



the 2016  
**Public Policy Forum**

**SCIENCE AND SOLUTIONS  
FOR A RESILIENT OCEAN**

**Summary Report**

# MARCH 9, 2016 AGENDA

## RESERVE OFFICERS ASSOCIATION BUILDING

# 2016 Public Policy Forum Sponsors

- 8:15a Registration and Breakfast
- 9:00a **COL President and CEO Introduction**  
Dr. Rob Dunbar, *Chair of Ocean Leadership Board of Trustees*
- 9:10a **Welcome Remarks**  
Jon White, *President and CEO of Ocean Leadership*
- 9:30a **Ray Toll, Old Dominion University**
- 10:00a **Panel – Deep Sea**  
Dr. Tony Koslow, *Moderator, Scripps Institution of Oceanography*  
Dr. Mark Abbott, *Woods Hole Oceanographic Institution*  
Dr. Lisa Clough, *National Science Foundation*  
Dr. Samantha Smith, *DeepGreen Resources*
- 11:35a **Congressman David Jolly (R-FL-13)**
- 11:45a **Congressman Mike Honda (D-CA-17)**
- 12:00p Lunch
- 1:00p **Panel – Science Solutions for Resiliency**  
Dr. Robert Corell, *Moderator, Global Environment Technology Foundation*  
Dr. Andrea Dutton, *University of Florida*  
Dr. Nancy Rabalais, *Louisiana Universities Marine Consortium*  
Dr. David Cash, *University of Massachusetts, Boston*  
Scott Rayder, *University Corporation for Atmospheric Research*
- 2:30p **Senator Dan Sullivan (R-AK)**
- 2:45p **Senator Ed Markey (D-MA)**
- 3:00p Break
- 3:30p **Panel – Resilient Fisheries**  
Thomas Bigford, *Moderator, American Fisheries Society*  
Dr. Steven Murawski, *University of South Florida*  
Dr. Richard Merrick, *National Oceanic and Atmospheric Administration*  
D.J. King, *King Lobsters*  
Dr. Fern Gibbons, *Senate Commerce Committee*
- 5:00p **Senator Sheldon Whitehouse (D-RI)**
- 5:30p **Closing Remarks**  
Jon White, *President and CEO of Ocean Leadership*
- 5:45p **Release to Reception**  
Dr. Rob Dunbar, *Chair of Ocean Leadership Board of Trustees*
- 6:00p Reception



## EXECUTIVE SUMMARY

# SCIENCE AND SOLUTIONS FOR A RESILIENT OCEAN

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The world's ocean is highly dynamic and will continue to change in the coming years. As a country that relies on the ocean economically, socially, and for national security, the U.S. must prepare for every eventuality, both natural and anthropogenic. From abrupt events like hurricanes, tsunamis, and oil spills to longer-scale changes like sea level rise, ocean acidification, and changing fish migrations, many marine issues are on the horizon for U.S. domestic and international policy. On March 9, the Consortium for Ocean Leadership hosted a diverse forum to discuss our changing ocean and how science can best prepare for a safe and healthy ocean future.

### The Forum featured distinguished speakers including:

- Captain Ray Toll, U.S. Navy (Retired)
- Dr. Richard Merrick, Director, Scientific Programs and Chief Science Advisor, NOAA Fisheries
- Dr. Lisa Clough, Section Head, NSF Division of Ocean Sciences
- Congressmen David Jolly (R-FL-13) and Mike Honda (D-CA-17)
- Senators Dan Sullivan (R-AK), Ed Markey (D-MA), and Sheldon Whitehouse (D-RI)

### Almost 300 people participated, including:

- 50+ congressional staff
- 60+ representatives from federal agencies
- 100+ participants from private entities (industry and NGOs)
- 60+ academics and students

### Panel Topics Included:

#### **Climate and the Deep Sea**

Stakeholders discussed the need for more research and exploration in the deep sea, with a particular focus on effects of climate change, continuous observing, seabed mining, and ecosystem complexity and resilience.

#### **Science Solutions for Resiliency**

Researchers explained how preparedness drives resiliency and noted that more scientific contributions should enter the policy arena.

#### **Resilient Fisheries**

Fisheries experts from government agencies and industry described how conservation, stock assessment, innovation, and flexibility can work together to create a more robust fisheries sector.

The Forum included conversation surrounding the state of scientific knowledge of resiliency in various sectors and how this expertise can make the ocean more resilient.

## FEATURED SPEAKER

### CAPTAIN RAY TOLL, U.S. NAVY (RET.)

*Director for Coastal Resilience Research at Old Dominion University*



In 2014, feedback from a task force formed through President Obama's Executive Order 13653, "Preparing the United States for Impacts of Climate Change," led to the development of several Preparedness Pilots through the country. With the effects of climate change varying greatly in different geographic areas, the Preparedness Pilots focus on developing a regional "whole of government" and "whole of community" approach to mitigate climate change and to increase resiliency on the regional level. One of these pilots is directed by Captain Ray Toll at Virginia's Old Dominion University – the

Hampton Roads Sea Level Rise Preparedness and Resilience Intergovernmental Planning Pilot Project.

Each region, Toll said, "has their own challenges, priorities, and solutions. So, you couldn't just canvas the whole country and come up with a generic solution." Focusing on smaller regions has the added benefit of greater community and stakeholder involvement, which is vital for successful sea level rise preparedness and resilience planning. Toll stressed the importance of local contributions and noted that government cannot battle the effects of sea level rise alone. "If we can't figure this out with the citizens in mind ... we're missing the boat. It can't just be government," he stressed.

Toll explained the mechanics, deliverables, and lessons learned as his team wraps up their second year of this pilot project. To ensure their process is exportable to other parts of the country, they created and have shared a charter. They have also worked to find a way for the ocean science community to integrate into this regional planning process. When garnering community involvement, Toll described his approach as not one of talking about climate change "as much as to say, 'we all acknowledge that the water's rising ... so how can we mitigate and strategically adapt together.'" He found that questioning the causes and effects of climate change would derail the conversation, while focusing on the action plan was more effective. Toll also expects to propose legislation, approved by the state, to pursue a regional IOOS construct to monitor resiliency going forward.

Old Dominion has been working closely with the Virginia Institute of Marine Science (VIMS) on this pilot project, which provided resources they would not otherwise have had. Toll found that universities have a key role to play in this process as a convener. No other parties are capable of bringing everybody to the table – government agencies and private companies have limited influence, while universities have expanded freedom to bring together diverse groups.

The implementation of this pilot project laid the foundation for a proposed Center for Sea Level Rise. This center is planned in partnership with VIMS, one of the oldest and largest schools of oceanography focused on coastal ocean and estuarine science in the United States. The center would provide real-time sea level data to coastal communities and the government, allowing them to respond to and mitigate the effects of a rising sea more quickly and efficiently.

## FEATURED SPEAKER

# CONGRESSMAN DAVID JOLLY (R-FL-13)

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As a U.S. representative from the state with the longest coastline in the contiguous United States, Florida Representative David Jolly expressed his deep concern for ocean resiliency. The majority of Florida's population lives in coastal regions and depends on the ocean, its resources, its effects on weather, and the opportunities it creates for recreation and economic activities. "I am constantly reminded how the vitality of the Gulf of Mexico and the Atlantic Ocean are critical to my home state's way of life," he stated.

Over the last several decades, the ocean and its living resources surrounding Florida have shown great resiliency while enduring significant challenges. He noted the ability of the preserved, natural coastal areas to return to their former conditions after hurricanes. He addressed the strengths and economic viability of the state's fish stocks despite the devastating effects of red tide, a harmful algal bloom, and the state's fisheries ability to recover after overfishing. Rep. Jolly applauded the ocean science community for their collaborative recovery effort following the Deepwater Horizon oil spill and noted that, "when given adequate fiscal resources, the ocean science community can achieve remarkable results in gathering data and providing sound recommendations to policy and decision-makers."

Rep. Jolly raised two common themes that the ocean science community should communicate to legislators. The first is that increased and improved research and understanding of the ocean environment will provide policymakers with more options and better information. Secondly, the knowledge that our ocean and its living resources have inherent resiliency can lead to restoration after disasters. Rep. Jolly concluded by calling on the science community to engage with Congress to increase the number of ocean champions on Capitol Hill. He recognized the importance of keeping government leaders updated with the most current ocean science so they can make informed decisions for a healthy, resilient ocean.

## FEATURED SPEAKER

### CONGRESSMAN MIKE HONDA (D-CA-11)

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Representative Mike Honda's district is in the heart of Silicon Valley, an area renowned for innovation and scientific advancement. Despite the ocean covering almost three-quarters of our planet, Rep. Honda noted that "we know more about the surface of Mars than we do about the deep ocean." He expressed concern that we have gradually undermined ocean health through overfishing, pollution, man-made climate change, and marine debris. Overall, the congressman scrutinized the long, ongoing exploitation of the ocean for resources and as a dumping site and called on humanity not to take it for granted.

Rep. Honda found the 2015 Paris Climate Conference to be a "huge step forward in our ability to limit global warming and to lessen the effects of our changing climate." However, he criticized that the ocean was excluded from the final agreement since "our growth, prosperity, and future depends on the resilience of the ocean, and not enough attention is being paid to this vital part of our lives."

Rep. Honda highlighted a number of positive steps for the ocean over the past few years, including the establishment of the National Ocean Policy (NOP); the *Illegal, Unreported, and Unregulated Fishing Enforcement Act of 2015* becoming law; plans for new national marine sanctuaries, and the creation of the National Ocean and Coastal Security Fund. He also spoke of the bill he introduced, the *Land Based Marine Debris Reduction Act* and a House resolution to recognize earth science week.

Despite this progress, there is more work to be done. Rep. Honda offered two steps Congress can take to support ocean resilience: to continue supporting NOP through legislation that encourages interagency coordination and marine planning and to continue investing in earth and ocean science research. He called on the scientific community to communicate research to policymakers and the general public and warned against the short-sightedness of ignoring science.

The congressman concluded his remarks by stressing that science is a national priority, and scientists have an important role to play as advocates in the policymaking process. He emphasized, "If you are not on the table, you may be on the menu."

## FEATURED SPEAKER

# SENATOR DAN SULLIVAN (R-AK)

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Democrats and Republicans came together last year to pass an important piece of oceanic legislation, the *Illegal, Unreported, and Unregulated Fishing Enforcement Act of 2015*, which President Obama then signed into law. Senator Dan Sullivan opened his remarks talking about the passage of this bill, and he emphasized the role of scientists in the policymaking process, stating that “none of the decisions we make can be made without good science.”

Sen. Sullivan continued to stress the importance of bipartisan cooperation on sound ocean policy, especially in states like his own. Alaska has 6,640 miles of coastline, inevitably making the health of coastal communities and environments a state-wide priority. “Native Alaskans ... have been involved with fisheries for generations, and their traditional knowledge on a lot of these issues is really the basics, the start of science on oceans and our fisheries thousands of years ago,” he said. Alaskan fisheries continue to play a vital role of cultural and economic significance to the state and to the U.S. as a whole. Last year, more than 470,000 sport fishing licenses were sold in a state with a population of 730,000; commercially almost 60 percent of all seafood harvested in the United States is from Alaska. Sen. Sullivan jokingly called Alaska, “the superpower of seafood.”

Fisheries management has always been an important issue for the state and was one of the main drivers of Alaska’s statehood. While Sen. Sullivan believes that Alaska has always effectively managed state-run fisheries, they have not had control over federal waters. Landmark federal legislation, the science and data-driven *Magnuson-Stevens Fishery Conservation and Management Act* (MSA), “has successfully Americanized our fisheries and built the fishing industry.” The passage of this act was an especially important economic driver for Alaska, since the fishing industry employs more Alaskans than any other sector. The MSA’s guiding principles and regional fisheries management councils help Alaskans manage their fisheries more sustainably. The economic value of the fishing industry, particularly in Alaska, makes science-based and data-driven policy decisions of the utmost importance. Sen. Sullivan concluded, “oceans are not a partisan issue; they *should not* be a partisan issue.”

## FEATURED SPEAKER

### SENATOR ED MARKEY (D-MA)

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Massachusetts Senator Ed Markey opened with a statement showing the value of fisheries in his state. “New Bedford is the highest grossing fish port in the United States of America,” he proclaimed, with fish landings valued at \$369 million. However, he continued, “another record we hold just off the coast off of Massachusetts is far less positive ... The Gulf of Maine sea surface temperature is warming faster than anywhere in the world. The effects of climate change are being felt now. Just like all politics is local, all climate change is ultimately local as well.” Familiar cold water fish, like cod, are moving further north while

typically southern species, like black sea bass, are being caught in greater numbers in this region.

Warming waters and displaced fish populations are not the only major threats on the horizon for Massachusetts fisheries. Ocean acidification is also wreaking havoc on the scallop fishery in the port. “Massachusetts’ claim as a seafood superpower is under threat, and the villain is climate change,” Sen. Markey declared. He expressed concern for the changing ocean ecosystem and noted that, in addition to being an important food source for millions of people around the world, the ocean provides more than half of the oxygen in the atmosphere. Our planet would be uninhabitable without the ocean. Rapid oceanic changes unquestionably call for research and continued observation, which is at the core of science.

Sen. Markey dedicated significant time to stressing the important role of ocean observations to ensure proper planning for resilient and sustainable fisheries. Using the bleaching effects of El Niño on coral reefs as an example, he noted the dire need to understand how climate change is influencing the natural El Niño phenomenon. Do climate models have trouble predicting El Niño because the models are missing something or because we are missing key ocean observations? “Is this El Niño just an outlier or the beginning of a new norm?” he asked. He continued by elevating the importance of long-term observations in the face of changing norms due to climate change. “Ocean resiliency starts with good prediction. Good prediction starts with good understanding. And good understanding cannot occur without good observations. This information is critical to making well-informed policy decisions.”

Sen. Markey called for an extension of the global ocean observation network, both geographically and in the types of observations being made. “Increasingly, what is happening in the ocean far from shore has consequences back on land. Not knowing what is happening out there is no longer an option. That’s why we need to expand our ability to observe oceans and fill the gaps in our knowledge,” he closed. He lauded the role of science to save our planet from the impacts of our changing climate.

## FEATURED SPEAKER

# SENATOR SHELDON WHITEHOUSE (D-RI)

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“Amateurs tend to take the resilience of the oceans for granted -- they are enormous, they seem endless. We find enormous spiritual solace being near the oceans,” Senator Whitehouse opened. “It would seem hard to imagine that little mankind could be having the effect on them that we are, but indeed we are.” In fact, the ocean has absorbed more than 90 percent of the excess heat trapped by greenhouse gasses and a quarter of the carbon dioxide emitted annually by humans. A recent study found that the ocean has absorbed as much energy from this since 1997 as in the previous 130 years. One report compared this to the ocean, since 1997, absorbing the man-made heat energy equivalent of a Hiroshima-style bomb being exploded every second for 75 years.

Rhode Island’s waters were historically home to bountiful supplies of winter flounder and lobster, but these species have disappeared due to the combined impact of changing ocean conditions and fishing pressures. Forty percent of northeast fishermen surveyed in 2015 reported catching species they do not usually see in their regular fishing areas. These fishermen, who were previously disinterested in climate change, are now coming to Sen. Whitehouse about the cobia, mahi-mahi, and grouper they are catching – species that were not previously abundant. They have commented to the senator, “It’s not my grandfather’s ocean,” and “Sheldon, it is getting weird out there.” According to Sen. Whitehouse, “that weird is becoming the new normal.”

On top of global warming and ocean acidification, he also talked about pollution as a major destructive force, specifically the choking of our oceans with millions of tons of plastic and other debris. One study found that by 2050, the weight of plastic in the ocean will outweigh fish, and 99 percent of the world’s seabirds will be affected by ingesting plastic. Plastic pollution is clearly illustrated by protocols in the Volvo Ocean Race, the world’s premier offshore race, which will stop in Newport, Rhode Island. Race participants will not only practice man overboard drills but now must do keel-clearing drills to remove the plastic debris picked up by their boats.

Sen. Whitehouse shared ways that Congress has gotten more serious about facing these ocean challenges. The Senate Oceans Caucus recently added seven new Republican members, bringing their membership to 30. Last year, the *Illegal, Unreported, and Unregulated Fishing Enforcement Act of 2015*, the *Microbead Free Waters Act of 2015*, and the *National Ocean and Coastal Security Act* became law.

“To secure the future of our coast and oceans, we have to learn not to be only takers, but caretakers,” the senator said. He criticized the hold the fossil fuel industry has on Congress and asked the rest of corporate America to step up and fight for what they believe to “tip the balance” and have an impact. “Nobody can tackle this issue alone, we all have to pull together ... Do what you can in your circles of influence, to reach out to your congressmen and senators and make sure they know how serious you are about this. Also reach out to community and corporate leaders ... We can get this done,” he concluded.

## PANEL 1: CLIMATE AND THE DEEP SEA

### TONY KOSLOW, PH.D.

*Scripps Institution of Oceanography*

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Dr. Tony Koslow, Research Oceanographer Emeritus from Scripps Institution of Oceanography, has a long history of oceanographic research and understands the intricacies of the deep sea. Prior to introducing the panel, he described the deep sea as “a source of some of the greatest species and ecological diversity” with a “great need for improved stewardship based on scientific understanding and appreciation of its value.” The deep ocean provides a largely untouched wealth of oil, gas, and mineral wealth, as well as fisheries that have not been exploited. While there are great opportunities for

new resources and exploration, Dr. Koslow warned that the deep sea ecosystem is very different from shallow water and much of it has extremely low resilience.

Dr. Koslow acknowledged the deep sea is warming, acidifying, and losing oxygen. At a sampling site off of southern California, researchers found impacts of these changes resulted in a 63 percent decline in midwater fish abundance that was highly correlated with a decline in oxygen. To determine if this was a localized or globalized phenomenon, he proposed creating a global network to monitor ocean changes over time, from which could be developed ecological indicators that could be used for ecosystem based management and ecological assessments. Dr. Koslow’s outline of the panel addresses the major concerns facing deep sea resiliency.

## MARK ABBOTT, PH.D.

*Woods Hole Oceanographic Institution*

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Dr. Mark Abbott discussed exploration and monitoring of the hadal zone, named after Hades, the underworld in Greek mythology. This zone includes the deepest trenches in the ocean. The dynamics of the deep sea ecosystems are influenced by the way that deep water moves through the ocean along the so-called Great Ocean Conveyor. There are two ideas about how this system moves: does ocean circulation respond to the atmospheric temperature, or is the movement due to mixing in the deep ocean? Dr. Abbott explained that both occur at different time scales, and it is important to think ecologically about

these processes to understand ecosystem responses in short-term and evolutionary time scales. To help us better understand the connection between ocean and atmosphere and how this will change as atmospheric carbon dioxide increases, new monitoring arrays, such as the Overturning in the Subpolar North Atlantic Program and the Meridional Overturning Circulation and Heatflux Array have been established.

Dr. Abbott described research that showed how changes in the ocean's surface characteristics elicited a response in the deep sea that could linger for millennia. "The deep sea is warming, especially in the south," Dr. Abbott confirmed. He expressed concern for some larvae, whose movement is a key ecological response. Their dispersal patterns, and consequent survival, are dependent on ocean currents, and they are at risk as water becomes de-oxygenated and acidified.

Dr. Abbott emphasized the great wealth of the deep sea and its undiscovered species by explaining that "every thousand kilometers deeper we go, the more we find." This may hold the key to solving problems and challenges that humankind faces. For example, a supergiant amphipod was recently discovered five to seven miles below the sea surface, despite the enormous pressure. At extreme depth and pressure, normal cellular processes, such as mitosis and protein folding, are a challenge (if not impossible) due to the contracted space in the cell. Researchers found that these deep sea organisms contain 'osmolytes' that expand cells, allowing cellular functions to occur as normal. This discovery could aid in finding a cure to certain diseases, such as Alzheimers, that are linked to protein folding problems inside cells. However, this vulnerable ecosystem containing this amazing amphipod and other remarkable creatures needs to be preserved in order for humanity to unveil its many other secrets.

## LISA CLOUGH, PH.D.

National Science Foundation

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Dr. Lisa Clough brought the National Science Foundation (NSF)'s perspective to the panel discussion on the deep sea. Dr. Clough is the Section Head of NSF's Division of Ocean Sciences (OCE). She described NSF's focus on eight questions based on the National Research Council and National Academy of Sciences report: *Sea Change: A Decadal Survey of Ocean Sciences, 2015-2025*, which has been a significant driver for important science questions and provides advice for balancing NSF's budget between logistics and research.

These science questions have to do with: sea level rise; coastal and estuarine oceans and their ecosystem influencers; ocean biogeochemistry, physics and climate; biodiversity and resilience of ecosystems; marine food webs in the coming century; formation and evolution of ocean basins; geohazards (earthquakes, tsunamis, landslides, volcanic eruptions); and seafloor biosphere (biogeochemistry cycles and life).

Dr. Clough noted that several of these questions need to be addressed in the deep sea, so there is "plenty of room within the NSF science portfolio for those good science questions to be asked to respond to what *Sea Change* has recommended." NSF programs contribute varying amounts of funding to the deep sea; over the last three years the program that contributes the least has contributed 25 percent of their money to asking questions about the deep sea and vents while the program that invests the most in deep sea issues uses up to approximately 80 percent of their budget asking these questions.

She also addressed the distribution of funding between research and research-related activities (such as building and maintenance of facilities to support science). *Sea Change* noted that a transition had occurred whereby more money was going to facilities funding than science. She noted that many of the investments that increased facilities funding were made during a time where there were expectations of increasing budgets. In the current constrained budget environment, the *Sea Change* committee recommended getting to a 50-50 parity, which will be reached and maintained by 2018.

In addition, Dr. Clough emphasized the importance of continual deep sea observations in key locations for the years to come to understand how the ocean is changing. Reiterating what several speakers had said, she stated, "We need these observations, and we can't just make them as snapshots, we need them for years to come." A recent study found that it will take a minimum of 20 years of observations to be able to conclusively say that changes are occurring because of climate. There are no deep sea observatories, since they're challenging places to work, but geographic extrapolations can be made on certain parameters from some existing observatories. One existing network is the [Ocean Observatories Initiative \(OOI\)](#), which is led by the Consortium for Ocean Leadership and funded by NSF. OOI provides free access to a wide range of data collected from around the world's oceans and consists of seven arrays generating data from the deep sea. Over 200 unique data products are measured or derived from the over 800 instruments deployed from the air-sea interface to the seafloor amongst the seven arrays.

Overall, Dr. Clough emphasized the importance of NSF's focus on funding science questions, and she accentuated areas where deep sea fits into input the community has given to NSF.

## SAMANTHA SMITH, PH.D.

*DeepGreen Resources*

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As a representative of ocean industry, Dr. Samantha Smith spoke on opportunities and challenges of deep sea mining. Dr. Smith is the Director of Blue Globe Solutions, an environmental and social performance consulting firm. She was representing one of her key clients, DeepGreen Resources, a company aimed at providing the world with 'clean metal' from seafloor-based mineral deposits.

The worldwide demand for minerals and metals is increasing. As nations around the world strive for a middle class or higher standard of living and as alternate energy sources are explored, mineral and metal use rise. There are pitfalls associated with continuing to mine these minerals and metals from terrestrial sources, including diminishing resources; the creation of toxic byproducts; and social, economic, and environmental costs. Additionally, our planet is 70 percent covered in water, but we are currently mining only on the 30 percent that is land – “Does that make total sense ... is there another solution out there?” she asked.

Dr. Smith stated that seafloor mineral production will be able to offer social and environmental advantages for mineral development. “Deep sea mining,” Dr. Smith explained, “has several advantages over mining above sea level. One advantage is the higher grade of the products, which result in clean processing. Another advantage is that there is no need for displacement of human populations and no requirement to remove valuable acres of rainforest.” Additional advantages include research indicating that one seafloor deposit could replace three terrestrial mines; deposits can be on the surface, so digging is not always required; people do not have to be relocated; no deforestation is necessary; processing with zero waste can occur; and reusable infrastructure is possible.

However, she warned that excellent environmental practices and policies are needed to manage the inevitable environmental impacts to the deep sea system and that we take “a responsible and precautionary approach moving forward.” Dr. Smith highlighted deep sea environmental management goals that include maintaining biodiversity and ecosystem health and function; reducing, mitigating, and preventing impacts; and balancing impacts of extractive activities with conservation goals. Management techniques currently being considered include technologies and methodologies that limit sediment re-suspension during harvesting, the order and style of extraction (including establishing “set-aside areas” to help damaged ecosystems be more resilient and re-colonize faster), fully-enclosed ore delivery systems, and biodegradable fluids and oils in all subsea equipment (which minimizes impacts of any leaks).

To make this a participatory approach, groups such as DeepGreen have committed to transparency that includes stakeholder engagement. She spoke of the importance of collaborating with the “world’s best scientists” and making sure they have the freedom to publish on this, not just for the sake of transparency but to contribute to global knowledge of the deep sea. “We are at the dawn of new industry,” she proclaimed, “It’s important that we are taking a responsible and precautionary approach in moving forward.”

Seafloor mineral production may offer many social and environmental advantages for mineral development, but good environmental management practices will continue to be needed.

## PANEL 2: SCIENCE SOLUTIONS FOR RESILIENCY

### ROBERT W. CORELL, PH.D.

*Global Environment Technology Foundation*

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Dr. Robert Corell opened the Science Solutions for Resiliency panel by repeating a message originated by Leonardo DiCaprio during his Oscars acceptance speech: “Climate change is real; it is happening now. It is the most urgent threat facing our entire species, and we need to work collectively together to stop procrastinating. We need to bring support leaders around the world who do not speak for the big polluters but who speak for all of humanity, for indigenous people of the world, for the billions and billions of underprivileged people out there who would be most affected by this change,

for our children, our children’s children, and for those people out there whose voices have been drowned out by the politics of greed.”

Dr. Corell’s opening statement set in motion the panel’s discussion addressing the various roles of science resiliency. He highlighted four key components of science, resilience, and future that the panel would cover: how nature adapts to massive changes over a long time frame, how humanity affects the ecological framework and how we could better build adaptive capacities, how we build more resilience in the ocean and the planet, and how the political system plays a role in this.

## ANDREA DUTTON, PH.D.

*University of Florida*

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Dr. Andrea Dutton is a carbonate geochemist who studies Earth's historic climate and sea level changes. Her research helps us understand how sensitive ice sheets are to changes in temperature, which will better inform us about future sea level rise. The purpose of her talk was to address how long geologic timescales are important to discussions on policy that relate to how we interact with oceans on human timescales and even political cycles.

Dr. Dutton began by defining ocean resiliency as “the capacity of the oceans to adapt and adjust to forces of change and to become strong and healthy and successful again.” There are three components to this: some type of transformation, mechanisms for adaptation, and the role of rates of change in determining overall resiliency of the ocean.

She used examples from the geologic past that inform our working knowledge of ocean resiliency. For example, 65 million years ago, an asteroid hit Earth and set into motion the fourth largest mass extinction event in geologic record. Not all such impacts cause mass extinctions, but this time, the asteroid plummeted into an already-stressed ecosystem. Several thousand years prior, there was an outpouring of lava and volcanic gases from the Deccan Traps, one of the largest volcanic features on the planet. The ocean absorbed these volcanic gases, temperatures rose from the eruptions, and then the asteroid struck and mass extinctions ensued, including to more than 75 percent of marine organisms. “This one-two punch story really tells us that a vulnerable ecosystem is more susceptible to collapse, and this is a very relevant lesson when we’re thinking about current policies for the ocean,” Dr. Dutton stated. Marine sediment records show that it took millions of years for recovery to happen.

During the Paleocene-Eocene Thermal Maximum (PETM), a geologically abrupt pulse of atmospheric carbon dioxide caused ocean acidification, a global spike in temperature (over five degrees in 10,000 years), and extinctions in the deep sea. Recovery took several hundred thousand years, with the ocean surface recovering faster than the deep sea. She cautioned that the PETM event is very similar to what we are experiencing today with respect to the accelerated anthropogenic carbon dioxide release.

“Oceans can adapt,” Dr. Dutton concluded, “they have the capacity to become strong and healthy again. But because the timescales of response operate over thousands to millions of years, large and abrupt perturbations to the system can lead to irreversible transformations of marine life, which has a cascading effect on other aspects of the system.”

## NANCY RABALAIS, PH.D.

*Louisiana Universities Marine Consortium*

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Dr. Nancy Rabalais opened by addressing the role of science in ocean management. “Science has played a role in identifying what we’ve done to the ocean,” she began, “And I think science will provide a way to understand what can we do to reverse some of these trends.”

Some of these problems humanity has caused in the ocean include warming waters, disappearing deltas, and rising sea levels. She noted that none of these changes are independent from one another, just as ocean acidification, de-oxygenation, and warmer temperatures are tied together.

Dr. Rabalais then described how science has played a role in reversing these trends and in increasing ocean resiliency and adaptation. For example, as a short-term solution for coral bleaching, scientists have experimented with putting farm-raised corals that are more tolerant to warmer conditions into the ocean environment.

She imputed the industrial revolution and human population growth as initial drivers for today’s problems and attributed the continued exacerbation to bad energy and agricultural policies. However, she believes that humanity can be a force for change, but “it’s going to take dollars. But it’s also going to take political and social will.” This includes not waiting until the next crisis, which she believes could be the collapse of the current century-old agricultural way of business, to act. She suggested adapting more sustainable agricultural practices, finding ways to mitigate sea level rise, creating a green economy, and improving river management. Finally, she said, “education, although it seems slow, is necessary to change how we address problems in the future. This is important for policy reasons and for needs of maintaining a level of economic stability as we now know it.” “Education is the one way to get to the younger people around the globe so that they can start thinking about their future ... there are opportunities, through education, to make a difference.”

## DAVID CASH, PH.D.

*University of Massachusetts, Boston*

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Dr. David Cash examines societal strategies as a way to enhance the resiliency of the ocean. Political dimensions are often not as clear cut as scientific recommendations, he explained. “When we get into the messy and sometimes ugly world of politics, or communities, or people with jobs at stake, there are many different truths; there are many different ways of understanding the world, and then, of course, how to respond to the world.” The interaction of society, science, and decision-making is very nuanced. Dr. Cash believes science does influence policy making, but there are several steps in between.

He discussed a framework he developed to ensure science is better used in the decision-making process. This framework includes three pillars of knowledge for action: salience (information that the decision maker wants or needs), credibility (using the right models, tools, and the peer review process), and legitimacy (the process for information development).

Lack of involvement in this process can create distrust, which Dr. Cash witnessed firsthand between fishermen and federal scientists. As Massachusetts Governor Deval Patrick’s key fisheries expert, Dr. Cash realized that the regulatory system was extremely fractured and political, and he saw the need for a bottom-up approach to replace balance. Instead of NOAA producing reports by themselves, he put together a proposal that requested \$3.2 million in federal funding to support a cooperative research study of key groundfish stocks. His goal was to create trust between agency findings and fishermen by involving fishermen in data collection and report development.

While NOAA rejected the request for funds for that particular cooperative assessment, the *Massachusetts Oceans Management Plan of 2010* was developed with the collaboration of 90 stakeholder consultants. When the plan came out, the science was broadly trusted; decision options, especially knowledge-based ones (information and science) were less contested; there was little obstruction to decisions made based on this knowledge; and decision options balanced multiple inputs. Ultimately, he said, stakeholder involvement in the process made the management plan more robust. “When we think about the pyramid of information coming up to decision making, I think we should think about it in a much more nuanced way that takes into account salience, credibility, and legitimacy,” he concluded.

## SCOTT RAYDER

*University Corporation for Atmospheric Research*

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Scott Rayder, senior advisor for development and partnerships at the University Corporation for Atmospheric Research, discussed ocean resiliency, legislation, and the political process. He expressed concerns about the efficacy of our leaders to make decisions that will help the ocean be more resilient if they do not understand the science behind the biological, chemical, and physical processes. Mr. Rayder asserted the lack of science community involvement in the policymaking process as a major roadblock to improved legislation. To drive the point home, he asked, “How many Ph.D.s are in Congress right now?”

The answer is one. Who is running for office in this room?... No one in this community says, ‘Hey, I’m going to run for office because I think I can help make things better.’ ... Please think about running for office, your country needs you.”

Good dialogue between the ocean science community and federal leadership is critical. Mr. Rayder emphasized the importance of having a clear message for the ocean community to communicate to our country’s leaders, and he shared the one Admiral James Watkins used to relay to members of Congress. “Oceanography won the cold war,” Watkins would state, which would focus the ensuing dialogue on the importance of understanding the ocean. Today, Mr. Rayder advised both the oceanographic and atmospheric communities to determine what that message is. “At the top level, I’m not sure that we have a message that resonates, and that is part of being resilient,” he said.

It is necessary, when talking about resiliency in the public policy context, to understand and explain the relationships between observing, modeling, and research. Mr. Rayder described the need to observe globally, assess regionally, and act locally but also to observe locally, assess regionally, and model globally. He expressed that global observations were the stepping stone that ideally act as a driving force for “the next level of observations and modelling, so we get better and better resolution from our models and our observations to understand: how resilient is the ocean?”

Mr. Rayder described the *Magnuson-Stevens Fishery Conservation and Management Act (MSA)* as a success in Congress. The MSA was enacted in 1976 to “promote optimal exploitation of coastal fisheries.” However, in 2006, the bill had seven new goals that included promoting fishing with conservation principles, supporting enforcement, and providing implementation of fisheries management plans. “What changed in those 30 years?” Mr. Rayder asked, “Congress strengthened the role of science. Congress actually started to recognize the oceans are not infinite ... The best tool to manage them is science, and that science has got to be based on observations, research, and modeling.”

He concluded by encouraging everyone to continue to think proactively. “Government is reactive,” he stated, “but you’ve got to have a plan to proactively go out there and make things happen.”

## PANEL 3: RESILIENT FISHERIES

### THOMAS BIGFORD

*American Fisheries Society*

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Thomas Bigford, Policy Director at the American Fisheries Society, introduced the speakers for the panel on resilient fisheries. Mr. Bigford has been Chief of the Habitat Protection Division at the Office of Habitat Conservation at NOAA's National Marine Fisheries Service for the past 18 years. He teed up the panel, which included representation from a variety of different players in the marine fisheries arena, including those involved in fisheries and ecosystem management, a fishers and a Capitol Hill staffer providing a political perspective on the *Magnuson Stevens Act* reauthorization.

## STEVEN A. MURAWSKI, PH.D.

*University of South Florida*

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“Fish is a four letter word,” Dr. Steven Murawski learned while living in Washington, D.C., describing how, to many policy makers, the phrase expresses the difficulty of managing fisheries. Dr. Murawski is a fisheries biologist with 40 years of professional experience. He worked at NOAA for 35 years as the Director of Scientific Programs and as Chief Science Advisor for the National Marine Fisheries Service before moving to the University of South Florida.

Dr. Murawski noted that resilience is essentially programmed into the life history of fishes because of the wide variety of life histories. Some species are fast growing, short lived, and only stay around until they reproduce, such as the Pacific sardine. Other species are slower growing, may lead a long life, and can reproduce multiple times, like the red snapper. Good management can amplify the resiliency of a fishery; bad management can be devastating. Therefore, it is important to be attuned to the life history of the species and potential stressors on the population, as well as to meticulously monitor stocks, since overfishing status can change quickly.

Recent documents note a decline in overfishing in the developed world and especially in the U.S., which Dr. Murawski attributed to the *Magnuson-Stevens Fishery Conservation and Management Act (MSA)*. MSA reauthorizations, especially in 1996 and 2007, have been successful in meeting many of their goals, but he believes there is still significant work to be done. One of these areas that needs improvement involves fish the U.S. imports. He noted that we buy fish from some countries that have poor sustainability and resiliency records and that we have a “moral obligation to do more in terms of not only implementing standards from the people we buy from but also by insistence from those countries as well.”

## RICHARD MERRICK, PH.D.

*National Oceanic and Atmospheric Administration*

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As the head of NOAA Fisheries' scientific operations, Dr. Merrick directs NOAA's six regional Fisheries Science Centers, including 30 NOAA Fisheries Laboratories. While a single species approach was previously utilized, now NOAA follows an ecosystem approach to fisheries management, which includes a focus on ecosystem-wide issues in stock assessments. This is still far from Ecosystem Based Fisheries Management (EBFM), which looks at entire ecosystems. Dr. Merrick believes that EBFM is needed as a roadmap to ecosystem resilience.

EBFM offers many advantages, such as the economic advantage of fewer misses and better recommendations, triage and prioritization, and increased stability. Furthermore, it addresses tradeoffs of different choices. There are numerous ongoing EBFM efforts, including surveys of EBFM in Fishery Management Plans, Fishery Ecosystem Plan Analysis, and NOAA's EBFM Report. Dr. Merrick summarized that the EBFM policy statement "means that NOAA endorses the idea of Ecosystem Based Fisheries Management" and is starting to codify what an operational EBFM would entail.

Dr. Merrick also updated the audience on the development of the NOAA National Climate Change Policy. The goal was to increase production, delivery, and use of climate-related information in fulfilling NOAA Fisheries mandates. Human dimensions are also considered by the agency, and enhanced community resilience is thought of as a product of resilient fisheries and ecosystems.

## D.J. KING

### *King Lobsters*

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D.J. King began his career as one of 24 full-time lobstermen in Long Island. However, due to the steep decline in lobster populations, the region now only employs three part-time lobstermen. He joked that “in a museum, maybe I will be in there as an endangered lobsterman.”

The beginning of the end of the lobster fishery in Long Island Sound began in 1998. Newly-hatched lobsters, which bear a strong resemblance to mosquito larvae, were mistakenly killed in an effort to combat the west Nile virus by chemically eradicating mosquito larvae. In addition, 1998 was an El Niño year with record high temperatures. The combination of these two factors decimated the lobster population. Fishermen had to look for other ways to make a living off of the water, beginning a new age of diversified fishing. With a motto of “diversity or bust,” fishermen turned to conch, which saved the local fishing industry due to high foreign demand; oysters; and scallops. Mr. King professed that this diversification saved his job, and he has started farming oysters in order to further protect his future. However, oyster beds are in constant danger of getting wiped out by storms, which Mr. King found “have become less frequent but more violent.” He also discussed branching out to growing seaweeds, specifically kelp and gracilaria.

“The future here is uncertain,” Mr. King stated. “Due to climate change, lobster may never flourish again in Long Island Sound. Therefore, it is necessary for fishermen to pursue other options.” He believes these other options, which include sea farming, conching, and fin fishing, to be their ticket to success.

## FERN GIBBONS, PH.D.

*Senate Commerce Committee; Oceans, Atmosphere, Fisheries,  
and Coast Guard Subcommittee*

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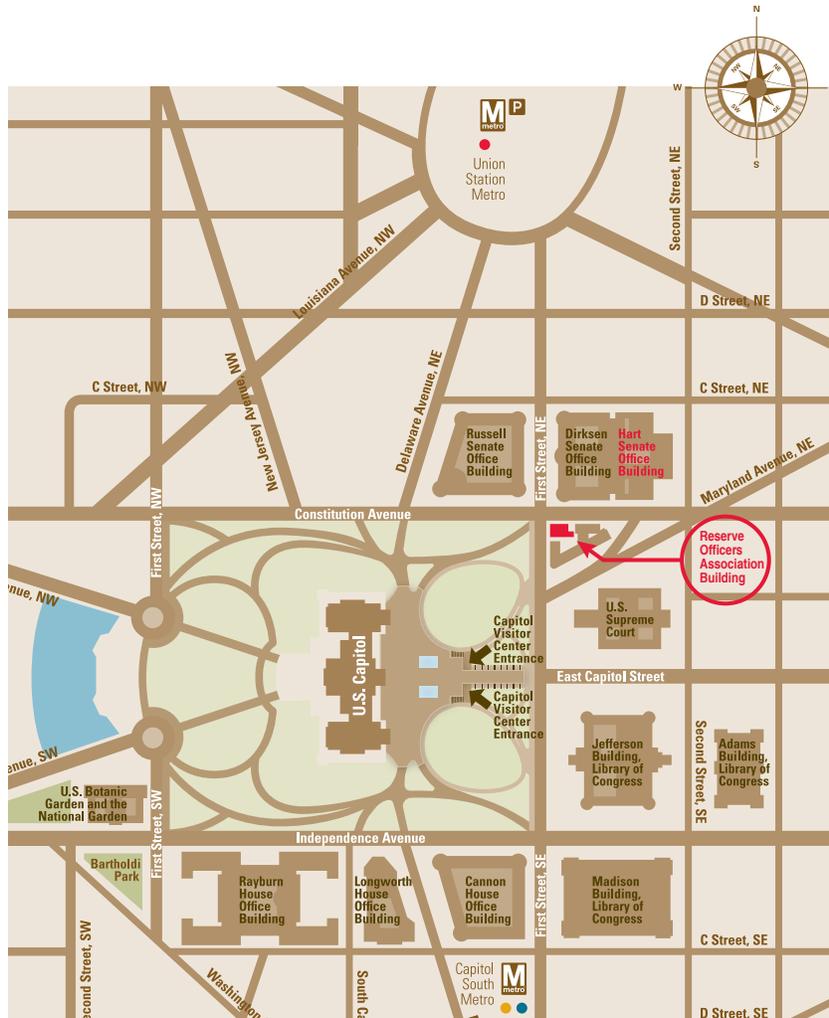
As professional staff for the Oceans, Atmosphere, Fisheries, and Coast Guard Subcommittee of the Senate Committee on Commerce, Science, and Transportation, Dr. Fern Gibbons is at the forefront of ocean policy making. She summarized recent ocean policy victories, such as the *Illegal, Unreported, and Unregulated Fishing Enforcement Act of 2015* (IUU), of which she said “passing the IUU bill was definitely a really big accomplishment for all of us who have been working on it.” Dr. Gibbons also provided outlook to the future of the *Magnuson-Stevens Fishery Conservation and Management Act* (MSA).

Since the last MSA reauthorization was comprehensive, she believes a “modest tweak at most” is all that is needed. Despite pressure not to reauthorize the MSA, she believes that “from a good governance perspective, it is good to reauthorize bills that have lapsed so they can stay current,” and she hopes to “move toward a productive, bipartisan, modest reauthorization.”

In relation to the panel topic, Dr. Gibbons examined the challenge of implementing legislative mandates to increase resilient fisheries. She explained that much occurs at the NOAA and councils level, and she hasn’t seen legislative proposals that wouldn’t be too burdensome and slow down the work of NOAA and the councils. Additionally, implementation will vary from region to region, and the councils are set up to deal with these regional issues without a national “one size fits all” solution. While she does not see a legislative mandate as necessary, she said the committee would be open to exploring the idea of a legislative solution as long as, “that answer is more nuanced than just always leaving more fish in the water.” Hand-in-hand with increasing the resiliency of the fish in the water comes the question of increasing the resiliency of the community.

Dr. Gibbons described another challenge for resilient fisheries as the structure of the councils. The council process is slow, which she believes is both a strength and a weakness. Their inability to react quickly to changing fisheries conditions can cause lasting, possibly permanent damage to fishing communities when a fishery is closed. Lastly, she addressed the difficulty of pinpointing the catch-share regime with the increase of migrating fisheries and how that is dealt with on a community level.

Despite all of the challenges that come with legislating resilient fisheries, Dr. Gibbons believes “that NOAA’s National Standard One revisions are going [a] ... long way in both addressing the problems of simultaneously creating a more resilient fishery and a more resilient fishing community.”



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