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Congress  
on  
Ocean Policy

# Congress on Ocean Policy

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*at*

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Washington, D.C.

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## **Acknowledgements:**

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**Robert D. Day**  
Executive Director

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Chair, **Donald Boesch**, Professor and President Emeritus, University of Maryland Center for Environmental Science; **Tom Chase**, Alternate Director, RNRF Board of Directors, American Society of Civil Engineers; **Robert D. Day**, RNRF Executive Director; **John Durrant**, RNRF Vice-Chairman, RNRF Board of Directors, American Society of Civil Engineers; **Richard Engberg**, RNRF Chairman, American Water Resources Association; **Sarah Gerould**, RNRF Board Member, Society of Environmental Toxicology and Chemistry; **Paul Higgins**, RNRF Board Member, American Meteorological Society; **Lu Gay Lanier**, RNRF Board Member, American Society of Landscape Architects Fund; **Raj Pandya**, RNRF Board Member, American Geophysical Union; **Howard Rosen**, RNRF Board Member representing the public interest; **Nancy C. Somerville**, Alternate Director, RNRF Board of Directors, American Society of Landscape Architects Fund; **Barry Starke**, RNRF Board Member representing the public interest; **Kasey White**, RNRF Board Member, Geological Society of America

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**Tom Bigford**, American Fisheries Society; **Jeffrey L. Payne**, National Oceanic and Atmospheric Administration

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# Introduction

Oceans are being affected by the chemical and physical impacts of climate change, unsustainable interferences with sea life populations, unprecedented destruction of marine habitats, and life-threatening pollution from land- and sea-based activities (nutrients, agricultural chemicals, plastics and petroleum, among others). These increasing pressures are disrupting ocean health, productivity, and resilience on a global scale, requiring innovative solutions from both regional and international actors.

Directors of the Renewable Natural Resources Foundation recognized the need for a critical examination of these and other key issues and called a Congress on Ocean Policy. The congress brought together a select group of professionals from RNRF member organizations and leaders from government, industry, academia, and nonprofit organizations. Delegates met on December 6, 2018, at the National Union Building in Washington, D.C.

Congress speakers outlined the challenges of tackling ocean issues that have global implications, amplifying

the need for all nations to embrace the international governance framework of the United Nations Law of the Sea Convention. Delegates further discussed solutions to broad environmental degradations from both land-based pollution and climate change. Global impacts on marine mammals from the far-traveling acoustic disturbances of commercial shipping, naval exercises, and off-shore development were also characterized. Delegates also highlighted local, state, and federal collaboration on marine resource management through regional ocean plans. The final presentations explored policy development and ecosystem impacts of offshore wind, petroleum, and deep-sea mineral resource extraction.

This report is a synthesis of information and professional judgments presented over the course of the congress. Presentations are supplemented by insights offered by delegates during each subsequent question-and-answer session.

## Renewable Natural Resources Foundation

The Renewable Natural Resources Foundation (RNRF) is a nonprofit, public policy research organization. Its mission is to advance the application of science, engineering and design in decision-making, promote interdisciplinary collaboration, and educate policymakers and the public on managing and conserving renewable natural resources. Member organizations are:

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*Editorial Staff:* Robert D. Day, editor; Amber Lee Todoroff, associate editor; Stephen Yaeger, assistant editor.

# Executive Summary

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## The U.S. and the UN Law of the Sea Convention

**Ronce Almond**, partner at The Wicks Group in Washington, D.C., provided an overview of the United Nations Convention on the Law of the Sea (UNCLOS), its history and context, and the United States' relationship with the agreement. UNCLOS is a vital international framework that governs maritime zones, resolves disputes, and protects ocean environments. As deep seabed mining emerges as a viable industry and the melting of sea ice opens the Arctic to exploration and resource exploitation, UNCLOS will become increasingly important. Despite having a long history of leadership in international maritime law, the United States has not yet ratified the treaty. A resolution to approve a treaty must be passed by a two-thirds vote in the senate, which then goes to the president for ratification. Creating such a large consensus on treaties has become increasingly difficult. Almond was confident that, if the U.S. does not ratify the convention, its interests at sea and status as a leader in maritime policy will be diminished.

## Ocean Acidification and Rising Ocean Temperatures

**Dr. Scott Doney**, Joe D. and Helen J. Kington Professor in Environmental Change at the University of Virginia, outlined the perils oceans face globally from rising greenhouse gas emissions. The oceans absorb 90% of heat built up through greenhouse gas emissions. As temperature increases, the warmer water expands in volume, contributing to sea level rise that is compounded by melting ice sheets in the high latitudes. Rising ocean temperatures further contribute to high levels of stratification between warmer and colder water, decreasing oxygen levels and impacting sea life across the food web. Dissolved atmospheric CO<sub>2</sub> acidifies ocean water, inhibiting the ability of some marine animals to create and maintain healthy shells. Doney emphasized how closely intertwined the atmosphere and ocean are, and reiterated that a strong stance against global climate

change would have tremendous benefits for ocean health as well.

## Land-Based Marine Pollution

**Dr. Donald Boesch**, president emeritus and professor of marine science at the University of Maryland Center for Environmental Science, presented cases studies of land-based ocean nutrient and plastic pollution mitigation. Smaller-scale pollution issues, such as those that plagued Tampa Bay in the 1970s as population rapidly expanded, can be solved through upgrades and innovations in waste-water management. Larger areas, such as the Chesapeake Bay or Gulf of Mexico, require more expansive policy decisions and coordination between multiple state governments. Boesch highlighted the difficulties scientist and policymakers face confronting agricultural runoff in particular, as increasing crop production often cancels out innovations in nutrient application efficiency. He further outlined the dramatic increase in single-use plastic production over the past 50 years, noting its impact on sea life and concluding that the best plastic waste solution is simply to produce less plastic.

## Ocean Noise and Marine Life

**Jason Gedamke**, director of the Ocean Acoustics Program at the National Oceanic and Atmospheric Administration, explained the impacts that anthropogenic ocean noise has on marine life and what can be done to mitigate those disturbances. Communication, essential to all animal life, is primarily sound-based in the ocean due to the efficiency with which water transmits sound. Marine animals rely on acoustic communication to feed, mate, avoid predators, socialize, and conduct other vital activities. Anthropogenic ocean noise from sources like shipping vessels, military activity, construction, and seismic surveys for oil and gas can harm animals, both physically and by causing undesirable behavioral responses. Through its Ocean Noise Strategy, NOAA is identifying and addressing the cumulative impacts of

noise in the oceans, mapping human activity and marine mammal migration to better understand and manage the impacts of ocean noise on sea life.

### **Regional Ocean Planning: Crossing Boundaries to Make Better Ocean Decisions**

**Betsy Nicholson**, North Regional Director for the NOAA Office for Coastal Management, presented an overview of regional ocean planning and the factors that have allowed ocean planning efforts to be successful in the Northeast. In the Northeast region, a beneficial set of circumstances including pre-existing relationships, foundational funding, and other precedents allowed for the initial success of the program. Additionally, the legal impetus provided by the Obama Administration's National Ocean Policy created accountability and promoted effective federal agency cooperation. One important outcome is the Northeast Ocean Data Portal, a public resource compiling data relevant to ocean planning. The portal has been used in many contexts, from aquaculture and wind-energy development to K-12 education. One major focus of successful ocean planning is maintaining a data-driven approach, promoting objectivity and transparency to promote continuity across changing regulatory climates.

### **Offshore Wind Energy**

**Bonnie Ram**, interim director of strategic partnerships and initiatives at the University of Delaware's College of Earth, Ocean and Environment, discussed the merits of offshore wind energy, lessons learned from past efforts in the EU and U.S., and the challenges and principles that must be considered in planning offshore wind development. Since 88 percent of the world's current offshore wind capacity is in Europe, the EU can provide valuable case studies for American development. Block Island, the first offshore wind development in U.S. waters, also serve as a helpful model. Offshore wind is an important emerging technology in the U.S. due to abundant wind resources off the Atlantic coast within proximity to large population centers. However, development needs to happen carefully, and with full consideration of environmental and public concerns.

### **Offshore Petroleum Exploration and Exploitation**

**Tommy Beaudreau**, first director of the Bureau of Ocean Energy Management (2011-2014), discussed his experiences in the Department of the Interior in the wake of the 2010 Deepwater Horizon oil blowout in the Gulf of Mexico. Beaudreau characterized the federal policy response to the disaster during the Obama administration and outlined the changes to those policies during the Trump administration. Ultimately, Beaudreau observed, offshore drilling expansion will be more reliant on geological and economic limitations than preferences within administrations. However, drilling expansion in remote parts of the Arctic presents a slew of logistical and environmental concerns different from those in the Gulf.

### **Deep Sea Mineral Exploration and Exploitation**

**Dr. Cindy Van Dover**, Harvey W. Smith Distinguished Professor of Biological Oceanography at Duke University and director of the Duke University Marine Laboratory, explained developments in international seabed mineral mining policy and the current state of seabed ecosystem research. The International Seabed Authority, an organization created by the U.N. Law of the Sea Convention, grants seabed mining contracts in international waters. Currently, only exploration contracts have been granted, but the ISA will be finalizing exploitation rules by as early as 2021. Van Dover noted that because the US is a non-signatory in UNCLOS, it is difficult for American scientists and policy experts to have a say in rule-making. She also highlighted seabed research, observing that studies have shown large-scale seabed mining could have tremendous long-term effects on benthic marine ecosystems that will be impossible to rectify.

## Observations and Recommendations

The congress yielded many constructive observations and recommendations. These can be found throughout this report. A brief list of principal observations follows:

- 1) The UN Convention on the Law of the Sea provides a framework for coordinating the use of international waters and exploitation of the seabed. It is in the U.S.'s best interest to ratify UNCLOS in order to participate in negotiations and rulemaking around emerging issues such as seabed mining and Arctic navigation and exploitation.
- 2) It is imperative that global greenhouse gas emissions be reduced for the health of marine ecosystems. Data on acidity and ocean temperature should also be continuously collected in order to monitor global ocean health and gauge the effectiveness of CO<sub>2</sub> mitigation policies. Temperature and acidity data should also be incorporated into fisheries management plans as fish populations broadly decline or migrate out of traditional areas.
- 3) While some land-based pollution problems can be solved through more effective waste-management practices, agricultural nutrient runoff must be addressed if meaningful headway is to be made in large watersheds. For bodies of water that receive pollution from multiple states, calculating pollution loads and assigning nutrient reduction goals to each contributing state is an effective means of reducing pollution. However, overcoming political resistance to these assignments is a challenge.
- 4) Marine mammals and other sea life are harmed by exposure to anthropogenic acoustic disturbances. Noise from commercial shipping has been observed to cover up the noises of social marine mammals, making it difficult for them to find prey and communicate with each other. Other anthropogenic ocean noises have been connected to beaching events. Noise can travel over thousands of miles in the ocean; cumulative impacts of both chronic and acute sources of anthropogenic noise across entire ocean basins should be considered when designing policy or research.
- 5) Near-shore ocean areas are subject to many competing commercial, social, and environmental interests that are often difficult to reconcile. When dealing with overlapping jurisdictions and regulations, it is crucial to develop partnerships and channel communications among stakeholders and governing agencies to produce more effective policy. The Northeast Regional Planning Body has been a model for this kind of marine governance, which has been further enhanced by their Northeast Ocean Data Portal. The widespread availability of accurate and accessible data provides context for all stakeholders to effectively plan and manage coastal development projects.
- 6) Offshore wind is an important, viable contributor to renewable energy goals in the context of climate change. Offshore wind development, however, also impacts ocean ecosystems. Noise disturbances from construction activity and disruptions of bird migration patterns are important to consider, and can be minimized with proper planning. The EU and Block Island in the U.S. can provide valuable lessons to help with this planning process.
- 7) Environmental risks should be considered as the U.S. contemplates expanding offshore oil and gas leasing in new near-shore areas along the Pacific, Atlantic, and Arctic coasts. In addition to expanding leasing areas, the Trump administration is rolling back new safety rules created in the wake of the Deepwater Horizon disaster and compromising policy language that made oil companies more responsible for environmental damage.
- 8) If the U.S. wishes to regain its position as leader in seabed science and policy, and formally engage in on-going mineral exploitation rule-making with the ISA, it should 1) become a UNCLOS signatory and 2) invest in training scientists specializing in seabed research. The science and the potential impacts of wide-scale mining on seabed ecosystems are still unclear, so extreme caution must be taken when planning and permitting mining areas. Additionally, hydrothermal vents, which occur on mineral-rich polymetallic sulfides, should be entirely protected from mining for their highly unique biodiversity.

# The U.S. and the UN Law of the Sea Convention

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## Introduction

The United Nations Convention on the Law of the Sea (UNCLOS) is an international treaty that was signed and adopted in 1982. It provides important international legal framework to govern marine territory and the use of natural resources. While the United States is not a party to this treaty, it played a significant role in the adoption of early international agreements codifying maritime law. **Ronce Almond**, a partner at The Wicks Group in Washington, D.C., spoke about UNCLOS, its history and context, and the United States' relationship with the agreement.

## United States and International Law: Legal Context of UNCLOS Debate

To understand the role of the U.S. in the UNCLOS debate, a history of international law from the U.S. perspective is necessary. This debate goes back to 1793, when a new government was forming in France and war was beginning in Europe. France had been the main ally of the U.S. during the War for Independence, and so the U.S. had a treaty agreement to support France in international conflicts. Once France called upon its ally for assistance, leaders in the U.S. had to decide whether to honor their obligations or to declare neutrality. This turned into a debate between Alexander Hamilton and James Madison, known as the Pacificus-Helvidius Debate.

Almond explained that this debate, at its core, was between a stricter or more liberal reading of the Constitution. Hamilton, arguing for robust executive power, said that since both the legislative and executive branches deal with matters of international law, it is within the president's rights to declare neutrality in this case. Madison, arguing for congressional deference, said that the Senate alone had the power to decide whether to honor treaty obligations.

Importantly for international maritime law, part of France's request to the United States was that they declare maritime boundaries. This mattered in terms of interdicting commerce, keeping the English, Spanish, and Dutch from freely shipping wealth across the Atlantic Ocean. This led to the adoption of the "Cannon Shot Rule," which stated that a country's maritime jurisdiction extended as far as they could shoot a cannonball from the shore. Almond emphasized that this was an early example of technology dictating the ability to effectively control a jurisdiction, which was codified into customary international law, an important precedent.

In general, there are three sources of international law: treaties, customs, and general principles. A treaty is an international convention, whether general or particular, establishing rules expressly recognized by contesting states. This definition was established by the Vienna Convention on Treaties. Customs are more fluid. Almond described them as general practice among states, or things that states are doing because they believe they are legal. General principles of law are the assumptions that underline the way that nations practice international law—for example, the assumption that a nation will follow its treaty obligations.

There are two ways that the U.S. enters into international obligations: treaties and executive agreements. From other countries' perspectives, these function identically. The difference lies in how they are ratified by the U.S. Treaties, as defined in the Constitution, are made by the executive with authorization from two-thirds of the Senate present. Executive agreements, rather than having been established in the Constitution, are born out of practice, and are made unilaterally by the Executive. There are four types of executive agreement:



**Congressional executive agreements**, which are authorized by congress either before (*ex ante*) or after (*ex post*) the President makes the agreement.

**Executive agreements per treaty**, which are made by the President based on authorization from another treaty.

**Sole executive agreements**, which are made by the President based on their own congressional authority.

**“Non-Binding” executive agreements**, which are made between the Executive and a foreign nation or agency.

UNCLOS and most other international agreements related to the law of the sea have been presented to the Senate as treaties.

### United Nations Law of the Sea Convention: Background, Status, and U.S. Policy

While the United States has not ratified UNCLOS, it has a long history of participation in international maritime policy. In 1958, following Senate approval, the U.S. ratified four new Law of the Sea conventions codifying proclamations made by President Truman in 1945. These conventions put into place policies regarding the Territorial Sea, Contiguous Zone, the High Seas, fishing and conservation, and the continental shelf, all areas that would later be addressed in UNCLOS. In fact, the U.S. helped provide the impetus for the drafting of UNCLOS with President Nixon’s *Ocean Policy Statement* in 1970, which proposed the negotiation of a new multilateral legal framework for the oceans.

Following this statement, UNCLOS was negotiated between 1973 and 1982. However, in 1983, President Reagan declared that the United States would not ratify the treaty due to concerns about deep seabed mining, but would still follow other provisions such as recognition of the territorial sea and exclusive economic zones. Despite renegotiation of deep seabed provisions in the treaty, support from presidents Clinton, Bush, and Obama, and two committee votes in favor of the treaty by the Senate Foreign Relations Committee, the treaty was never brought to vote in the full Senate. Most recently, in the 115<sup>th</sup> Congress, identical bills in the Senate and House were introduced calling for ratification; however, neither of them was voted on by the full Senate.

### Barriers to Ratification: Institutions, Politics, Alternatives

The failure of the U.S. to ratify UNCLOS has a variety of potential explanations. First, the proportion of treaties that get ratified by the Senate has declined steadily over recent decades. President Obama submitted 38 treaties in his eight years, and only 15 were ratified. Currently, only 6% of international agreements are treaties, compared to 80% that are *ex ante* executive agreements.

Almond presented potential explanations for this trend. One was a lack of institutional capacity by Congress to address matters of international relations when compared to the executive branch, which has much more funding for such matters. Another was partisan politics, specifically the unwillingness of a Senate majority of one party to cooperate with an Executive of the other party. Finally, separation of powers is relatively inefficient. If the President can act unilaterally to make executive agreements, they tend to get done far more quickly.

However, Almond noted that there are also specific concerns with UNCLOS that make its ratification more difficult. For instance, participation in the treaty could lead to new taxes, including fees on U.S. corporations engaging in seabed mining and payments of up to 7% for drilling on the outer continental shelf. Concerns have also been raised about UNCLOS’s provisions about land-based pollution, which have been seen as a “backdoor” to coerce compliance with the Kyoto Protocol, which was not ratified by the U.S. International interference and surveillance activities have also been raised as worrisome, since the U.S. wants to be able to continue to operate in international waters without oversight.

These barriers prevent UNCLOS’s ratification as a treaty, and unilateral presidential action is unlikely since law of the sea treaties have never before been ratified by executive agreement. Almond listed some costs for the U.S.’s inability to ratify this important international agreement:

**Maritime Claims and Dispute Resolution:** The U.S. has little authority to speak on maritime claims, such as in the South China Sea, that go against the stipulations of UNCLOS.

**Codify Limitations on Maritime Zones:** Without certainty on the boundaries of the territorial sea, exclusive economic zone, and continental shelf, it is more difficult for science, commerce, and industry to operate off of America's shores.

**Protect High Seas Freedoms:** The U.S. currently engages in Freedom of Naval Operations (FONOPS), military operations to challenge perceived excessive maritime claims in locations like the South China Sea. However, its authority to engage in these activities is weakened by its failure to participate in UNCLOS.

**Assert Arctic Claims:** With the extent of Arctic sea ice rapidly shrinking each year, the region is rapidly opening to resource exploitation. Much of the determination of resource rights in the Arctic Ocean will be determined by the extent of the continental shelf. However, it is debatable whether the U.S. can make claims to the Arctic extended continental shelf without first ratifying UNCLOS. During the exchange with RNR Congress delegates, Almond speculated that the Arctic would most likely drive U.S. adoption of UNCLOS in the near future. He said that, since the Arctic holds such a massive oil and gas resource, U.S. reservations about UNCLOS adoption might be overcome.

**Oversight of Deep Seabed:** Without ratifying UNCLOS, the U.S. cannot participate in the International Seabed Authority (ISA), the primary authority to administer seabed mining rights in international waters. Almond expressed doubt that the ISA would be a primary driver of the U.S. adopting UNCLOS because it has existed for decades and has proven multiple times not to be an adequate motivator.

Mining is not the only commercial use of the deep seabed. International submarine cables, such as those used to transmit the internet, are protected from "undue" interference under UNCLOS. American companies seeking to voice concerns over interference currently have to seek foreign-state sponsors.

**Sustaining Living Resources and Environment:** As with other disputes, the U.S. has little ground to complain about international environmental issues in the oceans without first ratifying UNCLOS.

**Impact on Other Shared Domains:** If the U.S. cannot agree on how to govern shared domain on Earth, it will be difficult to do so in outer space. This is an increasingly important frontier as technology improves and countries pass legislation defining property rights in space.

### **Key Conclusions: Anomie, Anarchy, or Alternative**

The U.S. has historically embraced a tradition of leadership in maritime law, and there is broad bipartisan consensus that UNCLOS reflects existing international law and is consistent with U.S. policy. However, in modern times, treaties have not been a viable path for the U.S. to enter into international agreements. It is likely the case that UNCLOS will only be ratified as a treaty in response to precedent regarding law of the sea agreements. Therefore, the only option to ratify UNCLOS will be a combination of presidential leadership and strong congressional action. In the absence of ratification, U.S. national interests will be diminished along with the status of the U.S. as an international leader in maritime policy.

To view the PowerPoint associated with this presentation, click [here](#).

# Ocean Acidification and Rising Ocean Temperatures

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## Introduction

Rising greenhouse gas emissions are rapidly creating warmer and more acidic oceans, with huge potential consequences for marine ecosystems and the communities that depend on them. **Dr. Scott Doney**, Joe D. and Helen J. Kington Professor in Environmental Change at the University of Virginia, spoke about the threats oceans face from global climate change.

## The Current State of Ocean Temperature

Carbon emissions have outpaced the abilities of natural sinks on land and in the ocean to sequester carbon. Atmospheric carbon dioxide has risen roughly 45% from pre-industrial levels and is continuing to climb.

Correlated with an increase in atmospheric carbon dioxide is a broad increase in global temperatures, including ocean temperatures. Over 90% of excess heat built up through anthropogenic greenhouse gas emissions is absorbed by oceans. The oceans will continue to emit this excess heat even if atmospheric anthropogenic greenhouse gases are eliminated, increasing the urgency for lowering atmospheric greenhouse gas emissions as soon as possible.

Ocean water expands as its temperature rises, contributing to global sea level rise. Thermal sea level rise is compounded by glacial melting from the Greenland and Antarctic ice sheets. High-latitude sea ice melt will also dramatically alter ecosystems, shipping routes, pollution control measures and search-and-rescue programs in the Arctic.

## Where We Might Go

We are currently in an interglacial period of the Earth's history, known as the Holocene. The Holocene began after the last ice age, about 10,000 years ago. Agriculture and civilization more broadly have developed during this period, which has been characterized by a relatively warm and stable global climate.

The previous ice age lasted around 10,000 years. During that time, temperatures rose 3°C, and this

higher temperature held relatively stable throughout the Holocene until the industrial age. Over the past 150 years, there has been a 1°C spike in global temperatures.

Where global climate is heading depends on future greenhouse gas emissions. The International Panel on Climate Change (IPCC) has stressed the need to keep global temperatures below 2°C, ideally no higher than 1.5°C. Realistically, Doney noted, as global temperatures have already risen 1°C in just 150 years, keeping temperatures below the 1.5°C target will be unlikely given current climate actions. A temperature rise above 2°C is more likely, which would have drastic impacts on wildlife and ecosystems worldwide.

To assure that global temperatures stay within a 1.5°C range, there would have to be substantial reductions of greenhouse gases by 2025. And, not just CO<sub>2</sub>, but also methane, nitrogen dioxide, and chlorofluorocarbons. Doney observed that the Paris Agreement is a remarkable example of global climate diplomacy, but is not sufficient to keep temperatures even under 2°C, and further commitments are needed to address this issue.

## Rising Temperatures and the Oceans

The latest scientific models, which have been validated against historical observations, suggest that the ocean will continue to warm, even if greenhouse gas emissions stabilize fairly quickly. If those emissions do not stabilize, however, ocean warming will continue more dramatically.

The patterns for the ocean are not uniform. Sea temperature change is lower in the higher latitudes because melting sea ice is taking energy that would otherwise be used to warm overall water temperatures. However, high latitudes are being impacted by a decrease in sea ice distribution (Figure 1).

## Primary Production

Increasing ocean temperatures prompt changes in primary production – photosynthesis by small plants and other microbes at the base of the ocean food

chain. Energy that is being created from sunlight is turned into organic material, which can then be consumed by zooplankton, fish and marine mammals. Dramatic changes in primary production affect the entire ocean ecosystem.

Areas with the highest reductions in primary production are mostly concentrated in the tropics (Figure 2). When oceans become warmer, the water becomes less dense. This increases ocean stratification, making it more difficult for nutrients from the deeper, colder, and more dense parts of the ocean to reach the surface layer. Phytoplankton need both light and nutrients like nitrogen, phosphorus, and iron, in order to photosynthesize. A reduction in available nutrients is a main reason models and satellite observations suggest that warming tropics are correlated with decreasing overall photosynthesis rate. Higher latitudes see an increase in primary production, however, because reduced ice cover stabilizes the water column and allows for photosynthetic activity all year long.

### Ocean Acidification

About 25% of atmospheric CO<sub>2</sub> ends up in the ocean. Carbon dioxide combines with water to create carbonic acid, a weak acid in small quantities, but the huge volumes found in the ocean can shift the pH of the water. pH is a logarithmic scale, every one unit change in pH is an order of magnitude – a factor of 10. Models suggest a 50% change in overall acidity of the ocean's surface, which is occurring globally, but even more acutely in higher latitudes (Figure 3).

Declines in pH are also associated with declines in carbonanine, an ion, which organisms such as clams, mussels, oysters, and corals use to build shells made out of calcium carbonate. A recent study discovered that shells of a mollusk species began shrinking and became malformed over time when subjected to elevated CO<sub>2</sub> in their water. Other organisms across marine taxa, from corals to crustaceans, experienced similar growth stunts. Some, such as seagrass, actually experienced more growth. Either way, studies such as these indicate a drastic change in water acidification will dramatically alter marine life.

### Ocean Hypoxia

Most marine life, such as fish and many invertebrates, depend on oxygen in seawater to drive their metabolism. Colder water can hold more gas than warmer water – as ocean temperatures increase, oxygen levels decrease. Increased stratification caused by increased temperatures also changes the rate at which relatively high-oxygen surface water can access the interior of the ocean, a process known as ventilation. There is strong evidence that ocean oxygen levels are declining, which can get worse over time, and can limit the extent of habitat for many forms of marine life (Figure 4).

### Conclusions and Policy Recommendations

Doney emphasized the need for continuous monitoring, noting that it is very difficult to understand the problems associated with rising ocean temperature and acidification without data. He further recommended incentivizing adaptation strategies in fisheries management, with a special emphasis on the need to bring climate change and acidification considerations into the core of management decision processes. He observed

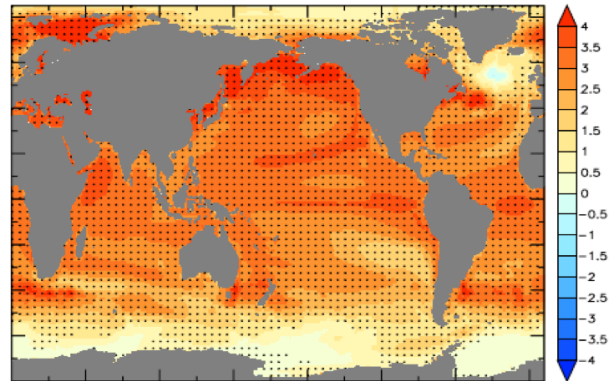


Figure 1: Sea surface temperature change model predictions. Bopp et al. Biogeosciences 2013

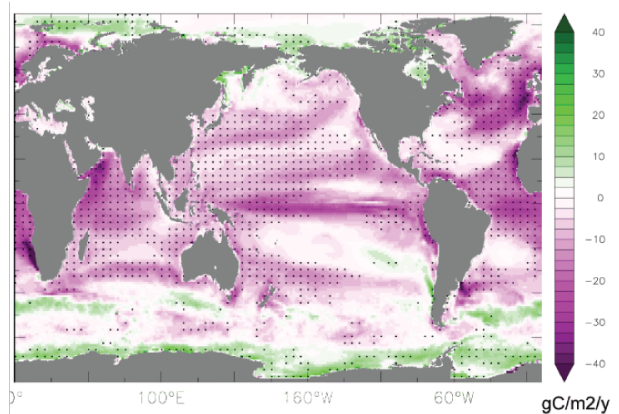


Figure 2: Ocean primary production change model predictions. Bopp et al. Biogeosciences 2013

the time mismatch between the gradual degradation ocean ecosystems will face in the coming decades and the short-termism of current fishery management planning, where the focus often lays on catch limits within the coming year. A longer-term approach would be more conducive to more effective and sustainable fishery management planning. Doney contends that, rather than relying on far-off technology that may not work as intended, the best and most effective answer to both stabilizing global temperatures and ocean acidification is dramatically reducing global greenhouse gas emissions.

To view the PowerPoint associated with this presentation, click [here](#).

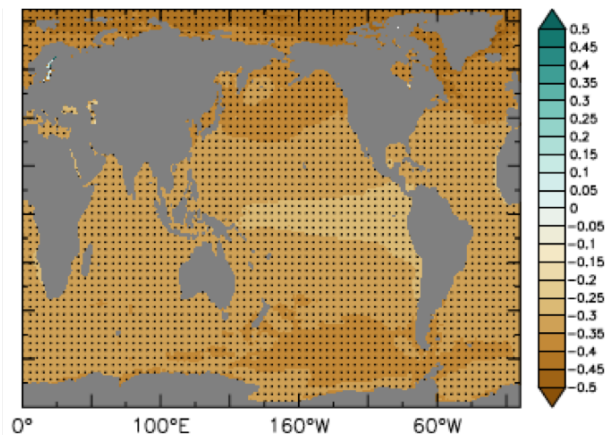


Figure 3: Sea surface pH change model predictions.

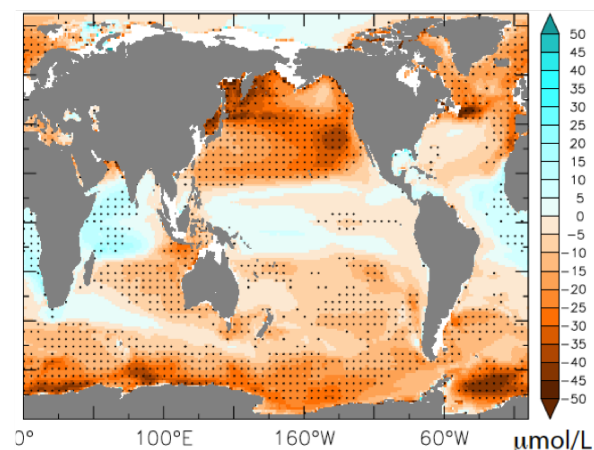


Figure 4: Oxygen concentration change at 200-600m model predictions. Bopp et al. *Biogeosciences* 2013

# Land-Based Marine Pollution

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## Introduction

Detrimental marine ecosystem changes prompted by global climate change are further exacerbated by land-based pollution. **Dr. Donald Boesch**, president emeritus and professor of marine science at the University of Maryland Center for Environmental Science, spoke on land-based ocean pollution issues and provided case studies of sound management practices. Land-based marine pollution consists of all kinds of contaminants – hormones, antibiotics, and heavy metals, to name a few. Boesch narrowed his presentation to nutrients, sediments and plastics.

## Nutrients and Sediments

Marine nitrogen and phosphorus contamination encourages phytoplankton growth. Phytoplankton colonies then become too dense, shading the sea floor so that marine plants wither and die. The death of plants that depend on sunlight can have ramifications throughout the food chain. Furthermore, ocean climate change induced acidification can lead to decreased oxygen levels, which are deadly to marine life. Large areas of deoxygenated water, known as dead zones, develop with increases in human population, and growth in industrialized agriculture and fertilizer production and application. Dead zones are also fed by atmospheric nitrogen sources. As fossil fuels are burned, nitrogen oxidizes in the air, which can eventually add to nitrogen loads in the water. Phytoplankton algae blooms that create dead zones can also emit toxins that kill or injure marine life and cause discomfort to people and wildlife on land.

## Case Studies

Starting in the 1980s, dead zones and algae blooms from land-based pollution started to become environmental crises that caught the attention of policymakers. Several areas have been able to develop successful solutions to these serious problems, and lessons can be learned from their examples.

### Tampa Bay, Florida

Huge human population expansion and attending sewer runoff increases caused severe environmental

degradation to Tampa Bay waters in the 1970s. Algae blooms smothered seagrass and otherwise harmed marine life, and the resulting smell was unpleasant to city residents. There was a tremendous effort by state and local policymakers to clean up the bay and dramatically reduce nitrogen offloads into the water. New requirements and investments were made in waste treatment and sewage systems, particularly from non-industrial sources. Wastewater treatment plants were updated to more effectively remove nitrogen, and nitrogen loads in the water dropped considerably. Seagrasses also began to recover, and in 2014 the bay exceeded policymakers' original goal of 15,378 hectares of seagrass. Other bays have been able to successfully reduce their nitrogen levels using similar policy levers. Boesch noted that it is crucial for policymakers to think about offsetting land-based pollution as their populations grow.

While Tampa Bay has been able to reduce pollution loads, Florida coasts have been hit on both sides by harmful algae blooms. Red tide has plagued the west coast, and green tide the east coast. The driver in both of these cases is effluent from Lake Okeechobee, the large natural lake in the middle of the state. Lake Okeechobee receives agricultural runoff from grazing lands to its north and sugar plantations to its south. Heavy rains create runoff from Okeechobee that gets carried away into the Apalachicola and St. Lucie Rivers, which respectively drain to the west and east coasts of the Florida peninsula. The resulting marine ecosystem disasters caused by the harmful algae blooms became a political hot potato during the 2018 Florida senate elections, with candidate Governor Rick Scott blaming Senator Bill Nelson for not getting funding for the Army Corps of Engineers to increase the water carrying capacity of the levees in Lake Okeechobee, and Nelson blaming Scott for cutting funding to the state's environmental restoration workforce.

### Chesapeake Bay

In 1987 state governments within the Chesapeake Bay watershed, along with D.C. and the EPA, signed a compact agreeing to reduce nutrient loads in the bay by 40% by 2025. Since then, nitrogen and phosphorus

levels have been substantially lowered, with most reductions occurring before 2009 (Figures 1 and 2). However, the Chesapeake Bay is not on track to 40% reduction by 2025, and reduction goals in 2000 and 2010 were not met. This is a serious problem for state-level policymakers, because when the loads could not be reduced voluntarily by 2010, the Clean Water Act federally mandated a Total Maximum Daily Load (TMDL) for nutrient run off assigned to individual states.

Agriculture pollution must be reduced, Boesch argued, because the easiest nutrient-load reductions, coming from improved wastewater management practices, have already been implemented. Maryland reduced its wastewater load, for example, by instituting a ‘flush fee’ on water consumption, making the polluter pay for wastewater treatment advancements. The Clean Air Act, passed in 1963 and expanded in 1970 and 1990, improved air quality by reducing emissions from coal-fired power plants. These improvements have also contributed to reducing nitrogen levels in the bay.

Agricultural runoff is by far the most substantial contributor to land-based nutrient pollution in the Chesapeake Bay, and those run offs have come down only slightly since 2010. Policymakers are developing creative solutions to deal with agricultural runoff. One idea is to pay agricultural polluters to make necessary upgrades to their operations that would reduce their nutrient load output.

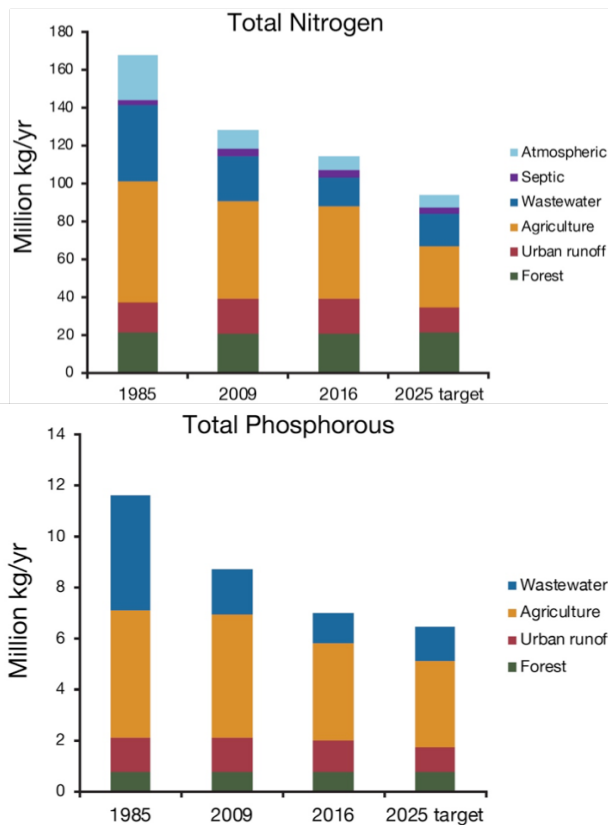
Reducing ongoing nutrient runoff is only one challenge. Legacy phosphorus has built up in soils over time, and these nutrients can leak out of enriched soils for years. Climate change has also created a moving target for bay restoration, as rising bay water temperatures can increase marine microbes, increase the bay’s volume, and lengthen agricultural growing seasons, further amplifying the effects of nutrient offloading.

#### Hypoxia and Nitrogen Cycling

While targets have not been met so far, there has been enough nutrient reduction in the bay to already see tangible signs of improvement. The low-oxygen dead zone in the Chesapeake Bay is getting smaller. This is creating a positive feedback loop. As oxygen levels increase in the deep water of the Bay, the amount of ammonia that accumulates from the degradation of organic matter decreases, while the amount of nitrate is going up. This indicates that the ammonia is being nitrified – is becoming nitrate. Microbes can take nitrogen out of marine systems and release it into the atmosphere through a process called denitrification, which can only work with nitrate, rather than ammonia. This process is one way in which improvements build off of each other.

#### Biological Improvements

Submerged aquatic vegetation, similar to the sea grass in Tampa Bay, are increasing. The amount of acreage has doubled since the compact was signed. However, one genus of seagrass, *Zostera*, is declining in the southern part of the Chesapeake Bay. Boesch hypothesized that this was due to climate change, as *Zostera* thrives in colder waters and the Bay is warming. Another recent study showed multiple indicators: dissolved oxygen, water clarity, submerged aquatic vegetation, all improving in the Chesapeake Bay, consistent with the downward trend in nutrient loads.



Figures 1 and 2: Total nitrogen and phosphorous levels in Chesapeake Bay compared to 2025 target. Pollution from agriculture remains almost unchanged for both nutrients. [www.chesapeakeprogress.org](http://www.chesapeakeprogress.org)

## Legal Battles

Policies implemented since 1987 have reduced nutrient pollution and improved the ecosystems of the Chesapeake Bay. Agricultural runoff remains the biggest obstacle. In 2011, the American Farm Bureau (AFB), along with several agricultural businesses, sued the EPA to stop the application and implementation of the TMDL to reduce nutrient runoff. AFB argued that TMDLs were not lawful and that it was unconstitutional for a state upstream to put requirements on a state downstream – states should only be responsible for the water quality in their own state. The initial district court and the appeals court ruled against the AFB, and the Supreme Court declined to hear the case. Boesch noted that the AFB lawsuit was only loosely related to Chesapeake Bay agriculture. Rather, the AFB was concerned that a TMDL precedent set on the Atlantic Coast could be later applied to more agriculture-heavy regions in the Midwest and drain into the Mississippi River Basin.

There are other general push-backs to agricultural nutrient runoff reform. Boesch recounted an instance where new regulation could be implemented in the state of Maryland after a harmful algae bloom threatened locals with a listeria outbreak. A possible public health crisis was able to overcome agriculture industry objections and a modest reform was implemented requiring farmers to design individual plans showing how they are being efficient in their nutrient use (although following those plans was not a requirement).

## The Gulf of Mexico

There is a large dead zone in the Gulf of Mexico caused by agricultural runoff transported by the Mississippi river. Hypoxia in some regions of the Gulf, particularly near the Louisiana and Texas coastline, is such that oxygen levels are too low to support shrimp fisheries. An assessment of the dead zone was carried out by coastal states in 2000. Those states, along with the EPA, in 2001 signed on to an agreement that by 2015 the size of the dead zone would be reduced by about two-thirds, to no more than 5,000km sq. Since then, Boesch observed, no improvements have been made and the dead zone is about the same size as it was in 2000. No data was collected in 2016. That year it was decided NOAA would use the money for the data-collecting expedition from its fleet operations budget. This meant that a NOAA vessel would have to be used in the expedition instead of the vessels that had been used in previous years. The NOAA ship was too large to enter the shallow water of the dead zone, and this, coupled with a mechanical failure, made it impossible to collect dead zone data that year. Boesch observed that this mix-up illustrates the difficulty of coordinating agencies and conducting research in the federal government.

Goal setting by individual polluter states is one of the main policy levers that drove pollution management upgrades in the Chesapeake Bay. In the Gulf of Mexico, there has been a reluctance by policymakers to even identify a nutrient load goal, much less allocate reduction goals to the states. In 2013 when it became obvious that the two-thirds dead-zone reduction goal would not be met, the parties came together and decided to extend the goal to 2035. They established, but did not make individual commitments towards meeting, a 45% reduction in nitrogen and phosphorus, along with an interim goal of 20% reduction by 2025.

### Climate Change and Land-Based Pollution

Climate change is exacerbating the negative effects of land-based pollution on marine habitats and ecosystems. Environmental variables such as wind speed, precipitation, and temperature all impact the distribution of ocean pollutants. As climate change alters how these factors function and interact, pollutants are becoming **more likely** to reach more remote areas.

**Biomarkers** used to better understand and measure the effects of toxic pollutants on marine life may also become less useful due to climate change. Organisms commonly used as biomarkers may no longer exist in sufficient numbers in certain areas because of changes in migration patterns. Additionally, contaminants' environmental persistence and likelihood to be taken up by organisms may change with changing salinity, pH, and temperature, all of which are changing with the climate. Organisms unable to migrate will experience increased stress, compromising their health and ability to survive.



As of 2018, still no progress has been made reducing the Gulf's dead zone. Advances in increasing efficiency in fertilizer use and application have been cancelled out by an increase in production of corn-based ethanol. Boesch further argued that a lack of assigned responsibility to each state has lowered the urgency for individual states to reduce their nutrient loads.

#### The Baltic Sea and Policy Solutions

The Baltic Sea is home to a large and growing dead zone, and a recent [paper](#) published in Science Advances suggests that the Baltic Sea could be seen as an example of how other marine bodies could look in the future after more years of degradation due to industrialization, pollution, and climate change. The Baltic Sea has seen large decreases in oxygen levels, decreases in water transparency, increases in blue green algae, and decreases in cod and herring stocks. This comprehensive report was funded by the BONUS program, which is jointly funded by the European Union and countries bordering the Baltic Sea, with the express purpose of studying Baltic Sea ecosystems and pollution issues. Boesch commented that the BONUS program could be used as a model to other national cooperative research initiatives around the world.

#### Plastic Pollution

Global plastic production has increased dramatically since the 1950s, and plastic ocean pollution has become a recurring topic in scientific research and the broader public debate over the past 10 years. The leaders in plastic production that could end up in the ocean are China (27%), North America (18.5%) and Europe (18.5%). Microplastics have been found in remote corners of the world, including in the Mariana Trench – the deepest part of the ocean.

Rates of plastic ingestion in seabirds and sea turtles have increased significantly since the 1950s. Boesch likened the crisis to Rachel Carson's *Silent Spring*, a seminal environmental book exposing the effects of the chemical DDT on wildlife. The chemical effects of microplastics on sealife are less well understood or studied, but evidence is being uncovered that shows how microplastics can be ingested and moved through the food web.

Some policies, such as straw or plastic bag bans, have been developed to address this issue at the local and city level. Some countries have also begun regulating plastic use and production. Large retailers, such as Walmart, can also regulate their supply chains to reduce plastic in shipping. Although improvements in waste management and recycling are generally good, the most effective way to reduce plastic pollution, Boesch noted, is to produce and consume less plastic across the board.

To view the PowerPoint associated with this presentation, click [here](#).

# Ocean Noise and Marine Life

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## Introduction

In the oceans, sound can travel extremely long distances. Marine life has adapted to take advantage of this reality by using acoustic communication to find food, mate, and sense their surroundings. Underwater noise pollution from anthropogenic sources is interfering with this communication and harming sea life. **Jason Gedamke** discussed the impacts that anthropogenic noise is having on marine mammals and what NOAA is doing to better understand and reduce these impacts.

## The Importance of Acoustic Communication to Marine Life

Communication is essential to all animal life. It exists in many forms, such as tactile, visual, chemical, and acoustic. Over long distances underwater, most forms of communication are not practical. For example, water filters light, making it impossible to see long distances. However, sound can travel very efficiently in the ocean. To illustrate this, Gedamke described the Herd Island Feasibility Test, an experiment conducted in the early 1990s. In the test, sounds were played from the Southern Ocean in the Sound Fixing and Ranging (SOFAR) channel, a channel underwater that focuses sound and allows it to travel very long distances. Even when they were testing the speaker before the experiment formally began, the sounds coming from it could be heard all the way across the world in Bermuda. This demonstrates the immense efficiency with which sound can travel in the ocean, which is the reason why marine life has evolved to rely on it so heavily.

To survive and reproduce, marine animals need to attract mates, defend territories and resources, establish social relationships, coordinate feeding, interact with parents or offspring, and avoid predators and other threats. For all of these functions, acoustic communication is essential, and external interference is detrimental. While the ocean has always had natural

background noises like ice cracking, lightning strikes, noises from animals, etc., the phenomenon of man-made sounds dominating the ocean is relatively recent and is interfering with ocean life.

## Forms of Anthropogenic Ocean Noise

Anthropogenic ocean noise comes in many forms. Sometimes it is brief, like that from a construction project; other times, it is chronic and long-term, such as seismic surveys for offshore oil and gas. More human activity in the ocean means more anthropogenic noise, and more impacts on marine life. These impacts are generally more severe the louder a sound is and the closer a marine animal is to its source. At their closest and loudest, acute ocean noises can cause tissue damage and hearing loss in animals. As the distance from the sound source grows, effects are generally restricted to masking of natural noises used for communication, and behavioral disturbance (eliciting unnatural responses from animals). Past these ranges, noises can still be audible, even if they do not cause serious problems to marine life.

Gedamke discussed some of the specific sources of anthropogenic noise in the oceans. These include shipping traffic, naval activity, and offshore oil, gas, and wind energy development. Shipping traffic generally produces moderate and steady background noise that can lead to the masking of noise from marine mammals. While there are hypothetically ways to make ships quieter, such as adapting propeller and hull designs to produce smaller wake fields, the case needs to be made to shipping companies that these changes are a worthwhile investment.

Noise from naval activity in the oceans can also interfere with marine life. Gedamke noted that sonar from navy ships can mimic noises made by predators, sometimes invoking predator responses from whales and causing them to become beached. However, the U.S. Navy has also been the largest funder of marine mammal and noise research in the last two decades,

and has worked closely with NOAA to minimize the impact that its traffic has on marine life. The most effective method to minimize impact is simple: plan activities in times and locations when and where species of interest are not present.

Offshore energy development, in the form of both wind energy and oil and gas exploration, was also discussed as a source of anthropogenic ocean noise. These two offshore sources of energy produce different types of noise. The acoustic impacts of wind turbines on ocean life are restricted to the construction process. Pile-driving turbine supports into the seabed produces a massive amount of noise but regular, everyday operation of wind turbines is quiet. Thus, the impact of offshore wind development on marine ecosystems can be minimized by planning construction in times and locations that will be minimally disruptive to sensitive species.

Offshore oil and gas development causes a different problem, stemming from seismic surveys conducted to determine where to drill. These noises are chronic and have demonstrated impacts on marine mammal species. However, studies about their impacts on other sea life, including plankton and larval fish, are still in early stages. According to Gedamke, more information will be necessary to understand the full effects of seismic surveys on these types of species. In the meantime, he said, monitoring will provide essential information to mitigate potential impacts.

### **Current Forms of Noise Management and Goals for the Future**

In the past, noise management was largely on an activity-by-activity basis, trying to understand and control noises coming from individual sources. These analyses of ocean noise looked at short-term, small-scale effects, like whether animals will change their movement patterns or be hurt by a specific activity. Efforts to limit sound levels and make informed decisions about where and when to conduct ocean activity have been very important to the process of limiting anthropogenic ocean noise, and will continue to be in the future.

However, Gedamke noted, this activity-to-activity management is not sufficient. Looking to the future, much more emphasis is being placed on long-term wide-scale activities, and looking at cumulative footprints from multiple source types. Additionally, currently, high-intensity and transient noise sources are often regulated, while in the future, chronic lower-intensity sources will receive more attention. Future goals also will include consideration for ambient noise variability (both natural and anthropogenic) and will emphasize impacts to a wider variety of marine animals and habitats than are currently considered.

### **NOAA's Ocean Noise Strategy**

NOAA has developed and is implementing a strategy to identify and address noise impacts on marine species and habitats. Gedamke presented this strategy as it was developed, in three phases:

#### **Phase I: CetSound (Cetaceans and Sound)**

The CetSound Program began in 2010 with the goal of developing tools to help comprehensively address the cumulative impacts of anthropogenic sound in the ocean. This program began with two working groups in 2011 aimed at developing two tools: CetMap and SoundMap.

The Cetacean Density and Distribution Mapping Working Group (CetMap), compiles all the data that NOAA has about the distribution and density of marine mammals. This includes everything from the highest-level modeling and survey data to data from individual observers saying that they saw a certain animal in a certain location. A focus of the program is descriptive mapping and public accessibility to products.

The NOAA Underwater Sound Field Mapping Working Group (SoundMap) compiles and maps sound patterns in the oceans. This includes data from individual, localized activities like the construction of wind farms, as well as basin-wide data from chronic and widespread background noise deriving from sources such as shipping traffic. The tool can also take data from these different sound sources and layer them over each other to create a

cumulative sound map of a region.

NOAA then combined these two tools to allow overlaying of sound maps and marine mammal population maps. The combination of these data allows for visualization of where the highest densities of marine mammals line up with the highest densities of anthropogenic ocean noise. This tells NOAA where they should be focusing their attention most closely to determine whether anthropogenic sound is having a negative impact on sea life.

### **Phase II: Ocean Noise Strategy Roadmap**

Based on numerous recommendations, NOAA developed a document called the Ocean Noise Strategy Roadmap to define the agency's goals for the next ten years regarding ocean noise. They divided these goals into four categories. First, to support science to fill in existing knowledge gaps and build understanding of noise impacts over ecologically-relevant scales. Second, to implement effective management, integrating actions across the agency and minimizing effects of noise on marine species and their habitats. Third, to develop publicly-available decision support tools, such as the previously discussed CetSound mapping tools. And fourth, to conduct outreach and better educate the public about this issue.

The full roadmap document can be found at [cetsound.noaa.gov](https://cetsound.noaa.gov). It summarizes the status of the science and management of noise impacts on protected marine taxa, outlines intent to support better marine acoustic habitats, and outlines broad recommendations for better addressing noise impacts through NOAA science and management activities.

### **Phase III: Implementation and Flagship Projects**

After the publication of the Roadmap in 2016, NOAA began work to achieve its goals. One way that it did this was through the NOAA Noise Reference Station Network. This program consists of a series of monitors placed throughout the ocean to conduct low-frequency, long-term passive acoustic monitoring. Basically, it is a listening network throughout U.S. waters. With these monitors in place for decades to come, NOAA scientists will be able to define and compare soundscapes for different areas of U.S. waters with different traffic conditions. The most important aspect of this project is understanding whether sound levels are continuing to increase in the ocean. Importantly, NOAA has placed one monitor in the Arctic, which represents the closest thing to a neutral baseline for shipping noise. However, this is expected to change in the future as sea ice extent shrinks and the Northern Sea Route opens up, so it is very beneficial to have baseline data before that happens.

### **Conclusion**

In summary, sound can travel incredibly large distances underwater, and so marine life has adapted to take advantage of this reality. Sound from human activities has fundamentally changed ocean soundscapes but the extent of this change is still not fully understood. NOAA's Noise Ocean Strategy is aiming to better understand and manage the impacts of ocean noise on sea life.

To view the PowerPoint associated with this presentation, click [here](#).

# Regional Coastal and Marine Spatial Planning

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## Introduction

Much of the ocean's value comes in the form of the ecosystem services that it provides. These include transportation, jobs, spiritual value, recreation, shipping, wind, and countless others. **Betsy Nicholson**, the north regional director for the National Oceanic and Atmospheric Administration (NOAA) Office of Coastal Management, discussed the importance of properly managing this indispensable resource and the most effective strategies that her office has used to do so in the Northeast.

## Merits of Ocean Planning in the Northeast

Ecosystem services from the oceans are only going to increase in value as technology, the economy, and ecosystems continue to change. As this happens, the growing challenge is how to view all of these ecosystem services together as an integrated system. There are over 140 laws giving different jurisdictions the authority to govern, manage, and study different parts of the oceans, so decisions are usually made on a prescriptive basis without consideration of wider contexts. In a vacuum, there is no incentive for agencies to look past their single-sector authorities. This is what makes regional planning for the oceans so important, and at the same time, very difficult.

Regional ocean planning does not work well everywhere. Nicholson described the beneficial set of circumstances in the Northeast that led to the success of the program there. There were a set of pre-existing relationships that facilitated further cooperation. For example, a volunteer ocean partnership called NROC (Northeast Regional Ocean Council) had been in place for more than ten years, and had already brought federal and state governments together to talk about these types of issues. This created networks in which people knew and trusted each other and were accustomed to working together.

There also are precedents at other scales. For example, Massachusetts and Rhode Island already had state-level legislation in place. This caused their constituencies to become accustomed to the process of ocean planning and created seasoned state leaders.

Legal impetus also played a role in the initiation of Northeast regional ocean planning. Executive orders can be used to get federal agencies like the Army Corps, Federal Energy Regulatory Commission, and others that are not necessarily a part of these activities to get involved. However, Nicholson emphasized that when talking to constituents, the phrase "executive order" should not be used because it can create an unfavorable perception of the federal government overstepping its jurisdiction.

Ocean planning also requires public process, which costs money to conduct and is rarely included in the budgeting process. Fortunately, in the Northeast many areas had some private foundation funding to convene stakeholders. Importantly, this included native tribes, who often did not have the capacity to get to these meetings on their own but whose attendance was vital.

Finally, any successful ocean plan requires real drivers to motivate action and cooperation – there needs to be a real, concrete problem that planners are trying to solve. Nicholson emphasized that, while these are all reasons that the Northeast is an ideal environment for ocean planning, they are also the reasons why efforts have been less successful in other regions.

## Methods Used in the Northeast

The Obama Administration's National Ocean Policy provided the structure that initially allowed this level of ocean planning to take place on a regional scale. This policy provided a prescriptive framework for regional ocean planning, which was adapted to work well with individual jurisdictions. From the beginning of the process, a key focus was asking what the

problem was that needed to be solved. The problem that was identified was a lack of information and coordination around the important emerging issues in the near offshore waters of the Northeast. Since political boundaries have no bearing on ecosystems, cooperation to facilitate the preservation and use of ecosystem services requires regional ocean planning.

The National Ocean Policy prescribed the stakeholders who would comprise the Northeast Regional Planning Body. These include states, the Fishery Management Council, federally-recognized tribes, federal agencies, and *ex officio* neighbors. Luckily, these Northeast stakeholder groups all have about the same number of representatives. This is not the case in some other areas like the West Coast, which has three states and over 200 tribes. Goals that the planning body determined were priorities were maintaining healthy ocean and coastal ecosystems, effective decision-making, and compatibility among ocean uses. Nicholson categorized these uses, both existing and emerging, into ten groupings: marine life and habitat, national security, aquaculture, restoration, commercial and recreational fishing, offshore sand resources, cultural resources, recreation, marine transportation, and energy and infrastructure. These are all categories that the Northeast Regional Planning Body wanted to improve.

The ocean planning process began with an outreach and engagement stage in 2012. This took place through a series of regional stakeholder forums and workshops, state public meetings and advisory groups, targeted outreach to specialists in relevant fields, social media and website engagement, and pre-existing meetings and events. Providing the forums for all stakeholders to have their voices heard was foundational to the success of the program.

The outcomes that the framers of the Northeast Ocean Plan intended to achieve were threefold: public transparency of decisions made, predictability from history, and accountability from across government. Nicholson explained these goals by outlining the measures that are being undertaken to ensure that they are achieved. First, the Northeast Ocean Plan makes accessible an unprecedented amount of integrated ocean information, available all at once, in the same place, for use by the ocean-management and planning community. Second, it created an expectation that federal agencies would use this platform to directly guide and inform their regulatory management decisions. Informing and improving the work of government is a high priority, as a series of best practices for the government to work better and engage the public were included as well. The plan also helps to identify conflicts, capabilities, and potentially affected stakeholders. Third, it aims to identify what is not yet known, and future priority science and research needs.

One indispensable tool created to achieve these goals is the Northeast Ocean Data Portal, a publicly accessible resource compiling authoritative data and organizing it into relevant themes. Nicholson emphasized that this is only one tool for ocean planning, not the only one. It is meant to give context so that the right people can be engaged and the right questions asked. NROC, which maintains the portal, is also working with fishermen to improve their data. For example, fishermen can help to understand where vessels are transiting, versus where they are actually fishing. Nicholson emphasized that the maps included in the portal are purely factual, untied to an agenda, and only seek to convey data sets accurately.

Nicholson described the process of using the Northeast Ocean Plan to inform decisions. This begins with providing background on each ocean resource or activity, describing why each is important to ocean management and describing the specific regulatory and management landscape. Maps and data from the portal are then applied to ensure that all subsequent decisions are well-informed using the best available information. And, finally, a series of regulatory and management actions are identified by Regional Planning Body agencies. The National Ocean Policy was an executive order, and so only applied to federal agencies; states and tribes are volunteers. Therefore, it is important that the Northeast Ocean Plan direct federal agencies on how to best carry out their existing mandates. This includes schedules on when agencies must update their data, as well as specific directions on how to use it to inform their decisions. The plan also serves to enhance interagency coordination.

Importantly, all of the guidelines on how federal agencies should implement their directives were written by the agencies themselves.

Implementation of the plan begins with an agreement across agencies to use relevant information from the portal, plan, stakeholders, and other sources. Proper use of this information allows agencies to fully understand the proposed project and broader issues early in the process, which is vital. Additionally, an informed and engaged constituency is essential, for which full transparency is very important. And, finally, coordinated review among federal and state agencies and native tribes is necessary.

### **Outcomes**

Nicholson continued with an overview of the results that have been achieved to date. There has been massive use of the Northeast Ocean Data Portal, in diverse contexts like New England Fishery Management Council meetings, NOAA charts, and NEPA reviews. The program has also been instrumental in the founding of the first shellfish aquaculture program in Atlantic federal waters, helping to gain valuable background on siting to avoid harming sea life and obstructing ocean traffic. It has also had other valuable applications, like working with native tribes to identify culturally sensitive areas, siting a wave-monitoring buoy in Cape Cod Bay, and inspiring K-12 students to investigate the ocean ecosystem and ocean uses.

Importantly, the Northeast Ocean Data Portal is informing planning for offshore wind energy development. Offshore wind in the Atlantic near the Northeast is a rapidly emerging activity. Large wind resources off the coast and the proximity to major population centers, means that the area is excellent for erecting wind turbines. However, it is also an area busy with traffic from shipping, Coast Guard, and fishing vessels. Therefore, planning is important to ensure that turbine locations are compatible with sea lanes.

### **Political Windows of Opportunity**

To conclude her presentation, Nicholson discussed political windows of opportunity that can be found for ocean planning in the current administration. She noted that the programs in the Northeast managed to continue working past the National Ocean Policy's repeal in 2018 due to strong pre-existing relationships that do not rely on federal directives. Additionally, while ocean policy has steadily evolved over time, it always keeps one central theme: using better data for better decisions and transparency. Keeping policy grounded, timely, and data-driven are very important. While the current administration has shifted away from some of the more conservation-oriented aspects of the Obama policy, planners have continued to center efforts around a data-based approach since the repeal of the National Ocean Policy. This approach was one of the primary reasons that ocean planning was initially successful in the Northeast, and continues to be today.

To view the PowerPoint associated with this presentation, click [here](#).

# Offshore Wind Energy

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## Introduction

Offshore wind energy is becoming an increasingly viable and important technology for facilitating the sustainable energy transition in the United States and around the world. However, this innovation comes with a wide array of challenges. **Bonnie Ram** discussed the history of offshore wind in the EU and U.S., as well as many of the technology's benefits and challenges.

## Lessons Learned from the EU

Ram began her discussion with a background of offshore wind energy in the EU, and how the U.S. can learn from Europe's experience. Eighty-eight percent of the world's current offshore wind capacity is in Europe, making it the most important role model for development elsewhere. One country that has been particularly successful is Denmark. It pioneered offshore wind and has successfully transitioned from the use of centralized power plants to the use of countless decentralized wind farms. However, even Denmark has not finished developing offshore wind capacity. Turbines are becoming larger and more efficient, and a more regional approach is being taken to share and diversify different types of low-carbon electricity across borders and add resiliency to their own system.

From the EU's experience, the U.S. can also learn lessons about the environmental impacts of offshore wind. One such impact is the effect on bird migration patterns. Some species of birds will attempt to fly through wind fields, causing casualties as many of them to fly into the turbines. However, other species fly around turbines, which can have other impacts on their migration but is better than their flying into the turbines.

The construction of wind turbines can also produce high levels of noise due to the pile-driving process, which can be detrimental to marine mammals and other animals. The Germans have spent many years of

investigating which technologies are the most effective in reducing sound. These include bubble curtains (which are already used in oil and gas platforms), and hydrosound dampers and sleeves placed around turbines during construction. While all of these measures work to varying degrees, all are very expensive.

Ram also discussed the EU's motivations to develop offshore wind at such an accelerated pace compared to the rest of the world. Primarily, their goals are to combat climate change and hedge against a lack of domestic energy sources. The latter does not apply to the U.S. due to its wealth of oil and gas resources but climate change remains a motivator that could apply to the U.S.

The EU also pioneered Strategic Planning Areas, or planning the construction of offshore wind turbines to avoid sensitive species. However, there are other factors to consider when deciding where to place wind turbines offshore. Construction closer to the shore is easier but has other implications, including interference of ocean views.

## Why Offshore Wind?

Ram discussed the reasons why offshore wind is a viable opportunity in the U.S. First, the U.S. has a massive potential offshore wind energy resource. This represents an opportunity to decarbonize a large proportion of its electricity generation mix. Much of this potential is located near America's largest energy markets along the eastern seaboard. These markets are currently facing significant coal and nuclear plant retirements. Additionally, energy production from offshore wind would correspond with peak demand, offering an increasingly valuable and cost-competitive energy source. Finally, if developed responsibly, offshore wind power can have minimal impacts on coastal and marine wildlife.



## Brief History of U.S. Offshore Wind

Ram summarized the U.S.'s brief history with offshore wind energy. Her timeline began in 2001 when the first Cape Wind permit was granted by the Army Corps of Engineers. In 2005, the Energy Policy Act was passed, and final regulations about how the industry could proceed were approved in 2009. However, the first competitive lease was not sold until 2013, before the first pilot plant was opened near Block Island, Rhode Island in 2016. In 2018, there are 10 GW of project plans and commitments – signaling increasing ambition to grow this industry in the near future.

The Bureau of Ocean Energy Management (BOEM) coordinates the federal ocean lease process for offshore wind. It collects sale and annual revenues and uses them to fund environmental and social science studies. It also coordinates the National Environmental Policy Act process and public hearings. The planning process that BOEM oversees is very long, and the policy impacts of its decisions can last more than 30 years: three years of siting and permitting, two years of construction, 25 years of operation, and two years of decommissioning.

Recently, there have been rapid changes in offshore wind opportunities in the U.S. making development more viable. Improvements in technology, primarily turbine size, along with policy developments, have made wind energy cost competitive with other forms of electricity generation. This has led to the commitment of a very large market expansion of 10 GW over the next 10 years.

The Block Island, Rhode Island, 30 MW turbine project began with the goal of reducing dependency on diesel fuel for electricity. Its location contributed to its success. A supportive governor, a local developer, and other existing relationships helped it get it underway. The University of Rhode Island and the state funded many of the studies that led to its completion.

Ram listed some lessons learned from Block Island that can be applied to future offshore wind developments in the U.S. Scaling up is important. Block Island is comprised of only five turbines, a very small number compared to European offshore wind fields which can have over 100 turbines. Another lesson is that site planning and species conservation are specific within each regional and ecological context, and should be considered as such. Also, a comprehensive and inclusive planning process across different regional stakeholders, including ongoing risk communication, is essential. This planning process can lead to the development of community benefits for stakeholders, like the commercial and recreational fishermen in the Block Island area.

## Key Environmental Principles

While offshore wind turbines represent an opportunity to decarbonize electricity generation, they are not without their own environmental concerns. The turbine construction process can cause sound at levels damaging to marine life. Once built, turbines can also be harmful to bird populations, either as a deadly obstruction to their flight paths or by rerouting migratory patterns. The damage that turbines can cause to birds and marine animals are very important to discuss and address early in the planning process, starting with siting and planning. Decisions made in this stage should be informed by the best available data, effective expert and stakeholder engagement, current ocean planning efforts, and ongoing, comprehensive monitoring. The mitigation of environmental problems should continue throughout all stages of development, through the construction, operation and maintenance and decommissioning process.

## Public Concerns and Values

Ram also noted that environmental issues are not the only considerations when planning and constructing offshore wind turbines. Often, there are concerns over visibility of turbines and the aesthetics from the shoreline. These can include considerations about the spiritual value of the ocean, often from native tribes. In addition, risks and benefits must be distributed fairly among stakeholders, and transparency and inclusivity are of paramount importance in the decision-making process.

## Conclusion

Ram ended her presentation with an overview of offshore wind energy's role in moving forward with the sustainable energy transition. Currently, rapid policy changes and commitments for more in-state utility scale offshore opportunities are happening. However, it is important to ensure that proper planning goes into these new developments. Technology is also changing at a rapid rate, as more advanced installation methods and larger and more efficient turbines become available. Lessons about how to approach these rapid changes in policy and technology can be learned from the EU and Block Island, both of which have had robust planning processes. And, finally, state and federal agencies should actively engage with stakeholders to quantify and address risks and benefits of offshore wind. Offshore wind energy has the potential to be an important asset in the sustainable energy transition, but for it to be successful proper planning and collaboration are necessary.

To view the PowerPoint associated with this presentation, click [here](#).

# Offshore Petroleum Exploration and Exploitation

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## Introduction

The British Petroleum Deepwater Horizon disaster in 2010 prompted numerous reforms to offshore oil and gas drilling safety rules, many of which have been modified and rescinded by the Trump Administration's 'America First' energy agenda. **Tommy Beaudreau** helped to develop and lead the Department of the Interior's reforms of offshore energy management in the wake of the blowout. He later served as first director of the Bureau of Ocean Energy Management (BOEM) from 2011-2014.

## Reforms after the BP Deepwater Horizon Macondo Well Blowout

The Macondo well was about 50 miles off the coast of Louisiana. The well itself was a mile deep, and the reservoir was two miles further beneath the seafloor. The BP Deepwater Horizon was a mobile offshore drilling rig. It was dynamically positioned through a series of engines and controls, and then was connected to the seafloor through a riser system that connected to the well's blowhead.

On April 20, 2010, there was a blowout. Eleven workers were killed, 17 injured. The well flowed uncontrolled for 87 days before an improvised cap stack system was able to arrest the well. It was another month before a relief well that was being drilled parallel to the Macondo well during the spill was in a position to cement the well and "kill" it.

The blowout resulted in an estimated 4.9 million barrels of oil spilled in the Gulf of Mexico (observed a [NOAA report](#) published in 2011). Scientific studies on the effects of the spill are still ongoing. (Many studies on the environmental impacts of Deepwater Horizon have been released, including a 2012 [feature](#) from the National Academies of Science) There were multiple attempts to close the well in the immediate emergency response. One attempted to activate the shear rams, a fail-safe mechanism that would immediately cut off the well. As later discovered, the shear rams had already activated during the initial blowout, but had hit the pipe at an angle and failed to seal the well. Another attempt to close the well

included a 'top hat' containment device, which would have ideally fit over the well head and controlled the flow through a system of hoses. However, because the well was a mile under the ocean, methane hydrates would form underneath the top hat, creating enough buoyancy to keep the top hat from fitting correctly.

While the effort to cap the well was underway, then-Secretary of Interior Ken Salazar imposed a moratorium on any new offshore drilling (only new exploration drilling – not affecting ongoing production). The rationale behind the moratorium was 1) authorities needed to understand the current blowout and determine what changes needed to be made to reduce risk and improve safety operations, 2) all of the response assets available to the U.S. were already deployed for the BP Deepwater Horizon spill – there wouldn't be enough available to respond to a second blowout, and 3) with oil still spilling into the Gulf, authorities needed to develop a cogent plan to present to the American people on what they would do should this happen again.

On the state level, Louisiana was experiencing both an economic and environmental calamity. The offshore oil and gas industry provided tremendous economic activity to the state. While the Louisiana coast was being hurt by the oil spill, the drilling moratorium caused anxiety among citizens that rely on the industry for their livelihoods.

There were multiple investigations into the root causes of the spill, including from the president's National Commission on the BP Deepwater Horizon Spill, which put out a host of recommendations. Others included a joint investigation between Interior and the Coast Guard that attempted to discover engineering failures leading to the blowout.

There was an immediate regulatory response during the moratorium in the form of emergency rulemaking, covering new requirements on well design and blowout preventer functionality. The Safety and Environmental Management Systems (SEMS) rule was established, which covered new standards for how crews work on rigs and improved performance-based

standards for how offshore drilling operations manage risk. Additionally, the Department of the Interior produced notice to lessee (NTL) 2010-N10, which provided new guidance on subsea contaminants. NTL 2010-N10 required lessees to get a permit to drill on the Outer Continental Shelf (OCS) and demonstrate the capability to deploy containment systems similar to those that were ultimately used to cap the Macondo well.

After NTL 2010-N10 was issued, the Department of the Interior lifted the drilling moratorium. In 2016 the Well Control Rule was developed, which was the capstone of the federal government's research and investigative efforts. The Rule contained many provisions which are still in effect, such as those outlining a safe drilling margin within the wellbore – the amount of pressure that is high enough to contain hydrocarbons, but low enough to prevent fracturing surrounding geology. The rule also covered testing the functionality of blowout preventers, and guidelines making sure wells are contained before being abandoned. One thing that never happened, Beaudreau observed, was that the U.S. Congress never enacted formal legislation on drilling reforms – which the Obama administration had advocated – and there was fear that some of rules could come undone in another administration.

The Department of the Interior also took a hard look at the federal oversight of offshore drilling. The Minerals Management Service (MMS) was criticized for potential conflicts of interests between divisions that conducted National Environmental Protection Act (NEPA) environmental reviews, planning oversight, and revenue collection. Those functions were broken apart with a reorganization of MMS. The Bureau of Safety and Environmental Enforcement (BSEE) was created to take on the oversight and monitoring roles of MMS. The Bureau of Ocean Energy Management (BOEM) took over MMS's NEPA reviews and leasing allocation functions.

### Leasing After Deepwater Horizon

The DOI issues five-year oil and gas leasing plans under the Outer Continental Shelf Lands Act. A five-year plan is a schedule for potential lease sales, which can be cancelled and do not have to be held but Section 18 of the Outer Continental Shelf Lands Act establishes a schedule identifying when and where offshore oil and gas lease sales will occur in a given planning area.

After BP Deepwater Horizon, the last five-year plan put into place by the Obama Administration, which is in effect until 2021, focused on leasing in the central and western Gulf of Mexico. There were a few reasons for this, 1) the Gulf of Mexico is one of the most prolific basins in the world for oil and gas, 2) Gulf of Mexico geology is understood very well, 3) there is already a strong network of infrastructure to support the oil and gas industry in the region. While the Obama Administration considered opening the Atlantic Coast to drilling, those areas, along with the Alaskan Arctic, were not scheduled for lease sales. Late in the Obama Administration, Obama used an executive order to withdraw most of the Arctic from future leasing considerations, with some exceptions.

### Since 2017

The Trump Administration has developed an America-first energy policy and Trump's first Secretary of the Interior Ryan Zinke made establishing energy dominance a priority for the DOI. On March 28, 2017, Trump issued an executive order promoting energy independence and economic growth, requiring actions in all agencies to be placed in the context of whether they put undue burdens on domestic energy production. Another executive order was issued the next month implementing an America-first energy strategy, which rescinded Obama's leasing withdrawals in the Arctic and directed the DOI to draft a new five-year leasing program that would be considerably more expansive than Obama's. The executive order further directed agencies to advance the permitting of seismic surveys in the Atlantic, and required agencies to review and potentially modify a series of existing rules, including well control rules. A few days later, Zinke announced Secretarial Order 3350, his America-first strategy to implement Trump's executive order.

Under the Outer Continental Shelf Lands Act there are three steps to revising a five-year plan: 1) a draft proposal program, 2) a proposed program, and 3) a final proposed program. The Trump Administration took the first step last January, and their draft proposal included the entire outer continental shelf under U.S. management as available for potential leasing. The only planning area that was not claimed was Bristol Bay, the north Aleutian basin off of Alaska, which is a critical salmon fishery that Obama had previously withdrawn from leasing.

Opening up almost all planning areas, Beaudreau commented, was meant to show how much more accommodating the new administration was to offshore oil and gas than its predecessor. The proposal was met with a great deal of objections from both Democrats and Republicans. Zinke later met with Florida Governor Rick Scott and announced that there would be no leasing off the coast of Florida. Soon after, leaders from other states began demanding the same deal. Beaudreau noted that while the proposed plan sounded dramatic, people familiar with offshore geology recognized that many proposed areas, particularly in the northern Atlantic, would not be able to yield oil in an economically viable way.

The DOI intends to finalize its five-year program in 2019, which will then be in effect until 2024. The next step will be forthcoming in 2019 when the DOI releases its proposed program along with environmental impact statements. Beaudreau expects the Eastern Gulf of Mexico, which is currently under Congressional moratorium until 2022, to be in the proposal. He also speculated that BOEM will design buffers, perhaps 20-50 miles wide, around Florida to keep Zinke's promise of a Florida coastal drilling ban to the governor. The mid- and southern-Atlantic will also likely be included in DOI's five-year offshore leasing plan, along with Southern California.

Beaudreau further expects lease sales in the Alaskan Arctic, the Chukchi Sea and the Beaufort Sea. While there may be leases for sale in the Chukchi, Beaudreau does not believe that there will be much, if any, actual drilling. Shell began exploratory drilling in the Chukchi in 2015 and quickly pulled out because of escalating costs. The company had to bring in a large number of expensive support vessels due to the Chukchi's lack of already-available infrastructure. A lack of pipelines leading from the Chukchi Sea also led Shell to insist on being allowed to ship the oil out instead, which carries additional risk to marine ecologies.

While the Beaufort Sea has its own challenges, they are not as severe as in the Chukchi. The Beaufort Sea is permitting a new production facility and has some infrastructure from existing (albeit small) state and federal oil and gas drilling. Beaufort also has relatively shallow water with islands that can be used as production facilities. Compared to the Chukchi, the Beaufort has lower-risk geology as well. Even compared to the Gulf of Mexico, Beaufort's geology is lower pressure, so in the event of a blowout there wouldn't be the same volume of oil pouring out as in the Macondo well failure. However, because the Beaufort is in a more remote part of the world and is inaccessible due to sea ice for parts of the year, the infrastructure necessary to respond to a well blowout is essentially nonexistent.

Beaudreau observed that earlier in 2018 the Trump Administration decided that seismic surveying off of the Atlantic Coast, which the Obama administration decided not to permit, will move forward. NOAA has already issued incidental harassment authorization for sea life and BOEM will begin approving permits for those surveys.

Beaudreau noted that while oil and gas exploitation policies frequently change between more conservation-friendly Democratic administrations and more industry-friendly Republican administrations, geology and economic viability will always be limiting factors in oil and gas expansion. The Gulf of Mexico has the infrastructure and abundant resources that will make it operational for decades to come. Other areas such as the northern Atlantic coast and parts of Alaska, will be harder to exploit because of lack of oil deposits, underdeveloped necessary infrastructure, or inclement environmental conditions.

# Timeline of Deepwater Horizon Regulatory Response and Rollbacks

*This timeline was adapted from an on-going compilation by Harvard Law School's Environmental & Energy Law Program. Some additional details on rules have been added for clarification. The original Regulatory Rollback Tracker from HLS can be accessed [here](#). - Eds.*

Following the Deepwater Horizon explosion and oil spill, the Department of the Interior (DOI) issued rules and guidance to fill regulatory gaps in emergency response and operational oversight. Meanwhile, President Obama removed certain areas of the outer continental shelf (OCS) from oil and gas development, because of i) their proximity to productive fisheries, ii) their ecological value, or iii) their being too remote and rugged to support a proper response to spills and other accidents. (The OCS consists of ["all submerged lands lying seaward of state coastal waters...under U.S. jurisdiction."](#))

## Obama Administration

**April 5, 2016** The Bureau of Ocean and Energy Management (BOEM) / DOI proposes an [offshore air quality rule](#). The proposed rule would require the reporting and tracking of the emissions of all pollutants defined by the Environmental Protection Agency (EPA) and establish new recordkeeping and performance measure criteria, among [other](#) functions.

**April 29, 2016** The Bureau of Safety and Environmental Enforcement (BSEE) / DOI finalizes a rule to [enhance blowout preventer and well control requirements](#), including well design, casing, cementing, and monitoring upgrades.

**July 2016** Department of Commerce ("Commerce") / National Oceanic and Atmospheric Administration (NOAA) / National Marine Fisheries Service (NMFS) [finalize guidance on acoustic thresholds](#) for underwater activity, to lessen the impact of offshore development on marine mammals.

**July 15, 2016** BSEE / BOEM / DOI finalized a rule to govern exploratory [offshore Arctic drilling](#). The rule is intended to help ensure the safe, effective, and responsible exploration of Arctic OCS oil and gas resources, while protecting the marine, coastal, and human environments, and Alaska Natives' cultural traditions and access to subsistence resources.

**September, 7, 2016** BSEE issues a [final rule amending and updating offshore oil and gas production safety regulations](#). The rule covers safety and pollution prevention equipment design and maintenance, production safety systems, subsurface safety devices, and safety device testing.

**September 12, 2016** BOEM / DOI issues a [Notice to Lessees and Operators](#) (NLT No. 2016-N01) on the Outer Continental Shelf (OCS), to consider increasing financial security to meet decommissioning costs.

**December 20, 2016** President Obama issues a [Presidential Memorandum](#) withdrawing 3.8 million acres of OCS oil and gas development in the Atlantic and 115 million acres in the Arctic. All told, President Obama protects 125 million acres of the Arctic offshore.

**January 6, 2017** BOEM [denies six pending geophysical and geological permit applications](#) to conduct airgun seismic surveys in the Mid- and South Atlantic because President Obama removed the waters from leasing consideration.

## Trump Administration

**April 28, 2017** President Trump issues [Executive Order 13795](#) directing actions to reconsider the prior administration's efforts to limit or regulate offshore oil and gas development.

**May 1, 2017** Interior Secretary Zinke issues [Secretarial Order 3350](#) instructing the agencies under his purview on how to implement the Executive Order.

These two orders kick off numerous actions related to leasing, regulatory rollback efforts, and permitting, described below.

Regulatory Rollbacks:

**June 19, 2017** President Trump issues [Executive Order 13840](#) rescinding and replacing Obama's Ocean Policy (Executive Order 13547, July 19, 2010). The new order establishes a new policy regarding oceans, establishes an Ocean Policy Committee, and includes a requirement that within 90 days of the order agencies on the committee must review their regulations, guidance, and policies for consistency with the order and consult regarding any revisions or rescissions necessary. This may result in additional deregulatory efforts beyond those already tracked in this report.

### BSEE Offshore Safety Regulations Rule Update

**December 29, 2017** The Bureau of Safety and Environmental Enforcement (BSEE) [publishes a proposal](#) to [revise or rescind the offshore drilling safety requirements issued on Sep. 7, 2017](#). The proposal takes aim at rules that were crafted to prevent disasters like the Deepwater Horizon explosion. In its proposal, BSEE says it "reassessed" the original provisions in the process of implementing them and "determined that some provisions could be revised to reduce or eliminate some of the concerns expressed by the operators." The comment period closed on January 29, 2018.

**September 28, 2018** BSEE issues its [final rule](#) revising the Obama-era Offshore Safety Regulations Rule, [rolling back a number of safety requirements](#) for offshore equipment. The revised rule became effective December 27, 2018.

### BSEE Blowout Preventer and Well Control Rule

**May 11, 2018** BSEE [proposes changes](#) to the Blowout Preventer Systems and Well Control rule issued on April 29, 2016, [opening a 60-day comment period](#) that ended on July 10, 2018. BSEE says the proposed rule will "amend, revise, or remove current regulatory provisions that create unnecessary burdens on stakeholders."

Seismic Activity (Incidental Take Permit Process, Acoustic Thresholds Guidance, Geological and Geophysical Surveys, etc.)

**May 10, 2018** [BOEM announces](#) it will resume evaluation of applications from six companies seeking geological and geophysical permits to conduct seismic airgun surveys in the Atlantic Ocean, asking the Interior Board of Land Appeals to remand the companies' appeals of January 2017 permit denials made under the prior administration.

**June 21, 2018** NMFS / NOAA [publishes in the Federal Register](#) an April 2018 Revision ([NOAA Technical Memorandum NMFS-OPR-59](#)) to its July 2016 Technical Guidance on the effects of anthropogenic sound on marine mammals and the acoustic thresholds for underwater activity. While NOAA Fisheries did not adjust the threshold levels from the 2016 document, it did revise the guidance to address implementation concerns. The agency said the comment and review process "affirmed that the Technical Guidance is based on upon [sic] the best available science." The document is guidance for assessing the effects of underwater human-made sound on the hearing of marine mammal species, such as from seismic testing.

**June 22, 2018** NMFS / NOAA publishes a [proposed rule](#) to regulate authorization of incidental takings due to geophysical survey activities in the Gulf of Mexico. The rule would establish a framework under the Marine Mammal Protection Act allowing for authorization, through Letters of Authorization, of taking of marine mammals incidental to the conduct of geophysical surveys (including seismic airgun surveys) for oil and gas activities in the Gulf of Mexico. The comment period ended August 21, 2018.

#### BOEM Offshore Air Quality Rule

**May 1, 2017** Zinke's Secretarial Order instructs BOEM to cease all activities to promulgate the offshore air rule. (The offshore air rule had been proposed by the Obama BOEM in April 2016.)

#### BOEM Notice to Lessees and Operators (NTL) 2016-01 Requiring Additional Security

**May 1, 2017** Zinke's Secretarial Order instructs BOEM to promptly complete its review of the NTL and provide a report with options for revising or rescinding it. BOEM NTL 2016-01 [remains active](#) as of January 9, 2019. No report has yet been made public.

#### BSEE & BOEM'S Exploratory Arctic Drilling Rule

**May 1, 2017** Zinke's Secretarial Order instructs BOEM and BSEE to jointly review the July 15, 2016 exploratory Arctic drilling rule and submit a report within 21 days with recommendations as to whether to suspend, revise, or rescind the rule. News about the results of that review has yet to be made public.

#### Changes to Offshore Leasing Plans:

**January 4, 2018** The Department of Interior proposes a [5-year leasing plan](#) for 2019-2024, [opening most US coastal waters to oil and gas drilling](#). The comment period on the proposed plan ended March 9, 2018.

**July 12, 2018** [BOEM announces an Aug. 15, 2018 lease sale](#) for 78 million acres in the Gulf of Mexico, the largest in U.S. history. The notice of availability of the Record of Decision for the [proposed Lease Sale 251](#) is published in the Federal Register on July 16, 2018. This is the third sale in the 2017-2022 leasing program. Ten are scheduled for the Gulf of Mexico during this period.

**November 16, 2018** BOEM [announced](#) it has begun the process of developing an Environmental Impact Statement (EIS) for the proposed 2019 Beaufort Sea Lease Sale in the Beaufort Sea Planning Area. Public comments were due by December 17, 2018.

**November 30, 2018** NOAA [announced five final incidental take authorizations](#) under the Marine Mammal Protection Act for companies planning to conduct geophysical surveys using airgun arrays (sometimes referred to as seismic surveys). The authorizations allow them "to incidentally, but not intentionally, harass marine mammals to companies proposing to conduct geophysical surveys in support of hydrocarbon exploration in the Atlantic Ocean."

The next phase of this permitting decision now moves to the Bureau of Ocean Energy Management, which will complete an environmental review before granting or denying the survey applications.



# Deep-Sea Mineral Exploration and Exploitation

## Introduction

Seabed mining in international waters has become a contentious topic as the International Seabed Authority writes new rules for mineral exploitation. **Dr. Cindy Van Dover**, Harvey W. Smith Distinguished Professor of Biological Oceanography at Duke University and director of the Duke University Marine Laboratory, discussed the scientific research and knowledge gaps that could inform laws governing international marine mining.

## Seabed Mining Overview

Interest in deep seabed mining is increasing for a variety of reasons. Global demand for rare earth metals is on the rise. Geopolitical anxiety caused by China's near monopoly (90% of rare earth elements come from China) on certain minerals have pushed countries to seek alternative sources – known deposits of minerals on the seafloor exceed terrestrial reserves. Deposits off the coast of Small Island Developing States could provide a source of income to countries with otherwise little economic diversity. Although technologically more challenging, seabed minerals would not face the scrutiny over human rights issues that terrestrial mining often faces, although environmental destruction would still occur for marine life.

The minerals of particular interest are: manganese, nickel, molybdenum, cobalt, arsenic, bismuth, yttrium, tellurium, and thallium. The mineral resources of the deep sea include:

**Polymetallic nodules:** potato-sized deposits that sit on the surface of the abyssal plain between 5,000-6,000 m depth (Figure 1).

**Polymetallic sulfides:** Large deposits of hardened super-heated metal-rich fluids from hydrothermal vents. Some are still active and host unique lifeforms. Located on mid-ocean ridges, back-arc spreading centers, and island arcs, between 1,500-3,500 m depth (Figure 2).

**Polymetallic crusts:** Occupy 2-26 cm of certain parts of the seafloor on seamounts, guyots, ridges, and plateaus, between 800-3,000 m depth (Figure 3).

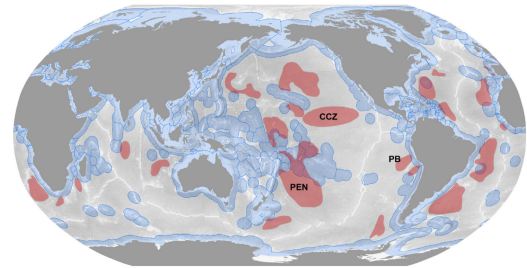


Figure 1: Global known polymetallic nodule deposits. The Clarion-Clipperton Zone (CCZ), Peru Basin (PB), and Penrhyn Basin (PEN) are of particular commercial interest. Peterson et. al

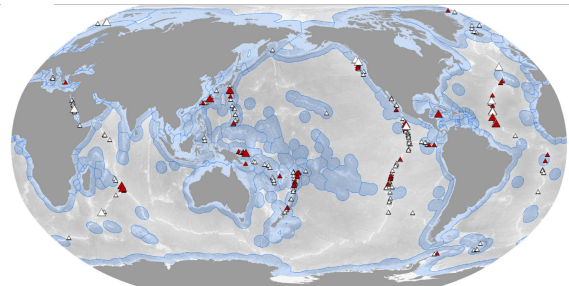


Figure 2: Global known polymetallic sulfide deposits. Larger triangles are of particular commercial interest. Peterson et. al 2016

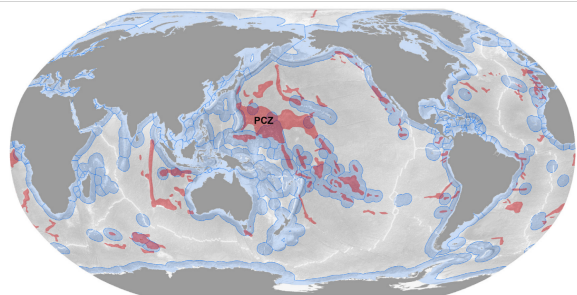


Figure 3: Global known polymetallic crust deposits. The Prime Fe-Mn Crust Zone (PCZ) is of particular commercial interest. Peterson et. al 2016

The International Seabed Authority (ISA), set up through the UN Convention on the Law of the Sea (UNCLOS) administers exploration and exploitation contracts for mineral mining in international waters. All areas outside of country's 200 km wide exclusive economic zone (EEZ) are under ISA jurisdiction. ISA has an obligation to protect the environment from serious harm while facilitating seabed access for all UNCLOS signatories.

ISA divided actions on the seabed into exploration and exploitation. As of November 25, 2018, there are 29 contractors working in international deep water. All contracts are in the exploration phase. Exploration contracts are subject to many rules, and even more rules, currently being written, are expected for exploitation. There are currently two exploitation licenses within national jurisdictions, one to Nautilus Minerals, working off the coast of Papua New Guinea. Nautilus Minerals has postponed the date it would continue mining for several years and it does not seem likely to begin within the near future due to funding issues. In the Red Sea is Diamond Field Resources, which has been having issues with its partners and which also will not begin mining in the near future.

There is also some test mining in EEZs. Japan had a high profile test mining run in August 2017 on an inactive polymetallic sulfide deposit. Japanese scientists said they conducted environmental impact studies on their deep sea mining tools and saw no detrimental effect on the ecosystem but did not release their data. Global Sea Mineral Resources (GSR), a Belgian company, has been granted an exploration contract in the Clarion-Clipperton Zone (CCZ) and is currently testing their prototype mining tool. They invited global feedback on their environmental impact statement (EIS) and are looking to set a high bar for ISA rules in terms of environmental impact (although, as was suggested during audience discussion, this could be as much to limit competition as it is for environmental concern).

The U.S. has been less active in marine mineral exploitation and exploration than its global counterparts, in part because it is not a UNCLOS signatory. This lack of participation is in spite of being the first country to discover hydrothermal vents and metals in sulphides. The U.S.'s Glomar Explorer mission even mapped polymetallic nodule deposits in 1974. Additionally, an EIS was drafted for sulphide exploitation with proposed lease offerings in 1983 within the U.S. EEZ. The Minerals Management Service (MMS) was involved with this process but decided not to move forward with proposed leases because the environmental impact of mineral mining the seafloor was still very unclear.

For more information on ISA governance structure and exploration and exploitation contracts, visit the Pew Charitable Trust's Deep Seabed Mining Factsheet: [https://rnrf.org/Pew\\_Deep\\_Seabed\\_Mining\\_Factsheet.pdf](https://rnrf.org/Pew_Deep_Seabed_Mining_Factsheet.pdf)

### **Biology of Deep Sea Mineral Deposits**

Polymetallic nodules host a low biomass of marine life but are home to a wide variety of animals, many of which are small and not very charismatic. Van Dover noted that, given the vastness of the seafloor, disturbing a few square meters of mud won't make a huge impact on ocean ecosystems. However, what remains unknown is how much area can be altered before ecosystems are substantially – and perhaps irrevocably – impacted. Mining contract terms will be set for 30 years and mining areas can cover spaces as large as Austria. No one really knows how such large changes to the benthic ecosystems could affect marine ecology.

Active hydrothermal vents, where polymetallic sulfides are found, serve as oases of vibrant and exotic life dependent on microbes that produce food using chemical energy expelled from the vents. These marine life forms cannot live anywhere else. Active vents are rare in terms of area, globally covering an area that would be about 1% of Yellowstone National Park (the equivalent of approximately 20,000 acres). Currently, active hydrothermal vents are protected from bottom fishing by international laws due to their unique ecologies and research potential across disciplines. Inactive hydrothermal vents may be of more commercial value. Little is known about inactive vents' biology, and there is growing interest in them as contractors find them a more viable resource than active vents. So far, studies suggest inactive vents are not only home to lifeforms that could be found in surrounding locations on the seafloor.

Polymetallic crusts are often home to a great deal of biodiversity, such as hundreds-of-years-old cold water corals and filter feeders situated on sea mounts. They can also play an important role in the life cycle of many fish species.

## Ecosystems at Risk

Because there will not be just one mining event in a single area, and multiple contractors will be attempting to exploit the same resource, negative effects will begin to accumulate on seafloor ecosystems once mining begins. These include:

- Chronic regional losses of brood stock, genetic diversity, species abundance, trophic interactions and complexity, and overall resilience
- Genetic isolation
- Increasing number of invasive species

Polymetallic nodules take about 1,000 years or more to form, and animals have adapted to live in those habitats. One experiment simulated deep-sea polymetallic nodule mining and monitored the experiment site (about the size of two city blocks) for 25 years, finding:

- Very few faunal groups returned to baseline or control conditions.
- Considerable negative biological effects.
- Variation in sensitivity amongst organisms of different sizes and functional groups.
- The effects of nodule mining are likely to be long term.

Soft sediment environments will also create potentially dangerous plumes when mining is conducted on a wide scale. Plumes of sediment can travel for many kilometers, which could harm filter feeding animals. Similarly, sedimentation could disperse minerals that animals naturally avoid, such as copper, causing unknown effects to broader ecosystems.

## Stemming Biodiversity Loss

Biodiversity loss will be a serious risk in deep sea mining. One option that extractive industries talk about is restoration. Van Dover commented that there is little science supporting, or current projects involving, deep sea restoration. While some cold water corals are being grown by humans in relatively shallow water, she noted that creating such a system on an industrial scale would be incomprehensible. Offsets, another common practice on land, would also be impossible as there are no places like these polymetallic mineral ecosystems that could be used as offsets.

ISA is taking a precautionary approach to its seabed mining rules. After contracts were awarded in the CCZ, areas of particular biological interests outside of contracted areas were marked out for preservation. While benthic ecology is not well understood, marked-out areas were distributed across environmental gradients of productivity so that a range of possible life forms could be protected. The ISA is looking to expand preservation areas to cover 30-50% of the CCZ. A similar process of demarcation is currently being proposed for the Mid-Atlantic Ridge.

Van Dover suggested active hydrothermal vents should be completely protected from mining, as they are from bottom fishing. While life on active hydrothermal vents returns quickly when disturbed, cumulative effects of multiple mining ventures could completely destroy these unique ecosystems.

## Conclusion

ISA is currently developing its deepsea mining rules and regulations. Van Dover emphasized that policy and science experts should be trying to influence those decisions. Because the U.S. is not a UNCLOS signatory, American experts will have to influence the process through international proxies. She cautioned that it is imperative that the environmental regulations associated with the mining code for seabed exploitation should be the best that it can possibly be.

Van Dover recommended that ISA be guided by strong precautionary governance principles when designing their rules for deep sea exploitation. She suggested that regional environmental management plans,

collaborative agreements between neighboring countries under UNCLOS, for seabed mining be assessed for their ability to achieve environmental management objectives and be approved before exploitation is allowed to take place. Further, exploitation regulations must include best practices for environmental impact assessments and environmental management and monitoring plans, with clear plans for stop work orders.

Van Dover urged a rebuilding of domestic scientific and technological expertise to bolster American seabed research and exploration. Many of the leading seabed experts, she noted, are emerging in Europe and Asia. Seabed research is extremely expensive, and government support is necessary to advance domestic scientific research. Currently, many deep sea scientists can only get funding from private companies seeking to exploit resources. From 1990-2010, the National Science Foundation sponsored early-career scientists to study the deep sea. Continuing such funding would be important to regain American leadership in the field. The NSF is funding the Ocean Observing Initiative, an integrated infrastructure program studying the marine environment off of the West Coast, however, OOI does not have the mandate to go into international waters. Continued investment in research and education would help keep America on the edge of the next frontier in seabed mineral exploration and exploitation.

To view the PowerPoint associated with this presentation, click [here](#).

# Appendix A: Congress Attendees

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Stacy Aguilera-Peterson  
John A. Knauss Marine Policy  
Fellow  
Executive Office of the President,  
Office of Science and Technology  
Policy

A. A. Aguirre  
Chair  
Department of Environmental  
Science and Policy  
George Mason University

Ronce Almond  
Partner  
The Wicks Group, LLC

D. James Baker  
Consultant  
UN FAO

Michelle Barretto  
Policy Associate  
American Geosciences Institute

Tommy Beaudreau  
Partner  
Latham & Watkins

Taylor Berry  
Development and Operations  
Coordinator  
National Marine Sanctuary  
Foundation

Donald Boesch  
Professor Emeritus  
University of Maryland  
Center for Environmental Science

Tom Chase  
Director  
Coasts, Oceans, Ports & Rivers  
Institute  
American Society of Civil Engineers

Shirley Chu  
Student/Policy Intern  
Consortium for Ocean Leadership

Sarah Cooley  
Director  
Ocean Acidification Program  
Ocean Conservancy

Emily Cox  
Writer/Editorial Design Assistant  
Landscape Architecture Magazine  
American Society of Landscape  
Architects

Robert Day  
Executive Director  
Renewable Natural Resources  
Foundation

Matthew Dixon  
RNRF Volunteer  
University of Oxford

Scott Doney  
Professor  
Department of Environmental  
Sciences  
University of Virginia

Brock Eckel  
Ocean Policy Analyst  
Executive Office of the President,  
Office of Science and Technology  
Policy

Edna Fernandez  
Science Communication Intern  
Association for the Sciences of  
Limnology and Oceanography

Jason Gedamke  
Director  
Ocean Acoustics Program  
National Oceanic and Atmospheric  
Administration

Zoe Gentes  
Public Information Manager  
Ecological Society of America

Sarah Gilts  
Marine Scientist  
Oceana

Steve Gray  
Director  
Alaska Climate Adaptation Science  
Center  
U.S. Geological Survey

Priyanka K. Hooghan  
Professional Staff  
Committee on Science, Space, and  
Technology  
U.S. House of Representatives

Rich Innes  
Senior Fellow  
Meridian Institute

Karina Khazmutdinova  
Associate Program Officer  
Gulf Research Program  
National Academies of Sciences,  
Engineering and Medicine

Thomas Kitsos  
Senior Ocean Policy Consultant  
(retired)  
Joint Ocean Commission Initiative

Kristi Lieske  
Planner  
Delaware Department of Natural  
Resources and Environmental  
Control

Jason Link  
Senior Scientist for Ecosystem  
Management  
NOAA Fisheries

Eva Lipiec  
Analyst in Natural Resource Policy  
Congressional Research Service  
Library of Congress

Natalie Mamerow  
Senior Manager  
Federal Government Relations  
American Society of Civil Engineers

Heather Mannix  
Assistant Director of Policy  
Engagement  
COMPASS

Emily Markowitz  
John A. Knauss Marine Policy  
Fellow  
National Oceanic and Atmospheric  
Administration

Meghan Massaua  
Mediator and Program Manager  
Meridian Institute

Andrea McCurdy  
Senior Program Manager  
University Corporation for  
Atmospheric Research

Marc Monaco  
Director  
Marine Spatial Ecology Division  
National Oceanic and Atmospheric  
Administration

Lenica J. Morales-Valenzuela  
Analyst  
The Wicks Group, LLC

Betsy Nicholson  
North Regional Director  
Office for Coastal Management  
National Oceanic and Atmospheric  
Administration

Conn Nugent  
Director  
Seabed Mining Project  
Pew Charitable Trusts

Noah Oppenheim  
Executive Director  
Pacific Coast Federation of  
Fishermen's Associations

Bonnie Ram  
Interim Director  
Strategic Partnerships and  
Initiatives  
College of Earth, Ocean and  
Environment  
University of Delaware

Nicole Rodi  
Planner  
Delaware Department of Natural  
Resources and Environmental  
Control

Howard Rosen  
Public Interest Member  
Renewable Natural Resources  
Foundation

Johan Schijf  
Associate Professor  
Center for Environmental Sciences  
Chesapeake Biological Library  
University of Maryland

Laura Szymanski  
Senior Policy Fellow  
Geological Society of America

Amber Todoroff  
Program Manager  
Renewable Natural Resources  
Foundation

Giuliana Torta  
Environmental Counselor  
EU Delegation to the US

Amy Trice  
Director of Ocean Planning  
Ocean Conservancy

Diego Valderrama  
Assistant Professor  
Environmental Sciences and Policy  
George Mason University

Cindy Van Dover  
Professor  
Marine Science & Conservation  
Division  
Nicholas School of the Environment  
Duke University

Drue Winters  
Policy Director  
American Fisheries Society

Stephen Yaeger  
Program Associate  
Renewable Natural Resources  
Foundation

Keith Yearwood  
Lecturer  
Geographical Sciences Department  
University of Maryland

# Appendix B: Congress Program

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**Thursday, December 6, 2018**

8:15 am – 8:35 am                      **Registration and Continental Breakfast**

8:35 am – 8:40 am                      **Welcome and Opening Remarks**

**Donald Boesch**

Chair, RNRF Congress Program Committee  
Professor of Marine Science  
Former President (1990 to 2017)  
University of Maryland Center for Environmental Science  
Cambridge, MD

8:40 am – 9:10 am

**The U.S. and the UN Law of the Sea Convention**

How does UNCLOS reflect current U.S. policy and how does the U.S. currently engage in international maritime policy? What challenges prevent U.S. from signing UNCLOS and what institutional changes need to occur to do so?

**Ronce Almond**

Partner  
The Wicks Group  
Washington, DC

9:10 am – 9:30 am

**Questions and Discussion**

9:30 am – 10:00 am

**Ocean Acidification and Rising Ocean Temperatures**

What is the relationship between ocean acidification and rising temperatures and how do those phenomena affect sealife? How does ocean pollution exacerbate these environmental stressors and increase the susceptibility of marine organisms to disease and habitat disruptions? What is the future of U.S. marine ecosystems based on model predictions? What federal, state, and local action needs to occur to preserve and protect oceans?

**Scott Doney**

Joe D. and Helen J. Kington Professor in Environmental Change  
Environmental Sciences Department  
University of Virginia  
Charlottesville, VA

10:00 am – 10:20 am

**Questions and Discussion**

10:20 am – 10:35 am

**Break**

10:35 am – 11:05 am	<p><b>Land-Based Marine Pollution</b>  What are the biggest contributors to nonpoint source pollution and marine debris? How does this pollution impact marine ecosystems? What policies are currently reducing these impacts and how can they be duplicated or expanded?</p> <p><b>Donald Boesch</b>  Professor of Marine Science  Former President (1990 to 2017)  University of Maryland Center for Environmental Science  Cambridge, MD</p>
11:05 am – 11:25 am	<p><b>Questions and Discussion</b></p>
11:25 am – 11:55 am	<p><b>Ocean Noise and Marine Life</b>  What current strategies are being used to prevent acoustic damage to marine mammals and other sea life? What policy or technological changes can be implemented to protect marine mammals from collisions and acoustic disturbances?</p> <p><b>Jason Gedamke</b>  Director  Ocean Acoustics Program  NOAA Fisheries Office of Science &amp; Technology  National Oceanic and Atmospheric Administration  Silver Spring, MD</p>
11:55 am – 12:15 pm	<p><b>Questions and Discussion</b></p>
12:15 pm – 1:00 pm	<p><b>Lunch (provided)</b></p>
1:00 pm – 1:30 pm	<p><b>Regional Coastal and Marine Spatial Planning</b>  What are the merits, methods, and barriers to developing a successful regional ocean plan? How can planners use political opportunities to position a region to effectively respond to real changes in how ocean space and resources are managed?</p> <p><b>Betsy Nicholson</b>  North Regional Director  NOAA Office for Coastal Management  National Oceanic and Atmospheric Administration  Gloucester, MA</p>
1:30 pm – 1:50 pm	<p><b>Questions and Discussion</b></p>



1:50 pm – 2:20 pm	<p><b>Offshore Wind Energy</b> A brief history and prospects for wind energy in the U.S. and lessons from the EU market. What are the potential effects and benefits from this new low-carbon energy source? What may be the concerns of decision makers and stakeholders regarding potential risks to the marine environment?</p> <p><b>Bonnie Ram</b> Interim Director, Strategic Partnerships and Initiatives College of Earth, Ocean and Environment University of Delaware Newark, DE</p>
2:20 pm – 2:40 pm	<b>Questions and Discussion</b>
2:40 pm – 2:55 pm	<b>Break</b>
2:55 pm – 3:25 pm	<p><b>Offshore Petroleum Exploration and Exploitation</b> How have environmental disasters of the past influenced current and prospective practices? What is the future of offshore drilling?</p> <p><b>Tommy Beaudreau</b> Partner Latham &amp; Watkins <i>First Director of Bureau of Ocean Energy Management (2011-2014)</i> Washington, DC</p>
3:25 pm – 3:45 pm	<b>Questions and Discussion</b>
3:45 pm – 4:05 pm	<p><b>Deep-Sea Mineral Exploration and Exploitation</b> What is currently known about this emerging industry? What are the potential consequences of seafloor exploration? What policies should be put in place now to protect marine ecosystems and reduce negative impacts?</p> <p><b>Cindy Van Dover</b> Harvey W. Smith Professor of Biological Oceanography Marine Science &amp; Conservation Division Nicholas School of the Environment Duke University Beaufort, NC</p>
4:05 pm – 4:25 pm	<b>Questions and Discussion</b>
4:25 pm	<p><b>Closing</b></p> <p><b>Robert Day</b> Executive Director RNRF</p>

# Renewable Natural Resources Foundation

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