typically, seed cake is shipped as a dry bulk cargo in pellet, pulp, cake, or meal forms. Domestically, seed cake is shipped under 46 Code of Federal Regulations Part 148, though the majority of seed cake is shipped internationally under the International Maritime Solid Bulk Cargoes (IMSBC) Code. Under the IMSBC Code, seed cake is shipped under four different schedules or entries listed below:

1. SEED CAKE, containing vegetable oil UN 1386 (a)—mechanically expelled seeds, containing more than 10 percent oil or more than 20 percent oil and moisture combined
2. SEED CAKE, containing vegetable oil UN 1386 (b)—solvent extractions and expelled seeds, containing not more than 10 percent oil, and when the amount of moisture is higher than 10 percent, not more than 20 percent oil and moisture combined
3. SEED CAKE UN 2217—with not more than 1.5 percent oil and not more than 11 percent moisture
4. NON-HAZARDOUS

➤ *Fire Concerns:*

As with other organic materials, seed cake is affected by oxidation and moisture. Residual oil content in the seed cake can oxidize, which causes the release of heat. Whole seeds and whole vegetables have a protective outer layer that prevents oxidation and protects against microorganisms. This protection is eliminated when seeds or vegetables are processed.

Depending on moisture content levels, this oxidation process can be accelerated. Additionally, higher moisture content can support the growth of microorganisms, which aids oxidation and can release heat on its own. If these hazards are not controlled, the cargo can reach a temperature where the cargo can spontaneously ignite. For cargoes that were subjected to a solvent extraction technique, residual solvent may add an additional flammability hazard to the cargo.

What is the Coast Guard doing about it?

The current schedules in the IMSBC Code require many mitigating actions prior to loading the cargo. Depending on the oil content, the cargo may be required to be aged prior to loading in a cargo hold to allow oil to oxidize and release heat.

The temperature of the cargo must be measured at different levels of the cargo stockpile prior to loading. Furthermore, the cargo is prohibited from being handled during precipitation and must be kept as dry as practicable. The moisture content must be measured prior to loading, as well.

Recent efforts are underway at the International Maritime Organization to amend the seed cake schedules and add a new schedule for seed cakes that meets the definition of Material Hazardous only in Bulk (MHB). These changes are intended to make the schedules more user-friendly, eliminate overlap across the schedules, broaden the scope of the entries to include more types of source materials, and better identify the hazards within the schedule names. This discussion will continue over the next two years; however, the basic mitigating measures designed to safely ship seed cake will not change.

About the author:

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References:

International Maritime Solid Bulk Cargoes Code

46 Code of Federal Regulations Part 148 (Subchapter N)

IMO Paper CCC 3/5/11

The Standard Newsletter "Carriage of Seedcake," October 2011, Charles Taylor Consulting

Nautical Engineering Queries

Prepared by NMC Engineering Examination Team

1. What is the function of a shading coil as used in an AC magnetic controller?

A. Reduce chatter and noise in the contactor.
B. Prevent flux build-up in the operating coil.
C. Eliminate arcing when the contacts close.
D. Energize the operating coil and "pull in" the contacts.

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2. A journal rotating in its bearing relies on hydrodynamic principles for lubrication. Under steady load conditions, the journal rotating in the bearing will assume a position _____.

A. at bearing bottom center
B. concentric in the bearing
C. at bearing top center
D. eccentric in the bearing

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3. In diesel engines, the four basic events (intake, compression, power, and exhaust) are performed once in _____.

A. two crankshaft revolutions in a two-stroke cycle engine
B. two power strokes in a two-stroke cycle engine
C. one power stroke in a two-stroke cycle engine
D. two piston strokes in a two-stroke cycle engine

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4. Why is it essential to introduce CO_2 from a fixed fire extinguishing system into a large engine room as quickly as possible?

A. The fire may warp the CO_2 piping.
B. To keep the fire from spreading through the bulkheads.
C. Updraft from the fire tends to carry the CO_2 away.
D. CO_2 takes a long time to disperse to all portions of a space.

Answers

1. *Note: A shading coil used on an AC magnetic controller is a shorted turn where current is induced that is 90 degrees out of phase with the main coil current. This creates and maintains enough magnetic field flux to keep the armature pulled in when the main coil current transitions through zero current. Without this shading coil, the contactor has a tendency to exhibit noise and chatter associated with magnetic field flux fluctuations inherent to alternating current.*

A. Reduce chatter and noise in the contactor.	**Correct answer.** As explained in the note above, with the use of a shading coil, chatter and noise associated with the contactor are reduced.
B. Prevent flux build-up in the operating coil.	Incorrect answer. The shading coil actually helps prevent flux decay when the main coil current transitions through zero current.
C. Eliminate arcing when the contacts close.	Incorrect answer. Arcing associated with the contacts potentially occurs when the contacts open, not when they close.
D. Energize the operating coil and "pull in" the contacts.	Incorrect answer. The energizing of the coil and "pulling in" of the contacts is achieved by a switching or pilot device, not a shading coil.

2. *Note: Lubrication of a rotating journal within a bearing requires the establishment and maintenance of a hydrodynamic wedge, which in turn requires the journal to assume a position within the bearing that is eccentric to and below the center of the bearing.*

A. at bearing bottom center	Incorrect answer. The journal is at bearing bottom center only when the journal is at rest.
B. concentric in the bearing	Incorrect answer. A rotating journal positioned concentric in the bearing would not form the hydrodynamic wedge required for lubrication.
C. at bearing top center	Incorrect answer. The journal is not normally at bearing top center at any time.
D. eccentric in the bearing	**Correct answer.** As explained in the note above, the hydrodynamic wedge needed for lubrication requires the rotating journal to be positioned eccentric to and below the bearing.

3. *Note: The four basic events of a diesel engine all occur within one complete operating cycle, which can be analyzed in terms of the number of piston strokes or the number of crankshaft revolutions, depending upon whether a two-stroke or four-stroke operating cycle is used.*

A. two crankshaft revolutions in a two-stroke cycle engine	Incorrect answer. A complete operating cycle for a two-stroke cycle engine occurs in one crankshaft revolution, not two revolutions.
B. two power strokes in a two-stroke cycle engine	Incorrect answer. In excess of one complete operating cycle for a two-stroke cycle engine is required for two power strokes to occur.
C. one power stroke in a two-stroke cycle engine	Incorrect answer. In one power stroke of a two-stroke cycle engine, only one half of an operating cycle takes place.
D. two piston strokes in a two-stroke cycle engine	**Correct answer.** Two piston strokes of a two-stroke cycle engine constitutes one complete operating cycle.

4. *Note: The principle of extinguishment for CO_2 is that of displacing oxygen by rapidly saturating the space with CO_2 to reduce the oxygen content below that required to support combustion.*

A. The fire may warp the CO_2 piping.	Incorrect answer. CO_2 has a negligible cooling effect, and discharge rates have no appreciable impact on warpage of CO_2 piping.
B. To keep the fire from spreading through the bulkheads.	Incorrect answer. CO_2 is discharged into the engine room only as a last resort when all other attempts at extinguishment have failed.
C. Updraft from the fire tends to carry the CO_2 away.	**Correct answer.** This would tend to happen if the CO_2 was discharged at a lower than optimal rate into the engine room. Complete saturation requires the engine room to be flooded quickly with CO_2.
D. CO_2 takes a long time to disperse to all portions of a space.	Incorrect answer. Extinguishment depends on quickly achieving saturation, not on dispersal rates.

Nautical Deck Queries

Prepared by NMC Engineering Examination Team

1. BOTH INTERNATIONAL and INLAND: Which vessel would exhibit sidelights when underway and not making way?

A. a vessel trawling
B. a vessel not under command
C. a pilot vessel
D. a vessel engaged in dredging

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2. Which compensates for errors introduced when the vessel heels over?

A. the soft iron spheres on the arms of the binnacle
B. magnets placed in trays inside the binnacle
C. a single vertical magnet beneath the compass
D. the Flinders bar

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3. Why should storage batteries be charged in a well-ventilated area?

A. They generate heat.
B. They emit hydrogen.
C. Because of the toxic fumes they emit.
D. They recharge faster in a well-ventilated space.

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4. On an OSV, how many ring buoys are required to have a buoyant line attached?

A. 8
B. 4
C. 2
D. 1

1.

A.	a vessel trawling	Incorrect answer.
B.	a vessel not under command	Incorrect answer.
C.	a pilot vessel	**Correct answer.** Reference: International and Inland Rule 29 Rule 29 states: *"(a) A vessel engaged on pilotage duty shall exhibit:* *(i) at or near the masthead, two all-round lights in a vertical line, the upper being white and the lower red;* *(ii) when underway, in addition, sidelights and a sternlight;* *(iii) when at anchor, in addition to the lights prescribed in subparagraph (i), the anchor light, lights, or shape prescribed in Rule 30 for vessels at anchor."*
D.	a vessel engaged in dredging	Incorrect answer.

2.

A.	the soft iron spheres on the arms of the binnacle	Incorrect answer.
B.	magnets placed in trays inside the binnacle	Incorrect answer.
C.	a single vertical magnet beneath the compass	**Correct answer.** Reference: The American Practical Navigator, Bowditch, 2002 Edition, Glossary, page 773 *"Heeling magnet. A permanent magnet placed vertically in a tube under the center of a marine magnetic compass, to correct for heeling error."*
D.	the Flinders bar	Incorrect answer.

3.

A.	They generate heat.	Incorrect answer.
B.	They emit hydrogen.	**Correct answer.** Reference: Marine Fire Prevention, Firefighting and Fire Safety, Maritime Administration, page 9 Chemical Data Guide, page 176, Flammable Gas (Not Toxic) *"When storage batteries are being charged, they emit hydrogen, a highly flammable gas. A mixture of air and 4.1% to 74.2% hydrogen by volume is potentially explosive."*
C.	because of the toxic fumes they emit	Incorrect answer.
D.	They recharge faster in a well-ventilated space.	Incorrect answer.

4.

A.	8	Incorrect answer.
B.	4	Incorrect answer.
C.	2	**Correct answer.** Reference: 46 CFR 133.70(a)(4)(i) *"At least one lifebuoy on each side of the OSV shall be fitted with a buoyant lifeline."* The regulation stipulates the length of the line, minimal diameter, breaking strength, and resistance to deterioration from ultraviolet light.
D.	1	Incorrect answer.

In the News: $60K in illegally harvested shrimp seized

A Coast Guard and National Oceanic and Atmospheric Administration (NOAA) joint boarding team boards the *Ronald E.*, a 68-foot commercial fishing vessel, near the Dry Tortugas Shrimp Sanctuary Preservation Area on January 12, 2018. The team boarded the vessel to ensure fisheries and safety regulations compliance, ultimately seizing about 6,000 pounds of shrimp with an estimated value of $60,000 from the vessel, and citing the operators with illegal fishing and safety violations. Coast Guard photo

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