# STATUS OF OCEAN OBSERVING SYSTEMS IN THE UNITED STATES

## OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE AND OCEANS

OF THE

COMMITTEE ON RESOURCES
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED EIGHTH CONGRESS

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# OVERSIGHT HEARING ON THE STATUS OF OCEAN OBSERVING SYSTEMS IN THE UNITED STATES.

**Tuesday, July 13, 2004**
**U.S. House of Representatives**
**Subcommittee on Fisheries Conservation, Wildlife and Oceans**
**Committee on Resources**
**Washington, D.C.**

The Subcommittee met, pursuant to notice, at 10:07 a.m., in Room 1334, Longworth House Office Building, Hon. Wayne T. Gilchrest [Chairman of the Subcommittee] presiding.

Present: Representatives Gilchrest and Pallone.

## STATEMENT OF THE HON. WAYNE T. GILCHREST, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MARYLAND

Mr. GILCHREST. The Subcommittee will come to order.

Good morning and welcome. I want to thank all of you for coming this morning and we look forward to hearing our witnesses. We have not seen or heard from Don Boesch yet, but when he comes in, we will welcome him with open arms, I am sure.

The balloon on the ceiling is to test the atmosphere at the top of the hearing room. We have the technology to be able to detect hot air from really good information.

But anyway, welcome all of you to our hearing this morning.

The topic for today's oversight hearing is the need for, and the Nation's progress regarding, the development and implementation of an integrated and sustained ocean observing system.

Dr. Boesch, welcome. You may come up to the front table, sir. We just barely got started. Thank you for coming, and good morning to you.

The Ocean Commission recently released its draft Governor's report and recommended the development of a national integrated ocean observing system, and many States have commented that this type of integrated system is a high priority. The Commission stated the forecasting and observational capacity of these systems, and the products produced by the information collected, should be as useful and analogous to the benefits received by the general public through the national weather forecasting and warning network.

Over 150 years ago the Nation embarked on a mission to create a comprehensive weather forecasting and warning system. It took a lot of ingenuity, manpower, and extraordinary amounts of funding, but our Nation was successful in this endeavor and today people cannot live without a daily, if not hourly, update of weather reports.

Our Nation has also put space exploration as a high priority and we know more today about the moon, Mars and other planets in our solar system than we did 40 years ago. The development of rockets and shuttles, satellites, telescopes, lunar modules, and many other technologies have allowed us to go into space, land on the moon, send land rovers to Mars, and glean valuable information that would have been impossible to collect otherwise.

Our space exploration and our weather program show that when our scientists and the Nation support a program and devote time, money, and, more importantly, the human mind into these types of endeavors, we are highly successful.

What has occurred in our atmosphere and in space has not occurred in our oceans. The ocean has been referred to as the last frontier, a place where we still find new organisms and species in its deepest depths. It is quite amazing that there are still places on our planet where a creature awaits discovery or where we struggle to understand the implication of climate change and the causes of those changes.

Global climate change has been in the news for quite some time and the information and misinformation available to the public can be quite alarming. Recently Hollywood produced a feature film, "The Day After Tomorrow." When I was watching that film, I would have preferred to stay in New York City after the cold weather hit. But "The Day After Tomorrow," about climate change, where the world's climate changed radically in a 4-day time span. Most people understand the earth's climate would not change this quickly, but there have also been reports of climate change occurring within decades, which may be a somewhat new phenomenon. Changes in our climate could affect the North Atlantic Oscillation and Thermohaline Circulation. We look forward to discussing these issues with our prestigious witnesses here today.

We are also interested and hope to get a better understanding of how regional, coastal, national, and global ocean observing systems will help us understand the chemical, physical, and biological processes in our oceans. I would like to get a better understanding of the technologies used to run these systems, the type of physical, chemical, and biological data collected, the products developed from this data, and the users of these products. In addition, I would like to discuss how these systems will help us understand the ocean's involvement in the changes to the earth's climate. In particular, I would like to know if these ocean observing systems can assist in determining whether changes are occurring due to human influences, natural processes, or both.

I understand that there are up to 40 coastal ocean observing systems throughout the United States that are running fairly independently, and that a plan is being developed by Federal agencies to coordinate the functions of these regional systems to support a national ocean observing system. I also understand that before we can have an integrated system, we face a number of hurdles, including limitations in our data management systems and predictive model capabilities.

Today's hearing should shed some light on the current status of ocean observing systems and the critical first steps necessary to see an integrated ocean observing system come into fruition in the very near future. And we, as Members of Congress, would like to be partners in that, what we believe is a most extraordinary, necessary effort.

I thank you for coming this morning, and will yield at this time to my good friend from New Jersey, Mr. Pallone.

[The prepared statement of Mr. Gilchrest follows:]

**Statement of The Honorable Wayne T. Gilchrest, Chairman, Subcommittee on Fisheries Conservation, Wildlife and Oceans**

Good morning. I would like to welcome our witnesses and thank them for taking the time to be with us today.

The topic for today's oversight hearing is the need for, and the nation's progress regarding, the development and implementation of an integrated and sustained ocean observing system.

The Ocean Commission recently released its draft Governor's report and recommended the development of a national integrated ocean observing system, and many states have commented that this type of integrated system is a high priority. The Commission stated the forecasting and observational capacity of these systems, and the products produced by the information collected, should be as useful and analogous to the benefits received by the general public through the national weather forecasting and warning network.

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Our space exploration and our weather programs show that when our scientists and the nation support a program and devote time, money and most importantly the human mind into these types of endeavors we are highly successful.

What has occurred in our atmosphere and in space, has not occurred in our oceans. The ocean has been referred to as the last frontier, a place where we still find new organisms and species in its deepest depths. It is quite amazing that there are still places on our planet where a creature awaits discovery or where we struggle to understand the implication of climate changes and the causes of these changes.

Global climate change has been in the news for quite some time and the information and misinformation available to the public can be quite alarming. Recently Hollywood produced a feature film—THE DAY AFTER TOMORROW—about climate change, where the world's climate changed radically in a four day time span. Most educated people understand the earth's climate would not change this quickly, but there have also been reports of climate changes occurring within decades, which may be a somewhat new phenomena. I have a personal interest in how changes in our climate could effect the North Atlantic Oscillation and Thermohaline Circulation. I look forward to discussing these issues with our prestigious witnesses today.

I am also interested and hope to get a better understanding of how regional, coastal, national and global ocean observing systems will help us understand the chemical, physical and biological processes in our oceans. I would like to get a better understanding of the technologies used to run these systems, the type of physical, chemical and biological data collected, the products developed from this data and the users of the products. In addition, I would like to discuss how these systems will help us understand the oceans involvement in the changes to the earth's climate. In particular, I would like to know if these ocean observing systems can assist in determining whether changes are occurring due to human influences or if they are a part of natural processes.

I understand that there are up to 40 coastal ocean observing systems throughout the U.S. that are running fairly independently, and that a plan is being developed by Federal agencies to coordinate the functions of these regional systems to support a national ocean observing system. I also understand that before we can have an integrated system, we face a number of hurdles, including limitations in our data management systems and predictive model capabilities.

Today's hearing should shed some light on the current status of ocean observing systems and the critical first steps necessary to see an integrated ocean observing system come into fruition.

I yield to the Ranking Member, Mr. Pallone, for any opening statement he may have.

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## STATEMENT OF THE HON. FRANK PALLONE, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEW ERSEY

Mr. PALLONE. Thank you, Mr. Chairman. I appreciate your having decided to move ahead with today's hearing regarding ocean observation, because it is such an important issue.

But I did want to reiterate a procedural problem which I mentioned to you yesterday, and that is that, for whatever reason, the Resources Committee, the full committee, is having a hearing today, a very important hearing, actually, and—I know I have already mentioned it to you, but I will mention it again and I mentioned to Chairman Pombo that I think it is inappropriate for us to have hearings before both the Subcommittee and the full committee at the same time, because it makes it difficult, if not impossible, for Members to participate. As you can see, it is just the two of us here today. And I know there are Members on the Democratic side who wanted to come, but are at the other committee, full committee hearing down the hall.

I know it is not your fault, but I just hope that we can work together so that we don't have these conflicts in the future. Because I am actually have to step out myself at some point to go down there and participate.

I also hope that this is only the first in a series of oversight hearings concerning the recently released recommendations of the U.S. Commission on Ocean Policy. I was heartened by the strong endorsement that ocean observation initiatives have received and view the Ocean Commission's recommendation as a very positive development.

I have been a long-time supporter of increased funding for the design, coordination, and deployment of innovative automated observation technologies to improve our basic understanding of the coastal and ocean environment of the United States. Much of what I do know about coastal observations I attribute to Dr. Fred Grassle and his work at the Institute of Marine and Coastal Science at Rutgers University. And I would like to thank Dr. Grassle for again coming before the Subcommittee to update our members about the significant research conducted through the LEO-15 array and planned expansion of this planned technology in the southeastern United States. Of course, several of my Democratic colleagues are equally enthusiastic about the potential for a national ocean observation system, especially Congressman Sam Farr and Congressman Tom Allen.

I also wanted to thank both Dr. "Toby" Garfield and Mr. Evan Richert for traveling to Washington to inform the Subcommittee of the regional programs they are involved with in California and Maine.

I am compelled to say that I am very concerned about where we are going to find the funding to design, build, deploy, and maintain a comprehensive ocean observation system. I don't want to be negative, but, as many Members know, last week the House passed legislation significantly cutting funding for NOAA's ocean and coastal programs from last year's appropriation. A number of us, including myself, went on the floor and expressed our hope that, in conference, that some of that funding would be restored. But the stark reality is that, unless Members coalesce around the need for a genuine ocean observation system, the funding is never going to be there.

And no less important, the Administration must bring to this initiative the very same commitment it brought to the modernization of NOAA's weather forecasting and satellite programs, which Chairman Gilchrest mentioned. In the absence of such a commitment, a comprehensive observation system will remain dead in the water. We simply can't afford to have that happen.

Mr. Chairman, I think we have to work together, as you know, to better inform our colleagues about the many cross-over benefits that a nationwide ocean observation will bring in research, national security, hazard mitigation, and natural resource management. And I know this is going to be a challenge, but I pledge to you my cooperation in that effort and thank you again for having the hearing today.

[The prepared statement of Mr. Pallone follows:]

**Statement of The Honorable Frank Pallone, Jr., a Representative in Congress from the State of New Jersey**

Thank you, Mr. Chairman. I appreciate that you have decided to move ahead with today's hearing regarding ocean observations.

I hope that this is only the first in a series of oversight hearings concerning the recently released recommendations of the U.S. Commission on Ocean Policy. I was heartened by the strong endorsement that this initiative received and view that recommendation as a very positive development.

I have been a long-time supporter of increased funding for the design, coordination and deployment of innovative, automated observation technologies to improve our basic understanding of the coastal and ocean environment of the United States.

Much of what I do know about coastal observations I attribute to Dr. Fred Grassle and his work at the Institute of Marine and Coastal Science at Rutgers University. I would like to thank Dr. Grassle for again coming before the subcommittee to update our members about the significant research conducted through the LEO-15 array and planned expansion of this technology in the Southeastern U.S.

Of course, several of my Democrat colleagues are equally enthusiastic about the potential for a national ocean observation system, especially Congressman Sam Farr and Congressman Tom Allen. I also want to thank both Dr. Toby Newell and Mr. Evan Richert for traveling to Washington to inform the subcommittee of the regional programs they are involved with in California and Maine.

But in closing, I am compelled to say that I am very concerned about where we are going to find the funding to design, build, deploy and maintain a comprehensive ocean observation system.

I do not want to be pessimistic, but as many Members know, last week the House passed legislation significantly cutting funding for NOAA's ocean and coastal programs from last year's appropriation. Frankly, the stark reality is that unless Members coalesce around the need for a genuine ocean observation system, the funding will never be there.

And no less important, the Administration must bring to this initiative the very same commitment it brought to the modernization of NOAA's weather forecasting and satellite programs. In the absence of such a commitment, a comprehensive observation system will remain dead in the water.

We simply cannot afford to have that happen. Mr. Chairman, we must work together to better inform our colleagues about the many cross-over benefits that a nationwide ocean observation will bring in research, national security, hazard mitigation and natural resource management.

This will be a challenge but I pledge to you my cooperation in that effort.

Thank you.

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Mr. GILCHREST. Thank you, Mr. Pallone. And we will see if we can work to try to avoid the conflict of the hearings schedule in the future.

I would also like to say I would like to work with you and other Members on both sides of the aisle in dealing with ocean issues, and this one in particular that we are hearing testimony on today. There are a whole range of scientific endeavors that Congress supports, whether it is health care, diseases, manned exploration/non-manned exploration of space, and a variety of oceans issues. It would be important for us to prioritize all of these research and scientific endeavors so that we can allocate the funds to the things that are most needed in the near future, and I think ocean issues—the full range of what the Navy does, what the scientific community does dealing with the health of the planet, climate change, fisheries, coastal areas—those things probably, in my judgment, should take priority.

The ocean has always been a little bit of a set-back to the Congress, but I think, working together, we can help make that priority for oceans a reality.

We are very happy this morning to have Dr. Richard Spinrad from NOAA, the assistant administrator. Welcome, sir. Dr. Margaret Leinen, National Science Foundation. Mr. Robert Winokur, an oceanographer for the Navy—thank you very much for coming this morning. Dr. Robert Weller, senior scientist, Woods Hole—thank you for coming down from Massachusetts. And Dr. Donald Boesch, president, Center for Environmental Science, from the University of Maryland. Welcome to all of you.

We will start with Dr. Richard Spinrad.

**STATEMENT OF RICHARD W. SPINRAD, Ph.D., ASSISTANT ADMINISTRATOR, NATIONAL OCEAN SERVICE, NOAA**

Dr. SPINRAD. Good morning, Mr. Chairman, and members and staff of the Subcommittee. I am Rick Spinrad, the assistant administrator of NOAA for ocean services and coastal zone management.

Imagine, if you will, that you are a ship pilot steering your cargo vessel into the Houston ship channel. Dead ahead of you, and steering straight toward you, is another vessel heading out to sea. You and the other pilot both maintain course toward a head-on collision, veering to the side only at the last possible moment.

Well, you don't have to imagine this. This scenario actually happens. It's called the Texas Chicken. The channel leading to the Port of Houston is so narrow that pilots sometimes use this precise technique to reduce the chance of collisions and groundings along the shallow banks. But every day disasters are avoided because the pilots have access to reliable, real-time data on the direction and speed of the surface currents and winds to guide their transit in the channel.

Now imagine that you are a coastal resource manager in the State of Maine. You receive a call from a group of scientists on a research vessel offshore who are mapping the bloom of a toxic marine alga responsible for red tides. The toxin this alga produces can cause paralysis and death in humans if consumed in contaminated shellfish. So your immediate concern is whether you will need to close the shell fisheries. By using a system that combines data from satellites, ship-board measurements, and buoys, the scientists are able to tell you where and when the toxic algal bloom will wash ashore. As predicted, you detect an increase in toxicity at shellfish monitoring stations in this area and you are able to close affected sites before serious illness occurs—another true success story courtesy of ocean observations.

Every day, several times a day, ocean observations provide accurate, reliable, real-time data on the marine environment to inform both routine and critical actions and decisions of government managers, ship pilots, fishers, farmers, beach-goers, and others. These observations represent the individual components of an integrated ocean observing system or, as we call it, IOOS, that all of us on these panels are working to create.

It is not the ocean observations per se that benefit us, it is the products to which they contribute, and how we use those products. For example, ocean observations can generate annually between $275 and $300 million in economic benefits to agriculture through improved seasonal forecasts. They can yield $100 to $200 million in savings to the tourism industry each year by better informing beach closure decisions. They can increase shipping revenue by up to $1 million per vessel—$1 million per vessel—for each additional foot of under-keel clearance that we forecast.

Research and operational efforts contribute to our knowledge of the marine environment. It is the integration of these diverse components into a system that will result in the whole being much more than the sum of its parts. Both programmatically and through our representation on key oversight planning and organizational bodies, NOAA plays an active role in ocean observation efforts at the national and international levels. For example, I co-chair, with Dr. Leinen, the National Science and Technology Council's Joint Subcommittee on Oceans. This subcommittee is currently establishing a task force on ocean observations to focus on national research interests and needs in this area.

I have provided for the record a separate document of representative NOAA ocean observation capabilities. As this list of examples demonstrates, NOAA's contribution to the Federal observation assets—called the IOOS national backbone—is significant. As you will hear from Dr. Leinen and Mr. Winokur, many other Federal agencies have observing capacities that are a critical part of the national backbone. Coordination and integration of Federal capacity with regional observing systems is needed to realize their full potential.

The National Ocean Research Leadership Council, currently chaired by NOAA, established the interagency Ocean.US office to coordinate the planning and development of the IOOS. Under the direction of the interagency executive committee, which I chair, Ocean.US is currently working with regional and local stakeholders to develop the IOOS implementation plan expected to be approved by the council this fall. The plan envisions a national coastal and ocean observing system borne through the integration of Federal capabilities and regional coastal observing assets with a coordinated network of regional associations to guide the development and implementation of the regional system.

Bringing together diverse efforts into one system results in critical data management and communications issues. Ocean.US is addressing these issues through a data management and communications steering committee that has produced an initial implementation plan.

I want to take just a final moment to mention some critical international activities. And integrated ocean observing system for the U.S. would be a subset of the international global ocean observing system and therefore a component of the larger global earth observation system of systems. I have just returned from a meeting of the United Nations Intergovernmental Oceanographic Commission Executive Council, where I serve as the permanent U.S. representative. I can tell you with utmost assurance, Mr. Chairman, that the strength of the U.S. investment in ocean observations is being watched globally. Our ability to share capabilities and capacities with other nations can serve as in important tool in international relations. It is only recently that mechanisms have been established to pull the international, national, and regional communities together, along with the experience and expertise of the private sector, to make IOOS a reality.

The challenges that now exist are largely associated with governance, data management, coordination, and sustainability. Solutions to these challenges are now being shaped into a strategy to pursue IOOS both nationally and internationally.

Mr. Chairman, this concludes my testimony. I would be pleased to answer any questions that you or other Members may have. Thank you.

[The prepared statement of Dr. Spinrad follows:]

**Statement of Richard W. Spinrad, Ph.D., Assistant Administrator, National Ocean Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce**

*Introductory Comments*

Good morning, Mr. Chairman and members of the Subcommittee. My name is Richard W. Spinrad, Ph.D., Assistant Administrator of NOAA for Ocean Services and Coastal Zone Management. In this capacity, I administer the programs within NOAA's National Ocean Service (NOS). This includes programs addressing coral reef conservation, marine protected areas, marine sanctuaries, oil and chemical spills, coastal resource management, coastal ecosystem science, coastal monitoring and observations, ecological forecasting, national estuarine research reserves, natural resource restoration, aerial photography and shoreline mapping, global positioning and marine navigation. A number of NOAA's ocean observation programs fall under my purview. I was recently named the U.S. Permanent Representative and Head of Delegation to the Intergovernmental Oceanographic Commission. I am also the chair of the executive committee overseeing Ocean.US, the interagency office developing plans for the Integrated Ocean Observing System (IOOS). Within NOAA, I co-chair the NOAA Ocean Council, which is one of two NOAA-wide bodies focused on the coordination of observing system activities. I appreciate this opportunity to discuss the wide-ranging benefits of ocean observations and NOAA's role in developing an integrated system for gathering much-needed information on the coastal and marine environment.

The oceans cover 70 percent of Earth's surface. The Integrated Ocean Observing System seeks to harness the wealth of technologies and capabilities that have developed over the last quarter century to more accurately and comprehensively understand how oceans impact our lives and how we impact the oceans. The goal is to use that understanding to inform and improve the capability of governments at all levels, as well as commercial, recreational and other interests, to meet a variety of needs, including the ability to make wise decisions. While IOOS will certainly result in new discoveries, its reach extends far beyond research. It provides a framework for merging environmental data with new technologies to create products that improve our management and use of the world's coastal and ocean areas. In fact, the early success of demonstrations and pilots has been a primary driver of the growing interest and support for the development of a more comprehensive system.

The users and beneficiaries of IOOS include everyone who traverses our marine waters from the tanker operator to the recreational boater, from the commercial fisher to the avid surfer. But, a farmer in the Midwest who may never visit the shore will also directly benefit. IOOS will speed trade and commerce, and also make it safer for vessels to navigate increasingly congested ports, harbors and waterways. It will directly benefit the nearly half of all Americans living near the coast by mitigating vulnerability to storms and enhancing security. It will support agriculture by providing better weather forecasts. It will improve the management of fish stocks and marine mammals through enhanced ecological information. In its preliminary report, the Preliminary Report of the U.S. Commission on Ocean Policy concluded implementation of IOOS must be a priority, stating that "High quality, accessible information is critical to making wise decisions about ocean and coastal resources and their uses to guarantee sustainable social, economic, and environmental benefits from the sea. [page xiii]

The tools and capabilities provided by IOOS will help us to address many needs including the ability to:

1. Improve prediction of weather as well as climate change and variability and their impact on coastal communities and the nation;
2. Improve the safety and efficiency of marine operations;
3. More effectively mitigate the damaging effects of natural hazards;
4. Improve national and homeland security;
5. Reduce public health risks;
6. More effectively protect and restore healthy coastal marine ecosystems; and
7. Sustain use of marine resources.

Highlighting the importance of IOOS, the Preliminary Report of the Ocean Commission devotes an entire chapter to its development and implementation. But because the benefits of IOOS will be so far reaching, it is referenced in many other chapters. Throughout the Commission's report, the term "Integrated Ocean Observing System" appears 85 times, and the acronym "IOOS" 150 times. The Commission concludes that, "The United States simply cannot provide the economic, environmental, and security benefits noted above, achieve new levels of understanding and predictive capability, or generate the information needed by a wide range of users, without implementing the IOOS. [page 320]

*Why Ocean Observations Matter: The Need for an Integrated Ocean Observing System*

Coastal waters and adjacent lands are one of the most productive and active areas of the planet. Our coastal communities are major population and economic centers. Over half the U.S. population lives in coastal watershed counties, and about half of the nation's Gross Domestic Product—some $4.5 trillion—and 60 million jobs are generated in coastal watershed counties and ocean waters. About 75 million Americans are directly involved in on-the-water activities and 90 percent of international trade by weight is carried by sea. On a global scale, over 25 percent of the world's energy is produced within nations' exclusive economic zones, which also yield approximately 90 percent of all fish landings [1].

But pressure on the marine environment is mounting:

[1] Cicin-Sain, B., R.W. Knecht, and N. Foster, eds. Trends and Future Challenges for U.S. National Ocean and Coastal Policy Workshop Proceedings. 1999.

- Regularly up to 12,000 square miles (according to some estimates) of the Gulf of Mexico becomes hypoxic, or abnormally low in oxygen, in the summer months [2].
- Thousands of beach closures and swimming advisories are issued annually [3].
- Of the 267 major fish stocks in the U.S., which represent 99 percent of total commercial landings, approximately 29 percent are already overfished or are experiencing overfishing [4].
- Over 500 invasive species are now established in North American coastal habitats [5].
- Harmful algal blooms cost the U.S. an average of $49 million each year due to fisheries closures, loss of tourism and recreation, and increased health care and monitoring expenses [6].
- Roughly 1,500 homes are lost to erosion each year [7].
- 70% of Federal Emergency Management Agency repeat flooding losses are in the coastal zone.

Managing multiple, complex and often competing demands is a major challenge. This task is made all the more formidable by a lack of basic understanding of marine processes and a reliable and sustained flow of data. How can we manage what we do not even fully understand? Safe and sustainable navigation, the continued use of marine resources, the safeguarding of both local and global marine environments, and the protection of human lives all require an enhanced capacity to gather data and provide information.

We know that the oceans drive long term and seasonal climate, as well as daily weather. But we are just beginning to understand the ocean/atmosphere interface and to develop systems that provide increasingly accurate predictive capabilities. On a global scale, improved earth and ocean observations will improve our ability to calculate and predict the timing and scope of significant interannual and seasonal climate events such as drought, floods and major storms. The potential humanitarian, ecological and resulting economic benefits of being able to meaningfully mitigate the impacts of these events is vast.

By way of example, on the morning of May 9, 1980, during a blinding spring squall, the freighter SUMMIT VENTURE rammed into the Sunshine Skyway bridge in Tampa, knocking out a 1,400-foot length of the bridge across the mouth of Tampa Bay. Seven vehicles and a Greyhound bus fell from the bridge killing thirty-five people. An experienced pilot was at the helm of the empty freighter, but suddenly caught in zero visibility without radar, the pilot did not realize the wind was pushing his high-riding vessel off course until it was too late. It was this incident that led to the concept of using real-time information on the ocean environment to improve navigation—and eventually to the first installment of the Physical Oceanographic Real-Time System (PORTS"). This program of NOAA's NOS supports safe and cost-efficient navigation by providing ship masters and pilots with accurate real-time information required to avoid groundings and collisions.

It is not the ocean observations per se that result in direct benefits for the nation; it is the products to which they contribute and how we use those products. For example information on water levels, tides and currents coupled with nautical charting and shoreline mapping support marine transportation; surveys of living marine resources support fisheries management; weather and current information supports offshore energy production management; and habitat and water quality information supports estuarine and marine protected areas management. We now know that the ocean and atmosphere are not only linked and collectively create weather and climate, but that fisheries, transportation, planning, coastal management and protection, and energy forecasts all benefit from improved ocean-atmosphere predictability. We also know that modern capabilities of high-resolution mapping, integrated with water level reference points can provide baseline maps for a wide range of non-navigation applications including coastal inundation and benthic habitat maps.

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[2] Boesch, D.F., et al. Marine Pollution in the United States: Significant Accomplishments, Future Challenges. Arlington, VA: Pew Oceans Commission. 2001.

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[5] Ruiz, G.M. Written testimony before the U.S. House of Representatives, Committee on Science, Subcommittee on Environment, Technology, and Standards. June 20, 2002.

[6] Anderson, D.M., P. Hoagland, Y. Kaoru, and A. White. Estimated Annual Economic Impacts from Harmful Algal Blooms (HABs) in the United States. 2000

[7] The H. John Heinz III Center for Science, Economics and the Environment. Evaluation of Erosion Hazards Summary. Washington, DC. 2000.

Ocean observing systems provide information that benefit the world in numerous ways. Excellent examples exist in the area of weather forecasting. In agriculture, many decisions could be improved with a reliable seasonal weather forecast. One recent study found that by incorporating El Nino Southern Oscillation (ENSO) forecasts into planting decisions, farmers in the U.S. could increase agricultural output and produce benefits to the U.S. economy of $275-$300 million per year. Another study estimated that the value to society of ENSO forecasts on corn storage decisions in certain years may be as high as $200 million—or 1 to 2 percent of the value of U.S. agricultural production. A third study on the costs and benefits of ENSO forecasts concluded that for agricultural benefits alone, the real internal rate of return for federal investments in ocean observation for ENSO prediction is between 13 and 26 percent [8].

Improved weather forecasting can also benefit marine commerce. At least half of all commercial ocean transits today take advantage of weather-based vessel routing services, including National Weather Service (NWS) high seas forecasts, which rely on weather and oceanographic observations and forecasts, saving on the order of $300 million in transportation costs annually. Increases in future water-borne trade traffic, accompanied by improvements in routing based on enhanced weather and oceanographic observations, should lead to even greater returns on investment.

But the benefits of accurate, reliable and up-to-date data from ocean observation go far beyond improved weather forecasts. Even small improvements (on the order of one percent) in search efficiency as a result of accurate, real-time information on the immediate marine environment could enhance search and rescue performance sufficiently to generate life and property savings in excess of $100 million per year [9]. Better information on the marine environment can also result in as much as $225,000 per event in saved effort for oil spill responses.

For the tourism industry, $100 to $200 million savings each year could be realized through more precise information on water quality and transport to better inform beach closure decisions and improve safety at beaches [10]. Some preliminary work also suggests that annual benefits for recreational boating (e.g., better trip planning with marine conditions forecasts) would be in the tens of millions of dollars annually [11].

Ocean observations made far out at sea can also help ensure beach safety. Waves generated by a storm well over the horizon can create unsafe beach conditions, leading to major injury or drowning. Wave action along the coast can also change the shoreline, resulting in beach erosion and loss of property such as houses and piers. Wave observations from buoys and satellites, as well as surface wind observations from buoys, ships and satellites, all provide information on wave height and enable more accurate forecasts that help protect people, and allow them to take appropriate measures to protect their property.

*What is the Integrated Ocean Observing System: Defining Terms*

I want to take just a moment to clarify each term in the phrase "Integrated Ocean Observing System" to shed light on the meaning of the phrase as a whole. "Integrated" means to join together and unify. This is a critical element of IOOS because an initial, and significant, task before us is to bring together existing international, national, regional, State, and local capabilities. The other bookend of IOOS is that it is a system, meaning it is a group of interrelated, interacting or interdependent elements forming a collective entity.

The "ocean" includes all international, national, and State ocean jurisdictions, including the Great Lakes. This includes the sea bottom, the water column and even water vapor at the interface of the oceans and atmosphere. It includes all coastal and near shore waters, bays, lagoons, sounds and estuaries. It even includes adjacent terrestrial regions and watersheds, which exert a significant influence on the condition of coastal waters. For example, fertilizers and pesticides that wash into estuaries from land enrich the waters and can lead to toxic red tides or other harmful algal bloom events. Any effort to understand, assess and predict change in the

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[8] Information on these studies can be found in: Economics of a U.S. Integrated Ocean Observing System, prepared by Hauke Kite-Powell, Charles Colgan, Rodney Weiher; and in: Sassone, P., and R. Weiher. 1999. Cost-Benefit Analysis of TOGA and the ENSO Observing System. In R. Weiher (ed.) Improving El Nino Forecasting: The Potential Economic Benefits, NOAA, Office of Policy and Strategic Planning. p. 47.

[9] Kite-Powell, H., C. Colgan, and R. Weiher. The Economics of Sustained Ocean Observations. March, 2002.

[10] Weiher, R. Preliminary results of an ongoing research effort (subject to revision).

[11] Kite-Powell, H., C. Colgan, and R. Weiher. The Economics of Sustained Ocean Observations. March, 2002.

coastal ocean requires understanding and observation of the land adjacent to it and the waterways that feed into it.

The word "observing" sounds rather passive, but in practice includes not only the observation itself, but also the data and products that may be derived and used from various observations. The term may bring to mind images of satellites flying far overhead or of large buoys stationed in the middle of the ocean silently and distantly recording data. In the jargon of ocean observations we refer to these as types of "remote sensing" and "in situ" platforms, and indeed satellites and buoys are two important ocean observing components, but observations are also obtained by aircraft, submerged current meters, and Vessel Monitoring Systems placed on fishing vessels. Observations include hydrographic surveys to detect submerged hazards, samples taken from sediments and shellfish to test for chemical contamination, dedicated oceanographic studies from research vessels, and atmospheric measurements taken from ships of opportunity. They also include habitat characterization and monitoring to support stewardship of living marine resources, and they extend inland to encompass measurements taken from stream gauges. The information gathered through these observations, coupled with economic and social science data associated with ocean resources and their values, are critical to management and use of our coastal and ocean resources.

The Integrated Ocean Observing System is the joining together and unification of ocean observations to form a collective, interrelated entity. It consists of research efforts, pilot projects, pre-operational efforts, and fully operational components, and it is the integration of these into a system that will result in the whole being much more than the sum of its parts. This also represents a major part of the challenge and opportunity of IOOS.

Finally, the term "sustained" often precedes IOOS, and in many of the rewards of IOOS will be derived from a commitment to sustain observations over the long term.

*NOAA's Role in the Integrated Ocean Observing System*

Both programmatically and through our representation on key oversight, planning, and organizational bodies, NOAA is maintaining an active role in ocean observation efforts at the national and international levels.

*NOAA's Ocean Observation Capabilities*

NOAA's broad mission "to understand and predict changes in the Earth's environment and to conserve and manage coastal and marine resources" is matched by an equally wide-ranging array of observation programs. Today, NOAA maintains about 100 operational observing systems, comprised of nearly 30,000 deployed platforms or stations and measuring more than 500 different environmental, meteorological, oceanographic, and related parameters.

NOAA's strategic goals to 1) protect, restore and manage the use of coastal and ocean resources through ecosystem-based management; 2) understand climate variability and change to enhance society's ability to plan and respond; 3) serve society's needs for weather and water information; and 4) support the Nation's commerce with information for safe, efficient, and environmentally sound transportation would be all but impossible without routine, reliable, sustained and credible observations. Many ocean observation capabilities reside within NOAA, including the direct observation of ocean and coastal conditions, living marine resources and their habitats, non-living marine resources, and necessary data management and distribution infrastructure.

Coordination and integration of NOAA, other federal and regional observing systems is needed to realize their full potential. This is not a trivial task. New technologies and new strategies now offer the potential for integrating and obtaining more value from these efforts both to support the NOAA mission and goals and to contribute to the emerging government-wide and international Earth observing system. While the challenges are significant, advances in data management and sharing protocols, improvements in observation technology and the recognition of the needs of the broader community within the IOOS planning framework provide new contexts for contributions from NOAA's long-standing and emerging observing programs.

I have provided for the record a separate document of representative NOAA ocean observation capabilities that describes a full range of data being collected and the uses for this information. As this list of examples demonstrates, NOAA's contribution to the federal observation assets (or national backbone) is significant. Within NOAA, a number of programs meet the IOOS specifications for operational or pre-operational status, making data available in a routine and sustained manner with broad spatial and temporal coverage. The National Data Buoy Center weather buoys and Coastal Marine Automated Stations are an excellent example of an operational system, as is the National Water Level Observation Program. Other NOAA offices also provide significant backbone contributions, including living marine resources surveys, PORTS", hydrographic surveying, and various mapping conducted to examine shoreline and coastal change. NOAA has been working to organize itself so that its mission can be achieved in a way that looks at the "whole Earth system." By understanding our existing observing systems and how they are structured to meet mission goals, NOAA hopes to provide a basis upon which its systems can easily be integrated with other agency observing systems and international programs.

Many other Federal agencies have observing capacity that also will be a required part of the national backbone. While NOAA works to synthesize its observing capacity internally, it must also work externally with other agencies and various regional and local stakeholders to bring all the observational resources together in an organized manner and build a system that takes advantage of existing assets while assessing gaps and prioritizing for future investment.

*NOAA's Coordination Activities*

NOAA has joined national and international partners in placing top priority on Earth observations and considers an Integrated Global Environmental Observation and Data Management System its top crosscutting priority.

Domestically, NOAA Administrator VADM Conrad C. Lautenbacher, Jr. currently chairs the National Ocean Research Leadership Council (NORLC). The NORLC prescribes policies and procedures for the National Oceanographic Partnership Program (NOPP), oversees the allocation of funds for NOPP partnership programs, and assesses needs for managing the Nation's coastal and ocean data. The NORLC also directs Ocean.US, which is coordinating the planning and development of IOOS.

VADM Lautenbacher is also one of three Co-Chairs on the National Science and Technology Council's (NSTC) Committee on Environmental and Natural Resources (CENR), which is developing a multi-year plan for U.S. observational activities, through an Interagency Working Group on Earth Observations (IWGEO). IWGEO has 15 agencies working together to develop the U.S. national plan, as well as the U.S. inputs to the international effort.

In a related effort, I co-chair the NSTC Joint Subcommittee on Oceans that links the NSTC's CENR and the Committee on Science. The Joint Subcommittee on Oceans, which has representation from nearly two dozen federal entities, is currently establishing a Task Force on Ocean Observations to focus on national interests and needs in this area.

Internationally, VADM Lautenbacher serves as the co-chair to an intergovernmental working group on global Earth observation systems (Group on Earth Observations—GEO), along with representatives of the European Commission, Japan and South Africa. GEO was developed as a result of the first Earth Observation Summit that was held in the United States last July. At this Summit, it was agreed that a blueprint of a global system for monitoring the Earth's complex natural system was needed. GEO strives to monitor global climate and environmental systems at the international level and is currently working on a 10-Year Implementation Plan for building a comprehensive, coordinated and sustained Earth observation system (Global Earth Observation System of Systems—GEOSS), of which ocean and coastal systems are a component. Just this spring, at the second Earth Observation Summit in Tokyo, ministers of 47 nations and the European Union adopted the Framework Document for the 10-Year Implementation Plan. The plan itself will be presented at Earth Observation Summit III in February 2005. With the creation of a framework such as GEOSS and the current development of an Implementation Plan, we will begin to see the fruits of these efforts at not only the global level but at the local level to the "end users" where our technological abilities in observations will be used to support decision making.

As noted above, I serve as the U.S. representative to the Executive Committee of UNESCO's Intergovernmental Oceanographic Commission, or IOC. Through its Global Ocean Observation System (GOOS) efforts, the IOC is working to establish a permanent global system for observations, modeling and analysis of marine and ocean variables. An integrated ocean observing system for the U.S. would be a subset of GOOS, which in turn is a subset of the Global Earth Observation System of Systems.

In May, I attended the tenth meeting of the U.S. GOOS Steering Committee, and I have just returned from a meeting of the IOC Executive Council. I can tell you, with utmost assurance, that the strength of the U.S. investment in ocean observations is being watched globally. Our ability to share capabilities and capacities with other nations can serve as an important tool in international relations. Further, the Ocean Commission notes that, "high-level U.S. participation in international global observing planning meetings is essential, particularly by top-level NASA and NOAA officials."

Because observations are such a critical issue across NOAA, we have created two internal councils that assist with NOAA-wide coordination of observing systems activities. The NOAA Observing Systems Council (NOSC) is addressing integration of observations by providing recommendations on observing system requirements, architectures, and acquisitions to meet NOAA, national, and international observing needs. The goal is to develop a NOAA Observing System Architecture (NOSA). The second council, the NOAA Ocean Council (NOC), is focused on, among other issues, NOAA's capability to meet its contributions to the operational national backbone requirements of the IOOS, ensuring connectivity across the IOOS and the Global Ocean Observing System and NOAA support for NOPP.

*Integrated Ocean Observing System Implementation Plan*

The technology currently exists to gather data from a variety of sensors deployed on buoys, gliders, ships and satellites and integrate this information into useful, useable products for a range of stakeholders. What we are lacking, however, is the connection to create a national integrated ocean observing system, linked to a global system.

Through the working arrangements established by the National Ocean Research Leadership Council, the Ocean.US office is working with NOAA, other agencies, and regional and local stakeholders to develop the IOOS Implementation Plan. Much effort over the last few years, building on the work of the last decade, has gone into developing this plan. NOAA provides much of the funding to support Ocean.US, and, along with nine other federal agencies, works through the NORLC and the Ocean.US Executive Committee to guide the efforts of Ocean.US as it spearheads the development of IOOS. Many other agencies, regional, and local stakeholders are also involved with the development of IOOS.

In March 2002, Ocean.US convened the seminal Airlie House Workshop, which produced Building Consensus: Toward an Integrated and Sustained Ocean Observing System (IOOS) http://www.ocean.us. This effort brought together federal agencies and academic representatives to begin defining the scientific and environmental variables, and observing techniques, that should drive the IOOS. This report has been provided for the record.

The Draft IOOS Implementation Plan is under development and currently consists of three parts covering 1) structure and governance; 2) the current state of the nation's operational observing assets; and 3) priority needs for future funding. A great deal of work has been done to begin integrating and augmenting the IOOS, while at the same time developing specific plans and structures to ensure it is an efficient and effective tool for meeting the needs of various stakeholders. Undertaking these efforts at the same time—both building and designing the IOOS—has proved challenging, but has also offered a real-time look at the issues, problems and opportunities that IOOS offers.

*A Regional Approach*

The Draft IOOS Implementation Plan envisions a national coastal and ocean observing system (the IOOS) formed through the integration of federal assets (the national backbone) and assets of regional coastal ocean observing systems (RCOOS). The Draft IOOS Implementation Plan documents the need for a coordinated network of regional associations (RAs), to guide the development and implementation of the RCOOS. This regional approach is fundamental to meeting user needs on global, national, regional, and local scales.

The purpose of IOOS is to integrate the disparate regional efforts and achieve greater efficiencies and utility of the collected information. At present, however, there are few examples that can be considered Regional Observing Systems. The Gulf of Maine Ocean Observing System (GoMOOS) is perhaps the best candidate. What presently exists in the United States is a loose collection of independent observing capabilities. The Draft Implementation Plan does not prescribe a specific number of regional systems needed. Instead, it is expected that the regional systems will be self-forming around natural biogeographic boundaries and established relationships. The Draft IOOS Implementation Plan expects on the order of ten to twelve regional systems, comprised of those assets within each region and coordinated by a Regional Association. Ocean.US is leading an ongoing effort, with representatives from various sectors and regions, to help define and establish criteria for RA certification and a national body to represent all the Regional Associations (the National Federation of Regional Observing Systems). Regardless of the final number of regional systems, it is imperative that assets within the regions, non-federal and federal, are integrated to form a comprehensive system that meets national and regional priorities.

NOAA is contributing to the regional approach by funding competitively selected projects in eight geographic regions to begin the process of forming Regional Associations. The Coastal Observation Technology System (COTS) is targeting two critical elements for establishing regional capacities for coastal and ocean observations: 1) creating the infrastructure and methodologies to collect, share and integrate environmental data and create useful information products and 2) developing the organizational and governance structures (Regional Associations) necessary for regional partnership formation, user-driven requirements assessments, and system management and sustainability. All regions except the Gulf of Maine, the Caribbean Islands and the Pacific Islands are presently funded to support RA development. NOAA is working with the other regions to also establish such projects.

*Data Management*

Improved data management infrastructure is also critical to the success of the IOOS. Merging disparate efforts into a truly integrated system is the primary challenge in establishing an Integrated Ocean Observing System. In 2002, Ocean.US established the Data Management and Communications (DMAC) Steering Committee to plan for the data management and communications subsystem of IOOS. The RAs have stated that the challenges of data management should be considered an overarching issue that must be funded and adhered to at all phases of the creation of IOOS. The DMAC Steering Committee has produced an implementation plan with 10-year budget estimates, which has not yet been vetted by the National Ocean Research Leadership Council (NORLC).

There are a variety of "data management issues" that need to be considered as IOOS is implemented. These are being addressed, and will continue to be addressed as technology changes. At the national level, the DMAC helps guide direction, but solutions will likely emerge from those people addressing the issues head on as they form regional collaborations. DMAC can help "mainstream" such solutions nationally.

While funding individual projects helps establish capacity (infrastructure) for ocean and coastal observations at specific institutions, such capacity development is not itself sufficient to build an integrated ocean observing system or to realize the vision of a national backbone supplemented by regional observations. Achieving the benefits of IOOS requires cultural and technological frameworks that facilitate data standards, data sharing, data integration, and product development for users within and beyond the scientific community. NOAA, the Office of Naval Research, and Ocean.US have been working with the grant recipients to establish linkages among projects and with the federal agencies to ensure that data collection and management efforts are compatible with the goals of IOOS, recognizing that the cultural shift and commitment required to meet the IOOS vision is significant.

Through a special focus on data development, management and communications, integration, and applications, NOAA is working with COTS recipients to ensure that these projects contribute most effectively to IOOS, and thus to federal mission agency and public user needs. This is an on-going process that requires a high degree of commitment to relationship building, and to helping regional partners through technical assistance and other means to establish the capacities they need to help fulfill the IOOS vision of regional and national integration.

The monitoring and forecasting of El Nino events is a good example of integration of many data sources (terrestrial, coastal, ocean) to craft an understanding of El Nino o formation and intensity. The data management protocols are critical to establishing the capability for such integration.

*Making it Happen*

While the Draft Implementation Plan outlines a detailed strategy for effectively realizing the goal of an IOOS, much work has been done to attain this goal. International collaborations have led to the deployment of systems such as the Tropical Atmosphere Ocean, or TAO/TRITON, array and the Argo profiling array, described in the accompanying list of NOAA ocean observation capabilities. In the U.S., systems such as National Water Level Observation Program and those run by the National Data Buoy Center (NBDC) provide data on a national (coastal) scale. Regional systems currently run by a growing number of organizations also collect data at the higher resolution scale needed to forecast impacts to coastal communities.

Based on the work of the international and national observing community highlighted above, the general reasons, needs, technologies, and drawbacks to building an IOOS have been detailed multiple times over the years. However, it is only recently that mechanisms have been established to pull the international, national and regional communities together to make it happen. In the U.S., direction and input from Congress, NOAA and other federal agencies, the U.S. GOOS Steering Committee, local and regional stakeholders, and the coordination efforts of the Ocean.US office are the impetus pushing to make IOOS a reality.

Twenty years of ocean observational experience in NOAA suggest that the human ability to utilize and apply large amounts of ocean data is a critical limiting factor for the effective use of data from large-scale ocean observational networks. Obtaining a better understanding of regional economic, social, and environmental requirements for IOOS is a key consideration as the system evolves. Validating these requirements through rigorous analysis is an equally important task that will serve to distill the highest priority activities for consideration as IOOS investments.

A three-year regional study on economic and policy drivers for the design of IOOS is currently underway. To-date, the study documents that five key economic sectors (intermodal transportation, construction and engineering, energy, financial services, and recreation and tourism), as well as the public health sector, are factoring ocean and coastal observational information into economic, business, operational, and policy decision making. The study is revealing that increasing the use of this information in and beyond these sectors will strengthen economic activities and fill these sectors— identified needs, such as watershed-based geographic information system (GIS) mapping, more reliable forecasting, improved and higher resolution data on wind fields, and enhanced hurricane models and storm predictions.

There is much work to be done to involve the private sector in IOOS, both as a provider and a beneficiary. The private sector brings years of experience and expertise to operational observing of the environment including for the fields of research, technology development and application, the fielding and maintenance of platforms and instruments, environmental monitoring and analysis, and the operation of complex systems involving the ingestion, processing and delivery of real-time data. Studies are being done to help to identify and validate business sector requirements for IOOS data and information. It will be important, especially in the near term, to maintain an open dialog between the private sector, Ocean.US, federal and state agencies, and the developing RAs.

*Concluding Remarks*

The Preliminary Report of the Ocean Commission notes that “an integrated ocean and coastal observing system that is regionally, nationally, and internationally coordinated and is relevant at local to global scales can serve a wide array of users, be more cost-effective, and provide greater national benefits relative to the investments made. Although the current regional systems are valuable assets that will be essential to the implementation of the IOOS, they are insufficiently integrated to realize a national vision. [page 321]

The challenges that now exist to bring together individual observing efforts to create an integrated system are largely people issues:

- Governance
- Mapping the respective roles and responsibilities of the public and private sectors
- Interoperability and access to data, information and products
- Integration and coordination
- Different needs across a spectrum of users
- Sustainability

It is these challenges which now hold our attention and for which solutions are now being shaped into a strategy to pursue an IOOS both nationally and internationally. NOAA is working both internally (through NOSA, NOSC, and NOC) and externally (Ocean.US, IOC and others) to complete plans for integrated and sustained ocean observations.

Mr. Chairman, this concludes my testimony. I would be pleased to answer any questions that you or other Members may have.

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Mr. GILCHREST. Thank you very much, Dr. Spinrad.

We have some—on the lower dais, there are a number of seats here. So the people standing in the back, if you want to come up and sit down here, you are welcome to. We are not going to ask you to change your political affiliation or anything like that. If you do want to sit up here, you are welcome to sit up here.

Dr. Leinen.

**STATEMENT OF MARGARET S. LEINEN, Ph.D., ASSISTANT DIRECTOR FOR GEOSCIENCES, NATIONAL SCIENCE FOUNDATION**

Dr. LEINEN. Thank you, Mr. Chairman, members of the Committee, Subcommittee, and staff. Thank you for inviting me to testify. I am Margaret Leinen, assistant director for geosciences at the National Science Foundation. My directorate supports ocean science research. As you heard, I also co-chair with Dr. Richard Spinrad the National Science and Technology Council's Subcommittee on Oceans.

In my testimony, I would like to make four points about the National Science Foundation role in the evolving plans for long-term ocean observations and how we are coordinating our planning with NOAA, Navy, NASA, and other agencies that are part of the National Ocean Partnership Program.

First, NSF's mission is to support basic research, primarily at U.S. academic institutions, and that is our role in long-term ocean observations. Thus, our primary involvement is through researchers who successfully compete for NSF grants. The specific research directions come from the broad ocean science community, through workshops, National Academy reports, and other activities. This community has made the need for long-term ocean observations very clear through all these mechanisms.

In the past, progress in ocean research was driven strongly by the ability to make observations in new places or using new types of measurements. Now we know that few characteristics of the ocean are constant. The ocean and the seafloor beneath it are highly dynamic environments. Thus, observations are needed over the time scales of these changing processes, often decades, centuries, and beyond. A new mode of understanding the ocean will evolve over the next decade, driven primarily by these long-term observations.

My second point is that basic research is most effective when researchers plan and design their own experiments and define their infrastructure requirements. Based on such definitions, NSF is planning to fund construction and operation of an innovative new research observatory network that we call ORION. Funds for the construction of the network are being sought through NSF's major research equipment and facilities construction account in a project call the Ocean Observatories Initiative, OOI. OOI was listed in NSF's Fiscal Year 2005 budget submission to Congress as a candidate for a new start in Fiscal Year 2006.

The ORION network and its infrastructure have three elements. First, a regional array of sites that are connected by electro-fiber-optic cable. Two, relocatable deep sea buoys that can be deployed in harsh environments, like the Antarctic Ocean. And three, an expanded network of coastal observatories. These elements will, for example, allow oceanographers to understand the factors that control the diversity and species composition of coastal biological communities, a key requirement to implement ecosystem-based management strategies. They will allow them to understand the processes that form gas hydrate deposits on continental margins and to discriminate natural from anthropogenic climate change. This data will be provided in real time to researchers so they can respond and adjust to events as they develop. Educators and outreach specialists will be able to use the real-time information to spread the excitement of discovery to students and the general public.

ORION is part of the broader national and international observing effort that Dr. Spinrad told you about, that has multiple goals and serves multiple communities. The relationship between ORION and operational ocean observing systems at the national level is within the integrated ocean observing system IOOS. NSF is thus a major participant in the interagency process that is planning IOOS.

My third point is that ocean observatory systems need to evolve in response to new capabilities. We believe that new technology and scientific knowledge are necessary to meet existing user requirements to improve products and to develop new applications that are not currently anticipated. Engaging researchers and research agencies in long-term ocean observations is thus critical to IOOS's evolution, ultimately leading to a broader use of the information and increased user satisfaction with the products.

Fourth, and finally, NSF has already begun to make progress. NSF funded the Monterey Bay Aquarium Research Institute to install a fiber-optic-cabled observatory in Monterey Bay that will serve as a test bed for our future efforts. This year, we also funded a small ORION project office. An executive steering committee comprised of renowned scientists from institutions throughout the U.S. and Canada, including Dr. Weller, who is testifying today, was also established and is working closely with the project office staff. In the near future, we will need to develop a data system to serve both research and operational observing requirements. We are discussing this issue with the other Federal agencies and expect a plan that will serve research users as well as other customers for IOOS and ORION data.

In conclusion, NSF believes that ocean observatories are the vehicle for a new type of exploration which some refer to as exploring in time. We are excited about the possibilities, and anticipate that long-term ocean observations will lead to many new and important discoveries.

I am pleased to answer any questions. Thank you.

[The prepared statement of Dr. Leinen follows:]

**Statement of Margaret S. Leinen, Ph.D., Assistant Director for Geosciences, National Science Foundation**

*Introductory Remarks*

Mr. Chairman, members of the Subcommittee, thank you for inviting me to testify as to how the National Science Foundation (NSF) is supporting ocean observing systems and coordinating with NOAA, Navy and the other agencies that are part of the National Ocean Partnership Program (NOPP) to support the development of regional and national ocean observing systems. I am Margaret Leinen, Assistant Director for Geosciences at the National Science Foundation. The three divisions in my directorate support research in Ocean, Atmospheric and Earth Science.

I also Co-Chair, with Dr. Richard Spinrad, the National Science and Technology Council's (NSTC) Joint Subcommittee on Oceans that reports to both the NSTC's Committee on Environment and Natural Resources and the Committee on Science. The Joint Subcommittee on Oceans is currently establishing an interagency Task Force on Ocean Observations to focus on national interests and needs in this area.

NSF's mission is to support basic research, including oceanographic research, primarily at U.S. academic institutions. Thus, our primary interest and involvement in ocean observations is through the researchers who successfully compete for NSF grants, as well as the broader ocean science community who provide guidance to our programs through workshops, National Academy reports and other venues.

*Need for Ocean Research Observatories*

Since the earliest expeditions of H.M.S. Challenger in the 19th century, progress in ocean research has been driven strongly by the ability to make new observations—either located in new places (i.e. classical exploration-going to places on Earth that have not been observed before) or using new types of measurements that permit natural phenomena or processes to be understood in different ways. As our knowledge of the oceans has improved, the realization has grown that few characteristics of the ocean are in steady state—the ocean and the seafloor beneath are highly dynamic environments. If these processes are to be understood, if new insights are to be gained, if quantitative models are to be validated satisfactorily, then observations are needed over the time scales appropriate to the dynamics of these processes. We know enough today to realize that these time scales span milliseconds to decades, centuries and beyond and that a new mode of observing the ocean will evolve over the next decade, driven primarily by the growing need for sustained time-series observations. This need is clear, not only in our most reliable source of information concerning research trends—the proposals that are submitted—but also in essentially all of the community-based planning documents that have been produced in recent years.

NSF continues to invest in research that explores new regions or explores new processes that have recently been discovered. In this mode of observation, we have invested in exploration that discovered deep sea hydrothermal vents, in exploration that discovered new underwater volcanoes, and in exploration that discovered new species of organisms in the ocean. However, today I would like to highlight another, equally important, kind of exploration. When investigators work to understand the ocean by making sustained time-series observations they are, in effect, "exploring-in-time". The earliest oceanographers made great discoveries by conventional spatial exploration—they traveled to new places in the oceans and discovered unexpected phenomena that catapulted their understanding of a particular process to a new level. Today, innumerable examples exist in the published literature of important and sometimes unexpected discoveries resulting from the collection of long time-series data sets. Some people have considered this type of ocean observing as "monitoring." It is not—it is the classical combination of hypothesis testing and exploration, but in the time domain, not the space domain. Researchers are continuously developing, changing, and improving measurement strategies and techniques to maximize understanding and insight.

*What Have We Learned to Date from Sustained Measurements in the Ocean?*

Sustained measurements at a few coastal, open ocean and sea floor locations have yielded some very exciting results, some with broad policy and management implications, and attest to the potential impact of research observatories currently under development. Some examples:

1. Measurements from a seafloor observatory show that fluids from aging ocean crust support microbial life of high diversity.
2. Sustained biological and nutrient measurements off Hawaii and Bermuda show changes in the basic life support system of the oceans—from nitrogen-limitation to phosphorus-limitation of biological production—that control life in the North Pacific gyre, and possibly in parts of the Atlantic.
3. Sustained measurements of the carbon dioxide system in seawater off Bermuda and Hawaii show that interannual changes in ocean mixing in the Atlantic, and changes in regional precipitation and evaporation in the Pacific, cause interannual variations in the amount of carbon dioxide that the ocean absorbs from the atmosphere.
4. Measurements in the Pacific reveal that long-period (about 50 years) shifts in air and ocean temperatures affect biological productivity and fisheries off Japan, California, Peru and Chile, as well as changes to the carbon dioxide sink and source flux of the equatorial Pacific.
5. Floats that recorded temperatures in the Southern Ocean throughout the 1990s show that the Southern Ocean has warmed by about 0.2 C just since the 1950s.
6. Measurements of salinity over the past several decades show that tropical ocean waters have become dramatically saltier over the past 40 years, while oceans closer to the Earth's poles have become fresher.

*NSF's Ocean Research Interactive Observatory Networks (ORION) and the Ocean Observatories Initiative (OOI)*

The U.S. oceanographic research community and the National Research Council (in two recent reports), as well as the international oceanographic research community have all highlighted that modern ocean science research requires new types of infrastructure that are capable of providing long-term, high-resolution observations of critical environmental parameters on appropriate time and space scales. Consequently, NSF's Division of Ocean Sciences (OCE) is planning to construct and operate an innovative new ocean observatory network, Ocean Research Interactive Observatory Networks (ORION), of which the Ocean Observatories Initiative (OOI) is the infrastructure component. Funds for the OOI are being sought through NSF's Major Research Equipment and Facilities Construction (MREFC) account. OOI was listed in NSF's FY05 budget submission to Congress as a candidate new start for FY06. OOI infrastructure will provide the oceanographic research and education communities with new modes of access to the ocean. The OOI has three primary elements: 1) a regional cabled observatory (RCO) consisting of interconnected sites on the seafloor spanning several geological and oceanographic features and processes, 2) relocatable deep-sea buoys that could also be deployed in harsh environments such as the Southern Ocean, and 3) new construction or enhancements to existing systems leading to an expanded network of coastal observatories.

*ORION Science Plans*

The U.S. and international ocean science community is currently engaged in extensive planning efforts to determine how to focus ORION observatory assets on the most appropriate and exciting research questions. The ORION science plan is not yet final, but based on workshop and other reports (see Glenn and Dickey 2003 and Jahnke et al. 2003), I can provide a sampling of the types of science programs we expect to see in the final ORION plan.

The coastal research community will use ORION to determine and quantify the processes at the ocean boundaries that affect the global carbon and related cycles; to better understand the environmental factors that control the diversity and species composition of coastal biological communities—a key requirement to implement ecosystem-based management strategies; to better understand fluid flow and life in continental margin sediments, including the processes that form gas hydrate deposits; and to achieve a much better understanding of water circulation in the coastal ocean.

Researchers will use instruments on open ocean buoys and on the seafloor to improve our understanding of earthquakes that occur far from land; to develop the long records required to delineate climate cycles from long-term change; to quantify changes in the ocean's ability to absorb atmospheric carbon dioxide; and to determine the impact of anthropogenic CO2 on the ocean carbonate system—which is of critical importance to many ocean organisms, including corals. Other instruments will be deployed to study the circulation of water flowing through the upper ocean crust, which exceeds the flow of all the rivers that pour off of the continents, and its impact on subseafloor biological and chemical processes. For example, some of holes drilled deep by U.S. and Japanese scientific drill ships will be capped with elaborate structures called Circulation Obviation Retrofit Kits ("CORKS)". CORKS will enable scientists to monitor processes beneath the seafloor and conduct experiments. These advanced seafloor observatories allow measurements of temperature, pressure, fluid chemistry, and microbiology to be obtained from different depths in the borehole.

Canadian and U.S. scientists will connect CORKS and other instruments to the Regional Cabled Observatory (RCO), to be located on the Juan de Fuca plate, to answer questions about how the sea floor forms and subsides at plate boundaries; as well as the effects of geological processes on biological processes on and within the seafloor. Instruments connected to seafloor cables but extending up into the overlying water column will be used to quantify mixing between deep and shallow waters and the rate of gas exchange between the ocean and atmosphere.

An important ORION goal is to provide real-time observatory data to researchers, and to those involved in education and outreach. Thus, scientists will be able to respond and adjust to events as they develop. Educators and outreach specialists will be able to use the real-time information to spread the excitement of discovery to students and the general public.

Just as the U.S. academic research fleet is accessible to all investigators, the OOI will begin building an openly accessible network of ocean observatories to facilitate the collection of long time-series data sets needed to understand the dynamics of biological, chemical, geological and physical processes. The primary infrastructure for all components of the OOI includes both dedicated fiber-optic cables to shore and moorings capable of two-way communications with a shore station. Moorings are envisioned to be both freestanding, as for the global array of buoys, and they will also be attached to fiber optic cables to provide the capability for water column investigations. Seafloor junction boxes connected to this primary infrastructure will support individual instruments or instrument clusters at varying distances from cables as well as the moorings. These junction boxes include undersea connectors that provide not only the power and two-way communication needed to support seafloor instrumentation, but also the capability to exchange instrumentation in situ when necessary for conducting new experiments or for repairing existing instruments.

NSF will cooperate with other U.S. Federal agencies and international partners to implement the ORION network and as described in the next section, to link the ORION researchers with IOOS activities. The RCO will be located on the Juan de Fuca plate in US, Canadian and international waters (off Washington and British Columbia) and will be designed, constructed and operated in cooperation with Canada. Institutions that are competitively selected to construct and operate coastal observatories will likely be members of the Regional Associations that are envisioned as part of the coastal observing component of IOOS. Thus, NSF-funded infrastructure and operations funds will help support the activities of the RAs. NSF and the ORION Project Office are also discussing direct cooperation with NOAA's Office of Climate Observation (OCO) to deploy some of the open ocean observatories to serve both research and NOAA operational needs and requirements for open ocean measurements.

*Relation between ORION/OOI and the Integrated Ocean Observing System (IOOS)*

The research-driven ORION (with its infrastructure construction OOI component) is part of a broader national and international effort to establish long-term ocean observatories, for basic research and education, as well as for operational oceanographic needs. The most fundamental relationship between the OOI and operational ocean/Earth observing systems at the national level is with the proposed U.S. Integrated Ocean Observing System (IOOS)- an operational observing system that is being planned under the auspices of the National Ocean Partnership Program (NOPP). As will be/was described by Drs. Spinrad and Winokur, the primary purpose of the IOOS is to provide data of societal interest to "customers," ranging from fishermen and shippers, to coastal zone managers, to the U.S. Navy. Data to be collected are aimed at supplementing current knowledge. In contrast, the NSF's OOI is focused on developing new knowledge and new technologies that will advance our understanding of the oceans. By addressing the ocean research community's needs for time-series measurements of ocean processes, the OOI will provide the infrastructure needed to advance knowledge and understanding of the ocean/atmosphere/earth system, as well as the technical capabilities for monitoring that system.

In a recently released National Research Council Report (NRC, 2003), a key finding states (p.158) :

> "The OOI will greatly improve the ability of operational ocean observing systems such as the Integrated and Sustained Ocean Observing System IOOS and the Global Ocean Observing System (GOOS) to observe and, predict ocean phenomena."
>
> "The research based OOI is an important complement to the proposed IOOS. IOOS is an operational system driven by the needs of potential users, and designed to improve the safety and efficiency of marine shipping, mitigate effects of natural hazards, reduce public health risks, improve weather and climate predictions, protect and restore a healthy coastal environment and enable sustainable use of marine resources. The OOI, in contrast, is driven by basic research questions and its principal products will be improved understanding of the oceans and new and improved technologies. The OOI will thus provide the key enabling research for IOOS, including fundamental advances in observatory platforms and, through the research of investigators using the OOI, basic understanding and in sensor technology that will enable IOOS to meet its longer term operational goals. The IOOS is important for the OOI because it will provide a larger framework of observations and background data necessary for interpreting the process oriented experiments that are the centerpiece of basic research."

The Preliminary Report of the U.S. Commission on Ocean Policy (http://www.oceancommission.gov/) reached a similar conclusion. The report states on p. 327:

The national IOOS will also have significant synergies with the NSF Ocean Observatories Initiative, which is being designed to address the ocean research community's needs for long-term, in situ measurements of biological, chemical, geological, and physical variables over a variety of scales. The NSF observatories will be used to examine the processes that drive atmospheric, oceanic, and terrestrial systems and will serve as an incubator for new technologies to monitor these processes. While the IOOS and the NSF observatories have thus far been planned independently, the basic research and technology development from the NSF Observatories and the information generated by the IOOS are in reality interdependent, with each program supplying ingredients essential to the other. Close coordination and cooperation between NOAA and NSF will be necessary to capitalize on these benefits.

*NSF and the Interagency Process to Plan and Develop IOOS*

NSF is part of the National Ocean Partnership Program (NOPP) and is one of the original signatories to the NOPP MOU for Establishing a NOPP Interagency Ocean Observation Office (http://www.ocean.us/documents/doc). The signatories of the MOU support the Ocean.US office, which serves as a national focal point for integrating ocean observing activities. Along with Navy, NOAA, NASA and other agencies, NSF provides funds to operate the office and supports two researchers to participate in Ocean.US planning and coordination activities. Dr. James Yoder, Director of the Division of Ocean Sciences, represents NSF on NOPP's Ocean Observations Executive Committee (EXCOM), which oversees Ocean.US activities and provides policy guidance, ensures sustained Agency support, and approves implementing documents. At present, Ocean.US and EXCOM are developing a draft Implementation Plan for IOOS to be vetted by the National Ocean Research Leadership Council, which NSF chaired last year.

NSF also participates in the annual NOPP solicitation for research projects and is one of the principal sources of funding for projects selected through the peer review process. Three of the topics that generally appear each year in the NOPP solicitation are chosen by the agencies to support ocean observations: Research Observatories, Observational Technique Development, and "Commons" for Ocean Observations. NOPP projects funded cooperatively by the Office of Naval Research (ONR), NOAA, NASA, NSF, Sloan Foundation and others during the past few years that are related to these ocean observing themes include:

- An Innovative Coastal-Ocean Observing Network (ICON), Naval Postgraduate School;
- Design Study for NEPTUNE: Fiber Optic Telescope to Inner Space, University of Washington;
- Coastal Marine Demonstration of Forecast Information to Mariners for the U.S. East Coast, University of Maryland, Horn Point Laboratory;.
- Developing Long Range Autonomous Underwater Vehicles for Monitoring Arctic Ocean Hydrography, Monterey Bay Aquarium Research Institute;
- Autonomous Profilers for Carbon-System and Biological Observations, Lawrence Berkeley National Laboratory;
- Incorporation of Sensors into Autonomous Gliders for 4D Measurement of Bio-optical and Chemical Parameters, University of Washington;
- Accelerating Electronic Tag Development for Tracking Free-Ranging Marine Animals at Sea, Stanford University and the University of California Santa Cruz;
- Developing Gene-Based Remote Detection, NOAA Atlantic Oceanographic and Meteorological Laboratory;
- The Environmental Sample Processor (ESP): A Device for Detecting Microorganisms In Situ Using Molecular Probe Technology, Monterey Bay Aquarium Research Institute;
- Development of an Integrated Regional, National & International Data System for Oceanography, University of Rhode Island;
- A Biotic Database of Indo-Pacific Marine Mollusks, Academy of Natural Science;
- Census of Marine Fishes (CMF): Definitive List of Species and Online Biodiversity Database, California Academy of Science; and
- Digital Archival of Marine Mammal/Bird/Turtle Data for OBIS, Duke University.

*Recent NSF Development Efforts to Prepare for Ocean Observatories*

In 2002, NSF's Division of Ocean Sciences funded the Monterey Accelerated Research System (MARS). MARS will complete the design and then install an advanced cabled observatory in Monterey Bay that will serve as the test bed for a state-of-the-art regional ocean observatory. MARS thus represents an important step toward harnessing the promise of new power and communication technologies to provide a remote, continuous, long-term, high-power, large-bandwidth infrastructure for multidisciplinary, in situ exploration, observation, and experimentation in the deep sea. MARS will be located in Monterey Bay offshore the Monterey Bay Aquarium Research Institute (MBARI). It will include one science node on 51 km of submarine cable with expansion capability for more nodes in the future. The science node will provide 8 science ports, and each port will have a 100-Megabit-per-second, bi-directional telemetry channel. The system will make use of the tools, techniques, and products developed over the last several decades for high reliability submarine telecommunication and military systems to ensure that this system can operate over a 30-year lifetime with minimum life-cycle cost.

In 2004, NSF's Division of Ocean Sciences funded a joint venture of the Joint Oceanographic Institutes (JOI), Inc. and the Consortium for Oceanographic Research and Education (CORE) to support an ORION Project Office to coordinate science community planning in preparation for ocean observing projects, including the proposed OOI/ORION initiative. The small staff is co-located with JOI, Inc. in Washington D.C. An Executive Steering Committee comprised of renowned scientists from institutions throughout the U.S. and Canada, including Dr. Weller who is testifying today, was also established and is working closely with the ORION staff. The two immediate tasks for the Steering Committee and the Office staff are to synthesize science community input from workshops and other sources to develop an ORION Science Plan to be followed by an Implementation Plan. The Office will also work with Ocean.US and implementing offices, such as NOAA's Office of Climate Observations (OCO), to develop and coordinate ocean observing plans and activities.

In addition to these direct contributions to observation of the oceans, I would like to highlight other critical roles played through the support of the National Science Foundation. All ocean observing systems depend on sensors which have been developed through ocean research. The evolution of the observing systems proposed today will come about through research into improvements in existing sensors and through new sensor development. This research is supported through the basic research programs of the National Science Foundation.

With new sensors come innovative ideas for the sensor networks and arrays that can make such measurement. ORION is an excellent example of a state-of-the-art sensor network that has evolved from the NSF-supported research community. Such systems must be tested and developed in a research environment before they can be deployed as operational systems. Research supported by the National Science Foundation provides a mechanism for the development of innovative new sensor networks.

Once data from observation systems are in hand, they need to be assimilated into quantitative computer models that reveal the relationship of the observations to the wealth of other ocean environmental data. The National Science Foundation has been a strong supporter of the research communities that develop such computer models of the ocean.

This end-to-end investment in new technologies for ocean observation, new paradigms for ocean observation, and new models for the interpretation of ocean observatory data is a hallmark of the National Science Foundation Ocean Sciences Division.

*Priorities for the Future Interagency Attention*

In addition to agency-specific planning and development activities, and to the Implementation Plan currently under development by Ocean.US and NOPP's EXCOM, NSF believes attention should be focused on two other high priority activities: (1) Development of a data system to serve both research and operational ocean observing requirements; and (2) as recommended by the U.S. Commission on Ocean Policy (SCOP) Preliminary Report, an approach and a plan for transitioning ideas and tools from research to operations. Ocean.US and EXCOM are currently discussing the data system issue and are receiving considerable input from NSF, Navy, NOAA, NASA and other agencies. A high priority is to agree on metadata and data standards that satisfies researchers, as well as other users of IOOS and ORION data. NSF is optimistic that a plan will soon emerge from these discussions that will lead to a flexible data system to serve research users as well as other customers for IOOS and ORION data. One of the NSF goals is for full and open exchange of data, emphasizing the importance of distributing as much as possible in near real-time. NSF and the ORION Office are also prepared to participate in interagency discussions on the transition issue, as well.

Mr. Chairman, Thank you for this opportunity to share these thoughts on the importance of ocean observations to researchers and the role NSF will play in the interagency efforts to develop a national ocean observing strategy and system. I am pleased to answer any questions.

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Mr. GILCHREST. Thank you very much, Dr. Leinen.

Mr. Winokur.

**STATEMENT OF ROBERT WINOKUR, TECHNICAL DIRECTOR, OCEANOGRAPHER OF THE NAVY**

Mr. WINOKUR. Thank you, Mr. Chairman, for inviting the Navy to participate in this hearing on the status of ocean observation systems in the United States. My name is Robert Winokur, and I am the technical director to the Oceanographer for the Navy. I also serve as the Chair for the interagency Federal Oceanographic Facilities Committee, and as the Navy representative to the interagency Ocean.US executive committee.

The Oceanographer of the Navy plans, coordinates, and implements the responsibilities of the Chief of Naval Operations with regard to naval oceanography. While our needs are mission-driven, we also recognize the need and responsibility to contribute to a national enterprise in ocean observing systems. The Chief of Naval Operations Sea Power 21 strategy has placed increasing demands on the Naval Oceanography Program to better characterize the ocean environment, to optimize naval operations on a global scale, but with particular emphasis on the coastal regions of the world. Our goal is to convert ocean observations into information and knowledge to support the war-fighting needs of the Navy. The Naval Oceanography Program is focused on developing an architecture and phased implementation and investigation strategy for battlespace sensing and time and space scales consistent with naval operations. Working together with the Office of Naval Research and partnering with the member agencies of the National Oceanographic Partnership Program, we have made major contributions to the national effort to establish an ocean observing system.

For the Navy, a thorough understanding of the ocean environment is critical to safe and precise navigation, anti-submarine warfare, locating and disarming mines, putting marine special warfare forces and equipment on the beach, and projecting offensive and defensive power from a secure maritime maneuver area. As military weapons systems and platforms become increasingly sophisticated, the impact of the environment becomes a more critical factor to their performance. To this end, we use adaptive sampling to obtain high-resolution bottom topography, current temperature, sound speed, salinity, surface wave, and atmospheric data by using satellites, moored and drifting platforms, seafloor cable systems, tide gauges, coastal radar, unmanned vehicles, and directed ship surveys and observations.

The Oceanographer of the Navy, through the Commander of the Naval Meteorology and Oceanography Command, conducts multi-function oceanographic surveys in the ocean basins of the world and in coastal regions. In addition, the Navy develops and operates numerical models that rely on real-time data from a variety of sources which are merged with climatological data to provide daily forecasts of atmospheric and oceanic parameters on a global scale. The Office of Naval Research has invested in the development of most of the observing tools now in use in the ocean. Many of the knowledge bases about the regions of the world ocean have come from ONR-funded programs or investigators.

The U.S. Navy has a global presence and must be prepared to respond to an emergency or contingency anywhere, any time. In almost every aspect of modern warfare, an accurate and timely description of the environment serves as a force multiplier. Contingency operations require rapid response, and that gives us scant time to complete an environmental assessment.

Modern diesel submarines operating in a shallow littoral environment can pose a serious threat to naval operations. Understanding thermal conditions in the water column, along with knowledge of bottom properties, is critical to optimizing sonar system performance. Similarly, accurate characterization of ocean conditions is critical to mine warfare, a potentially serious threat in choke points, harbors and ports, and coastal landing zones, impacting amphibious landings and special operations forces. Simply stated, rapid environmental assessment and the provision of environmental knowledge are critical elements to the safety and success of naval operations.

While timely and accurate knowledge of the environment is a force multiplier for a navy, knowledge of the oceans is also a force multiplier for non-defense purposes as well. The Navy is part of a National Ocean Infrastructure designed to coordinate and leverage existing programs to maximize investment in ocean research, resource management, and development. Navy has invested heavily in this National Ocean Infrastructure. Examples of this investment include recapitalization of the National Academic Oceanographic Research Vessel Fleet and periodic review and declassification of appropriate naval oceanographic data in accordance with policies for access by the civilian community.

And ocean observing system will provide data in support of both operational and research requirements, as being advanced by a number of U.S. Government agencies under the auspices of the National Oceanographic Partnership Program. A long-term and sustained ocean observing system will be coordinated through NOP interagency office, Ocean.US. Navy has been closely aligned with NOP since the program's inception and, in fact, provided its first director. The Navy supports Ocean.US's efforts to develop an ocean observing system involving regional associations and based on a national backbone as a high priority for implementing a national ocean observing system. The Navy has also partnered with other agencies to support regional observing systems in the southeast Atlantic, the Gulf of Maine, the Gulf of Mexico, and Monterey Bay.

The success of these regional systems is paving the way for a national and ultimately an international observing system. The Oceanographer of the Navy and the Office of Naval Research ensure that the full breadth of the Navy is contributing strongly and in appropriate ways to the development of an integrated ocean observing system. The Navy's observing system needs and programs are directed at providing the essential data, information, and knowledge required to continuously describe the battlespace to support naval operations.

Thank you, Mr. Chairman, and I look forward to answering any questions you may have.

[The prepared statement of Mr. Winokur follows:]

**Statement of Robert Winokur, Technical Director, Office of the Oceanographer of the Navy**

Mr. Chairman, members of the Subcommittee and distinguished colleagues, I want to thank you for inviting the Navy to participate in this hearing on the status of Ocean Observation Systems in the United States. The U.S. Navy has a long history of ocean observations, dating back to the early 1840s, and this program continues with increasing importance today.

While our needs are mission driven, we also recognize the need and responsibility to contribute to a national enterprise in Ocean Observing Systems. The Chief of Naval Operations Sea Power 21 Strategy, with its three essential pillars of Sea Strike, Sea Shield and Sea Basing, has placed increasing demands on the Naval Oceanography Program to better characterize the ocean environment to optimize naval operations on a global scale, but with particular emphasis on the coastal or littoral regions of the world. Our goal is to convert ocean observations into information and knowledge to support the warfighting needs of the Navy. The Naval Oceanography Program is focused on developing an architecture and phased investment and implementation strategy for battlespace sensing and observations at the time and space scales consistent with naval operations. Working together with the Office of Naval Research and partnering with the member agencies of the National Oceanographic Partnership Program (NOPP) we are proud of the leadership role and major contributions we are making to the national effort to establish an Ocean Observing System.

As military weapon systems and platforms become increasingly sophisticated, the impact of the environment becomes a more critical factor to their performance. Accurate knowledge of the environment maximizes combat effectiveness by helping decision makers pick the right platform, choose the right weapon, enter the right settings, pick the right target area, use the right tactics, and select the right time! System performance increasingly requires higher resolution data and more rapid refresh rates.

Before the Navy can fully realize the strategic and tactical advantage of the oceans, a comprehensive understanding of the ocean environment is required. Environmental characterization is a critical component of intelligence preparation of the battlespace. To achieve this, the Department of the Navy adaptively samples high-resolution ocean data, including bottom topography, volumetric current, temperature, and salinity measurements as well as surface wave data via in-situ and remote sensing sources. The Navy continuously monitors the ocean environment allowing us to better understand our operating environment and maintain our ocean stewardship role.

The Integrated Ocean Observing System (IOOS) has two components; the global ocean component and coastal U.S. waters component. The Navy's needs also focus on these components with emphasis on coastal regions of the world where the Navy operates. The Navy's participation in observing system efforts includes those operational activities that fall under the responsibility of the Oceanographer of the Navy, along with the science and technology activities of the Office of Naval Research that underlie the strategic surveys and database needs required to support fleet operations and weapons systems development.

The Oceanographer of the Navy, through the Commander Naval Meteorology and Oceanography Command, conducts multi-function oceanographic surveys in the ocean basins of the world and in coastal regions to provide a baseline for a variety of parameters. In addition, the Navy operates global forecast models that integrate real-time environmental data from a variety of sources, merges climatological data, and produces numerical models of atmospheric and oceanic parameters. These models are dependent on timely input data provided from in situ and space-based observations.

The Office of Naval Research (ONR) has invested in the development of most of the observing tools now in use in the ocean. Many of the knowledge bases about regions of the world oceans other than U.S. waters have come from ONR-funded programs or investigators. ONR's ocean science and technology niches in the federal funding system are in marine meteorology, small-scale ocean physics, optical oceanography, bioacoustics, coastal geosciences, and instrumentation development.

In the global ocean, ONR funds major programs developing and validating large-scale numerical models of the ocean using whatever data sources may exist, both research and operational. The model outputs provide the basis for Navy sound-velocity forecasts in support of sonar operations, and provide the boundary conditions for coastal and regional ocean models everywhere in the world. This work is done as part of the Global Ocean Data Assimilation Experiment (GODAE), to leverage the interests of other nations and agencies.

In the U.S. coastal ocean, ONR research efforts provide understanding of a variety of coastal systems and how Naval operations can best be performed in those environments, and act as test-beds for the development and testing of new technologies for observing the ocean. This understanding and technology are useful elsewhere in the ocean such as in those areas that are denied to us for research and operational purposes.

Another challenge will be our ability to manage efficiently the increasing data flow through sophisticated data networks. The various existing data collection resources must accept standardized formats that facilitate the dissemination, ingestion, and integration of data into processing systems and interactive databases.

The Integrated Ocean Observing System, which will provide ocean data in support of both operational and research requirements, is being advanced by a number of U.S. government agencies under the auspices of the National Oceanographic Partnership Program (NOPP). Navy has been closely aligned with NOPP since the program's inception. In fact, the Secretary of the Navy served as Chairman of NOPP's National Ocean Research Leadership Council (NORLC) for the first four years and currently serves as Vice Chair. The long-term and sustained ocean observing system will be implemented and coordinated through a NOPP interagency office, Ocean.US. The U.S. Navy strongly supports Ocean.US, and, in fact, provided its first director. Ocean.US's efforts to develop an observing system of regional associations based on a national backbone ranks among the most important national ocean initiatives currently underway. The U.S. Commission on Ocean Policy Preliminary Report recognized the importance of this observing system and recommended the development and implementation of a sustained, national Integrated Ocean Observing System.

Navy's reasons for strongly supporting the development of the integrated ocean observing system are compelling. In any military engagement, battlespace awareness is paramount; tactical application of environmental knowledge is a strong force multiplier. This is especially true in the complex and dynamic marine environment. The Navy/Marine Corps team is an expeditionary force required to respond rapidly to contingencies anywhere on the globe. Knowledge of the marine environment is critical to maintaining the tactical edge and allowing U.S. forces to operate more safely and efficiently. A network of ocean observations that are integrated and assimilated into a global operational system and resulting database is a major asset to any sea-based military operation, and also presents significant advantages for commercial and academic interests.

The lack of data over the oceans was recognized as early as 1842 when Navy Lieutenant Matthew Fontaine Maury, then Superintendent of the Navy's Depot of Charts and Instruments, began collecting weather and ocean data routinely recorded in the official log books of both naval and commercial ships. These data were compiled on a series of wind and current charts for all the world's oceans.

We no longer need to rely on ships' logs. Technology has increased our ability to observe the oceans through the use of satellites, moored and drifting buoys and platforms, sea floor cables, tidal gauges, coastal radar, unmanned vehicles, directed ship surveys and shipboard observations.

Observations from space are an essential component of the Integrated Ocean Observing System. Since 1998 representatives of the major international satellite space agencies have been working on an Integrated Global Observing Strategy (IGOS).

The U.S. has been a leader in this activity, and the Navy contributes to this and national planning through its own satellite remote sensing systems and its involvement in the next generation National Polar-orbiting Operational Environmental Satellite System (NPOESS). The Navy currently operates two oceanographic satellite systems; GEOSAT Follow On (GFO) which is a radar altimeter that measures sea surface height, and Coriolis/Windsat, which is used to also measure sea surface wind speed and direction and is an important risk reduction program for the future NPOESS. While both systems are designed to support Navy needs, data are being made available to civil agencies and the research community to further understanding of the ocean on global scales.

NPOESS is an interagency program involving the Defense Department, NOAA and NASA. In addition, the European Organization for Exploitation of Meteorological Satellites (EUMETSAT) is also a participant and demonstrates the global nature of observing systems and partnerships. The Navy is an active participant in the NPOESS program through Coriolis/Windsat and direct participation in the Integrated Program Office, as well as providing two potential ground sites for processing the data at the Naval Oceanographic Office and the Fleet Numerical Meteorology and Oceanography Center. In fact, both NPOESS and IGOS provide opportunities for interagency and international partnerships by which to achieve new levels of synergy and cooperation. Satellite remote sensing is also an emphasis of the U.S. Interagency Working Group on Earth Observations (IWGEO). Navy participates in this effort that is linked to an international process to establish a Global Earth Observation System of Systems (GEOSS).

The Navy's world-class military survey fleet collects high-resolution ocean data with state-of-the-art sensors. These vessels are critical to our ability to collect and analyze data. Navy operates oceanography and meteorology centers worldwide to process, model, disseminate, and archive data and products. These advanced facilities include production centers such as the Naval Oceanographic Office at the Stennis Space Center in Bay St. Louis, Mississippi, and the Fleet Numerical Meteorology and Oceanography Center in Monterey, California. In addition, the Naval Oceanographic Office, in collaboration with the Marine Corps Intelligence Center provides worldwide riverine support to joint operations. The National Ice Center, a tri-agency center involving the Navy, the National Oceanic and Atmospheric Administration (NOAA), and the United States Coast Guard, is responsible for sea and lake ice observations and forecasts for Arctic and Antarctic Oceans and their marginal seas as well as the Great Lakes and Chesapeake and Delaware Bays.

Within our own coastal waters, observations are obtained from a wide variety of sources to support Navy and Coast Guard operations, marine engineering enterprises, the commercial fishing industry, state and local governments, and academia. Efficient integration of these independent data sources presents a host of challenges related to communications and database management.

IOOS will provide a network to facilitate integration of data currently available, as well as increasing the distribution and types of ocean observations. These observations should encompass the physical, chemical and biological characteristics of the water column, as well as meteorological and coastal riverine characteristics. There will be many benefits to this system, including a better understanding of climate variability, marine resource and ecosystem management, safer marine operations, public health and national security. It is in the realm of national security that the Navy has the most vested interests.

When we talk about national security, there are two broad categories that should be considered: contingency operations abroad and homeland defense.

The U.S. Navy has a global presence and often serves as America's first response to international crises. Consequently, we must be prepared to respond to an emergency anywhere, anytime. For speed of transit and response, as well as safety of forces, environmental knowledge is critical.

Sea Power 21 is the Navy's strategic vision and transformational roadmap for 21st Century naval operations. It relies on three conceptual pillars: Sea Strike, Sea Shield, and Sea Basing.

Sea Strike is the ability to project dominant, decisive, and persistent offensive power from the sea in support of joint warfighting objectives through networked sensors, combat systems, and amphibious ground forces. Sea Shield is the ability to project naval defensive power to assure access and protect joint forces ashore.

Sea Basing provides enhanced operational independence and support for joint forces through networked, mobile, and secure sovereign platforms operating in the maritime domain. It envisions the sea as an independent and secure maneuver space for joint forces as they project power ashore. Weapons, sensors, and networked command and control functions will ensure a more defensible battle space while facilitating operational mobility, logistic support, and strategic flexibility.

Sea-based forces have historically been limited by the operational reach of weapons, limits of communications systems, logistic chains, and the vagaries of the environment. Today's precision missiles and strike aircraft have significantly increased the mission radius, with naval forces able to strike hundreds of miles inland, as demonstrated in Operation Enduring Freedom in Afghanistan. With advances in satellite technology and digital information, the capabilities of communication systems continue to improve with astonishing speed.

Although sea basing is predicated on the idea that the sea can be a great ally, there's no denying that at times the sea can be a formidable opponent. Globally distributed sea-based forces will need to rely on accurate and rapid weather and sea condition forecasts, and that requires data derived from ocean observations.

Modern diesel submarines are facile and lethal prowlers of the shallow littoral zone and we are witnessing a renewed emphasis on antisubmarine warfare. Understanding the thermal distribution in the water column will help predict sonar performance and highlight shadow zones, or acoustic blind spots. Likewise, knowledge of the bathymetry and characteristics of the ocean floor will assist submarine hunters as they search and destroy stealthy prowlers hiding in the complex undersea geography.

A competent characterization of the subsurface world is also critical to mine warfare, a serious threat in strategic chokepoints, harbors and ports, and coastal landing zones. Sea Strike includes the amphibious landing of ground troops and special operations forces, and here again environmental knowledge is a critical component to the safety and success of operations.

Mining of harbors is a threat, and accurate bottom surveys are necessary to establish a baseline for mine countermeasure ships as they search for "mine-like" objects buried in the sediment.

In almost every aspect of modern warfare, accurate and timely environmental characterization serves as a force multiplier. But contingency operations require rapid response, and that gives us scant time to complete an environmental assessment. A networked system of global ocean observations would greatly facilitate a comprehensive characterization of the operating environment.

IOOS will also be a great asset in the area of homeland defense. According to NOAA's National Ocean Service, the United States has over 95,000 miles of tidal shoreline that are vulnerable to asymmetric attack. Contaminants capable of causing mass casualties may be set adrift on tidal currents from offshore, harbors may be mined, and ships scuttled at strategic navigational chokepoints.

This integrated network of ocean observations will increase our knowledge of tidal currents and coastal circulation and increase the fidelity of our numerical ocean models. This knowledge will be essential to the prediction and consequence management of waterborne contaminants. Similarly, a network of offshore weather sensors will give us important atmospheric data to improve our ability to forecast the downwind distribution of airborne radiological, chemical, or biological contaminants.

Our reliance on real-time data to characterize the operational environment and to initialize and refine our numerical models is a compelling reason to support the development of a network of global observations.

While timely and accurate knowledge of the ocean environment is a "force multiplier" for Navy, knowledge of the oceans is also a "force multiplier" for non-defense purposes as well. The Navy is part of a National Ocean Infrastructure designed to coordinate and leverage existing programs to maximize taxpayer investment in ocean research, conservation, and development. Navy has invested heavily in this national ocean infrastructure. Examples of this investment include recapitalization of the national academic oceanographic research vessel fleet (providing five new or converted ships in the last decade alone), periodic review and declassification of appropriate naval oceanographic data in accordance with national policies for access by the civilian community.

The Navy has already partnered with other agencies to support regional observing systems such as the Gulf of Maine Ocean Observing System (GoMOOS), the Gulf of Mexico Coastal Ocean Observing System (GCOOS), the Northern Gulf of Mexico Littoral Initiative (NGLI), and the Monterey Bay Innovative Coastal Ocean Observing Network (ICON). The success of these regional systems is paving the way for a national, and ultimately an international observing system. In America's coastal waters there are many sensors already in use by commercial, academic and government activities, but getting their data into a national shared network will require a federal support structure of data management and modeling.

The Navy has extensive expertise in ocean information management and generation of operational information products, which it can apply to national ocean information management efforts. As such, the Navy has and will continue to coordinate with NOAA on ocean and coastal data and information management issues.

The Navy is an active member of the Executive Committee overseeing Ocean.US whose charge is the establishment of the Regional Coastal Ocean Observing System. As we move toward the implementation of the IOOS, we have also joined in a partnership with NOAA to engage industry to develop a synergistic project using disparate data sources to support specific multi-agency requirements.

Finally, the Navy is a strong advocate and participant in the international Global Ocean Data Assimilation Experiment (GODAE), an operational proof-of-concept demonstration for bringing existing ocean data assimilation developments and applications together. To this end the Navy is currently providing a U.S. GODAE data server operated by the Fleet Numerical Meteorology and Oceanography Center (FNMOC) in Monterey, California. This server is an integral node in the GODAE architecture. In addition to assimilated data, it will includes atmospheric and oceanic numerical model fields from both FNMOC and the NOAA National Center for Environmental Prediction (NCEP), as well as a number of Navy operational products.

In summary, throughout virtually all of its history the Navy has understood the need to explore, observe and understand the ocean. That need is as important today as it was before. The CNO's Sea Power 21 strategy requires that we understand and exploit the ocean to support all phases of naval operations, which, in turn, has placed increased demands for higher temporal and spatial resolution from in situ and satellite observing systems. The Navy also has a long-standing commitment to support national initiatives and participate in interagency and international activities. The Integrated Ocean Observing System is another example of Navy commitment to national priorities. The Oceanographer of the Navy and the Office of Naval Research ensure that the full breadth of the Navy is contributing strongly and in appropriate ways to the IOOS. Among other things, we have been involved in the National Oceanographic Partnership Program from its inception, we have provided one of the directors of Ocean.US and host the office, we host the international GODAE data server, participate in the interagency NPOESS program, and importantly, through ONR, have supported the development of most of the observing tools now in use in the ocean. Clearly the Navy's observing system needs and programs are directed at providing the essential data, information and knowledge required to continuously describe the battlespace to support naval operations. Nonetheless, we are committed to being a partner in the national efforts to build and operate an Integrated Ocean Observing System.

Today vast portions of the ocean remain unexplored. An ocean observing system will benefit national security and the nation, and permit us to expand our knowledge of the majority of the planet.

Thank you Mr. Chairman and I look forward to answering any questions the Subcommittee may have.

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Mr. GILCHREST. Thank you, Mr. Winokur.

Dr. Weller.

## STATEMENT OF ROBERT A. WELLER, Ph.D., SENIOR SCIENTIST, DIRECTOR, COOPERATIVE INSTITUTE FOR CLIMATE AND OCEAN RESEARCH, WOODS HOLE OCEANOGRAPHIC INSTITUTION

Dr. WELLER. Thank you, Mr. Chairman. I am Robert Weller, an oceanographer at Woods Hole Oceanographic Institution. I was recently a member of the NRC Committee on Seafloor Observatories. I am not formally reporting on that committee, but I am going to try to provide my own synthesis of the development of the open ocean observing system.

To lay a foundation for the global discussion, I want to mention a few examples. In May 1960, an earthquake in Chile triggered a tsunami that traveled across the Pacific and hit Hilo, Hawaii, killing 61 people. But we also know about the influence of remote regions of the ocean in modes of variability, such as the El Nino mode, where anomalous sea surface temperatures in the eastern tropical Pacific affect our climate in the United States, or the North

Atlantic Oscillation, which you, Mr. Chairman, mentioned earlier—again, involved with anomalous sea surface temperatures.

The great economic impact of some of these anomalous sea surface temperature—here is a recent result from Sig Schubert and colleagues at NASA Goddard, where they have found that anomalous sea surface temperatures are the cause of the great Dust Bowl anomaly in the central United States in the 1930s. In particular, in that decade of the great Dust Bowl, there was anomalously cold water off Japan and anomalously warm water to the east of Canada, between the United States and Europe. We also know that in recent time, in the last half of the 20th century, warming in the Indian Ocean has been reflected in change in the North Atlantic Oscillation.

So there is clearly need to make global observations and we are moving forward. Here is an example of the national contribution to this progress toward an ocean observing system. This is a summary of the NOAA Climate Observation Program, including, clockwise around the perimeter, a tide gauge, an open ocean buoy, a commercial ship used for observations, a research ship, equatorial buoy, a drifting buoy, profiling floats, and satellites.

Sea surface temperature is one of the things that we really need to monitor and keep track of because of its influence on climate and weather. To do that, we use the surface drifters and we use moorings, and we need to keep track of how the ocean observed exchanges heat and moisture with the atmosphere. And again, we use moorings, such as this one here, deployed under NOAA support off of Chile, and ships, like the Scripps Institution of Oceanography's Roger Revelle. We can also use these moorings, shown here, to put a lot of instrumentation in the water column and measure temperature, figure out the depth of the anomaly, and to measure the currents that affect the anomaly. Another tool are the ARGO profiling floats now being deployed around the world to help measure those temperature anomalies.

Measuring temperature anomalies is a central part in keeping track of what we need to do in an observing system, a global observing system. In particular, the thing that we are aware of is the large-scale ocean circulation, where water is cooled and made more dense at high latitude, sinks, and returns toward the Equator. This is a way in which the ocean transports heat from the Equator to the poles. Countries like the United Kingdom see this as a major focus for their observing efforts. They have actually installed an array across the Atlantic to measure the north-south transport of different classes of water, different temperature and salinity water masses as they participate in this Thermohaline Circulation.

This Thermohaline Circulation is critically important to our understanding how properties, such as carbon dioxide, are stored, removed from the atmosphere and stored in the interior. We have an agreement with other nations to move forward on repeat hydrographic lines that sample physical temperature, salinity, and chemical properties. As an example of what you can see, here is a section made north-south in the Atlantic showing chlorofluorocarbon penetration as well as carbon penetration. And you can see the slow evolution of quantities introduced by man into the interior of the ocean.

Of course, we have to do measurements for safety and security and have measurements of surface wave and sea level and biogeochemical parameters and populations of organisms. We know what to do, and we have to move forward. This is where the NSF contribution really comes in. We do not yet have the capability to go to all places in the world's oceans. Things that Dr. Leinen talked about, this is a large, very capable buoy that can be placed in the Southern Ocean to collect data we cannot now collect there. This is a more modest, but still more capable than we now have, surface mooring for mid-latitudes.

The crustal plates. We believe that there is interaction between seafloor seismic activity in the water column. This is the fiber optic and electric—

Mr. GILCHREST. Dr. Weller, could you say that again? I didn't hear. The interaction—

Dr. WELLER. Well, seismic activity on the seafloor, for example, the release of carbon dioxide or methane.

Mr. GILCHREST. From the opening of the—

Dr. WELLER. From seismic activity at the cracks in the plates, releasing gases—something we are just beginning to see. And we know about the hot water vents and the rich biological communities there. We haven't had the tools, so the NSF contribution is a cabled network to give us the real-time capability to investigate this interaction with the seafloor. And the third component is the coastal observatories, including endurance arrays that would be installed for long amounts of time, and movable pioneer arrays.

Let me move to sum up here and pick an area that I am familiar with. This is the region off New England. This is the sea surface temperature. It shows how dramatically complicated it is. Shortly after World War II, oceanographers and meteorologists at Woods Hole Oceanographic Institution moved to make predictions of the wintertime climate in New England, drawing on knowledge of the meteorology and the sea surface temperature in the North Atlantic. They failed, and they failed dramatically. We now know why. We know that the climate off New England and the variability in New England waters is not just a reflection of location processes; it is a concatenation of remote regions. And we know that the North Atlantic Oscillation influences this region, we know that the Indian Ocean Tropical SST influences this region.

The vision that I see of the future we are building is one in which we have meshed observing systems, in which the global observing system in the Atlantic provides information about the large-scale transported water masses. The global observing system provides the information about SST anomalies in remote places and tells you how, through the atmosphere, that influences this region. But it meshes with the coastal system, so that is when you see change in the ecology and the biology and the climate and the coastal processes in a region like this. You are building your understanding based upon the meshing of the coastal, regional, and global observatories. Indeed, as Dr. Spinrad mentioned, what we see is a future in which these ocean observing systems work in a comprehensive way together with the terrestrial and space-based observing systems to build a better future for us all.

Thank you for the opportunity to testify. I would like to answer questions later. It is an exciting time, with the synergy of the advances that the National Science Foundation has proposed, building upon the traditional heritage in this country of strong support from the ocean agencies, NOAA, Navy, NSF, and also NASA, through their remote sensing.

Thank you.

[The prepared statement of Dr. Weller follows:]

**Statement of Robert A. Weller, Ph. D., Senior Scientist and Director, Cooperative Institute for Climate and Ocean Research, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts**

Good afternoon Mr. Chairman and members of the Subcommittee. Thank you for the opportunity to testify. I am Robert Weller, an oceanographer at the Woods Hole Oceanographic Institution and, recently, a member of the National Research Council's Committee on a Seafloor Observatory Network for Oceanographic Research. I am not formally reporting on the work of that committee on behalf on the National Research Council. I am today providing my own synthesis of the development of the open ocean observing system. I do field research that involves deploying moorings to study the interaction of the atmosphere and ocean and better understand the role of the ocean in weather and climate. I am at present co-chair of the Science Steering Committee of the U.S. CLIVAR (Climate Variability) Program, and participate in national and international groups working to design and implement ocean observing systems. In my testimony, I will discus the development of open ocean observing systems, the synergy between open ocean and coastal ocean observing systems, and how terrestrial, coastal, and open ocean observations are combined to document variability and change in the ocean as well as to develop products for diverse users.

To lay a foundation for discussion of ocean observing systems and to illustrate how the development of an integrated ocean observing system would serve the nation's needs, I will start by several examples of the influence of the ocean on our lives in the United States. The ocean, the atmosphere, and the land interact, exchanging heat, moisture, and other constituents. The ocean and the atmosphere are mobile and can transport energy, heat, and moisture from one location to another so that local and regional variability and change in one of the three components can be communicated through the ocean and through the atmosphere to cause variability and change at other locations. The variability and change we experience at any one place is as a result driven by a combination of local and regional processes and large-scale processes that can bring to our location the influence of regions of the global ocean far from where we live or work. For example, in May 1960 an earthquake in Chile triggered a tsunami that traveled across the Pacific and hit Hilo, Hawaii killing 61 people, destroying 537 buildings, and causing over $23 million dollars of damage.

The impact of remote ocean regions is evident in weather and climate variability and change as well. The ocean and the atmosphere have large-scale patterns or modes of variability on different time scales, including the El Nino-Southern Oscillation or ENSO mode (Figure 1) and the North Atlantic Oscillation (NAO) (Figure 2). In these modes, departures from normal sea surface temperatures play a key role in driving anomalous weather and climate.

Work by Siegfried Schubert at NASA Goddard Space Flight Center and colleagues (Science, vol. 303, 19 March 2004, pp. 1855-1859) points to the role of such large-scale patterns and their related sea surface temperature anomalies in the climate of the United States. Taking the historical observations of sea surface temperature they found that the great drought in the central United States in the 1930's was linked with anomalously cold sea surface temperatures just east of Japan and anomalously warm sea surface temperatures between eastern Canada and Europe (Figure 3).

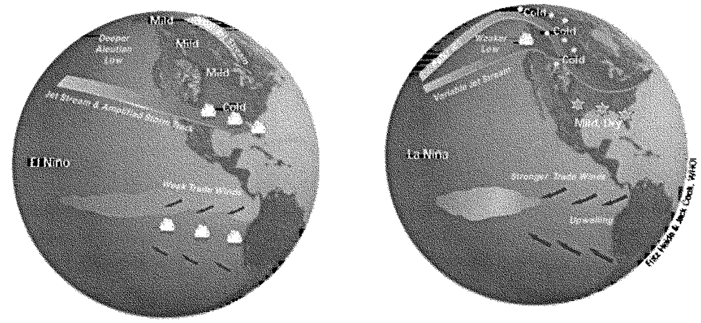



**Figure 1. Large-scale patterns of coupled ocean-atmosphere variability during the El Niño (left) and La Niño (right) phases of ENSO. (Courtesy of F. Heide, J. Cook, Woods Hole Oceanographic Institution.)**

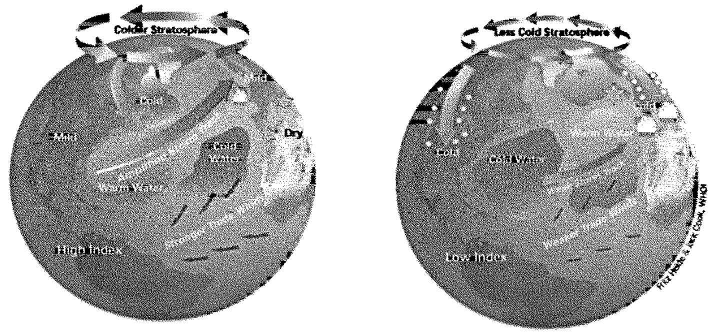



**Figure 2. Large-scale patterns of coupled ocean-atmosphere variability during the High or positive (left) and Low or negative (right) phases of the North Atlantic Oscillation. (Courtesy of F. Heide, J. Cook, Woods Hole Oceanographic Institution.)**

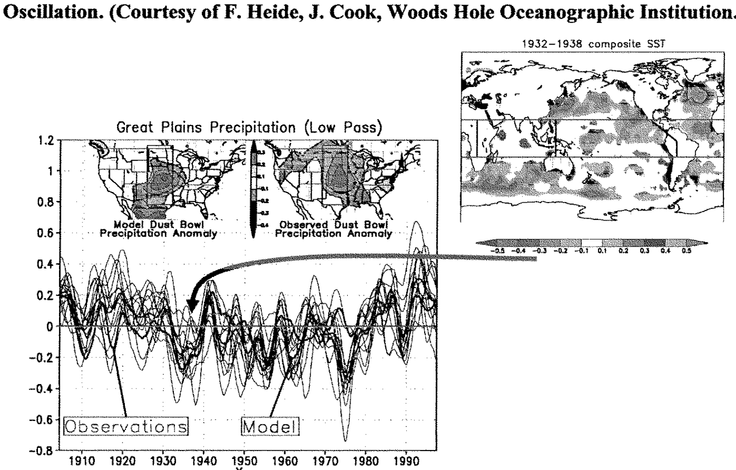



**Figure 3. Adapted from the work of Schubert et al. (2004) in which atmospheric models recreated the drought of the 1930s (time series of precipitation in mm day$^{-1}$ to the left showing that the average of the model runs in green replicated the observed rain in red) when forced with observed sea surface temperatures. During this period (upper right) the Pacific off Japan was anomalously cold and the North Atlantic between Canada and Europe was anomalously warm.**

Other recent results, these from a team of scientists at the National Center for Atmospheric Research, Marty Hoerling, Jim Hurrell, and colleagues (Hoerling et al., 2004, in press in Climate Dynamics) point to warming in the tropical Indian Ocean in the last half of the 20th century as a cause for change in the polarity of the North Atlantic Oscillation and thus in wintertime climate in the North Atlantic region.

Thus, though the earthquake in Chile, the anomalously cold ocean off Japan, and the warm water between Newfoundland and Europe are not close at hand, they impacted the United States. We have gathered much similar evidence of the role of the global ocean; the need now is to move forward to get the research and ongoing ocean data required to build understanding into new predictive capabilities and to provide the data required to initialize predictive models. We know from such evidence and present understanding the types of data that we should be observing. We are as a nation and in partnership with other nations at work on the task of developing ocean observing systems. This progress and the need for continuing work on ocean observations are being factored into the plans being developed by the intergovernmental Group on Earth Observations (GEO) that met first in July 2003.

Figure 4 is a summary presentation of the elements of the NOAA Climate Observing Program which has gone far to start the U.S. investment in the open

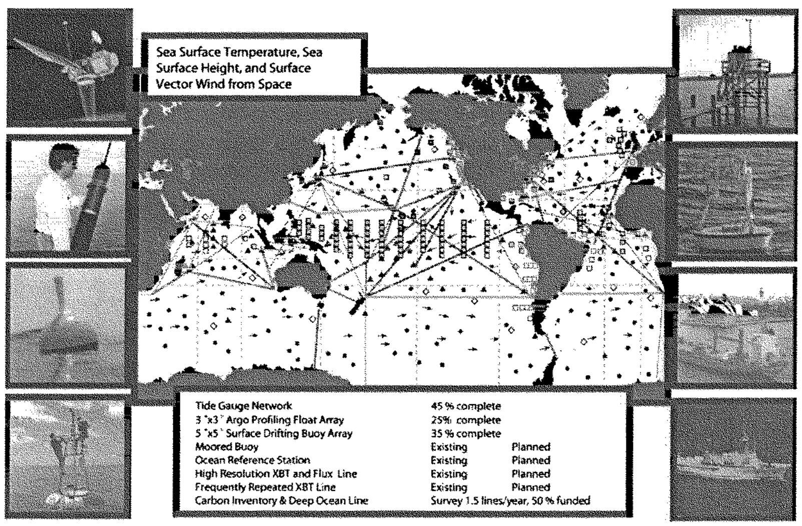



**Figure 4. The elements of the NOAA Climate Observation Program and status of their implementation (from http://www.ogp.noaa.gov/mpe/co/ocean.htm). Clockwise from the upper right: tide gauge sea level station, surface buoy of an open ocean reference station mooring, commercial ship used for dropping expendable temperature probes and measuring surface meteorology and other parameters, research ship used to make full ocean depth observations of temperature, salinity, carbon and other constituents along section occupied every five to ten years, surface buoy of the equatorial Pacific Tropical Atmosphere Ocean (TAO) array, drifting surface buoy, ARGO profiling float, and satellite used for surface wind, sea surface elevation, and sea surface temperature observations.**

Most of the key elements of the open ocean observing system are illustrated.

The ocean is a large source of energy, in the form of heat and water vapor; and anomalous patterns of sea surface temperature drive anomalous weather and climate via the atmosphere. To track the ocean anomalies, we need good global sea surface temperature measurements. This is done with surface drifters, which can also collect barometric pressure in support of weather prediction, and by satellite. To assess and to better model and thus predict the impact of sea surface temperature anomalies on the atmosphere, we need observations of the exchanges of heat and freshwater between the ocean and the atmosphere. These exchanges or fluxes are measured by surface buoys moored to the sea floor (Figures 5, 6) and by ships.

**Figure 5. A surface buoy instrumented for surface meteorology, moored off northern Chile since October 2000. Research ships service the mooring once a year; the Scripps Institution of Oceanography's *RV Roger Revelle* is shown here.**

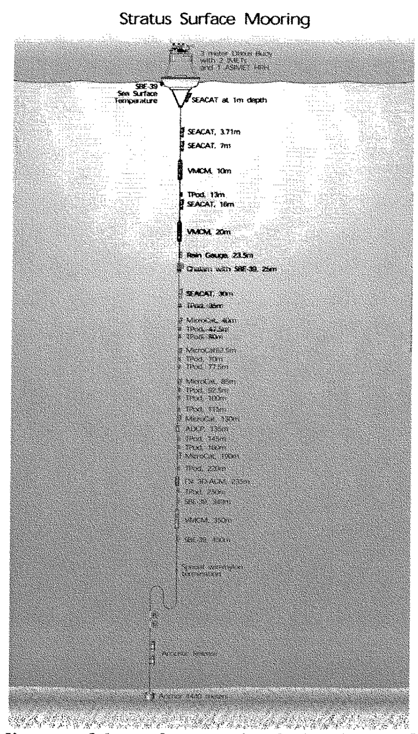



**Figure 6. Schematic diagram of the surface mooring deployed by the Woods Hole Oceanographic Institution off northern Chile since October 2000 with support from the NOAA Office of Global Programs and Climate Observation Program. The surface buoy is instrumented to measure surface meteorology. Along the mooring line, SEACAT's measure salinity and temperature; VMCM's measure temperature and velocity of the water, the rain gauge from Dr. Jeff Nystuen of the Applied Physics Laboratory of the University of Washington measures the noise created by raindrops, Tpod's and SBE-39's measure temperature, MicroCat's measure salinity and temperature, and the ADCP or Acoustic Doppler Current Profiler measures ocean velocity as does the FSI 3D-ACM.**

To understand the potential for the surface anomalies to last and thus have long-lived impacts, we need to measure how deep the anomalies are by getting temperature profiles in the upper ocean. A variety of techniques are used to obtain temperature profiles, including expendable probes dropped from commercial ships, instruments on ocean moorings, and the recently developed drifting profiling floats called ARGO floats (Figure 7). We need the observations required to understand why and how the sea surface temperature anomalies form; these observations are of the surface winds, the air-sea exchanges or fluxes of heat and freshwater, the depth of the ocean surface mixed layer, and the ocean currents. Surface winds are measured by moored buoys, by ships, and by satellites. Heat and freshwater fluxes are measured by buoys and ships, and work is underway to improve estimates of these quantities using satellite observations. ARGO floats, moorings, and expendable probes give us mixed layer depth. Drifting buoys and current meters attached to moorings give us direct observations of ocean currents. We also estimate currents from satellite observations of the surface winds and the elevation of the ocean surface together with information about the temperature and salinity of the ocean from ARGO floats, moorings, expendable probes, and drifters.

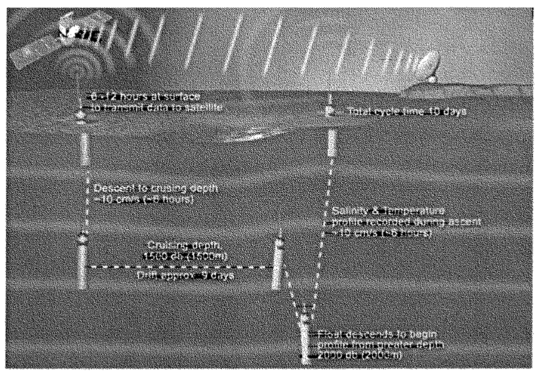



**Figure 7. Schematic of the mission of an ARGO profiling float, which drifts freely but can change its buoyancy to dive, drift at a fixed depth, and surface to measure salinity and temperature as a function of depth.**

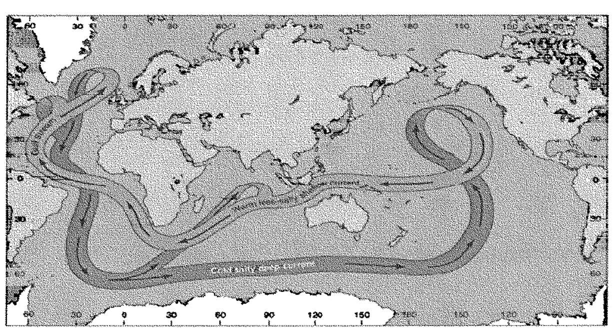
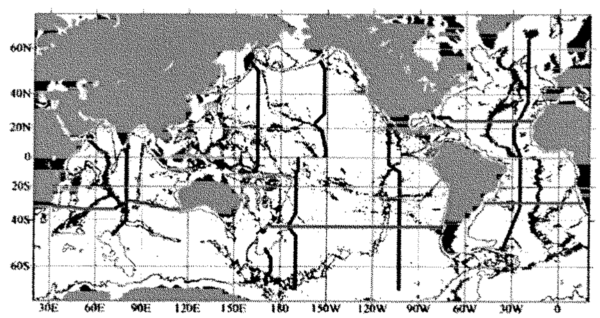


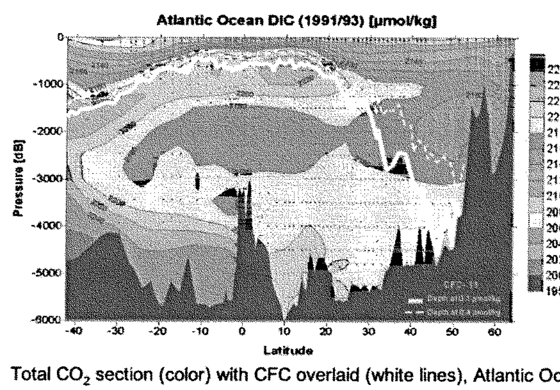

**Figure 8. A greatly simplified diagram showing how the water that sinks at high latitudes flow at depth throughout the global ocean, rising to the surface to be warmed and return to the high latitude source region.**

Ocean water exposed to the atmosphere in high latitudes loses heat and unless freshwater is added, it becomes denser and sinks as part of the large-scale three-dimensional circulation of the global ocean (Figure 8). Because the sinking depends on both the temperature and density of the water, it is called the thermohaline circulation. The thermohaline circulation plays a major role in carrying heat poleward from the tropics and in other countries, such as the United Kingdom, has become a major focus for ocean observations. Such observations seek to monitor the temperature and salinity of the water as well as the volumes of water of different temperature and salinity properties that move north and south through the ocean basins and circulate around the Antarctic in the Southern Ocean. At the same time, the process of exposure to the atmosphere and subsequent sinking into the interior of the ocean results in the ocean playing a major role in how carbon, as carbon dioxide and also in other forms of organic and inorganic carbon, and other compounds cycle through the atmosphere-ocean-land system. As a consequence, our observations should measure carbon dioxide, dissolved oxygen, and biogeochemical constituents and their exchange at the sea surface. Measurements of the penetration into the ocean of chemicals introduced by man into the atmosphere, such as chlorofluorocarbons (CFCs), provide a powerful means to assess change in the deep ocean and our ability to realistically simulate that change and the processes, including mixing that cause it. Passage of water through the deepest parts of the ocean on its way back to the surface is slow and a challenge to model; we need to at intervals of five to ten years make observations of temperature, salinity, and chemical constituents over the full depths of the oceans (Figures 9, 10).




Repeated sections to full depth along select lines, every 5 to 10 years

**Figure 9. Track line (dark) showing where ships would occupy stations, lowering profilers to record temperature, salinity, and oxygen while at the same time collecting water samples. To be done as a multidisciplinary, multinational partnership.**




Total $CO_2$ section (color) with CFC overlaid (white lines), Atlantic Ocean

**Figure 10. An illustrative north-south section from the Atlantic showing total carbon dioxide and chlorofluorocarbon; this sections shows water in the high Atlantic sinking into the interior.**

At the same time, for safety and for efficient use of the ocean, tsunamis, surface waves, and ocean currents should be measured. For tracking the tides and storm surges and for identifying long-term change in sea level, a global network of sea level gauges is needed. The U.S. partners in the global sea level network and the global surface drifter network, is building a tsunami warning network of moored buoys, and is working toward a global network of surface meteorological buoys. Because the ocean is a critical ecosystem for us as a food resource, as an element of global biogeochemical cycles, and as a resource for plants and animals that yield beneficial products other than food, we need to progress toward more comprehensive observations of nutrients, of populations of organisms, and of the biogeochemical properties of the open ocean.

We have as a community established these priorities for what to observe, identified key locations where to observe, and in some cases established multinational partnerships to scope what the contribution would be from the United States. However, we do not yet have the capability to implement all aspects of the global ocean observing system. Some locations, where there are high winds and high waves and where there are strong currents, are too challenging for present technology. Some locations require instrumentation that draws more power than we can provide with batteries alone. In some cases, the observations would be best done by laying cable that would both provide power and data communications. Further, we have not in these challenging locations yet done the detailed research-oriented observations required to develop the understanding and parameterizations of the processes that drive change and variability there and would be incorporated in predictive models that would be one user of long-term data coming from these challenging regions.

The ocean, though it is close at hand and has such impact on our lives, in many ways has proved a more formidable challenge to observe than space or the land surface. Seawater is corrosive. Marine life grows on sensors and causes them to degrade or fail. At the sea surface, the waves and currents can flex, fatigue, and break materials.

We are ready meet these challenges and soon push forward the state of the art of ocean observations and make a major step forward toward completion of an integrated ocean observing system. This will be done by building on the strong foundation of technology, capability, and research created over the past by the Office of Naval Research (ONR), the National Science Foundation (NSF), the National Oceanic and Atmospheric Administration (NOAA), and the National Aeronautics and Space Administration (NASA) and by the partnering of the new Ocean Observatories Initiative (OOI) of the National Science Foundation together with NOAA's commitment to lead a multi-agency partnership to implement the integrated ocean observing system.

The proposed NSF OOI aims to provide critical needed infrastructure and capability in three areas: the open ocean, on a regional scale, and along the coasts. Let me start with the open ocean and move through regional to coastal and end this talk by briefly pointing to the integrated system that we anticipate. To meet the challenge of severe environments and to provide power to instrumentation from the surface to the sea floor, the OOI is planning for a large, very capable surface buoy with a fiber optic and power cable to the seafloor (Figure 11). In locations with less severe sea states, a smaller buoy that provides a step forward in communications technology is planned (Figure 12). In both cases the emphasis is on bringing the observations of diverse ocean disciplines (physics, biology, geology, seismology, chemistry, optics) together for coincident collection of data, some or all of which would be available in real time, and thus enabling an unprecedented interactive, collaboratory open ocean observing capability.

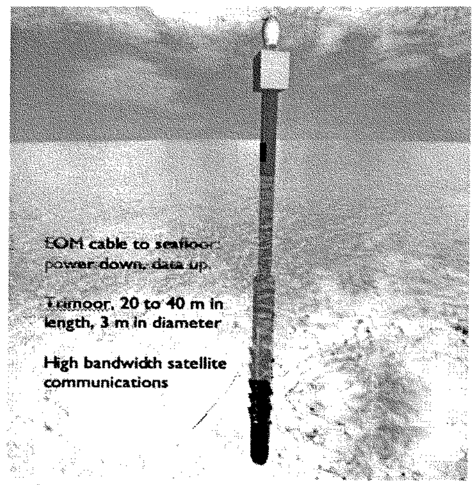



**Figure 11. Drawing of a spar buoy proposed to provide a stable platform for use in regions of high waves and winds that would also provide electric power from generators on board and a high speed communication link via an electro-optical-mechanical (EOM) cable to the sea floor.**

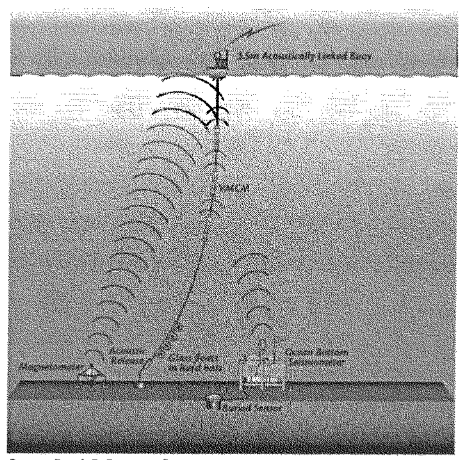



**Figure 12. Medium bandwidth surface mooring, where acoustic telemetry provide the data link from the seafloor and the water column to the surface platform.**

This intent to push the state of the art is also applied in the OOI to the notion of comprehensively instrumenting one of the plates that form the earth's crust beneath the sea. The goal is to make a step forward in capability to observe the interactions between the seafloor seismic activity, seafloor biology (for example, the rich ecosystems around hydrothermal vents) and seafloor geochemistry (for example, the release of methane during seismic activity) and the water column above. Because of the episodic nature of seismic activity, high sampling rates and a capable, flexible observing network are needed. This led to the development of the concept of the regional cabled observatory (Figure 13).

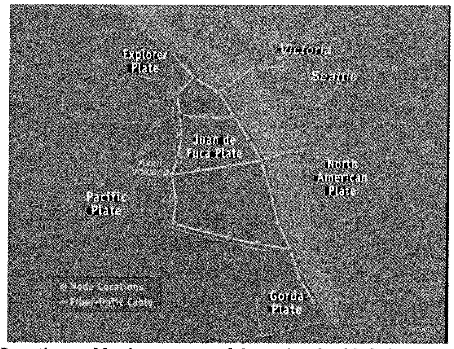



**Figure 13. Location and basic structure of the regional cabled observatory proposed for the Juan de Fuca Plate. Canada has become implementation of its contribution, and the U.S. component is proposed as an element of the NSF OOI.**

The third element of the NSF OOI addresses the aim of advancing the capabilities of coastal ocean observatories. At the coasts, additional processes contribute to variability and change (including nutrient and sediment runoff in rivers, mixing of bottom sediments, wind-driven coastal upwelling, breaking waves, and rip currents) and bottom topography and coastal orography combine to produce rich spatial variability on regional and local scales. To observe and understand variability and change in the coast, the OOI proposes a combination of long-term, fixed, well-instrumented arrays known as "endurance arrays" and more dense but shorter-lived "pioneer arrays". The endurance arrays would be permanent observing facilities at key locations. To achieve sufficient spatial sampling, the pioneer arrays would be installed in conjunction with an endurance array for several years at a time (Figure 14). The endurance and pioneer arrays would be instrumented to measure the surface forcing and air-sea exchanges (surface meteorology and heat and freshwater fluxes), the temperature, salinity, and velocity in the water column, and diverse biogeochemical parameters including dissolved oxygen, fluorescence, nutrients, and carbon dioxide. New sensor technologies would be tested for making observations of the populations of different species.

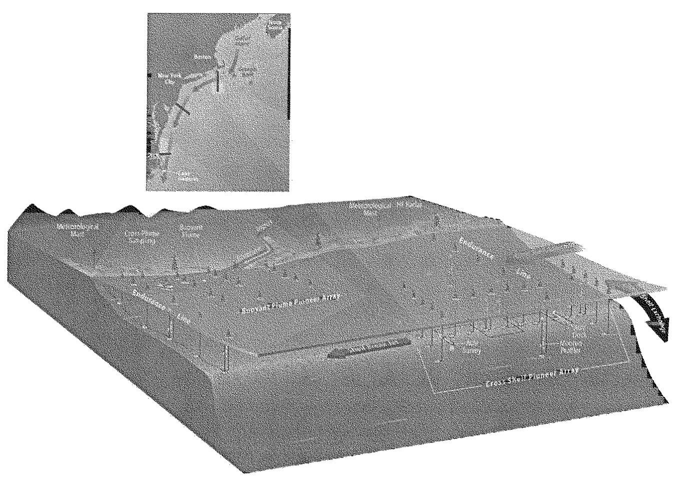



**Figure 14. Schematic of the combined deployment of long-term 'endurance lines' or endurance arrays of cabled or individual moorings and of additional 'pioneer arrays' of moorings installed to provide higher spatial resolution for a limited duration. The inset (above) illustrates how a line of coastal arrays could be used to observe the flow southward along the coast of water from higher latitude and, for example, to investigate how variability and change in the transport of this water leads to variability and change in local ecosystems.**

The NSF OOI will, in summary, greatly advance capability for global, regional, and coastal ocean observations. High spatial and temporal sampling and real time data links will advance our understanding of processes that cause variability and change and of the relationship, for example, between physical change and change in the ecosystem. At the same time, the OOI will result in a step forward in observing system capability, providing programs such as the NOAA Climate Observing Program with the technology and infrastructure experience required to successfully occupy the more challenging environments of the global ocean. Many of these locations, such as those in the Southern Ocean, are beyond present capability and yet are where the thermohaline circulation of the ocean is driven and where atmosphere-ocean exchange of heat and carbon dioxide is believed to be large. As a consequence, these sites are of very high priority in observing system plans.

I believe that we have in hand the all the elements to occupy such sites and thus make a leap forward in the development of ocean observation systems. We have the strong foundation built by the different ocean agencies. The Ocean Commission report and the international GEO process provide guidance at national and international levels for NOAA as the ocean mission agency to go forward. We have key remote sensing methods for sampling the ocean developed by NASA that should be recognized as of high national priority and sustained. We have the remarkable technological step forward proposed by the NSF to advance ocean sciences capabilities and the ongoing efforts of the Office of Naval Research to observe, understand, and predict ocean variability in support of Navy needs. There is a dialog between agencies that recognizes and builds on the synergy between ocean research, long-term ocean observations, assimilation of data, and improved predictive models and products.

Let me close be showing a satellite image of the Atlantic Ocean off the northeastern United States (Figure 15). This is an with productive fisheries, where many citizens live, work, and play, and a region where the ocean transports warm water from the south and cool water from the north. In the years after World War II, oceanographers at the Woods Hole Oceanographic Institution worked to develop techniques to predict the winter climate in New England based on knowledge of the weather systems in eastern North America and in the North Atlantic and on the sea temperature of the ocean off New England. They failed to develop reliable prediction methods.

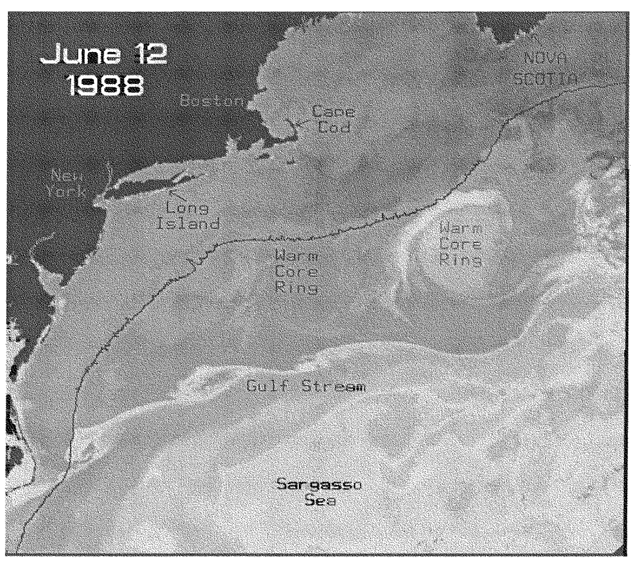



**Figure 15. Satellite image of sea surface temperature, showing warm water flowing northeast in the Gulf Stream, the prominent western boundary current of the North Atlantic, and cool water closer to the shore, with indications of penetration southward of cool water from the east coast of Canada.**

We now know why. Variability in change in New England climate or in the ocean off New England is not solely driven by local processes. It results from a concatenation of remote, regional, and local processes. The global ocean, as I discussed in the beginning of this testimony, is a driver of change in the NAO. Model studies point to the need to consider the influence of the tropical Indian Ocean and the western Pacific Ocean off Japan as well as of the northern North Atlantic Ocean. If the oceanographers at Woods Hole had known this in the 1950s, they would have admitted to little chance of success. It is a much different perspective 50 years later. The efforts to develop ocean observing systems will come together. Regions like the waters of the Mid-Atlantic Bight and New England will be instrumented by the NOAA National Ocean Service, National Data Buoy Center, and by the regional associations Dr. Spinrad described as part of the coastal observing system. The global ocean observing system will be implemented, building on the NSF OOI and on the ocean research carried out by ONR and NSF, and under the oversight of NOAA and programs such as the Climate Observation Program.

The coastal and open ocean systems will be meshed. In this case, the global system in the Atlantic Ocean will provide the large-scale patterns of variability and change in which the coastal waters are embedded. At the same time the global array will provide the information of the variability of the ocean in remote locations such as the equatorial Pacific that also drive variability and change in New England. The coastal arrays will provide the offshore transports of freshwater, sediments, nutrients, and other properties into the open ocean, information about the regional processes, and record the variability and change along the coast. These ocean observing systems will be complementary to terrestrial and atmospheric observing systems. The land, the ocean, and the atmosphere are linked. Research programs such as the Global Energy and Water Cycle Experiment (GEWEX) and CLIVAR work together and, for example, show that terrestrial observations, such as of soil moisture, are needed to further develop the ability to predict drought conditions.

In closing, thank you for allowing me to submit this testimony. The United States is at the forefront of developing and implementing ocean observing systems, supported in the past mainly by the National Oceanic and Atmospheric Administration (NOAA), the National Science Foundation (NSF), the Office of Naval Research (ONR), and the National Aeronautics and Space Administration (NASA). The past diversity of the funding and the engagement of both government and academic oceanographers in the endeavor has been a great strength. We now have a convergence of planning, synergy between research and mission oriented goals, the development of new capability, and the recognition of the value of ocean observations. It is an exciting time, and I would be glad to answer your questions.

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Mr. GILCHREST. Thank you very much, Dr. Weller.

Dr. Boesch, welcome.

**STATEMENT OF DONALD F. BOESCH, Ph.D., PRESIDENT, CENTER FOR ENVIRONMENTAL SCIENCE, UNIVERSITY OF MARYLAND**

Dr. BOESCH. Mr. Chairman, it is always good to see my congressman. Good to be here.

I am going to summarize my longer testimony and I am focusing on coastal observing systems. The rapid development of numerous coastal observing systems is testament not only to the entrepreneurial efforts of research institutions like mine, but also to an energetic, but often turbulent, confluence of significant push from emerging technologies in sensors, telecommunications, data management, and computation, and a growing pull for real-time nearly continuous information about the ocean, for both practical as well as scientific uses.

As you indicated in your opening remarks, depending upon how the existing systems are defined, there are between 40 to 60 coastal ocean observing systems in existence in our Nation today. Some are operational. Many others have been built for scientific purposes as opposed to functioning as operational systems for monitoring and prediction. And many of these scientific systems are also attempting to serve operational requirements as well.

By and large, these systems have different sets of protocols and standards, collect different physical, chemical, and biological data based on different calibrations. Coastal observing systems are operated by a variety of Federal, State agencies, regional authorities, universities, and research institutions, and they do not at this point adequately share data or provide information through single access points. Because of the differences among these systems, generally speaking there is no standardized inter-operability. Coastal observing systems are generally chronically under-funded and difficult to sustain, and compete, typically through a political process, for limited funding.

Although wonderful technology developments are proceeding, clearly the present situation is inefficient, less effective than it should be, and unsustainable. These concerns have naturally led to a call for an organization of national coastal observing systems as a network of regional associations in the plans for the integrated ocean observing system that was mentioned by my colleagues earlier. Both the environmental characteristics and user information needs of the Nation's coastal ocean vary enormously. Resources and uses also vary, from historically abundant fisheries of Georges Bank to the busy ports of the Mid-Atlantic Bight to the tourism of the Florida peninsula to oil and gas production in the Gulf of Mexico and fisheries in the Gulf of Alaska and Bering Sea.

Organization based upon regional associations allows the focus to vary within the regions while also serving the national need, and it also resonates very well with the call by the U.S. Commission on Ocean Policy for stronger regional governance of the Nation's ocean resources based upon the principles of ecosystem-based management. Regional associations can provide the backbone of observations required for national needs, while at the same time, as I say, cater to varying needs of individual regions.

Effective regional organization and management allows implementation on a scale sufficiently large to attain the critical mass necessary for successful delivery of useful products, but sufficiently small to focus on the most important scales of management and operations. With the advent of IOOS, the new regional associations will not only accelerate the development of these systems, but also accelerate the production and delivery of relevant information to the end users. Regional associations promise an organizational governance structure that ensures not only the interests of the participants are served, but also that the observational information forecast and analysis products will be delivered.

I want to briefly focus on the Chesapeake Bay as an example of our development of trying to bring people together on observing systems. As you know, Mr. Chairman, my center started in the early 1990s, the Chesapeake Bay Observing System, with some Virginia institutional partners. And after we put in some buoys in the Bay, we instituted a program of monthly aircraft remote sensing flights. And as this system expanded, other organizations also have gotten into the business of making observations. Dr. Spinrad's program in the National Oceanic and Atmospheric Administration operates the physical oceanographic real-time port system for the ports in the Chesapeake Bay, providing the same kind of service as he indicated using the example of the Houston ship channel. In addition to that, our own Maryland Department of Natural Resources has instituted a program called Eyes on the Bay, which deploys shallow-water sensors off piers and in other shallow-water areas to give us the full complexity of the diversity of environmental conditions and responses throughout the Bay.

In the Chesapeake Bay region, we are now working with Federal, State, and private partners to pull this all together into a more consolidated Chesapeake Bay observing system that integrates all of this information. But I have to tell you, it is challenging because the resources just to stay in this effort, for all of us, are very difficult to find.

On a larger scale, of course, we are now trying to integrate the Chesapeake Bay observing system, which has to be useful to serve the Chesapeake Bay management—port security, navigation, recreational boater interests—but also integrate that into a regional network. We find it is a great opportunity for us and advantage to us. For example, by bringing in what goes on in the Continental Shelf, of course, which—water comes into the Bay and affects in a major way conditions that take place in the Bay within this broader system. So we are looking forward to integrating this into a regional system.

Let me just very briefly conclude with a comment related to the fact that these investments in observing systems have to be integrated with equal and well sorted out investments in the science needed to understand and interpret the ocean environment, particularly around our Nation's coast. The U.S. Commission on Ocean Policy calls for a new era of ecosystem-based management of the Nation's ocean environment that is supported by the best available science. Ocean observations alone are insufficient in meeting these scientific and information knowledge requirements for ecosystem-based management. Research on the causes and effects underlying the observations and the integration of science that advances proved understanding and supports robust prediction are also required. I would urge you to think about the sustained and significant investment that the Commission recommends in the science that is needed to manage our ocean resources wisely well into the future.

So thank you very much for the opportunity to testify.

[The prepared statement of Dr. Boesch follows:]

**Statement of Dr. Donald F. Boesch, President, University of Maryland Center for Environmental Science, Cambridge, Maryland**

Chairman Gilchrest and Members of the Subcommittee, thank you for the opportunity to speak with you concerning our nation's present capabilities and future opportunities for ocean observing systems, particularly coastal observing systems.

I am Donald Boesch and serve as President of the University of Maryland Center for Environmental Science. My institution was in the first wave of those initiating a coastal observing system, the Chesapeake Bay Observing System, more than a decade ago. In addition I have been involved in considerations of the development of a national ocean observing system through involvement in activities of the National Research Council, Consortium on Ocean Research and Education, Southeastern Universities Research Association, and U.S. Commission on Ocean Policy.

I know it has proven difficult for Members of Congress to see a single compelling national objective for a national, integrated and sustained network of coastal ocean observing systems for several reasons. Is this for science or for some operational requirement? What is the primary purpose and which agency should be responsible for its management and funding? How will it support, replace, or improve what we are already doing in science and operations?

As the U.S. Commission on Ocean Policy argued in its preliminary report the ocean observing systems offer numerous benefits and should therefore serve multiple masters. These systems can help: detect and forecast climate variability, facilitate safe and efficient marine operations, ensure national and homeland security, manage resources for sustainable use, preserve and restore healthy marine ecosystems, reduce risks from natural hazards, support safe development and transportation of energy sources, and ensure public health and safety. This requires a national, interagency program for the efficient integration and service of these user needs.

*Coastal Observing Systems*

The rapid development of numerous coastal ocean observing systems is testament not only to the entrepreneurial efforts of research institutions like mine, but also to an energetic but often turbulent confluence of a significant push from emerging technologies in sensors, telecommunications, data management and computation and a growing pull for real-time and nearly continuous information about the ocean.

Depending on how the existing systems are defined, there are between 40 to 60 coastal ocean observing systems in existence in our nation today. Some are operational, such as the NOAA NDBC buoys, C-MAN stations, National Water Level Observing Network and PORTS systems, to name a few. Many others have been built for scientific purposes, as opposed to functioning as operational systems for monitoring and prediction. But, many of these are also attempting to serve operational requirements as well. By and large, these systems have different sets of protocols and standards, and collect physical, chemical, and biological data based on different calibrations. Coastal observing systems are operated by a variety of federal and state agencies, regional authorities, universities and research institutions and they do not share data or provide information through a single access point. Because of the differences among these systems, generally speaking, there is no standardized interoperability. Coastal observing systems are generally chronically under-funded, difficult to sustain, and compete—typically through the political process—for very limited funding. Although wonderful technical developments are proceeding, clearly the present situation is inefficient, less effective than it should be, and unsustainable.

These concerns have naturally led to the call for organization of the national coastal observing system as a network of Regional Associations in the plans for the Integrated Ocean Observing System by Ocean.US. Both the environmental characteristics and the user information needs of the nation's coastal ocean vary enormously. Geography, climate, ocean circulation, and ecosystem characteristics act to create a complex variety of local waves, tides, currents, fisheries, and water quality. Extending only 30 to 120 miles offshore from the shallow bays, estuaries and inner continental shelf to the deep ocean, coastal waters can show marked changes, from the cold, rough waters of the Gulf of Maine, to the South Atlantic Bight with its close proximity to the Gulf Stream, to the warm expanses of the continental shelf from west Florida to Texas, to the big waves of the cold California surf. Resources and uses also vary, from the historically abundant fisheries of Georges Bank, to the busy ports of the Middle Atlantic Bight, to the tourism of the Florida peninsula, to oil production in the Gulf of Mexico, to the fisheries of the Gulf of Alaska and Bering Sea.

Organization based on Regional Associations also resonates well with the call by the U.S. Commission on Ocean Policy for stronger regional governance of the nation's ocean resources based on principles of ecosystem-based management. Regional Associations can provide the backbone of observations required for national needs, while at the same time, cater to the varying needs of individual regions. Effective regional organization and management allows implementation at a scale sufficiently large to attain the critical mass necessary for successful delivery of useful products, but sufficiently small to focus on the most important scale of management and operations. The time has arrived when observing systems can produce real-time information on the coastal ocean that is valued by a variety of constituencies. With the advent of IOOS, the new Regional Associations will not only accelerate the development of these systems, but also accelerate the production and delivery of relevant information to the end users. The Regional Associations promises an organizational and governance structure that ensures not only that the interests of the participants will be served, but also that observational information, forecasts, and analysis products will be delivered.

*The Chesapeake Bay Example*

Observing systems to serve needs on subregional scales will, however, be the essential building blocks for the Regional Associations. As an instructive example I will briefly summarize our experience in the Chesapeake Bay and Middle Atlantic region.

For almost a decade and a half efforts have been underway to develop an observing system for the Chesapeake Bay and adjacent continental shelf. The Chesapeake Bay Observing System (CBOS) was started by the University of Maryland, with a few Virginia partners, by placing two radio-telemetry buoys in the northern Bay. Soon after these buoys were launched, a program of monthly aircraft remote sensing flights commenced. As CBOS expanded, other systems began to come online. The National Oceanic and Atmospheric Administration's National Ocean Service (NOS) Physical Oceanographic Real-Time System (PORTS) was initiated to help guide shipping to the ports of Baltimore, Hampton, and Norfolk. Recently, Maryland's Department of Natural Resources "Eyes on the Bay" program began to instrument docks and piers in Bay tributaries to track water quality in shallow waters. Similar efforts are underway in Virginia. In addition, there has been a 20-year long effort to monitor the water quality conditions and living resources in the Chesapeake Bay through periodic (weekly to monthly) sampling of the Bay from boats.

Although these systems have achieved some success and longevity, they have not yet been established with an adequate level of funding to ensure continuous, sustained observations. Continuous, multiyear records have been obtained, but the struggle to provide this information has come through comparatively small amounts of funding from multiple sources. This hand-to-mouth operation has not only prevented full spatial and temporal coverage, but has also limited the development of information products tailored to users needs. These products demonstrate the value of the system, and thereby help the search for funding.

Over the past two years, a Chesapeake Bay Observing System Association has formed from academic, governmental, and private-sector partners. This new, larger CBOS structure includes academic participants (University of Maryland Center for Environmental Science, Virginia Institute of Marine Science, and Old Dominion University), state agencies (Maryland Department of Natural Resources, the Maryland Department of the Environment, Maryland Emergency Management Agency, and the Virginia Department of Environmental Protection), federal agencies (National Weather Service, National Ocean Service, National Aeronautic and Space Administration, the U.S. Geological Survey, and the Environmental Protection Agency), the military (Aberdeen Proving Ground, Patuxent River Naval Air Station, Navair Atlantic Range, Fleet Base Norfolk, Fleet Base Little Creek, and Navy Meteorological and Oceanographic Forecasting), and a host of private-sector partners, including the Chesapeake Bay Foundation, the region's primary environmental advocacy group.

For the Chesapeake Bay region, forecasts of conditions in the Bay and over the adjacent continental shelf would greatly aid the effort to restore its water quality and productive fisheries, would support an ecosystems-based management for these resources, and also facilitate safe marine operations in the Bay and its ports of Baltimore, Norfolk, and Hampton, provide warnings for natural hazards, and increase the enjoyment and safety of marine recreation. The recent experience of Hurricane Isabel, which took the less-traveled route to the west of Chesapeake Bay, indicates that the timely delivery of detailed forecasts of storm surges would greatly improve the ability to diminish loss of life and property from such storms. Presently, the accuracy of marine forecasts over the Chesapeake Bay region is hampered by the lack of data of winds and the marine boundary layer over the water. Both short-term and long-term forecasts have been shown to be of significant value to the insurance industry. Real-time information is valuable for energy production such as Calvert Cliffs Nuclear Power Plant, which depends on Chesapeake Bay water for cooling its reactors. Safe operation of the nearby Liquid Natural Gas terminal also depends on accurate forecasts and nowcasts of currents and marine weather. Even port security would be aided by a real-time observing system over the Bay. The same high-frequency radars that are employed to measure surface currents are now being modified to provide a ship-tracking capability for vessels as small as 30 feet.

Recently, a CBOS Demonstration Project was funded through NOAA to produce real-time information products of winds and waves over the Chesapeake Bay. The majority of CBOS partners will be involved in this effort, which is expected to provide the seed for a fully sustainable operational system. Winds and waves are key inputs to the developing Chesapeake Bay Community Model, which will serve as the primary forecast tool, assimilating real-time data from CBOS to ensure high-accuracy predictions.

On the larger regional scale, the span of coastal ocean between Cape Cod and Cape Hatteras contains a dynamic and productive ecosystem, crossed by a web of busy shipping lanes and scoured by both midwater and groundfish trawlers. Many of the important resources and threatened ecosystems are located, not over the outer continental shelf, but along the shore and within the large and increasingly urbanized estuaries—Chesapeake Bay, Delaware Bay, Hudson-Raritan River, Long Island Sound, and Narragansett Bay. Into these estuaries, the Susquehanna, Potomac, James, Delaware, Hudson, and Connecticut Rivers drain a significant portion of the eastern United States, where about 23% of the nation's population lives. These nearshore waters contain tier-one ports, military bases, and important inshore shellfish and finfish grounds. It is here that economically valuable uses such as recreation, tourism, and fisheries readily conflict with other valuable uses, chief among which is the discharge of nutrients from watersheds and from municipal sewers. The regional ocean observing system for the Middle Atlantic must meet the challenge of incorporating these important nearshore environments as well as the continental shelf.

For the Chesapeake Bay, the new Mid-Atlantic Regional Association promises significant advantages, the most important being providing the observing system for the continental shelf with which the Bay communicates. Approximately half the water in the Bay at any one time originated from the shelf. Our forecast models will not be sufficiently accurate without accurate observing and modeling of the Middle Atlantic Bight. Furthermore, regionalization will provide an effective means for sharing of comparative information within the region and linkage with the national IOOS and cost efficiencies regarding data management and telecommunications.

Sustainability is a key challenge in the Middle Atlantic region as it is elsewhere. Through engaging users of these systems at the outset, they will produce information products that the users may deem sufficiently valuable to provide financial support. However, realistic assessments from demonstration efforts indicate that this business model is unlikely to succeed without base funding support from the federal government. The Weather Observing Network has been justified as being funded by the federal government because it serves a common good, common to the entire nation. In Chesapeake Bay, a successful Coastal Marine Demonstration Project produced valued products operationally for a variety of users, yet the development of the system and the size of the user base did not reach the stage where the threshold of self-sustainability was reached. Even the most mature Regional Observing System, the Gulf of Maine Ocean Observing System, has not yet reached that threshold. However, with the planned structure for both subregional and Regional Associations built around having users at the table as full partners, we can expect at least a portion of the financial support accruing from the user community.

*Science Requirements*

Additional investments in science will be necessary to fully reap the benefits of coastal observing systems. We must move beyond the basic set of measurements of temperature, salinity, winds and currents in order to take full advantage of the substantial investments in platforms. The explosions of new technologies that allow more miniaturization, lower power requirements, and ensure robust performance in the environment allow the reliable measurement of chemical and biological properties and processes. With support from NOAA's Coastal Services Center we have developed the Alliance for Coastal Technologies (ACT), a partnership of research institutions, state and regional resource managers, and private sector companies working together to develop, improve, and apply standardized sensor technologies for studying and monitoring our coastal environments. ACT provides an unbiased, third-party testbed for evaluating new and developing coastal sensor technology and sensor platform technologies, a comprehensive data and information clearinghouse on coastal technologies, and a forum for capacity building through workshops and seminars on specific technologies. Our partners represent all the key geographic areas and environmental conditions along our coasts. These include my own University of Maryland Center for Environmental Science for the Mid-Atlantic region; the Gulf of Maine Ocean Observing System for the New England region; Moss Landing Marine Laboratory and Monterey Bay Aquarium Research Institute for the Pacific coast; Skidaway Institute of Oceanography for the South Atlantic region; the University of South Florida for the Gulf region; the University of Hawaii for the western Pacific, and the University of Alaska for the northern Pacific.

NOAA's Coastal Services Center is also supporting a wide variety of efforts linking research to products and services for the coastal community by funding 16 organizations through its Coastal Observation Technology System (COTS). These grants are designed to further the development of an integrated regional coastal ocean observing system.

The U.S. Commission on Ocean Policy calls for a new era of ecosystem-based management of the nation's ocean environments that is supported by the best-available science. Ocean observing systems will make a contribution in that regard, but alone are insufficient in meeting the scientific and information and knowledge requirements for ecosystem-based management. Research on the causes and effects underlying the observations and integration of science that advances improved understanding and supports robust prediction are also required. The Commission recommends a substantial increase in investment in ocean science, strategically directed by an improved interagency process, to accomplish these objectives.

*Legislation*

In order to establish a nation-wide, integrated ocean observing system, legislation is called for that provides the proper authority to the responsible agencies to work together, takes advantage of and builds on the existing infrastructure that has already been developed on a regional and sub-regional basis, and relies on a regionalized operating structure.

The Senate passed S. 1400 in November of 2003. Congressman Curt Weldon (R-PA) has prepared legislation that update S. 1400 by incorporating the recommendations from the U.S. Ocean Commission and addresses concerns of many Members of the House. This bill has had the input of numerous constituencies and I believe that it provides a viable mechanism for the federal agencies to work together, taking advantage of and building on our existing observation infrastructure, and utilizing a regional approach for operations.

One of our great concerns regarding any legislation of this kind, however, is the jurisdictional situation. Any bill of this kind, like S. 1400, will be referred to more than one committee. In the instance of S. 1400, the bill has been referred in the House to your Committee, as well as to the Science Committee, Armed Services Committee, and the Transportation and Infrastructure Committee. With so many committees having jurisdiction, it is of critical importance that the Resources Committee, which has primary jurisdiction under the House Rules, provide the leadership necessary to move the legislation. In addition, we would urge you to work with the other committees sharing jurisdiction to promote hearings and markups so that legislation establishing an Integrated Ocean Observing System can be passed and signed into law as soon as possible.

Estimates of what the costs would be to fund such a nation-wide system may appear to be extremely large. However, when one considers the benefits to the large ocean and coastal constituencies, including supporting the national security mission of the Federal government, the costs are not high at all. The bottom line is that everyone of us within the United States is highly dependent upon our coastal and ocean waters; hence the costs, when analyzed properly and spread to the actual beneficiaries, are very reasonable. The recently updated, initial year estimate, spread among all the primary federal agencies, is about $140 million. With the necessary coordination and infrastructure development over the next five years, the number ramps up to about $500 million. These numbers were developed by Ocean.US and represent a more realistic cost outlook.

Although these sums seem quite large, an initial economic analysis by independent economists under contract to NOAA estimated a return of $5 to $6 for every $1 invested in ocean observing and predictions. This is an excellent return on the investment, and benefits all user communities of our oceans and coasts, including industry, government and the public. We hope you will bear this in mind when you consider legislation to establish an integrated ocean observing system.

*Conclusion*

All of us in the research community appreciate the interest you have shown in this issue, Mr. Chairman. Thank you for the opportunity to comment on it and support your subcommittee in its deliberations. I would be happy to answer any questions you may have.

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Mr. GILCHREST. Thank you, Dr. Boesch.

I want to thank all of you for your testimony. There is a lot of extraordinary things happening out there. There are enormous amounts of information, as you presented to us this morning, and we would really like to work with all of you to coordinate your testimony, that information, your background to bring in this ocean observing system as a premier tool of the United States to monitor 70 percent of the earth's surface, and then integrate that with the rest of the world and set the stage for a new generation of understanding.

Dr. Spinrad, in your testimony, you talked about an ocean observing system that could—I guess, if I am hearing right—detect areas of hypoxia, see beach closures necessary before they happen, determine or detect in a better manner over-fished stocks, invasive species, harmful algal blooms, storm damage, erosion, et cetera. How far are we right now away from determining those things in a timely manner? The existing system that we have right now, how integrated is it, how fragmented is it, how far are we away from being able to, in a real-time fashion, monitor and then predict the management necessarily to deal with those issues?

Dr. SPINRAD. In many of the cases, Mr. Chairman, we have been able to demonstrate through pilot studies a capability in targeted areas, in very specific examples, some dramatic improvements in our abilities. For example, with harmful algal blooms in the eastern Gulf of Mexico, we are, at NOAA, in a pre-operational mode, intend to go operational within the next six to 9 months to provide coastal managers in the Gulf of Mexico with that kind of forecast capability.

Mr. GILCHREST. To forecast where the hypoxic areas are going to be?

Dr. SPINRAD. Where and when we expect—not the hypoxia, the harmful algal blooms in the eastern Gulf of Mexico.

Mr. GILCHREST. So in six to 9 months, you would be able to predict that there is going to be a harmful algal

bloom outbreak?

Dr. SPINRAD. In six to 9 months, we will be going operational with the capability to provide forecasts on a days to weeks kind of timeframe.

Mr. GILCHREST. If there is going to be a red tide or something like that. When you have that capability of predicting that that is going to happen, do you know why that happens?

Dr. SPINRAD. Well, this is where the connection with the research community is so critical. We do have good fundamental understanding of primary productivity, that is, trophic interactions, what influence injection of nutrients will have to result in productivity of those kinds of algal blooms, and then which algal blooms themselves are the toxic algal blooms. We have a good basis of research, but this is a classic example of working with NSF, the Office of Naval Research, to define what the user community—in this case, coastal managers—need in terms of duration of forecast, what kinds of specific events they care about, that is, those that are most influential on the shell fishery, and therefore be able to define what sorts of research requirements we have for the Integrated Ocean Observing System.

Mr. GILCHREST. So in six to 9 months there will be operational capability to begin to predict those types of harmful algal blooms and get that information to coastal managers.

Dr. SPINRAD. That is correct, in the Gulf of Mexico.

Mr. GILCHREST. In the Gulf of Mexico. And is there then an understanding as to the contribution to those outbreaks of harmful algal blooms from the Mississippi River, from the coastal community itself, from the sources that—I guess, is there a distinction between the kinds of natural algal blooms that were out there 500 years ago and the type of algal blooms that are there now, possibly as a result of industry, sewer plants, just a whole range of human activity?

Dr. SPINRAD. I don't think we are at the point now where we can conclusively break out, say what the anthropogenically influenced harmful algal blooms might be versus those that were occurring over long periods of history. Clearly we have a much better understanding of the factors that contribute to the onset and also the dispersion of these blooms, but we are not at the stage where we can make that clear a discrimination.

Mr. GILCHREST. Is there some discrimination or understanding between harmful algal blooms and hypoxic waters?

Dr. SPINRAD. Those really are treated somewhat independently, although obviously one of the critical factors is the physical forcing mechanisms—the mixing, the distribution of the waters. And in fact, the hypoxia events, again in the Gulf of Mexico, or for that matter in the Chesapeake Bay, are predictable to a certain extent, but unless you incorporate the real-time weather information as well—as we saw just this year in the Gulf of Mexico, where the forecasts were somewhat controverted, if you will, by the late onset of storm mixing events which introduced oxygen where we had forecast stronger hypoxic events. So it calls out the real critical need not just to build an integrated ocean observing system, but that system has got to be well integrated with our meteorological observations as well.

Mr. GILCHREST. Would you call this, what you are doing, this integrated system in the Gulf of Mexico, a first stage of a long-range project to do this type ocean observing or create this type of system throughout the United States?

Dr. SPINRAD. Very much so, yes, from the standpoint that one of the things that we consider critical in the development of the Integrated Ocean Observing System is having a clear continuum from the basic research through pilot projects to pre-operational and then operational capabilities.

The other thing that particular example calls out nicely is that we do have specific regional interests. And the reason why you have heard each of the witnesses here allude to the Regional Observing System capabilities is because there are specific priorities. There are general needs for backbone kinds of observations, like water-level observations. But then there are specific regional priorities. And, for example, the Gulf of Mexico hypoxia and harmful algal bloom priorities are different from the kind of priorities we may have in other parts of the country.

Mr. GILCHREST. I understand. I have a few more questions, but at this point I will yield to the gentleman from New Jersey.

Mr. PALLONE. Thank you, Mr. Chairman. I wanted to get to the funding issue and ask Dr. Spinrad, in your written testimony you make a compelling case for why an Integrated Ocean Observing System is needed. Indeed, every witness sitting at the table has articulated why the U.S. needs such a system. And I have to say that

I am pleased to see such overwhelming support for it and, you know, applaud the efforts thus far in moving toward that goal.

But as I mentioned in my opening, even though we are all optimistic, there is a lot of pessimism regarding the funding to implement and sustain a national ocean observation system. As we saw with the President's budget request and then the recent House Commerce/Justice/State appropriations bill, there were significant reductions to NOAA's budget, I guess to the tune of $46 million from Fiscal Year 2004-enacted levels. And then in the Senate we have S. 1400. If you use that as a guide, implementation would cost all agencies involved a total of over $200 million for each of the next 5 years. So that is a billion dollars.

So you contrast what we think we need versus what we are getting, assuming that the CJS appropriations bill passes Congress, I would like to know, Dr. Spinrad, what NOAA programs will be specifically affected by the budget cuts with regard to their responsibility in helping to implement the ocean observing system. And perhaps you can talk about a few programs and then submit a list of the affected programs to the Subcommittee later. But if you would at least tell us what you can at this point, I would appreciate it.

Dr. SPINRAD. Yes, I would be glad to do that. There are a couple of important initial points that I would like to make in response. The first is that we are converging on a clear understanding of what the current level of investment is, and nationally we are looking at a level of investment on the order of about $900 million per year, from research through operations, among all of the agencies that are invested in the Integrated Ocean Observing System. NOAA's contribution to that, through our various pieces, is approximately $600 million per year. So the first important point is that our ability to sustain that investment persists. We will continue to invest in those levels. And you have heard some reference to the kinds of programs that we will be able to continue invest in the physical oceanographic real-time system—

Mr. PALLONE. But still, tell us how—I mean, there must be some impact from these cuts. And if you would give us some information about how the budget cuts would affect the system.

Dr. SPINRAD. Without the specifics associated with some of those cuts, it is hard to determine at a program level where we will see those cuts. Now, for example, in language in the House appropriation, there was sustainment of our navigation services efforts. Many of the kinds of observations that I am talking about here are in fact embedded within the navigation services investments. The water-level observations, for example, is part of that as well. There are research investments within NOAA, in our Ocean Assessment Program; we are trying to determine what the cut effects might be on those particular research programs. It is unresolved at this point.

Again, with respect to our budget submission, however, what you will see is that there are specific growth areas that we have proposed both in the navigation services and then in the climate-related ocean observations arena, to the tune of $24 million on the climate side.

Mr. PALLONE. But, well, I know you are trying not to be specific and maybe you can just get back to us later. But I mean, the bottom line is there has to be some impact. I mean, didn't the President's own Fiscal Year 2005 request cut some of the ocean observation earmarks specifically?

Dr. SPINRAD. Well, the budget request itself included sustainment of the baseline investments and two particular areas of proposed increases with respect to navigation services and climate investments.

Mr. PALLONE. But there were no cuts specifically in ocean observation earmarks?

Dr. SPINRAD. The earmarks that had been provided in past years were not resubmitted as part of the budget in the National Oceanic and Atmospheric Administration.

Mr. PALLONE. Now, what about—I mean, is it likely that what you are going to do is just divert funds from other programs to cover the expenses of implementation? I mean, you keep stressing overall and not wanting to get to the specifics. Is that what is likely to happen?

Dr. SPINRAD. I would hope it is not what is likely to happen. As I said, our budget actually included some specific increased areas for ocean observations and a determined effort to sustain those core, if you will, areas that we have retained within the $600 million figure that I identified earlier, as well as the sustained efforts in data management and communications.

Mr. PALLONE. But I just don't know how you are going to do it all and, you know, still not have some impact. But I guess you are reluctant to give me much in the way of details. But with the help, along with your support, Mr. Chairman, if we could get some, you know, written statement from you about how the CJS appropriations would specifically affect the different programs or line items, I would appreciate it.

Dr. SPINRAD. Absolutely. We are well prepared to develop those impact statements.

Mr. PALLONE. Could I just ask one more thing—with your indulgence. Is it reasonable to expect users of ocean observation data to pay for access to the data? In other words, who would be required to pay for access—commercial/recreational fishers, commercial shippers, recreational boaters? What would you think about that?

Dr. SPINRAD. There has been a long history in the meteorological community, that the Weather Service has been party to, in dealing with exactly that question, the availability of data. And I might add that this is a critical issue in the international scene. The World Meteorological Organization, for example, years ago established a policy for the full and open availability of those data. The oceanographic community is, to a large extent, taking a lead from that community, trying to make full and open availability of these data. Where we expect to see similar kinds of developments in the oceanographic community is in the development of tailored products for which there may be subscription services, for which there may be charges—not unlike, for example, what is seen in the meteorological community, where you clearly can get for free data from the National Weather Service, but should you choose to request a particular tailored product, there is a whole private-sector community that can provide outstanding services along those lines. I think we can do the same kind of thing in the oceanographic community.

Mr. PALLONE. Thank you. Thank you, Mr. Chairman.

Mr. GILCHREST. Thank you, Mr. Pallone.

This is not exactly a clarification, but in reference to the $400 million cut that NOAA received for the 2005 budget on the House side, in the 2003 appropriation—well, in 2003, when we appropriated for 2004, the NOAA budget was increased by 15 percent. And that was good. That was for this year. And we supported that. The 2005 budget, as a result of that increase, we were told by our good friends on the Appropriations that they were sustaining in a much more equitable fashion, given all of the other Government programs, of the $2 trillion that we spend, it was to get NOAA back to where they normally would be and still be able to fund the programs that they felt were necessary.

Now, while we all supported that 15 percent, we didn't necessarily support the $400 million cut. Even though it was a huge increase and if you got 6 percent or 7 percent increase that would have been good, and then that would have been matched by another 7 percent increase this year. So NOAA basically fared, given the last 2 years of appropriations, fairly well. A long way, though, from where we want to go. And we are competing with dollars for a man on Mars, a man on the moon, and all of those other things.

So I would like to say to the gentleman from New Jersey that long before we have an appropriations for the 2006 budget, where we generally go to the appropriators a week before it comes to the House floor, we probably should have a strategy, starting in January, to visit the Chairman and Ranking Member of that particular appropriations subcommittee to bring in some of the people who are testifying before us here today to talk about the need and the essential requirement for our understanding of how the ocean works, and this ocean observing system, how far along we can go with it with a few extra dollars. And maybe we can postpone the landing on Mars for a few years, set these priorities. NASA is a wonderful agency and we do know that a lot of the ocean observing systems are coordinated with NASA. But I think maybe you and I and some other Members can begin the process of talking to the appropriators starting in January.

I had a couple of questions for Dr. Leinen. You talked about the necessity of long-term ocean observations, whether it is a year, 10 years, even out to centuries. Now, I am going to play the devil's advocate here, even though I agree with you a thousand percent. I wish we could dump about $20 billion in the next appropriations process just for the system.

But we have to do deal in a different, very peculiar reality up here on Capitol Hill. Because people are here for a lot of different reasons other than ocean observing systems. So if I tell my good colleagues that an ocean observing system is absolutely essentially, they are going to ask me why. And if you could come up with— you know, it seems obvious for all of you here even in this room why an ocean observing system deals with the whole range of things that Dr. Spinrad discussed.

What would you tell a Member of Congress, that has no frame of reference to oceans, has never heard of an ocean observing system, doesn't have any idea that the climate is affected by the ocean because he was in a different business. So what would you say to him as to the importance of an ocean observing system?

Dr. LEINEN. Thank you, Mr. Chair. I think that my comment was that we understood that the processes take place over up to centuries. I think some wonderful examples of changes that we have documented as a result of looking at longer-term observations include our knowledge from sustained biological and chemical observations off Hawaii and Bermuda that show a basic change in the life-support system of the North Pacific Ocean from nitrogen limitation. For example, we fertilize our lawns with nitrogen. The North Pacific is changing from nitrogen limitation to phosphorus limitation. That—

Mr. GILCHREST. Let me ask you—biological, chemical makeup of the ocean is changing over time, I would guess. And when you say it is changing from nitrogen limitation to phosphorus limitation, what does that mean?

Dr. LEINEN. It means that over the last 20 years or so, as a result of looking at measurements of the biology, of the chemistry, including the phosphorus and nitrogen chemistry of the North Pacific, we have determined, the scientists have determined, that the basic life support, the plankton of the North Pacific, used to be limited by nitrogen. Now they appear to be limited by phosphorus instead.

Mr. GILCHREST. Why is that?

Dr. LEINEN. We don't know why that is yet. We know that—

Mr. GILCHREST. But that is going to affect the plankton in that area of the ocean?

Dr. LEINEN. It affects the plankton in that area of the ocean, it affects everything that lives on the plankton, which is essentially the entire trophic structure of the ocean. It also affects the chemistry of the ocean because the chemistry is so strongly influenced by the phytoplankton. There are also indications from the studies in the Atlantic that parts of the Atlantic may be moving from nitrogen limitation to phosphorus limitation.

Now, a wonderful question is why is this happening? Is this a regular alternation that has something to do with one of the decadal cycles that you mentioned in your remarks, or is this something else that is going on? In order to make those sorts of determinations, first we need to be able to link these observations and these findings to other parts of the ocean. We also need to be able to look at the ocean for a longer period of time, to see whether the North Pacific, for example, switches back to nitrogen limitation.

In addition, measurements of the salinity over the past several decades show that tropical ocean waters have become dramatically saltier over the past 40 years, while ocean waters closer to the poles have become fresher. One of the reasons that this is an important observation is that the formation of deep water in the North Atlantic and its relation to climate are very, very strongly influenced by the salinity, by how fresh the waters are in the North Atlantic. This is a change which appears to have taken place over about 40 years.

Mr. GILCHREST. Is that as a result of warming temperatures?

Dr. LEINEN. It is not necessarily directly a result of warming temperatures. There are certainly indications that the North Atlantic has warmed as well. But obviously, the salinity is related both to how much precipitation takes place—rainfall, and how much evaporation takes place. And so this balance—

Mr. GILCHREST. So that is related to warming temperatures?

Dr. LEINEN. It could be related to warming temperatures.

Those are excellent examples. In the latter, for example, a recent paper by Ruth Curry that talks about these processes really points out the data limitation that is there. Her records had many gaps in the records, although this 40-year trend was quite clear. And that points out the tremendous need that we have for these sustained observations and for observations over a greater part of the ocean. Those are just two examples.

A third would be an example of looking at the fisheries catch in the oceans over the last 50 years or so. Measurements in the Pacific show that shifts in the air and ocean temperatures affect the biological productivity and fisheries off Japan, California, Peru, and Chile. Obviously, those fisheries are affected by how many fish are removed from them as well. But it is only with those kinds of observations that we can tell whether the fisheries are responding primarily to the physical forcing of the ocean, the temperature and so forth, whether they are responding primarily to our removal of fish from the fishery, and how they are related on various parts of the ocean.

So those are three reasons that I would give a congressman who might ask that question.

Mr. GILCHREST. Thank you very much. We are going to use those.

Mr. Pallone?

Mr. PALLONE. Thank you, Mr. Chairman.

I wanted to ask Mr. Winokur a question. You were the assistant administrator at NOAA for the National Environmental Satellite Data Information Services. And during that time, you participated in the modernization of NOAA's weather forecasting and satellite observation platforms. I am not trying to over-simplify, but your work directly impacted the ability to monitor extreme and hazardous weather events, and that, of course, in the end, saved lives and money. So I just wanted to ask what parallels you can draw between the modernization of weather forecasting and the modernization of ocean observations systems in the certain. And are we not trying to achieve the same goals as those achieved for the atmosphere? And basically what I am trying to get out, you know, what is lacking about our current efforts to gain political and financial support to create an Integrated Ocean Observing System. You know, what do you suggest that we do, given that you were involved in this with the weather aspect?

Mr. WINOKUR. Thank you for the question. I see my past is catching up to me.

But it is a very good question, quite honestly, because there is a direct parallel between the modernization of the Weather Service and what we are trying to achieve with an Integrated Ocean Observing System. Many years ago, I think as Dr. Spinrad mentioned, the nations of the world got together and created something called the World Weather Watch. And that in fact was to build an international framework in which data would be collected and shared with respect to the atmosphere to improve our ability to forecast weather and hazardous events and everything that goes with that.

I think those of us—I won't speak for my colleagues here at this table, but we are sort of wannabes. We would like to be like the World Weather Watch. And an analogy I think that you could use for an Integrated Ocean Observing System is a World Ocean Watch, which would achieve very much the same thing—an integration of space-based operations with in situ data collection from all of the capabilities that my colleagues here have mentioned. I think if we were to do that, that would certainly give us the capability to forecast all of those types of events that Dr. Spinrad and Dr. Leinen had mentioned; but also, in the context of the Navy, for example, it gives us the ability to characterize the ocean environment on real-time basis anywhere in the world so that not only would the civil community be able to use it, but the military community as well.

I think it takes a concerted effort on the part of, certainly, all of those that are here—this panel and the panel you will hear from right after us—to convince the public, to convince yourselves, I think as Congressman Gilchrest said, your colleagues on the Hill of the importance of what needs to be done with understanding the contributions that ocean observations make to the ocean. So that ultimately we will not only have this Integrated Ocean Observing System, but—my words, I guess—a World Ocean Watch which would be very much parallel to the World Weather Watch. Everybody understands on a daily basis, because it is the lead-in every day on the news, what the weather is. It is the teaser every night: Stay tuned, and in 20 minutes we will tell you if it is going to rain. Well, we would like to do the same thing in the ocean—stay tuned, and in 20 minutes we will tell you if you can go to the beach and what the conditions are; if you are in my situation as I am right now, having moved from NOAA back to the Navy, what impacts the weather and knowledge of the ocean will have on military operations. So we need a good public relations firm, I guess.

Mr. PALLONE. OK. You know, along the same lines, I wanted to ask Dr. Weller or Dr. Boesch, many Americans, obviously, are unaware of the importance of the ocean. And both the Pew and U.S. Commission on Ocean Policy stress the need for a better-educated public with regard to the ocean. So sort of the same question: Do you see a link between public education on the oceans and success in implementing or sustaining a national ocean observation system? What strategies have either of you employed to raise awareness of ocean issues to the public and, you know, what would you suggest in that regard, if you would care to comment?

Dr. WELLER. Don?

Dr. BOESCH. Well, let me just say that one of the things that we realize as we develop observing systems is that the observing systems, or ocean observing systems are a marvelous educational tool, too, because it captures the fascination of young people, of things that are high-tech, things that are real-time. And so a number of programs all around the country are trying to bring these together with K-12 education. In the Mid-Atlantic region, for example, with your own institution, Rutgers, and the University of Maryland is partnering with several other institutions in the region on an NSF-sponsored education program called COSEE, which is to bring ocean science to the younger people, and the whole framework, the whole focus of our effort is the observing systems. We have LEO, Chesapeake Bay observing system. We are using this information to bring it to school groups, bring it to teachers. And it is marvelous how these kids really develop a better understanding of the ocean, get excited about it, and help to educate their own parents and other friends about it as well.

Mr. PALLONE. A good point.

Dr. WELLER. I agree with Don. NSF and NOAA both have a Teacher-At-Sea program, where we take middle school teachers to sea on cruises. And it is remarkable, the engagement of the classrooms. We have real-time communication.

But I think another thing we have to do better is be very clear and lucid when we develop products and understanding about the link between the ocean and things on the land. I mean, for example, drought in the central part of the United States or fire-fighting efforts. I mean, we are now, as we build observing capability and better models, gaining an ability to predict and link conditions in the dry and the wet periods. I think we should be right up-front about, you know, this is the way the buoy data from, say, the middle of the North Pacific gives you the information that tells you about the drought. One of the big sources of moisture for the central part of the U.S. is the Gulf of Mexico. This is the way that a buoy system in the Gulf of Mexico that measures the air-sea exchange of moisture, that is the way it contributes to understanding about drought conditions in the middle of the country. We need to do a bit better job at being clear about our science.

Mr. PALLONE. Thank you. Thanks a lot.

Dr. BOESCH. Could I just add one other thing, to add to Dr. Weller's comment about the connection, helping people understand the connection between the ocean and what happens on land. It works the other way, too, because I think, when we think about ocean observing systems, we have to think of it in a context of earth observing systems. And so much of what we do on land affects the coastal ocean, and the areas from the New York Bight, Chesapeake Bay, or Gulf of Mexico are great examples of that. But part of this has to be boosting and sustaining the observations we make on land, the river flow observations, USGS monitoring of the inputs to the system. So it goes both ways, both in terms of how the ocean affects us on land as we affect the ocean.

Mr. PALLONE. Thanks a lot.

Mr. GILCHREST. Thank you, Mr. Pallone.

Dr. Leinen, one more question. You mentioned in your testimony about the—and I am going to paraphrase. It is not an exact quote. I hope I didn't get it completely wrong. How do you discriminate—you said with an ocean observing system you would be better able to discriminate between manmade CO2 contributions, or greenhouse gas contributions, and those from natural variability, or the natural causes for CO2 in the atmosphere, or greenhouse gases. So how do you—can you, in fact, make a distinction between what comes from volcanos or other areas and what comes out of the tailpipe of SUVs?

Dr. LEINEN. What I said was that an ocean observing system would allow us to look at the question of climate change and which portions of that were naturally occurring climate change or had happened in the past versus those that might be related to anthropogenic change, not specifically CO2. There, I think, the biggest issue is that, as I mentioned before, the ocean is very data poor compared to measurements on land. And even those records that I talked about as wonderful examples of places in which we had seen substantial changes have been characterized by observations in one place, or in a very restricted area—and again, over a period of maybe a couple of decades or, at the most, 40 years.

You alluded to the fact that we see a lot of naturally occurring cycles like the North Atlantic Oscillation or the ENSO cycles. And in order for us to understand whether the changes that we see are related to those cycles or whether they are related to changes that are accompanying anthropogenic change, we have to be able to look at the ocean in enough detail and over a long-enough period to be able to discriminate a decadal oscillation or a decadal variability from something that is either an abrupt change or a change that is related to man's activity.

Dr. Weller showed several examples of what oceanographers are able to do tracing manmade substances that go into the ocean. There are examples both from chlorofluorocarbons, from bomb tritium, and so forth. And oceanographers have been able to link specific kinds of other changes in the ocean to the time scales of those changes. So that is another example where the observation, linked with things that we know are anthropogenic, can allow us to discriminate between natural cycles or natural changes and anthropogenic changes.

Mr. GILCHREST. So we can detect some of those differences now, but over a period of time, with a better integrated national and international ocean observing system, those mysteries will be a little more clear.

Dr. LEINEN. Not only will they be a little more clear, but the implications, or the impacts, of those changes will be clearer. And Dr. Weller gave a wonderful example, that he had related to the modeling that he talked about in his presentation, with the link between drought on land and changes in the ocean. There are many such linkages that oceanographers believe are important and believe are there, but we are unable to document them with the present observational capability in the ocean.

Mr. GILCHREST. Thank you.

Dr. Weller, the statement you made about the Dust Bowl in 1930s being related to sea surface temperatures, and then your other comment about warming in the Indian Ocean affects temperatures in the North Atlantic, those are observations that are known, that because of sea surface temperatures you can say categorically that there was a drought in the Midwest? There is a pretty clear link?

Dr. WELLER. Yes. In the first result, Sig Schubert and modelers at NASA Goddard, what they did is they took observed sea surface temperature fields over time, took a variety of state-of-the-art atmospheric models, used the observed sea surface temperature fields, and ran the models to do a hindcast of precipitation over the United States. And what they saw was that the models agreed, and agreed in the average over all the models quite well, with predicting a drought in that 1930 period.

And then they went in and looked for what was anomalous in that sea surface temperature forcing field and unique to that 1930s. And what stood out was that the picture I had showed of cold water off the coast of Japan and warm water in the North Atlantic.

Now, I think the North Atlantic result you could understand in the context of the North Atlantic oscillation where temperature anomalies in the Atlantic Ocean modify the balance of low- and high-pressure systems and the storm tracks and how things would enter into the middle of the United States, whether storms would come in and drop rain.

I think the surprising thing in their result is the link to the cold temperatures very close to the coast of Japan. That is an unexpected result. That is not something I can give you an answer for. And it goes—you know, one of the things I have to be up front about is we are building observations and we are trusting models, but a lot of the things built into the models, for example, how ocean and atmosphere exchange heat and moisture in a model, we just need more observations to get that right.

Mr. GILCHREST. OK. Let me ask you sort of an ancient question. The conveyor belt in the North Atlantic, that heat pump that dries the current, there has been—there is a lot of discussion around here about whether or not there is climate change, global warming. Some people in higher offices will say this science is a sham and it is the Europeans trying to subvert the U.S. economy. That is the beginning and the end of the conversation.

There will be people who are saying there is a discerning effect out there that can be observed that human activity is causing or adding to the global warming.

One of the topics that come up for conversation is that this heat pump, conveyor belt type thing in the North Atlantic shut down 10,000 or 11,000 years ago, and since it shut down, if, in fact, it did—and I am not that familiar with this kind of issue. But if, in fact, it did shut down 10,000 or 11,000 years ago and you had a mini or some type of Ice Age that lasted several hundred years, it is only normal that the potential for it to shut down is because of natural causes and not human causes. And, besides, nobody knows that caused the shutdown 10,000 or 11,000 years ago.

And so I have been sort of wondering, does somebody know why it was possibly shut down 10,000 or 11,000 years ago so I can tell this potential person that we do know why it shut down? You know, more complicated than that, but did it shut down 10,000 or 11,000 years ago, and do we know the reason it did?

Dr. WELLER. My understanding, talking to people like Ruth Currey and her husband, Bill Currey, who is a paleo-oceanographer, is that in the paleo record, I mean, the record in the sediments and things, we do have evidence of shutdown, slowing, and warming changes in that. And, indeed, you know, the early results of some of the Atlantic observations now besides—in addition to the changes in temperature and salinity, suggest that that thermohaline circulation is changing its rate.

I think the thing you have to get across to people in these discussions is that against the backdrop of the natural variability in the hydrologic cycle and the temperatures, is we are doing an experiment now where we are going into some place where we have not been before with the amount of greenhouse gases and things.

When I talk to people who study high latitudes, they say, you know, we are really surprised at the dramatic rate of loss of glacial ice and ice caps, and, you know, new results are showing that when it gets warm enough to have water flowing underneath the ice, between the ice and the land, that you can rapidly accelerate the loss of ice. I think the questions we should ask are: In this place where we have never been before, if you took most of the ice away and so you changed the reflectivity, I think there is a chance we will never get back to where we were historically. And I think those are the things we have to worry about and better understand.

Mr. GILCHREST. Thank you very much. I might have this person call the Curreys to have this conversation.

Dr. Boesch, you mentioned the need for—not only the need for an ocean observing system, but also for these regional associations to be able to manage this type of activity a little bit better. So I have two questions.

Are there regional associations—or how many regional observing systems are currently operational right now? And what type of data are they collecting and for what purpose? So where are those regional associations right now?

And the other thing is, as we move toward a more integrated system, would they be better able then to predict a storm like Isabel that we experienced last fall in the Mid-Atlantic States and in small communities on the upper Eastern Shore saw a tide rise 8 or 9 feet above normal?

And then last night, for example, in Havre de Grace, North East, parts of northern Kent County, they ranged from 4.5 inches in less than an hour to close to 8 inches of rain, a pretty dramatic event.

So those kinds of things, will they be—you know, that is a quick rush thunderstorm, and can you predict that kind of thing a day in advance? You know, we heard yesterday that there is a 60-percent chance of afternoon thundershowers, and all of a sudden, boom, we really had some thundershowers.

Also, let me also go into—as we collect this data, we want to improve water quality. We want to improve that whole ecosystem out there. And when we look at the issues affecting water quality around the country, the Chesapeake Bay in particular, because we see hypoxia areas, we see algal blooms. As soon as it gets warm, you see this massive green freckle system move into those little tidal basins. We are trying to improve the sewer plants as far as their nitrogen and phosphorous contributions, and we are improving those wastewater treatment plants. Maryland now has this flush fee, flush tax, or whatever.

But as we improve the percentage of release of these nutrients, while the percentage might stay the same, then we have this relatively huge increase in little communities from 100 people to 500 people, from 3,000 people to 12,000 people, up and down the

Delmarva Peninsula. So that is adding to the sewage treatment output of nutrients while not changing the percentage based on the volume. Then we have development and you have power boats. When you travel out of some of these little tidal basins to some of the larger estuaries that reach into the Chesapeake Bay, it is like 495 on the weekend, the number of boats that are out there, and the whole other range of reduced forest cover.

So we know that specific human activity is having an effect on that local ecosystem. With this more integrated ocean observing system, with these regional associations, can you get that kind of information to the people who determine land use, how it is going to be used? So do you foresee a better way to get this information in a timely fashion to planning and zoning, to county commissioners, local government, to make use of this information?

Dr. BOESCH. There were a lot of questions there. Let me start—

Mr. GILCHREST. I do not know if you have the ability to answer all that in about 30 seconds.

Dr. BOESCH. Just amending Bob on your other question about your fictitious friend who is a skeptic, I would recommend, highly recommend—

Mr. GILCHREST. He is not fictitious. This is a real human being.

Dr. BOESCH. I would highly recommend today's Kids' Page in the Washington Post, to read it. It is a very interesting graphic on glacial retreat, real world, in the United States, as well as a simple explanation of how greenhouse processes work.

Let me see if I can try to address some of the points you made, Mr. Gilchrest. With respect to are there regional systems in place now, I guess the short answer, the real answer is no. Most of the systems that are in place, the 40 or so that we talked about, are what we might call subregional. So, for example, our programs in the Chesapeake Bay or the programs that Mr. Pallone mentioned off of New Jersey, they are not covering the whole Mid-Atlantic region. So when we talk about regions, we are talking about large sections of the country, pretty much in the same line as what the Ocean Commission talks about, regional scale management, on the scale of, say, the Regional Fisheries Management Councils, those sorts of things.

So the effort now underway is to take the existing programs as well as emerging programs that may be at this point subregional and to integrate them within regions so that we have a system that might involve observing platforms off of New York Harbor, for example, and those in New Jersey, Delaware Bay, the Chesapeake Bay, the shelf off of the Delmarva area. And they will all be talking to one another and be integrated as a whole. And they will have to serve not only sort of the regional scale assessments and information users, but, of course, all of these users are—sort of like politics, they are local. And so one is concerned about not only how the Mid-Atlantic is doing or what is going on in the Mid-Atlantic, but what is going on in the Chesapeake and, furthermore, what is going on in Chester River as opposed to the whole Chesapeake Bay. So it has to be multi-scale in which we can bring information down to the relevant scales of the users.

You mentioned forecasting and our ability to forecast. You used as an example the heavy rainfall that we had in some parts of

Maryland and the flooding that took place. Well, interestingly, I remember yesterday morning listening to the radio, listening to a Baltimore station, where there was a prediction of flash floods. That was hours before they occurred, and the reason we had that predictive capability is that we had a good measurement system in that we used in the weather system and we had excellent models that can make those kinds of forecasts, with some level of uncertainty. That is why the estimate was 60 percent and so on. But if you were attentive, you should know that, you know, we are going to have heavy rains, likely have heavy rains, and there could be flash flooding. So that is the benefit of these models.

Mr. GILCHREST. Let me just interject one quick item, and I do remember hearing yesterday that there was potential flash flooding in several of the counties where there eventually was flash flooding. Is there some way that these ocean observing systems, as they get more sophisticated, can pinpoint why this particular storm is occurring? Can that be fine-tuned based on what happened in the 1930s with the sea temperature?

Dr. BOESCH. I think the models that are used in the weather forecasts are the why. They are deterministic models that are based upon a lot of scientific understanding of the processes.

With respect to the specific example you used of Hurricane Isabel and the surprise that many Bay communities got during this last year because of the higher-than-projected storm surge, here again is where these observing systems could play a very critical role because they could give you estimates and to correct the misunderstanding that we normally have of how do we project storm surge with a lead time of some hours in advance. So, yes, indeed, I think if we had a functioning integrated observing system for the Chesapeake Bay, we would have had better warning, better forecasts about tidal flooding due to Hurricane Isabel.

You mentioned the water quality issue, and, interestingly, maybe it will come out soon in the Post, I was just interviewed yesterday by a reporter who was questioning what some of us believe might be an overreliance on models to judge the state of the Chesapeake Bay. You know just reading the paper that while the Bay program estimates that nitrogen levels are down 20 percent. Well, how do we really know that because it is based upon some estimates, some models that they do? And the metaphor that I used—and, unfortunately, I might be quoted by it—is that we use—just like a weather situation. We use weather forecast models—and they are very sophisticated—all the time to make plans and judgments. But if we want to know what it is doing right now, I do not just look at the newspaper and say, well, it should be raining. I look out the window. And so that is why you need to couple these with the observing systems to help us understand the dynamics, whether it is navigating up the Houston Chip Channel or the Chesapeake Bay, in real time to correct the imperfection of our understanding that underpins the models.

Mr. GILCHREST. I see. Thank you very much, Dr. Boesch.

Dr. Spinrad?

Dr. SPINRAD. Mr. Chairman, if I can add something to Dr. Boesch's comments, and it gets right back to the example that you cited of Hurricane Isabel, and it also brings to mind some of the comments that the panelists have made with respect to education. In fact, as a direct result of some of the Chesapeake Bay observing system stations that Dr. Boesch alluded to, as well as NOAA's water level observations scattered throughout the Bay, we were able to provide the best, most accurate forecasts of storm surge for Hurricane Isabel that we have ever seen in terms of intensity, timing, and location.

What we found—and if you ask constituents, they will tell you this—is that there was a very low credibility for those forecasts. And, consequently, the actions taken by the public were not consistent with the quality of the forecasts. So part of this is, in fact, improving the modeling and the forecast capability, but an awful lot of it is enhancing the education and outreach to the community.

Mr. GILCHREST. A lot of those people know that now.

Dr. BOESCH. They do.

Mr. GILCHREST. They are going to move their cars.

The last question, and what we are going to do after this last question is take a 10-minute break before the next panel so people can stretch their legs. I guess anyone can answer this question. As far as limited budgets are concerned, we have got this big budget deficit, we have a lot of other interest area priorities. So given the realistic limitations upon which we operate up here, how would you suggest, as far as an ocean observing system is concerned and the difficulty of trying to fund that and make it really integrated, how would you suggest we proceed with the limited funding that is out there? And if you have any suggestions for how to prioritize moving forward with this, we would appreciate it.

Dr. SPINRAD. Mr. Chairman, if I may, I think one of the very first things that we need to do is adequate convey the cost avoidances and the cost savings associated with having a fully implemented integrated ocean observing system. We have got some anecdotal and some preliminary information, economic studies and analyses, which suggest that there would be extraordinary benefits and gains from such a system. But I do not think we have adequately made that compelling argument. So, in effect, what I am saying is we cannot afford not to develop an integrated ocean observing system, and we need to develop those studies in a more effective and compelling manner.

Mr. GILCHREST. Thank you very much.

Mr. Winokur?

Mr. WINOKUR. I would just add, in addition to doing that type of analysis, the cost/benefit studies which I think would probably show the benefits and the costs that are involved, one of the key activities, I believe, that we all alluded to is the leveraging, and so we have seen certainly over the last few years with the advent of the National Oceanographic Partnership Program a willingness on the part of all of the agencies to really band together and work together on this issue, since I think we all collectively see it as a national issue and not just an individual agency issue. So that as we move forward and again, as alluded to by the panelists, we meet regularly at least once a month. The agencies get together and invest a lot of time and energy in trying to put together a true national program and not just an individual agency program. So I think you see a significant amount of cooperation going on right now that probably heretofore did not exist 10 years ago.

Mr. GILCHREST. Thank you very much, Mr. Winokur.

Dr. Weller?

Dr. WELLER. Yes, I would like to just respond to your question, Mr. Gilchrest, and say that I think one of the things you have seen here are some common themes. We have identified some priorities. We know the things we need to measure. And we live in a world where the ocean observations will always probably be sparse. So we have a high reliance on models to get our products.

My personal view would be we need to move forward in a few key locations on the coasts and in the open ocean and sustain long time series, get into being multidisciplinary and new biological, biogeochemical, as well as physical observations, because there will be a synergy between these long time series observations and the research and understanding that will go right into the models, that will improve the value of the time series and improve our products.

Mr. GILCHREST. Thank you very much.

Dr. Boesch?

Dr. BOESCH. Congressman, I would like to suggest that—put the ball in your court and say that—

Mr. GILCHREST. The ball in our court.

Dr. BOESCH. And say that what could be done to help make the right decisions, making the right steps, the first steps and the right investments, is a framework that would empower the Federal agencies to do what is being discussed here and to commit Congress to working with the executive branch to meet those ends. And I think that mechanism is some version of an enabling legislation paralleling S. 1400. As you know, Mr. Weldon is developing such a bill, and he spent a lot of time trying to engage the—accommodate the interests of Members of Congress, make it consistent with the U.S. Ocean Commission recommendations, make it consistent with what the Ocean Leadership Council is doing through Ocean.US, and having that in place will give us a mechanism to make sure that we are making the right investments, the right steps in a logical way rather than a disorganized way without a real process to organize, make it truly integrated, put the “I” in IOOS.

Mr. GILCHREST. Thank you, Dr. Boesch, and I think the Ocean Commission report puts forth that kind of framework in a very workable fashion.

Dr. Leinen?

Dr. LEINEN. Yes, thank you, Mr. Gilchrest. I think that one of the things that you heard very clearly from the three agencies that were here was a similar message about our commitment to this, about our willingness to prioritize, and about the incredible importance of it to the mission of all of our agencies. And if you had the rest of the agencies who participate in the Joint Subcommittee on the Oceans or in the National Ocean Partnership Program, you would have heard the same thing.

And so the word that I want to leave you with is this is a topic over which the agencies have truly come together, both taking the priorities and the guidance of the scientific community as well as the interests of the Congress and your sense of wanting to get the priorities for that system. We really stand ready to do that because we all see the advantage to each of our missions in doing it. And I have rarely seen that kind of commitment to a common shared vision, but this sense of an ocean observatory capability has truly captured the imagination of the agencies.

Mr. GILCHREST. Well, thank you very much, and we will take advantage of that momentum.

I want to thank all the witnesses for coming this morning and giving us their testimony, and we would like to continue to work with you over the coming months.

We will now take a 10-minute break.

[Recess.]

Mr. GILCHREST. The hearing will come to order. I want to thank the witnesses for their patience and for still being here.

The hearing on Indian gaming is still going on, so Mr. Pallone will move back and forth, but we appreciate all of you coming here now this afternoon. We want to welcome Dr. Newell "Toby" Garfield, San Francisco State University; Ms. Molly McCammon, Executive Director, Alaska Ocean Observing System; Mr. Evan Richert, Muskie School University of Southern Maine, Gulf of Maine Ocean Observing System. My daughter is now attending College of the Atlantic in Bar Harbor. She is having a great time. Mr. Cortis Cooper—now that is an interesting word. Mr. Cortis Cooper, Metocean—Metocean?

Mr. COOPER. It is short for meteorology and oceanography.

Mr. GILCHREST. I see. A consultant and energy technology, ChevronTexaco. Mr. Fred Grassle, director of the Institute of Marine and Coastal Sciences, Rutgers, the State University of New Jersey, the Garden State; and Ms. Helen Brohl, President, National Association of Maritime Organizations. I want to welcome all of you here this afternoon and I look forward to your testimony.

Dr. Garfield, you may begin, sir.

**STATEMENT OF NEWELL "TOBY" GARFIELD, SAN FRANCISCO STATE UNIVERSITY, CENTER FOR INTEGRATIVE COASTAL OBSERVATION, RESEARCH AND EDUCATION (CICORE)**

Dr. GARFIELD. Chairman Gilchrest, Ranking Member Pallone, and members of the Subcommittee, thank you for the opportunity to present testimony on California State University's Center for Integrative Coastal Observation, Research and Education, or CICORE, and the development of ocean observing in California. My name is Newell Garfield. I am on the faculty of San Francisco State University and very involved with California ocean observing.

There are numerous ocean monitoring activities in California ranging from regional to very local. At first glance, they may appear to create duplication and overlap; however, California programs are remarkably complementary and are moving toward national observing system goals through collaboration, user outreach, through better communication, data sharing, and data distribution. This is in part because, like other regions, many California organizations have embraced the Ocean.US vision.

In California, we have two emerging regional associations, CeNCOOS and SCCOOS, which along with NANOOS in Oregon and Washington, will represent the Nation's west coast. These regional associations are in the initial formation stages, determining governance structures and seeking certification. They plan to become fully functioning within about 2 years.

My program CICORE is a NOAA Coastal Services Center Coastal Ocean Technology program. It was established in 2002 to focus on the region from the 100-meter depth up to the coast, including California's bays, estuaries, and wetlands. This shallow water area is where most impacts occur, yet is seldom systematically sampled because of the complexity of the ocean circulation there. CICORE draws upon the strengths of the 23 campuses of the California State University system and dots the entire coastline between Humboldt State in the north and San Diego State in the south. Our external partners include local, State, and Federal entities. We also leverage the expertise of scientists at Florida Environmental Research Institute and Virginia's Old Dominion University. California State University produces a large fraction of staffers who work in local, State, and Federal environmental agencies. Many professionals needed to implement coastal observing systems will be trained by the CSU, and the opportunities offered to students by the CICORE program are important for their preparation.

CICORE distinguishes itself by utilizing three key technologies:

First is high-resolution spectral imaging or hyperspectral imaging for mapping and classifying of shallow water and wetlands area. Just one application of this data is mapping not only the distribution of California kelp beds, but also assessing the age and health of the kelp fronds which will help guide management decisions like harvesting permits.

The second technology is high-resolution acoustic seafloor mapping and characterization of critical shallow water habitats. As an example, these analyses can aid the cruise ship industry in defining anchorage areas which will not disturb sensitive benthic habitats.

The third technology, in situ sensors for time series measurements of water quality and current measurements are being installed at discrete locations throughout California. The previous panel amply stated the need for this technology. In addressing education, we are actually partnering with the various aquaria to display that data real-time and have outreach programs.

CICORE is following the initial Ocean.US data management communication recommendations on data discovery, access, and archiving. CICORE data are posted to Web-accessible sites as quickly as possible to ensure that the data are openly available to the public.

To address external requirements, CICORE has established an advisory board whose members include representatives from industry, the regulatory community, scientists, EPA, NOAA, and other observing programs. And CICORE actively seeks community partnerships in identifying program stakeholders and products.

The State of California is also investing heavily in coastal monitoring, and its efforts are being coordinated with the emerging regional associations.

In 2002, California voters authorized $21 million to monitor coastal circulation. Anticipating Ocean.US recommendations, the principal observing tool will be a statewide array of surface current mapping radars, or SCM radars. Dr. Grassle will probably refer to them also.

The system will help with predicting beach closures caused by bacterial contamination, search and rescue operations, tracking oil and other pollutant spill trajectories, and the fate of early larval stages of commercially important fisheries species.

In summary, deployment of an integrated and sustained ocean observing system will address well-established national priorities. Federal legislation is needed to resolve issues of governance, roles, and responsibilities and to allocate sustained funding. The research community appreciates that this committee is taking a serious look at the best ways to approach this work.

As Congress considers the recommendations of the U.S. Commission on Ocean Policy and efforts to establish a coherent national coastal ocean monitoring program, it is imperative to realize that the stability of the long-term operations is a goal that is as important as the development of its infrastructure. With that in mind, I encourage you to promote a broad interagency approach, led by Ocean.US, to support the emerging regional associations. They will need the ability to respond to local and regional needs and to be able to receive funding from multiple sources, whether they be Federal, State, or other.

This concludes my testimony, and I look forward to answering any questions you might have.

[The prepared statement of Dr. Garfield follows:]

**Statement of Dr. Newell (Toby) Garfield, Professor, San Francisco State University and CICORE Coordinator**

Chairman Gilchrest, Ranking Member Pallone, and members of the Subcommittee, thank you for the opportunity to appear before you today to present testimony on the California State University's Center for Integrative Coastal Observation, Research and Education (CICORE), and the development and implementation of ocean observing in California. My statement is organized to respond to the nine specific questions asked of me by Chairman Gilchrest in his letter of invitation to testify.

**1. Testimony on the development and implementation of California's ocean observing system:**

*Current Observing Systems in California*

The State of California has long recognized the importance of ocean observing and monitoring and has embraced monitoring systems at a number of levels. One of the original monitoring programs began in 1949 to study the ecological aspects of the collapse of the sardine population and fishery with the formation of the California Cooperative Oceanic Fisheries Investigations[1] (CalCOFI), a collaboration of NOAA National Marine Fisheries, California Department of Fish and Game and Scripps Institution of Oceanography. An expansion of this program, to cover the whole U.S. west coast and to focus on the management of its living resources, is being proposed as the Pacific Coastal Ocean Observing System (PACOOOS).

Over the last few years, the need to establish systems for the long-term monitoring of the nation's coastal regions has been recognized and promoted by policymakers in California and Washington, D.C. A number of initiatives have enabled both the transformation of existing programs and the establishment of new monitoring programs directed at coastal monitoring. In part because funding sources have varied greatly, at first glance they may appear to create duplication and overlap. However, ongoing California programs are remarkably complementary and synergistic. These programs are serving to bridge the gap between research and operations and, in fact, are moving explicitly toward observing system goals through

[1] http://www.calcofi.org/

user outreach and through better communication, data sharing and data distribution between academia, state and federal agencies, NGOs and the general public.

Presented here are some of these programs, their goals and funding sources:

CICORE [2] (Center for Integrative Coastal Observation, Research and Education) is a nearshore (<100 m water depth, up to and onto the coast) observatory conceived by the presidents of the California State University (CSU) [3] and endorsed by the system's Chancellor and Board of Trustees. The program has received Congressionally-directed funding and is administered through the NOAA Coastal Services Center (CSC) Coastal Ocean Technology Section (COTS). The principal goals of the program are to coordinate coastal observations at the 23 CSU campuses throughout California to provide a distributed monitoring program along the California coastline. This network allows characterization and observation of statewide and local coastal ocean variability, with a focus of making information accessible for applied needs and education. Ultimately, CICORE will become a key backbone element of both the CeNCOOS and SCCOOS Regional Associations, described below.

CIMT [4] (Center for Integrated Marine Technology) was initially known as the Winds to Whales Project. Based at UC Santa Cruz, in 2002 the program reorganized to pursue an integrated approach to looking at the ecosystem transformation of energy, starting with the initial forcing functions of the sun, wind and currents and following the energy up through the trophic levels of plants and animals to the top predators. The program uses northern Monterey Bay as its study region. The goals of the program also include sustained observations and technology development, and the program receives Congressionally directed funding administered through NOAA COTS. For these reasons, CIMT is also described as a monitoring program.

ACT [5] (Alliance for Coastal Technology) is a national program led by the University of Maryland. The program aims to be a clearinghouse for ocean instrumentation. This program is also a Congressionally directed funding program administered by NOAA COTS. Two California institutions, Moss Landing Marine Laboratories (MLML), and Monterey Bay Aquarium Research Institute (MBARI), are members.

There are other distributed observing efforts that exist in California. NEOCO [6] (Network for Environmental Observations of the Coastal Ocean) is funded by the University of California Marine Council to locate water quality monitoring devices at UC coastal campuses. PISCO [7] (Partnership for Interdisciplinary Studies of the Coastal Ocean) is a multi-institutional program, funded by the Packard Foundation, which addresses environmental issues at a number of specific sites along the west coast.

There are many other agencies and organizations that have monitoring operations in California, many of which are very local. NOAA and the California Regional Water Quality Boards are two examples of agencies that have specific observational mandates.

A goal in the creation of the federally recognized Regional Associations, described in detail in the next few paragraphs, is to identify all relevant needs and mandates, as well as existing efforts, so that coordinated systems can be developed to meet the regulatory and agency requirements for monitoring coastal California water quality. Taken together, the entities described above are making steady progress toward building the backbone of coordinated, integrated, regional systems, consistent with the policy goals recommended in the Pew Ocean Commission's report [8] the National Research Council's [9] Ocean Report and the Preliminary Report of the U.S. Commission on Ocean Policy [10].

*California's Emerging Regional Associations*

A recommendation from Ocean.US [11], the federal interagency entity that is charged with coordinating the development of an operational and integrated and sustained ocean observing system (IOOS), is that certified Regional Associations be formed that will work at the national level to promote the establishment of a national Coastal Observing System and work at the local level to coordinate observ-

[2] http://cicore.mlml.calstate.edu
[3] http://www.calstate.edu/
[4] http://cimt.ucsc.edu/
[5] http://www.actonline.ws/
[6] http://www.es.ucsc.edu/?neoco/
[7] http://www.piscoweb.org/
[8] http://www.pewoceans.org/
[9] http://www.nationalacademies.org/nrc/
[10] http://oceancommission.gov/
[11] http://ocean.us/index.jsp

ing efforts. In California, CeNCOOS[12] (Central and Northern California Ocean Observing System) and SCCOOS[13] (Southern California Coastal Ocean Observing System) are the two emerging Regional Associations. The overlap between the systems will be at Point Conception, a natural geographic boundary. They will work with NANOOS (Northwest Association of Networked Ocean Observing Systems) to represent the west coast of the continental United States. These Regional Associations are in the initial formation stages, determining their governance structures and seeking certification. It will probably take about two years until they become functioning Regional Associations able to conduct Ocean.US mandates.

CeNCOOS presently has initial members from over 40 different agencies and institutions and has identified about 70 existing monitoring or observing systems in central and northern California. The association has hired a coordinator and is focusing on determining its governance structure with the goal of becoming accredited by June 2005. SCCOOS, which is headquartered at UCSD's Scripps Institute of Oceanography, has also received Congressionally directed funding administered through NOAA COTS. Both SCCOOS and CeNCOOS have also received competitive grant money from NOAA to begin the work of forming Regional Associations. These two Regional Associations are part of the eleven member National Federation of Regional Associations[14], a group working with Ocean.US to ensure Regional Association accreditation.

*Supplementary Efforts Sponsored by the State of California*

The State of California continues to be a national leader in investing in coastal research, and its efforts are being coordinated thoughtfully with the federal Regional Association concept in mind. In 2000, California enacted the California Ocean Resources Stewardship Act, which led to the creation of the California Ocean Science Trust[15] (CalOST). This state-funded, non-profit organization has a mandate to fund marine and coastal research in California and to encourage coordinated, multi-agency, multi-institution approaches to ocean resource science. CalOST has appointed an executive secretary and is determining its role for promoting ocean observing and management in California.

In 2002, through voter-approved Propositions 40 and 50, the voters of California authorized the creation of a program to monitor coastal circulation. The California State Coastal Conservancy and the California State Water Resources Control Board will fund and administer the Coastal Ocean Currents Monitoring Program[16] (COCMP). Initial funding of $21 million dollars is for the development of backbone elements of coastal monitoring infrastructure. Two proposals, one from SCCOOS and the other from northern California, have been funded to create a statewide integrated system. The northern proposal will become a CeNCOOS component. The principal observing tool will be an array of surface current mapping[17] (SCM) radars, which will allow monitoring of ocean surface currents throughout the state. (SCM radars are also commonly referred to as "high frequency" or HF radar and by the name of the major manufacturer, CODAR.) Other infrastructure will include a shoreline surf and current monitoring array and three-dimensional modeling of coastal circulation. This program, with its emphasis on SCM radar technology, closely follows the recommendations of the Ocean.US surface current mapping initiative. SCM instruments are shore-based, seaward looking radars. Advantages of this technology include wide area coverage and lower maintenance costs compared with equipment placed in the ocean. SCM data will help with predicting beach closures caused by bacterial contamination, tracking oil and other pollutant spill trajectories, and the fate of the early stages of commercially important fisheries species.

**2. What is the status of the Center for Integrative Coastal Observation, Research and Education (CICORE) System?**

The CICORE program was established in 2002 as a coastal observing research and academic program distributed among CSU campuses located along the California Coast. CICORE leverages the intellectual and infrastructure resources of the CSU system and seeks to address the coastal monitoring priorities of stakeholders along the entire California coast. Among others, CICORE partners include the California Department of Fish and Game, the State Regional Water Quality Board, local harbor districts, the three National Marine Sanctuaries, and two of the three National Estuarine Research Reserves. Now in its second year, and funded for

[12] http://www.cencoos.org/
[13] http://www.sccoos.org/
[14] http://usnfra.org/index.jsp
[15] http://resources.ca.gov/ocean/CORSA/CORSA—index.html
[16] http://www.cocmp.org/index.html
[17] http://oceancurrents.us

a third year, CICORE is one of the 16 NOAA Coastal Observing Systems[18] (COTS) programs either funded by Congressional directive (nine) or through COTS competitive announcements (seven).

CICORE draws upon the strengths and expertise of California State University (CSU) campuses dotting the entire California coastline, including CSU Hayward, Humboldt State University, CSU Long Beach, CSU Monterey Bay, Moss Landing Marine Laboratories, San Diego State University, San Francisco State University, San Jose State University, and California Polytechnic State University, San Luis Obispo. In addition, CICORE leverages the expertise of scientists at the Florida Environmental Research Institute and Old Dominion University. Together these groups work together to perform in situ observations and collaborate on periodic field efforts in areas of stakeholder interest. The program anticipates adding other CSU campuses each year in an orderly manner to ensure maximal benefits to the identified educational and resource priorities in the coastal region.

The California State University and CICORE are indispensable to the region's ability to meet national and state goals related to coastal observation. The CSU is the nation's largest university system, with 23 campuses and seven off-campus centers, 409,000 students, and 44,000 faculty and staff. Stretching from Humboldt in the north to San Diego in the south, the CSU offers a wealth of relevant applied research expertise and is uniquely positioned geographically to undertake the observing mission. Moreover, the CSU is renowned for the quality of its teaching and for its job-ready graduates. For example, the CSU produces about 60% of California's teachers and a large fraction of the staffers in local, state and federal environmental agencies. Many of the professionals needed to implement coastal observing systems will be trained by the CSU, and the CICORE program is important for the preparation of all these individuals.

**3. What types of data are being collected and what technologies are used?**

The CICORE program set as its observational region an important area missed by many of the existing monitoring programs, the region extending from the 100 meter isobath (water depth) into and onto the coast, including California's bays, estuaries and wetlands. This critical zone, between "deep water" and the shore, is where most impacts occur yet is seldom systematically sampled and monitored. CICORE has distinguished itself in establishing a program based on three technologies, which provide critical information in the coastal region. These are:

- high resolution spectral imaging for mapping and classification of shallow water and wetlands areas,
- high resolution acoustic seafloor mapping and characterization of critical shallow water habitat areas, and
- in situ sensors for time series measurements of water quality and current measurements at discrete locations throughout California.

In addition, each CICORE partner may obtain local data directly pertinent to their regional needs. Data from these technologies are combined with other observational systems to develop and produce products to directly address concerns of policy makers, regulators, scientists and the public.

High Resolution Spectral Imaging: High resolution or hyperspectral imaging (HSI) is emerging as a key assessment tool for coastal water and shoreline characterization and monitoring. Florida Environmental Research Institute (FERI) is the civilian agency working with the Naval Research Laboratories' Portable Hyperspectral Imager for Low Light Spectroscopy (PHILLS) sensor, and is responsible for developing domestic applications. In collaboration with FERI, CICORE is developing this technology and using it for a number of assessment and monitoring purposes. Acoustic ship surveys cannot be conducted in very shallow water; it is too dangerous for safe ship operations. HSI technologies allow for high resolution mapping (on the scale of meters) over thousands of square kilometers per year. CICORE is actively collecting co-located seafloor mapping and hyperspectral imagery in order to develop and validate the retrieval of bathymetry and habitat classification in this difficult to assess environment. Once these algorithms are verified, the hyperspectral imagery will provide an effective way to quickly map the shallow water environment. The other uses of hyperspectral data being developed relate to terrestrial land-use and runoff interactions, vegetation mapping, and water column processes. These include (but are not limited to) fresh water fluxes and resulting ecological shifts, assessment of benthic vegetation and kelp canopy growth and coverage, and identifying and tracking of Harmful Algal Blooms (HABs). With the planned inclusion of laser ranging LIDAR, these data will be extended to issues of coastal erosion and shoreline instability. CICORE is presently working with the San Francisco Bay

[18] http://www.csc.noaa.gov/cots/projects.html

National Estuarine Research Reserve[19] to investigate invasive plant species (Spartina and Pepperweed), documenting both the spread of the invading plants and the ecological changes occurring as a consequence. Another application of HSI data is the ability to not only map the distribution of kelp beds, but also to assess the age and health of the kelp fronds. This information will help guide harvesting permits.

High Resolution Acoustic Seafloor Mapping: The second observing technology is the use of multibeam and sidescan acoustic imaging to characterize nearshore habitats. The seafloor mapping component is characterizing and quantifying the diverse benthic habitats found in the nearshore region. It will be many years before the entire coastal region will be mapped with the resolution possible with the multibeam acoustic surveys employed by CICORE. The program is identifying sensitive sites undergoing benthic modification. These data have been used to identify critical fishery habitats and, in a subtractive mode, identify areas of deposition and erosion. These are the first high-resolution images being produced in a number of critical areas. One application of these data are to assist the cruise ship industry in locating anchorage areas that will not disturb sensitive benthic habitats.

In Situ Monitoring: The third technology is in situ monitoring. Robust methodology for high temporal resolution monitoring of the basic water quality parameters temperature, salinity, density, sediment load, and water clarity provide the basis of a distributed network of instruments that provides web-accessible data in near real time. These in situ measurements are critical for both assessment of regulatory decisions and investigating long term trends related to climate variability. Other measured parameters at selected sites also include currents, fluorescence, oxygen and nutrients. In this shallow coastal environment, fluctuation of fresh water flow is one of the major modifying parameters. The deployed instrument array tries to focus on these critical regions to obtain the data that will assist scientists, planners and resource managers needing water quality information.

These combined measurements constitute an observing system that characterizes the near shore coastal zone and allows monitoring in real time of the water quality fluctuations. Real time water quality monitoring and habitat characterization are two data sets frequently requested by regulatory agencies to ensure balanced management plans for coastal resources.

**4. How are issues of data processing, distribution and archival handled?**

Data processing and archival systems pose a formidable challenge for coastal observatories, yet one that is critical to the success of any observing system. CICORE participates in regional workshops on data standards and is following the Ocean.US Data Management and Communications (DMAC) recommendations on data discovery, access and archiving. CICORE data are posted to web accessible sites as quickly as possible to ensure the data are openly available to the public. The in situ data are posted in near real time, while the acoustic mapping and hyperspectral imagery require more intensive post collection processing before the data can be made available. The numerous data sets can be accessed at the main CICORE site or through the individual partner sites listed in the table below. The hyperspectral imagery generates terabytes of data. Users can view these data through IMS servers at FERI and California Polytechnic State University, San Luis Obispo. Data extraction requests are handled by FERI. Similarly, the high resolution acoustic bathymetry can be viewed and retrieved from the California State University, Monterey Bay Seafloor Mapping site.

CICORE web pages at the member institutions:

Moss Landing Marine Laboratories—http://cicore.mlml.calstate
California Polytechnic State University, San Luis Obispo—
http://www.marine.calpoly.edu/cicore/default.shtml
California State University, Hayward—http://www.sci.csuhayward.edu/cicore/
California State University, Monterey Bay—
http://seafloor.csumb.edu/CICOREweb.html and
http://seafloor.csumb.edu/arcims.htm
Humboldt State University—http://cicore.humboldt.edu/
San Francisco State University—http://sfbeams.sfsu.edu
Florida Environmental Research Institute—http://www.flenvironmental.org/ and http://www.flenvironmental.org/HyDroDB/login.asp

[19] http://www.sfbaynerr.org

**5. Does CICORE represent all of the ocean observing systems in California?**

No, as detailed in response to question one, above, CICORE is one of many complementary programs in California engaged in ocean observing. These programs are working together to establish Regional Associations which are part of the coastal component of the U.S. Integrated Ocean Observing System.

**6. If not, are other systems and CICORE coordinating to avoid duplication and collect uniform data to support a regional system?**

Absolutely. The challenge of coastal ocean observing in California is larger than any one institution and the only way it can be effectively addressed is through collaboration. As detailed earlier, CICORE is one of several existing, and complementary, ocean observing programs. In northern California, other existing programs include CIMT, ACT, NEOCO, and PISCO. Many local, State, particularly California Fish and Game, and Federal (NOAA and USGS) agencies also maintain observing or monitoring programs that span portions of California's 3425 miles of coast line. In general, the existing programs complement one another well in a number of ways, including the area covered, the variables measured, and the technologies employed.

In recognition of the emerging national priority to monitor the coastal ocean, organizations on the west coast have begun to organize three regional associations that will allow the pursuit of the goals articulated by Ocean.US, the National Research Council Ocean Report, the Pew Oceans Trust Report, and the U.S. Commission on Ocean Policy. These associations are: Southern California Coastal Ocean Observing System (SCCOOS), the Central and Northern California Ocean Observing System (CeNCOOS), and Northwest Affiliated Network of Ocean Observing Systems (NANOOS) in Oregon and Washington. They will form three geographically overlapping and coordinated Regional Associations for an integrated approach to implementing local, state and federal ocean monitoring needs. CeNCOOS and SCCOOS have already signed a memorandum of understanding to ensure coordination of regional associations in California. CICORE partners are involved in all three emerging Regional Associations.

Meanwhile, the state-sponsored COCMP program will build backbone elements of a regional observing system. CICORE partners Humboldt State University, San Francisco State University, Moss Landing Marine Laboratories and California Polytechnic State University, San Luis Obispo are lead organizations in the State COCMP observing system that will directly support the national Integrated Ocean Observing System.

**7. How will the CICORE system support a national ocean observing system?**

The CICORE program was developed specifically with the nation's ocean observatory priorities in mind. Throughout the development and expansion of the CICORE program, partner institutions have paid close attention to the observational goals of Ocean.US, Congress and COTS. These have formed the basis of the CICORE observatory backbone and the technological approaches that are adapted through the program. As described earlier, once the Regional Associations are accredited and receive sustained federal funding, CICORE will conduct its monitoring as part of the federally recognized Integrated Ocean Observing Systems (IOOS). In addition, the core technologies being developed by CICORE (specifically high resolution digital mapping) will be made available to all other Regional Associations.

**8. Does the CICORE system incorporate requests or requirements of user groups to produce usable products?**

Yes. First, CICORE established an Advisory Council whose members include individuals from industry, the regulatory community, scientists, EPA, NOAA and other COTS programs. Secondly, CICORE has actively sought community partnerships in identifying program stakeholders and products. During the last data collection effort, CICORE partnered with the San Francisco National Estuarine Research Reserve and the Point Reyes National Seashore Recreation Area in planning the overflight and imagery coverage. In addition, CICORE carried a CIMT sensor on the airplane to provide intercomparison of instruments. CICORE is also working with the State Water Quality Board in expanding the in situ array. These are just a few examples of outreach efforts.

**9. Please include any other information you think is pertinent to the overall discussion of ocean observing systems.**

The technology, expertise, and organizational capabilities now exist to produce real-time, continuous observations of and predictions about the ocean in much the same way as we can produce observations and predictions about the atmosphere and weather. Deployment and operation of an Integrated and Sustained Ocean Observing System will (1) improve the safety and efficiency of marine operations; (2) mitigate the effects of natural hazards more effectively; (3) improve predictions of climate change and its socio-economic consequences; (4) improve national security; (5) reduce public health risks; (6) help protect and restore healthy ecosystems; and (7) sustain and restore living marine resources. An initial economic analysis by independent economists under contract to NOAA estimated $5 to $6 of return for industry, government, and the public for every $1 invested in ocean observing and predictions. Immediate returns are expected in maritime safety and efficiencies for shipping, fishing, energy, tourist, and other industries; search-and-rescue; national security; and monitoring and clean-up of discharges and spills to ocean waters.

Because responsibility for ocean observing and monitoring is currently distributed among a number of federal agencies, federal legislation is needed to resolve issues of governance, roles and responsibilities, and allocate sustained funding. We in the research community appreciate the fact that this committee, and others in Congress, are taking a serious look at determining the best ways to approach this important work.

As Congress considers the recommendations of the U.S. Commission on Ocean Policy and efforts to establish a coherent coastal ocean monitoring program, it is imperative to realize that the stability of the long-term operations is a goal, as important as the development of the infrastructure. With that in mind, I encourage you to promote a broad interagency approach, lead by Ocean.US, to support the emerging Ocean Observing Regional Associations (RAs). The RAs will become the regional mechanisms for monitoring the ocean and they need to have the ability to respond to local and regional needs and to be able to receive funding from multiple sources, federal, state and other.

This concludes my testimony. I hope that you will view me and my colleagues engaged in ocean observing in California as a resource to this committee as you continue your important work in coastal ocean observing.

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Mr. GILCHREST. Thank you very much, Dr. Garfield.

Ms. McCammon?

## STATEMENT OF MOLLY McCAMMON, EXECUTIVE DIRECTOR, ALASKA OCEAN OBSERVING SYSTEM

Ms. MCCAMMON. Thank you, Mr. Chairman. I will be presenting a shorter version of my written testimony today.

I represent a group of Federal agencies, universities, research institutions, and nonprofit organizations who have committed to organizing the Alaska Ocean Observing System as part of the national Integrated Ocean Observing System.

Alaska is the largest ocean State in the country, with more than 47,000 miles of coastline, about two-thirds of the total U.S. coastline. Alaska's oceans are among the most productive ecosystems in the world with healthy fish and shellfish populations producing over 50 percent of the Nation's seafood, more than 80 percent of the Nation's seabird population, and 36 recognized populations of marine mammals. Alaska's oceans and coastal watersheds produce 25 percent of the Nation's oil as well as minerals from several world-class mines. In short, Alaska is a tremendous national asset.

Currently, the Alaska Ocean Observing System—or AOOS, as we cal it—is in its early stages of planning and development. Our partners feel so strongly about the importance of the AOOS mission and goal that they have committed their own funds to help kick-start the effort in Alaska toward its development phase.

The vision for AOOS is to provide ocean data and information products to users of Alaska's marine environment, whether they are fisheries managers, offshore oil developers and transporters, or Alaska Native subsistence users.

We do not have an integrated ocean observing capability today. No process or forum currently exists for users to meet together with the providers of ocean observations to identify gaps and needs and jointly develop priorities. AOOS can provide that forum.

It is important to note that AOOS is not intended to supplant existing marine research entities and local observing capabilities in Alaska; rather, AOOS will serve as the overall facilitator and coordinator for the statewide system, providing funding and establishing standards to ensure that statewide and regional needs are met consistent with the national program.

We are now working with the three large marine ecosystems encompassed by Alaska: the Arctic Ocean, Beaufort and Chukchi Seas, the Bering Sea and Aleutian Islands, and the Gulf of Alaska. And within these three larger regions are smaller subregions, such as Prince William Sound and Cook Inlet, that will require more intensive observing systems.

In Prince William Sound, we are working to develop an integrated observing system that will provide important information to oil tankers transiting the sound to and from Valdez, the terminus of the Alaska Pipeline, to commercial fishermen who want to understand and better forecast salmon production, and to recreational boaters who want to know weather conditions for weekend trips.

In Cook Inlet, an integrated observing system will help captains pilot barges up the inlet more safely and more cost-effectively with better information about currents and tides. It will help oil spill responders better understand where oil might go in the event of a spill and help city and borough planners predict what will happen to bluff erosion along the shores of Cook Inlet.

In the Bering Sea, one of the richest fisheries in the world, an integrated system will help develop more accurate maps of the wintertime southern ice edge, a valuable tool for subsistence users who rely on marine mammals such as walrus and seals for food and for commercial fishermen who fish year round in the Bering Sea. The system will provide greater understanding of the ocean warming and its impacts on commercial fisheries and develop better predictive models of climate change impacts so that coastal communities can be better prepared to respond to rising sea levels and coastal erosion caused by more frequent extreme storm vents.

These are all benefits that will have substantial economic benefits not only to Alaskans, but to the Nation was a whole. One of the important aspects of AOOS, as well as other regional associations, is the requirement that a cost/benefit analysis be conducted when planning and developing the various components, and especially the information products, of the regional observing systems.

Although AOOS is still in the planning and early development stages, pieces of a system are already under development. The Prince William Sound Science Center and the Oil Spill Recovery Institute have been working for more than 5 years on a Nowcast-Forecast program to provide real-time information and predictions on ocean conditions in Prince William Sound.

The Exxon Valdez Oil Spill Trustee council's GEM program, whose aim is to monitor well into the future the area impacted by the 1989 oil spill, is funding the placement of ocean observing instruments on State ferries and tankers as "ships of opportunity."

In Cook Inlet, the Kachemak Bay Research Reserve, the city and borough of Anchorage, as well as other programs are collecting information in Cook Inlet.

But these are not adequate for the current needs. In the entire Gulf of Alaska, which includes Southeast Alaska, Prince William Sound, and Cook Inlet, we have only 11 NOAA buoys and 9 C-MAN stations. The Gulf of Alaska coastline is more than twice that of the Northern California, Oregon, and Washington coast, yet has about half the number of buoys and C-MAN stations.

The Bering Sea and Arctic has only one NDBC buoy, although several research buoys have been used intermittently.

Implementation of an Alaska Ocean Observing System represents an enormous challenge due to the vastness of the region. But in spite of these challenges, the opportunities and needs, as well as the economic benefits, warrant national attention.

Again, I want to thank you for the opportunity to testify and would be happy to answer any questions.

[The prepared statement of Ms. McCammon follows:]

**Statement of Molly McCammon, Director,
Alaska Ocean Observing System**

Mr. Chairman and Members of the Committee. I am honored to be here today to testify before you on the development and implementation of the Alaska Ocean Observing System.

My name is Molly McCammon and I represent a group of federal agencies, universities, research institutions, and non-profit organizations who have committed to organizing an Alaska Ocean Observing System as part of the national Integrated Ocean Observing System.

We are the largest ocean state in the country, with more than 47,000 miles of coastline, about two-thirds of the total U.S. coastline. Alaska occupies 20% of the nation's land base, 40% of the nation's surface water, and contains half the nation's wetlands. Alaska's oceans are among the most productive ecosystems in the world, with healthy fish and shellfish populations producing over 50% of the nation's seafood, more than 80% of the nation's seabird population, and 36 recognized populations of marine mammals. Bristol Bay alone supports the world's largest sockeye salmon fishery, and Alaska's snow crab fishery is the largest in the U.S. Alaska's oceans and coastal watersheds produce 25% of the nation's oil as well as minerals from several world-class mines. Compared to other oceans and watersheds elsewhere in the United States, Alaska's resources are healthy, productive and pollution-free. In short, Alaska is a tremendous national asset.

Currently, the Alaska Ocean Observing System—or AOOS as we call it—is in its early stages of planning and development. The consortium of government agencies, research institutes and non-profit organizations developing AOOS feel so strongly about the importance of the AOOS mission and goals that they have committed their own funds to help kick-start the effort in Alaska towards its development phase. These have been supplemented by two small planning grants from NOAA. These organizations—and for this purpose I'll call them the AOOS partners—have signed onto a Memorandum of Agreement that commits them to work collaboratively to develop an Alaska node for integrating coastal and ocean observing activities in anticipation of authorization of the national effort.

Thus far, our partners include federal agencies such as NOAA, including the National Weather Service, NOAA Fisheries, and the Office of Oceanic and Atmospheric Research; the Department of Interior agencies of USGS and Minerals Management Service; academic institutions including the University of Alaska; research organizations such as the North Pacific Research Board, the Alaska SeaLife Center, the Prince William Sound Science Center and Oil Spill Recovery Institute, the Barrow Arctic Science Consortium, and the Alaska Sea Grant Program. We are working closely with other potential partners including the U.S. Coast Guard, the State of Alaska, and industry groups who will likely be joining as partners as AOOS develops. Our office is co-located with the North Pacific Research Board, a program created by Congress to help meet the research needs of Alaska's oceans.

The vision for AOOS is to provide ocean data and information products to users of Alaska's marine environment whether they are fisheries managers, offshore oil developers and transporters, or Alaska Native subsistence users. Our program is developing in line with the national goals of improving the safety and efficiency of marine operations, mitigating the effects of natural hazards, especially coastal erosion from extreme storm events and earthquake generated tsunamis, improving predictions of climate change and its effects, improving national security, especially to our ports, reducing public health risks from contaminants in the marine environment, more effective protecting and restoring healthy coastal marine ecosystems, and enabling the sustained use of marine resources. The program is intended to be an operational provider of ocean observations, not a research program, although the research community is definitely a primary user group in Alaska.

We do not have an integrated ocean observing capability today. Historically, government agencies have had the responsibility for gathering these observations, but have had neither sufficient funding nor discretion to mount comprehensive long-term collection efforts or tailor data collection to meet practical local needs. As a result, many observation and information gaps exist in Alaska. As uses of the marine environment increase, the broader, ecosystem-based decisions expected in the future will require more systematic, coordinated databases.

No process or forum currently exists for users to meet together with the providers of ocean observations to identify gaps and needs and jointly develop priorities. AOOS can provide that forum. It is important to note that AOOS is not intended to supplant existing marine research entities and local observing capabilities in Alaska. Rather, AOOS will serve as the overall facilitator and coordinator for the statewide system, providing funding and establishing standards to ensure that statewide and regional needs are met consistent with the national program.

We are now working in the three large marine ecosystems encompassed by Alaska—the Arctic Ocean, Beaufort and Chukchi Seas, the Bering Sea and Aleutian Islands, and the Gulf of Alaska. Within these three larger regions, are smaller subregions—such as Prince William Sound and Cook Inlet—that will require more intensive observing systems.

In Prince William Sound, we're working to develop an integrated observing system that will provide important information to oil tankers transiting the sound to and from Valdez, the terminus of the Alaska Pipeline, to commercial fishermen who want to understand and better forecast salmon production, and to recreational boaters who want to know weather conditions for weekend trips.

In Cook Inlet, an integrated observing system will help captains pilot barges up the inlet more safely with better information about currents and tides; help oil spill responders better understand where oil might go in the event of a spill; and help city and borough planners predict what will happen to bluff erosion along the shores of Cook Inlet.

In the Bering Sea, one of the richest fisheries in the world, an integrated ocean observing system will help develop more accurate maps of the wintertime southern ice edge, a valuable tool for subsistence users who rely on marine mammals such as walrus and seals for food and for commercial fishermen who fish year round in the Bering Sea; provide greater understanding of ocean warming and its impacts on commercial fisheries; and develop better predictive models of climate change impacts so that coastal communities can be better prepared to respond to rising sea levels and coastal erosion caused by more frequent extreme storm events.

These are all benefits that will have substantial economic benefits not only to Alaskans, but to the nation as a whole. One of the important aspects of AOOS—as well as the other regional associations—is the requirement that a cost-benefit analysis be conducted when planning and developing the various components—and especially the information products—of the regional observing systems. In Alaska, we're working with the University of Alaska's School of Business Administration and Public Policy to develop a business plan for AOOS.

Our planning efforts are focusing on two separate, but closely related tracks. One track encompasses the "core" ocean observations supported by various federal agencies that desperately need to be enhanced as part of the national backbone for the Integrated Ocean Observing System. These include buoys collecting weather observations as part of the National Data Buoy Center, NASA satellite observations of sea surface variables such as chlorophyll-a, waves and currents, temperature and sea ice extent, USGS water level and tidal gauges, and NMFS fisheries stock assessments. Data from these enhanced observations will be incorporated into a Data Management and Communications subsystem that transcends individual government agencies, research and monitoring programs, and research institutions.

On a parallel track, we are meeting with user and stakeholder groups to identify local user needs and the local observations needed to meet those needs. These users include the oil and gas industry, marine shippers, the cruise ship industry (with more than 45 vessels carrying a million passengers in Alaska waters this summer), recreational boating organizations, commercial and recreational fishermen, the charter boat industry, Coast Guard search and rescue operations, oil spill response teams, and city and borough planners. All have expressed enthusiasm and support for AOOS efforts.

Although AOOS is still in the planning and early development stages, pieces of an Alaska Ocean Observing System are already under development. The Prince William Sound Science Center and its affiliated Oil Spill Recovery Institute have been working for more than five years on a Nowcast-Forecast program to provide real-time information and predictions on ocean conditions in Prince William Sound. That program is being enhanced to include additional precipitation and meteorological information, as well as surface current maps using High Frequency Radar.

Another program is the Exxon Valdez Oil Spill Trustee Council's Gulf Ecosystem Monitoring Program whose aim is to monitor well into the future the area impacted by the 1989 oil spill. The GEM program is funding the placement of ocean observing instruments on state ferries and oil tankers as "ships of opportunity".

In Cook Inlet, the Kachemak Bay Research Reserve, established as a National Estuarine Research Reserve, collects basic oceanographic conditions throughout the bay; the city and Borough of Anchorage collects water quality information as part of its sewage discharge permit, and a PORTS system in Anchorage and Nikiski gathers water level and meteorological information to aid marine traffic in the inlet. Experimental High Frequency Radar systems are being deployed to help improve tide predictions, but there is no entity that plans—or has the capability—to keep these in place operationally over the longer term. These observations are not sufficient for the needs of southcentral Alaska which is the most heavily populated region of the state and the largest port in the state.

In the entire Gulf of Alaska, which includes Southeast Alaska, Prince William Sound, and Cook Inlet, we have only 11 NOAA buoys and 9 C-MAN stations. The Gulf of Alaska coastline is more than twice as long as that of the northern California/Oregon/Washington coast, yet has about half the number of buoys and C-MAN stations.

In the Bering Sea and Arctic, we have only one NDBC buoy, although several research buoys have been in place intermittently over the past 10 years. Most observational data has been acquired as part of short-term research programs with no commitment for long-term deployment. What is needed are permanently based monitoring buoys with the capability to take physical and biological measurements above and below the water surface and ice profiling sensors where appropriate, as well as a network of C-Man stations along the coastline, several long range High Frequency radar surface current mappers at pulse points in ocean circulation (such as the Bering Strait and Aleutian Straits) and major fishing grounds, intensive cabled observatories in key areas, and enhanced fisheries surveys. The kinds of information products needed include improved sea ice forecasts, predictions of coastal erosion based on weather and wave data, and real-time access to data from moorings, HF radar systems, and cabled systems monitoring water and sea characteristics.

We are now using Prince William Sound's developing ocean observing system as the pilot project for the AOOS data management system. We envision a distributed system using multiple data nodes across the state with easy access from a centralized system as needed. Data would be provided in formats that are readily accessible to researchers, regulators, educators, and public and commercial users. That system will likely be housed at the University of Alaska Fairbanks supercomputer. Our long-term goal is a 24-7 real-time operational system. However, in Alaska, given our huge geographic range and current dearth of observations, our initial commitment is to make data available on a website as soon as practical. The data collected under the AOOS umbrella will meet national standards and feed into national databases as appropriate.

AOOS is designed to be user and information product-driven. The user needs vary widely. Some groups require precise navigation and real-time information, while others need only rudimentary knowledge of currents and water masses. Some needs exist today, yet others lie in the future, such as possible Northwest Passage transits under reduced Arctic ice cover. Increased surveillance, security and safety of transportation and commercial shipping activities (offshore, in ports, and in sea lines of communication between Alaska and the continental U.S.) are a recent and emerging area of concern for the U.S. that will be addressed by many of the proposed AOOS activities. Another area is climate change impacts. Since greenhouse gas-related global warming is thought to be amplified in polar regions, Alaska conditions can be viewed as a harbinger for climate change across the globe. All of the these needs are closely tied to forecasting of weather and oceanographic conditions as most weather systems, including extreme events, transit across marine waters before entering our state.

Implementation of an Alaska Ocean Observing System represents an enormous challenge due to the vastness of the region. Alaska's remoteness and extreme weather conditions make designing, installing and operating an ocean observing system throughout the three Alaska regions the most difficult undertaking of any shelf area in U.S. waters. However, in spite of these challenges, the opportunities and needs, as well as the economic benefits, warrant national attention.

Again, I want to thank you for the opportunity to testify before you today. If you have any questions, please don't hesitate to contact me at the Alaska Ocean Observing System office, 1007 West Third Avenue, Suite 100, Anchorage Alaska 99501, 907-770-6543.

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Mr. GILCHREST. Thank you very much, Ms. McCammon.

Mr. Evan Richert?

## STATEMENT OF EVAN RICHERT, PRESIDENT, GULF OF MAINE OCEAN OBSERVING SYSTEM

Mr. RICHERT. Thank you, Mr. Chairman, and thank you for the opportunity to testify. The Gulf of Maine Ocean Observing System is one of several young regional coastal ocean observing systems in the Nation.

GoMOOS, as we are known, has been in the water now for 3 full years—reporting on the hour, 24 hours a day, 365 days a year. We monitor waters across the 36,000 square miles of the Gulf of Maine, from Cape Cod to the Bay of Fundy. And if, before coming to this hearing this morning, you had logged onto www.gomoos.org, as I hope you did, you would have been one of several thousands users who are viewing our data at the rate of more than 1 million pages and 5 million hits per year, and growing. These are data for—

Mr. GILCHREST. Could you give me that www thing again?

Mr. RICHERT. Www.gomoos—

Mr. GILCHREST. GoMOOS?

Mr. RICHERT. G-o-m-o-o-s, Gulf of Maine Observing System—dot org. We had to get that before Alaska did, the GoMOOS thing.

Mr. GILCHREST. GoMOOS.

Mr. RICHERT. Yes.

Mr. GILCHREST. OK.

Mr. RICHERT. These are data for which there is a hungry public. The data products, all available on a free and open basis across the Internet, are designed to meet the needs of many users.

We track users because we are explicitly a user-based system, kind of a cooperative utility. We are a nonprofit with more than 30 organizations as paying members and a board of directors composed of representatives of educational and research institutions, marine industry, marine resource agencies, and NGO's.

We ask for feedback on our website on how our observations are used. Here are a dozen examples that I selected from the last 6 months, and these are not from our larger institutional users, such as the National Weather Service, the military, or NOAA, all of whom account for many visits to our site. But these are examples of individual users that might give you a flavor of who is using this data:

A business is using the data products for shipping analysis. Another business is using it in a report for siting an LNG Regas plant. A research organization is using the data for a study on cod larval transport. A hospital employee is using it for a presentation on marine hazards. A Coast Guard employee is using it for training and search and rescue. A marine surveyor is using the data to investigate weather-related damage, while a contractor is using it for a new marine construction project. A nonprofit group is using buoy data to help in a salmon tracking study in Cobscook Bay. A middle school teacher is using it for a science class, and a college student for a marine ecology class. A scientist is loading the data into a model of the Gulf of Maine. A member of the public is using the data to predict waves for surfing, another to plan sailing trips, and another for kayaking. A State government employee is using the data to help with lobster management zones. And an engineer is using the wind speed data to assess wind turbine electrical performance.

And so our users are mariners, fishermen, search and rescue personnel, scientists, recreationalists, educators, marine contractors and engineers, and resource managers. By delivering real-time information and forecasts to them, GoMOOS is helping to save lives, save dollars, and save a large and valuable marine ecosystem. A preliminary, independent NOAA analysis estimated that the return from GoMOOS may be worth as much as $30 million annually. If this is true, and if we amortize our initial capital costs of about $8 million and add our annual operating costs of about $3.5 million, the return to society is roughly 5:1. And you can get a sense of this, of the components of this, when you know and understand that simply the operating costs of shipping transiting the Gulf of Maine is about $50 million a year. A 1-percent increase in efficiency in those operations will translate into a savings of half a million dollars a year.

Or when we realize that there are 6,000 search and rescue missions in the Gulf of Maine each year, including 500 to 600 life-and-death situations, most of those are saved; 25 to 30 die. If we can through our system allow the Coast Guard to beat the 2-hour critical time period in which one must be rescued in the cold waters of the Gulf of Maine, we will help save lives.

Regional coastal ocean observing systems fill a large niche. With our real-time observations of ocean conditions, we are positioned between and complement the atmospheric observations of the National Weather Service, the long-term fisheries surveys of the National Marine Fisheries Service and State fisheries agencies, and the seafloor geological surveys of USGS. We measure winds, currents, waves, fog, sea temperature, salinity, dissolved oxygen, chlorophyll, and measures of fluorescence that track plankton blooms. We comply with high, uniform standards for the data and, as a result, are able to exchange it freely and routinely with the Weather Service and other agencies.

Indeed, we have formed a close bond with these agencies, as well as with the Census of Marine Life and other generators of large marine data bases on the gulf. Together, we have formed the Gulf of Maine Ocean Data Partnership, which GoMOOS hosts. This partnership is committed to a seamless system of data exchange—physical, geological, and biological—that will be available to the public on demand; in short, a truly integrated coastal ocean observing system for our region.

This is the forerunner of what will become over the next year a regional association of State, Federal, institutional, and nonprofit observing systems in the Gulf of Maine. In turn, the regional association will join a national federation of such associations and create a national system of observations and predictions for the coastal ocean similar in function and value to the observations and predictions of the atmosphere by our weather service. That is our goal.

Thank you, and I would be pleased to answer questions later on.

[The prepared statement of Mr. Richert follows:]

**Statement of Evan Richert, President, Gulf of Maine Ocean Observing System**

Mr. Chairman and members of the Committee, thank you for allowing me to testify on the status of Ocean Observing Systems in the U.S., and in particular about the Gulf of Maine Ocean Observing System (GoMOOS). GoMOOS is one of several young regional coastal ocean observing systems in the nation. Our existence is made possible by a new generation of technology, the skill of scientists at our region's universities, the investments of taxpayers and member organizations, and the commitment of dozens of user groups and volunteers in our region.

GoMOOS has been "in the water" now for 3 full years—reporting on the hour, 24 hours a day, 365 days a year. We monitor waters across the 36,000 square miles of the Gulf of Maine, from Cape Cod to the Bay of Fundy. And if, before coming to this hearing this morning, you had logged onto www.gomoos.org, you would have been one of several thousand users who are viewing our data at the rate of more than 1 million pages and 5 million "hits" per year, and growing. These are data for which there is a hungry public. The data products, all available on a free and open basis across the Internet, are designed to meet the needs of many users

We track users because we are a user-based system. We are a nonprofit with more than 30 organizations as paying members, and a Board of Directors composed of representatives of educational and research institutions, marine industry, marine resource agencies, and NGOs.

We ask for feedback on our web site on how our observations are used. Here are a dozen examples from the last six months:

- A business is using the data products for shipping analysis
- Another business is using it in a report for siting an LNG Regas plant
- A research organization is using the data for a study on cod larval transport
- A hospital employee is using it for a presentation on marine hazards
- A Coast Guard employee is using it for training and search and rescue
- A marine surveyor is using the data to investigate weather related damage, while a contractor is using it for a marine construction project
- A nonprofit group is using buoy data to help in a salmon tracking study in Cobscook Bay
- A middle school teacher is using it for a science class, and a college student for a marine ecology class
- A scientist is loading the data into a model of the Gulf of Maine
- A member of the public is using the data to predict waves for surfing, another to plan sailing trips, and another for kayaking
- A state government employee is using the data to help with lobster management zones
- And an engineer is using the wind speed data to assess wind turbine electrical performance.

And so our users are mariners, fishermen, search and rescue personnel, scientists, recreationalists, educators, marine contractors and engineers, and resource managers. By delivering real time information and forecasts to them, GoMOOS is helping to save lives, save dollars, and save a large and valuable marine ecosystem. A preliminary, independent NOAA analysis estimated that the return from GoMOOS may be worth as much as $30 million annually. If this is true, and if we amortize our initial capital costs of about $8 million and add our annual operating costs of about $3.5 million per year, the return to society is roughly 5:1.

Regional coastal ocean observing systems fill a large niche. With our real-time observations of ocean conditions, we are positioned between and complement the atmospheric observations of the National Weather Service, the long-term fisheries surveys of the National Marine Fisheries Service and state fisheries agencies, and the seafloor geological surveys of USGS. We measure winds, currents, waves, fog, sea temperature, salinity, dissolved oxygen, chlorophyll, and measures of fluorescence that track plankton blooms. We do so from an array of fixed buoys with remote sensors, high frequency radar stations, and satellite images. The system was designed by and is operated under contract to a Science Team based at the region's universities and research institutions. We comply with high, uniform standards for the data, and as a result are able to exchange it freely and routinely with the Weather Service and other agencies.

Indeed, we have formed a close bond with these agencies, and with the Census of Marine Life and other generators of large marine data bases on the Gulf of Maine. Together, we have formed the Gulf of Maine Ocean Data Partnership, which GoMOOS hosts. This Partnership is committed to a seamless system of data exchange—physical, geological, biological—that will be available to the public on demand; in short, a truly integrated coastal ocean observing system for our region.

It is the forerunner of what will become over the next year a Regional Association of state, federal, institutional, and nonprofit observing systems in the Gulf of Maine. In turn, the Regional Association will be part of a national federation of such associations. This will create a national system of observations and predictions for the coastal ocean similar in function and value to the observations and predictions of the atmosphere by our weather service. That is our goal.

Thank you, and I would be pleased to answer any questions.

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Mr. GILCHREST. Thank you very much.

Mr. Cortis Cooper?

## STATEMENT OF CORTIS COOPER, METOCEAN CONSULTANT, ENERGY TECHNOLOGY CO., CHEVRONTEXACO

Mr. COOPER. Thank you, Mr. Chairman.

The oil industry has had to operate safely in some of the harshest ocean regions on the planet, including the North Atlantic and Gulf of Mexico. Despite the hazards, we have compiled an excellent record with far fewer weather-related losses than other major marine industries such as fishing and shipping. This is due in large part to the considerable money and expertise that we spend on the issues.

I would like to start by making a couple of points. First of all, offshore U.S. oil production is important. Today, nearly 30 percent of the total U.S. production comes from offshore, virtually all of it from the Gulf of Mexico. This percentage is expected to increase in the next few years. For these reasons, the Gulf of Mexico will be the focus of the rest of my comments.

The second point I would like to make is the oil industry has been following the development of IOOS thanks in part to folks in the regional area who have continually encouraged us to participate.

The next slide shows two of the major concerns that we have in the Gulf of Mexico. Of course, the well-known hurricanes. Good forecasts in this case are especially important in guiding our mandatory evacuations. A less well known phenomenon is the loop current. This is a strong current which is shown by the dark red in the slide. It enters into the gulf through the Yucatan Straits and exits through the Florida Straits where it becomes known as the Gulf Stream. The loop and its eddies can generate currents of 5 to 6 miles per hour, well down into the water column, and create static loads equivalent to a 60-foot wave.

The IOOS products of potential interest to the oil industry are as follows: We would be very interested in measurements of currents, waves, wind, especially in real-time in the Gulf of Mexico. Second, we would be interested in operational satellite products in near real-time, especially from the four existing altimeters and from the coastal color scanners. Third, we would like to use or have access to the IOOS data management and archival infrastructure. Confidentiality issues will, of course, have to be addressed. And, last, IOOS could not only collect data but might also run operational current models which could be extremely useful.

The potential benefits of IOOS to the industry are: First of all, it could help improve forecasts for hurricanes, winter storms, and loop current eddies. Second, it could assist in spill response contingency planning and cleanup. Third, it could improve design and operational efficiency of our offshore activities. With improved knowledge from IOOS, the industry could reduce loss of life, reduce the likelihood and impacts of accidental spills, reduce operational downtime, and reduce capital costs for new facilities. As a result, IOOS could spur development of more marginal oil and gas fields that might otherwise remain undeveloped because they cannot compete with the less costly oil coming from places outside of U.S. waters.

There are a number of ways in which we could potentially cooperate with IOOS. First of all, we have lots of offshore real estate. The industry has approximately 3,000 platforms in the Gulf of Mexico alone, offering a good place to take ocean measurements from. Second, we collect a lot of data. We are or soon will be collecting ocean current profiles at the deepwater sites shown in this figure.

There are some key inhibitors to cooperation. First of all, collecting ocean data is expensive, which, of course, leads to the business question: Why should any company give away costly data to a competitor? Another issue is liability. For example, what happens if we inadvertently release erroneous data to the public and someone gets hurt? All of these factors will be considered during an offshore operators committee workshop planned for early this fall. The workshop will involve all the major players, including the oil companies, NOAA, MMS, and IOOS organizers.

Thanks for this opportunity to testify.

**[NOTE: Mr. Cooper's PowerPoint presentation has been retained in the Committee's official files.]**

Mr. GILCHREST. Thank you very much, Mr. Cooper.

Dr. Grassle?

**STATEMENT OF J. FREDERICK GRASSLE, DIRECTOR, INSTITUTE OF MARINE AND COASTAL SCIENCES, RUTGERS, THE STATE UNIVERSITY OF NEW JERSEY**

Dr. GRASSLE. Chairman Gilchrest, Mr. Pallone, and members of the Subcommittee and staff, thank you for inviting me to testify before this Subcommittee on ocean observing systems in the United States. I am director of the Institute of Marine and Coastal Sciences at Rutgers University. We built the Nation's first cable ocean observatory, LEO-15, on the continental shelf off New Jersey and have since extended this to become the New Jersey Shelf Observing System that provides information on the entire New York bight from Delaware to the end of Long Island. I have testified before you on this subject in 1989 and 2001, and it is a special privilege to speak again today. Since I last spoke, the urgent need for better coastal observing systems has become even more apparent. Coastal ocean observation and prediction systems are relevant to the business plans of most coastal business enterprises and are essential for improving safety and efficiency of marine operations. Information from ocean observing systems improves coastal weather forecasts, and economic studies show that better coastal forecasts enable the power industry to reduce emissions and costs.

Better ocean prediction is required to mitigate the effects of flooding and erosion from hurricanes and other severe storms. The ability to sense all aspects of our ocean surroundings is important for recreational mariners and the U.S. Coast Guard, Navy, and Merchant Marine. New technologies for surface current mapping were recently demonstrated to improve the Coast Guard's search and rescue capabilities. These radar technologies are also being adapted to routinely track and identify ships for national security. The sources, fates, and effects of pollutants cannot be understood without better means for tracking sediment in the ocean. Better methods for assessment of fish stocks, ocean habitats, and other natural resources will be available through new ocean observing system technologies.

Regional observing systems are taking shape with organizations forming in most of the regions of the U.S., as you just heard. Observing system development has occurred primarily through line-item congressional support for selected organizations in specific regions. Legislation is urgently needed to fund a coordinated approach that will allow all regions to work together and grow in concert. An integrated systems of well-established and advanced technologies will monitor biological, chemical, geological, and physical properties of the ocean for the benefit of our Nation's economy and well-being.

The text of my testimony supports the recommendations from the U.S. Ocean Policy Commission and places these in the context of the most recent description of IOOS by Ocean.US. Legislation is urgently needed to authorize funding for ocean and coastal observation systems in the NOAA budget. Within this NOAA authorization, at least half of these funds should be made available for regional associations to design, implement, operate, and improve regional ocean and coastal observing and information systems, building on existing assets in U.S. coastal waters.

Regional associations such as the Mid Atlantic Regional Association, of which Rutgers University is a member and the New Jersey Shelf Observing System is a part, are working to integrate existing regional and State-based, federally supported coastal programs. LEO-15 and the New Jersey Shelf Observing System was guild with support from the National Science Foundation, Office of Naval Research, and NOAA's National Underseas Research Program. Information about the ocean from a broad suite of sensors has been delivered since 1996.

I will diverge just a moment from my written remarks. I was stimulated by the questions that Chairman Gilchrest addressed to the previous panel about how upwelling works in the ocean, the causes of hypoxia, and harmful algal blooms. We had the opportunity for a brief period, 3 years, with support from the Office of Naval Research, to calibrate hyperspectral satellite systems to run ocean models on a 3-day basis. Data from the ocean was assimilated into models, and predictions were made. After each prediction, the system was evaluated and the observing system assets were redeployed to optimize predictions. At that time we worked in the context of a known system of upwelling based on satellite work we had done previously, but we were able to predict one moment when a harmful algal bloom appeared in the bight in the 3 years of 1-month observation.

A lot of the things that happen in the ocean happen as infrequent events, and it is only by having systems in place for very long periods of time do we understand the processes that control these infrequent events.

I should add that more recently, with support from the National Science Foundation, we now have funds for each spring for the next 5 years to look at the Hudson River plume. It used to be thought that upwelling in our coast was caused by this plume. We know now from our studies that this is not so, but there is an effect. And with dye studies and the high-frequency radar system we have in place, we can pinpoint exactly the contribution of this system.

Advanced data and information systems are the best means for integrating all components of the ocean observing system and a prerequisite for making data useful to all sectors of the economy, government, and the general public. Funding for the data management and communications plan is an essential first step toward developing this system.

The establishment of regional coastal ocean observing systems is central to the implementation of a more effective ocean policy. The coastal economy will run more efficiently with information from these systems. Americans living and/or vacationing on the coast need to be better informed in order to better protect our coastal resources and quality of life.

[The prepared statement of Dr. Grassle follows:]

**Statement of Frederick Grassle, Director, Institute of Marine and Coastal Sciences, Rutgers—The State University of New Jersey**

Chairman Gilchrest and members of the Subcommittee, thank you for inviting me to testify before this committee on Ocean Observing Systems in the United States. I have testified before you on this subject in 1989 and 2001 and it is a special privilege to speak again today. Since I last spoke, the urgent need for better coastal observing systems has become even more apparent. Coastal ocean observation and prediction systems are relevant to the business plans of most coastal business enterprises and are essential for improving safety and efficiency of marine operations. Information from ocean observing systems improves coastal weather forecasts and economic studies show that better coastal forecasts enable the power industry to reduce emissions and costs. Better ocean prediction is required to mitigate the effects of flooding and erosion from hurricanes and other severe storms. The ability to sense all aspects of our ocean surroundings is important for recreational mariners and the U.S. Coast Guard, Navy, and Merchant Marine. New technologies for surface current mapping were recently demonstrated to improve the Coast Guard's search and rescue capabilities. These radar technologies are also being adapted to routinely track and identify ships for national security. The sources, fates, and effects of pollutants cannot be understood without better means for tracking sediment in the ocean. Better methods for assessment of fish stocks, ocean habitats, and other natural resources will be available through new ocean observing system technologies.

Regional coastal ocean observing systems are taking shape with organizations forming in most U.S. coastal regions. Observing system development has occurred primarily through line-item congressional support for selected organizations in specific regions. Legislation is urgently needed to fund a coordinated approach that will allow all regions to work together and grow in concert. An integrated system of well-established and advanced technologies will monitor biological, chemical, geological, and physical properties of the ocean for the benefit of our Nation's economy and well-being.

There are many documents describing the U.S. Integrated Ocean Observing System (IOOS). The most notable is the Preliminary Report of the U.S. Commission on Ocean Policy (Governor's Draft, April 2004). I served on the Ocean Commission Science Advisory Panel and I strongly support the Commission's recommendations including the establishment of a National Ocean Council (Rec. 4-1) and a strengthened and enhanced National Ocean Research Leadership Council to be called the Committee on Ocean Science, Education, Technology, and Operations (Rec. 4-7). Commission Recommendation 5.2 asks Congress to immediately "establish regional ocean information programs to improve coordination and set priorities for research data collection, science-based information products, and outreach activities in support of improved ocean and coastal management. Program priorities should be carried out primarily through a grants process." The interagency ocean observation office, Ocean.US, should be established with a budget appropriate to its mission (Rec. 26-3). The Integrated Ocean Observing System (IOOS) should be a line item in the National Oceanic and Atmospheric Administration (NOAA) budget without fiscal year limitation, and a streamlined process for distributing funds to other federal and non-federal partners should be included (Rec. 26-9). A fund for modernization of critical ocean infrastructure and technology needs should be established based on an ocean and coastal infrastructure plan (Rec. 27-4). Congress should amend the National Ocean Partnership Act to establish a federal planning organization for ocean and coastal data and information management to be called Ocean.IT (Rec. 28-1).

The most recent complete description of the U.S. Ocean Observing System is the Ocean.US Implementation Plan of IOOS (4 June Draft) available at http://ocean.us. Its recommendations are consistent with those of the Commission and legislation is urgently needed to authorize funding for Ocean and Coastal Observation Systems in the NOAA budget. Within this NOAA authorization, at least half of these funds should be made available for regional associations to design, implement, operate, and improve regional ocean and coastal observing and information systems, building on the existing assets in coastal U.S. waters. Allocation of funds would be based on guidelines formulated by a newly authorized interagency program office (presently Ocean.US under the National Ocean Research Leadership Council of the National Ocean Partnership Program).

Regional associations such as the Mid Atlantic Regional Association (MARA), of which Rutgers University is a member, are working to integrate existing regional and state-based federally-supported coastal programs. Perhaps the best example of the possibilities for application of ocean observing system technologies comes from the evolving observatories spanning the continental shelf off New Jersey. LEO-15, built with support from the National Science Foundation and NOAA's National Undersea Research Program (NURP), is the nation's first cabled observatory and is a pioneer in developing the technologies that have led to the NSF's Ocean Observatory Initiative. LEO-15 has been delivering information about the ocean from a broad suite of sensors since 1996. Support from the Office of Naval Research and the National Ocean Partnership Program enabled LEO-15 to evolve into the New Jersey Shelf Observing System (NJSOS) which provided spatial data from satellites, high-frequency radars, and buoys that can be assimilated into predictive numerical models. This coupled observing system was demonstrated during experiments in 1998-2001. The Mid-Atlantic Bight NOAA NURP program continues to support development of new observing system technologies such as a system to measure turbulence at all depths and an underwater flow cytometer to continuously measure phytoplankton species abundance and composition. Although much has been accomplished with research funds, a sustained source of funding is needed to operate the system on a continuous basis and to provide products to meet user demands.

The observing system off the coast of New Jersey is also working to establish an education community that uses observing system information, and builds an observing system workforce. Rutgers and other universities are developing Masters Programs in Operational Oceanography that will train the operators of future ocean observing systems. An NSF-sponsored COSEE program brings scientists and educators together to improve public knowledge and understanding of how the ocean affects the daily lives of diverse audiences. I support the Commission on Ocean Policy recommendation to expand this program (Rec. 8-5). The Mid-Atlantic COSEE program features a thematic focus on coastal ocean observing systems. Public interest in ocean observations is used to develop strategies for improving science instruction among pre-service educators and to create a community of lifelong learners familiar with the practice of science. The NOAA National Estuarine Research Reserve System (NERRS) network has a well-established System-wide Monitoring Program for estuarine waters and a strong education program which will be integrated into MARA. In New Jersey, the NERRS Coastal Training Program uses science-based information from the regional ocean observing system to teach school children through highly successful teacher training. This program also informs environmental decision-makers through education and training programs.

Advanced data systems are the best means for integrating all components of the ocean observing system and a prerequisite for making data useful to all sectors of the economy, government, and the general public. The U.S. Commission on Ocean Policy devoted an entire chapter to the importance of a national ocean data and information system. In response to the critical need for an integrated data management and communications system, the Ocean.US Data Management and Communications Steering Committee (DMAC) was formed and an action plan for establishing a data and information system has been completed. I served on this Committee. Federal agencies, state agencies, academia, and regional groups will implement this plan. Funding for the DMAC plan is an essential first step toward developing this system.

The establishment of Regional Coastal Ocean Observing Systems is central to the implementation of a more effective ocean policy. The coastal economy will run more efficiently with information from these systems. The majority of Americans living and/or vacationing on the coast want to be informed in order to better protect our coastal resources and quality of life.

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Mr. GILCHREST. Thank you very much, Dr. Grassle.

Ms. Brohl?

## STATEMENT OF HELEN A. BROHL, PRESIDENT, NATIONAL ASSOCIATION OF MARITIME ORGANIZATIONS

Ms. BROHL. Thank you, Mr. Chairman. I thank you and Mr. Pallone for inviting us here today to have the opportunity to provide testimony regarding the status of ocean observing systems in the United States. I am Helen Brohl. I am the Executive Director of the United States Great Lakes Shipping Association. I am also in my second term as President of the National Association of Maritime Organizations, which is a coalition of shipping associations and marine exchanges, from coast to coast, who promote the safe and efficient navigation of commercial vessels through the navigable waters of the United States.

NAMO has been engaged with hydrographic services programs under the National Oceanic and Atmospheric Administration's National Ocean Service Division. We are founding members of the Marine Navigation Safety Coalition. There are over 60 organizations, including the American Pilots Association, Chamber of Shipping of America, INTERTANKO, the World Shipping Council, National Ocean Industries Association, and others who are members of the coalition. And we would like to thank you for your ongoing support of marine navigation monitoring programs. You have directly contributed to the increases in funding over the years, even though clearly 2005 is going to be a challenge for us. But, also, you created the Hydrographic Services Review Panel under NOAA, and you affirmed your believe in hydrographic monitoring programs for the safe and efficient movement of marine commerce through the United States in your amendments to the Hydrographic Services Improvement Act in 2002.

Many of the maritime organizations involved with the coalition have been directly involved in the development, the design, and operation of hydrographic observation systems, including local partnership cost sharing with NOAA.

Coalition members work closely with the NOS Office of Coast Survey and the Center for Operational and Oceanographic Products and Services, COOPS, who develop, operate, and maintain hydrographic surveying and observation programs. These are the programs that NOAA calls the "backbone" of IOOS. The maritime sector is extremely dependent upon the observation programs provided by COOPS for navigation safety.

The coalition supports the integration of ocean observing systems. We might, however, describe it as ocean and coastal observing systems. Most of the critical navigation areas for commercial shipping and other maritime operators and most of the critical resource management areas are along our Nation's coasts rather than in deep ocean areas. In any case, integration of data is a practical step for NOAA and the ten or so other governmental agencies that monitor and survey our waters.

We believe that a renewed emphasis on hydrographic monitoring and its sister—surveying, charting, and mapping—go hand in hand with the Marine Transportation System initiative and is one of the most direct ways that the MTS can be enhanced for safety and security. Subject to appropriations, of course, integration and expansion of our ocean and coastal observing systems can be done relatively quickly by using existing legislative authority under the Hydrographic Services Improvement Act of 2002, as amended by your Subcommittee in 2002. NOAA has stated that the backbone programs of an IOOS or an IOCOS, if you include the coastal component, are the services currently provided by COOPS.

The coalition views that using existing authority and assuming that Congress provides sufficient funding for the Tides and Currents line item and appropriate direction in the committee report, NOAA could begin the technical work necessary to integrate and standardize data from within NOAA—although I understand that within NOS they are already integrated and do cooperate with the Weather Service already—and between the other agencies for maritime, resource, or research uses. The first step involves an inventory of existing departmental programs engaged in ocean and coastal water-related monitoring and integrating data where appropriate. And it appears that Ocean.US has already done that.

Once the governmental agencies have integrated their data and standardized and certified its presentation to the public, the Hydrographic Services Improvement Act can also be used to expand monitoring points around the country. In fact, take systems like GoMOOS and apply them around the country. We view the existing national water level observation network already under COOPS, which includes over 200 points already in place, which could be expanded, as the base from which to go forward but using real-time systems as the model. The coalition specifically inquired about what it might cost to create real-time systems around the country, which would include water levels, currents, wind, temperature, GPS coordination, et cetera—in other words, any data needed for researchers, for resource managers, and navigation. The cost is approximately $50 million to build the sites and $15 million per year to maintain and operate them, and this would be under NOAA

COOPS. If Congress appropriated the full authorized levels under the Hydrographic Services Improvement Act and increased those levels even moderately in reauthorization, we would be well on our way to realizing that potential in just a few years.

The HSIA also provides an avenue by which local and regional interests can provide direction to NOAA on the type of information needed. The amendments of 2002 created the Hydrographic Services Review Panel. This is a Federal advisory committee to advise NOAA on hydrographic monitoring programs and services. This panel is now in place, and we highly recommend that the Subcommittee request that NOAA use this existing panel to investigate local and regional needs. The Federal advisory committee process provides a public forum by which local and regional representation could be received and an analysis presented to NOAA on those needs.

This could be coupled with the participation of existing organizations in particular—with regional emphasis, including the regional MTS committees and local harbor safety committees.

You asked us to talk about regional systems. The new NOAA vision for IOOS includes the creation of regional associations. We view these as two very different issues, and we are not sure to which you are referring. However, we would consider a system to be the physical equipment in place to provide hydrographic monitoring.

In the Great Lakes, we have a regional system. However, what this really means is that NOAA upgraded all the entire water level gauge sites to become real-time. So, in fact, in the Great Lakes, we have a regional system, but it is not a regional association. And it is maintained and operated by NOAA, which is appropriate.

Recreational and commercial maritime operations are not dependent upon a regional system as much as wanting critical navigation points around the country wherever they go to be monitored with data that is meaningful and useful. The coalition believes that there needs to be real-time monitoring systems at all critical navigation areas and supplement those with points that are meaningful for research and for resource managers.

As stated previously, we understand that an integrated system for all critical points around the country could be developed for approximately $50 million and maintained at $15 million per year and would include information that is meaningful for resource as well as research.

We do not yet understand the advantage of a regional association approach, although we have heard a number of good reasons today why bringing your information together is extremely important. As mentioned, many coalition members are already involved in hydrographic monitoring partnerships with NOAA. Some have taken the initiative to establish real-time data collection installations and at considerable expense. As such, marine exchanges, harbor safety committees, MTS committees would make excellent regional or local associations and coordinators. Being such significant stakeholders, they must be invited to the table, and we ask the Subcommittee to ask NOAA to present a plan for engaging the maritime sector into the grant application process and regional association development program.

Dr. Richard Spinrad, who spoke today, stated in the May 2004 Sea Technology Magazine article that his vision of IOOS is "an overwhelming task." The price tag of $700 million or more for this new concept is daunting. For almost 8 years, the coalition, our safety coalition, has struggled to convince Congress that the existing programs as authorized under the Hydrographic Services Improvement Act—despite the advantages of safer and more secure navigation to the environment and the resource management application—deserve full funding. While we have seen modest improvements in recent budgets and appropriations, the fact is that funding has been considerably less than it should be, and perhaps will be less this year. For that reason, the coalition is concerned that new regional association emphasis on a brand-new research-centered integrated system will diminish attention and funding for the existing programs upon which maritime safety is so dependent. Where does the commercial and recreational maritime community fit in this new research-based concept? How will navigation safety be a priority if the budgetary emphasis is on creating a new concept?

We recognize that research, especially with regard to the development of new technologies, is an important partnership. NOAA already works with the private sector to adapt technology for broader hydro monitoring needs. In fact, air gap technology which NOAA has now put on to bridges for maritime air gap use was adapted technology taken from oil platforms. NOAA also works in partnership with universities such as the University of New Hampshire in the bathymetric surveying program.

This and other academic partnerships are funded through the Hydrographic Services Improvement Act which the coalition has consistently supported. We recognize the academic research component in hydrographic monitoring but question the direction in NOAA to use academic institutions to determine the hydro monitoring needs of commercial and recreational maritime operations. How many professors pilot 100,000-ton vessels or work routinely with the industry?

Once again, the coalition supports the integration of ocean and coastal observing programs. However, we ask the Subcommittee to build from existing programs to integrate and enhance hydrographic monitoring in the United States and with other nations.

Thank you very much.

[The prepared statement of Ms. Brohl follows:]

**Statement of Helen A. Brohl, Executive Director, National Association of Maritime Organizations on behalf of the Marine Navigation Safety Coalition**

Chairman Gilchrest and members of the House Subcommittee on Fisheries Conservation, Wildlife and Oceans, we thank you for the opportunity to provide testimony at the oversight hearing on the status of ocean observing systems in the United States. I am Helen A. Brohl, the Executive Director of the United States Great Lakes Shipping Association which celebrates almost fifty years of service in the Great Lakes representing vessel agents and the owner/operators of vessels engaged in international trade to U.S. Great Lakes ports. I am also serving my second term as the president of the National Association of Maritime Organizations (NAMO) which is a coalition of shipping associations and marine exchanges—from coast to coast—who promote the safe and efficient navigation of commercial vessels through the navigable waters of the United States.

For the past ten years, NAMO has been engaged with hydrographic services programs under the National Oceanic and Atmospheric Administration's (NOAA) National Ocean Service (NOS) Division. We are founding members of the Marine Navigation Safety Coalition (the Coalition) and I am currently the national coordinator. Previous coordination leadership has been by the American Association of Port Authorities and the National Mining Association. There are over 60 additional organizations involved with the Navigation Safety Coalition including the American Pilots Association, Chamber of Shipping of America, INTERTANKO, the World Shipping Counsel, National Ocean Industries Association, and the Maryland Port Administration. [Membership list attached].

NAMO and the Safety Coalition testified at your hearing in September 2001 regarding the reauthorization of the Hydrographic Services Improvement Act of 1998. Many of the maritime organizations involved with the Coalition have been directly involved in the development, design and operation of hydrographic observing systems, including local partnership cost sharing with NOAA.

Coalition members work closely with the NOS Office of Coast Survey and the Center for Operational and Oceanographic Products and Services (COOPS) who develop, operate and maintain hydrographic surveying and observation programs, respectively. These are the programs that NOAA calls the "backbone" of IOOS. Maritime is extremely dependent upon the observation programs currently provided by NOAA for safe navigation. It was at the request of maritime that COOPS integrated air gap technology on two bridges between Baltimore and the Delaware River and one on the Mississippi River which provides critical vessel clearance information to the pilot house. NOAA also intends to install three air gap gauges on the Verrazano Narrows Bridge so the Queen Mary 2 can safely transit New York Harbor. Working with Great Lakes maritime interests, COOPS upgraded the 52 water level gauges in the Great Lakes to real-time and provides that information online, by phone and by radio. This is a typical example of how maritime currently works with NOAA to identify navigation needs and utilize the latest technologies to provide for safer maritime commerce.

The Coalition supports the integration of ocean observing programs. We might describe this concept, however, as ocean and coastal observing programs. Most of the critical navigation areas for commercial shipping and other maritime operators and most of the critical resource management areas are along our Nation's coasts rather than in deep ocean areas. In any case, integration of data is a practical step for NOAA and the ten or so other governmental agencies that monitor and survey our waters. This can prevent the duplication of data collection, standardize the data domestically and in coordination with the International Hydrographic Organization, and make it available to a larger number of stakeholders where appropriate.

We believe that a renewed emphasis on hydrographic monitoring and its sister—surveying, charting and mapping—go hand-in-hand with the Marine Transportation System initiative and is one of the most direct ways that the MTS can be enhanced for both safety and security. Subject to appropriations, of course, integration and expansion of our ocean and coastal observing systems could be done relatively quickly by using existing legislative authority under the Hydrographic Services Improvement Act of 1998 (HSIA) as amended by legislation recommended by your Subcommittee in 2002. NOAA has stated that the "backbone" programs of an IOOS or IOCOS (to include the coastal component) are the services currently provided by COOPS, which provides water level data, tides and currents, storm surge updates, and the real-time information under the Physical Oceanographic Real Time Systems or "PORTS." When you're on a beach vacation, you might look up the tide chart in the local newspaper. This is generated from COOPS. The maritime sector accesses the broader range of information from COOPS online, by phone, or by radio.

The Coalition views that using existing authority, and assuming that Congress provides sufficient funding for the "Tides and Currents" line item and appropriate direction in the committee report, NOAA could begin the technical work necessary to integrate and standardize data from within NOAA and from other agencies for maritime, resource, and research uses. The first step involves an inventory of existing departmental programs engaged in ocean and coastal water-related monitoring and integrating data where appropriate. Within NOAA, for example, the National Weather Service uses buoy data, COOPS uses water level gauges and PORTS sites, the Geodetic department investigates geospatial data for shoreline and coastal zone change analyses, among others. The Subcommittee might first ask NOAA to explain how information is being integrated for presentation under the current mechanisms.

The maritime sector also uses water levels data monitored by the Army Corps of Engineers and the U.S. Geological Survey. We believe that the NOAA should be the primary organization responsible for hydrographic monitoring and predictions for maritime because portals are already in place for ready access. We understand that

Congress mandated a partnership between Navy and NOAA with regard to the "National Oceanographic Partnership" program. Perhaps this can be expanded to include other interdepartmental partnerships and promote the mutual presentation of data for ready access under the existing commercial maritime access portals in COOPS.

Once the governmental agencies have integrated their data and certified its presentation to the public, the HSIA can also be used to expand monitoring points around the country. We view the existing national water level observation network as the base from which to go forward but using real-time systems as the model. The Coalition specifically inquired about what it might cost to create real-time systems around the country which would include water levels, currents, wind, temperature, GPS coordination, etc.—any data needed for researchers, resource managers, and navigation interests based upon regional and local needs. The cost is approximately $50 million to build the sites and $15 million per year to maintain and operate them. If Congress appropriated the full authorized levels under the HSIA and increased those levels even moderately in reauthorization, we would be well on our way to realizing that potential in just a few years.

The HSIA also provides an avenue by which local and regional interests—from navigation, resource management or research—can provide direction to NOAA on the type of information needed. The HSIA amendments of 2002 created the "Hydrographic Services Review Panel" (a FACA) to advise NOAA on hydrographic monitoring programs and services. This Panel is now in place and we highly recommend that the Subcommittee request that NOAA use this existing Panel to investigate local and regional needs. The federal advisory committee process provides a public forum by which local and regional representation could be received and an analysis presented to NOAA on those needs.

This could be coupled with the participation of existing organizations in particular regional MTS committees and local harbor safety committees. In every case with which we're familiar, the regional MTS committees already include commercial maritime, recreational boating, environmental interests, and government representatives such as U.S. Coast Guard, the Corps of Engineers, and NOAA. Harbor safety committees also are an excellent and quick source for recommendations on exactly what data points are needed to enhance the safety and security of a local harbor. There is a HSC in every major port in the country.

You asked us to talk about "regional systems." The new NOAA vision for IOOS includes the creation of "regional associations." We view these as two different issues and we are not sure to which you are referring. We would consider a "system" to be the physical equipment in place to provide hydrographic monitoring. There are no "regional systems" in place for hydrographic monitoring except in the Great Lakes but it could be more correctly called a regional program. Because of directed funding by the Great Lakes Congressional delegation, the existing water level gauge system across the region has been expanded and those gauges enhanced for real-time observations. With just a bit more funding, the entire Great Lakes could be wired for multi-dimensional hydrographic monitoring which would satisfy everyone's needs. This work was done in a relatively short time and for relatively little cost and addressed the need for real-time data under a state of critical low water levels which threatened the safety of maritime navigation. The Great Lakes regional system was built and is maintained and operated by NOAA. The Great Lakes maritime sector wants to stay on this path with funding through the 2003 amendments to the HSIA as proposed in H.R. 958 and supported by this Subcommittee. The Coalition believes that this concept could and should be applied to the entire country through NOAA's National Water Level Observation Network and the PORTS program. The HSIA specifically provides for NOAA development, maintenance and operation of real-time systems around the country.

The Great Lakes system may be referred to as regional because all the NOAA monitoring sites in the region were upgraded together. But NOAA operates the systems and presents the data which we believe is appropriate. Recreational and commercial maritime is not dependent upon a "regional system" as much as wanting critical navigation points anywhere around the country to be monitored with data that is meaningful and useful. Frankly, the type of information needed should be determined more locally than regionally. The Coalition believes that there needs to be real-time monitoring systems at all critical navigation areas. As stated previously, we understand that an integrated system for all critical points around the country could be developed for approximately $50 million and maintained at $15 million per year and would include information that is meaningful for resource managers and research institutions.

We understand that NOAA has a new vision of integrating hydrographic monitoring which is very different than the programs we've already mentioned. NOAA has provided 11 grants at $100,000 each to academic institutions around the country to develop "regional associations" that would set policy, determine regional needs, and even provide the hydrographic monitoring services. It is a concept that the Coalition has yet to fully understand as being advantageous to the existing program. NOAA has only recently engaged maritime in the discussion and we look forward to learning more. As mentioned, many Coalition members are already involved in hydrographic monitoring partnerships with NOAA. Marine exchanges, harbor safety committees, and MTS committees would make excellent regional or local associations and coordinators and must be invited to the table. We ask the Subcommittee to ask NOAA to present a plan for engaging maritime into the grant application process and regional association development program.

The Coalition has additional questions about NOAA's vision for IOOS. It is presented as being quite massive. Dr. Richard Spinrad (assistant administrator for NOS) stated in the May 2004 Sea Technology Magazine that it is "an overwhelming task." The price tag of $700 million for this new concept is daunting. The Coalition has struggled to convince Congress that the existing programs as authorized under the HSIA—despite the advantages of safer and more secure navigation to the environment as well as economy—deserve full funding. Under limited appropriations dollars, the Coalition is concerned that a new regional association emphasis on a brand new research-centered integrated system will diminish attention and funding for the existing programs upon which maritime is so dependent. In particular, we believe that the existing ten PORTS sites around the country deserve $3 million in federal assistance for yearly operations and maintenance. NOAA has, thus far, rejected that notion in their annual budget recommendations, but proposes to create a $700 million program of which $350 million will go to academia for research. Additionally, due to limited appropriations, NOAA has not been able to provide monitoring or charting and mapping specifically directed to the 700,000 + recreational boaters in this country. Where does the commercial and recreational maritime community fit in this new research-based concept and how will Congress preserve the core programs?

We recognize that research, especially with regard to the development of new technologies, is an important partnership. NOAA already works with the private sector to adapt technology for broader hydro monitoring needs. The air gap technology used on the bridges was adapted from technology developed privately for oil platforms. NOAA also already works in partnership with universities such as the University of New Hampshire in the bathymetric surveying program. This and other academic partnerships are funded through the HSIA which the Coalition has consistently supported. We recognize the academic research component in hydrographic monitoring but question the direction in NOAA to use academic institutions to determine the hydro monitoring needs of commercial and recreational maritime operations. How many professors pilot 100,000 ton vessels or work routinely with the industry?

Once again, the Coalition supports the integration of ocean and coastal observing programs. However, we ask the Subcommittee to build from existing programs to integrate and enhance hydrographic monitoring in the United States and with other nations. The International Maritime Organization states that there are four cornerstones of a hydrographic office. They are:

- To ensure that hydrographic surveying is carried out in a manner adequate for safe navigation,
- To prepare and issue nautical charts, sailing directions, lists of lights, tide tables, and other nautical publications, where applicable, satisfying the needs of safe navigation,
- To promulgate notices to mariners in order that nautical charts and publications are kept up to date; and
- To provide data management arrangements to support these services.

Resource management information should be incorporated as a positive byproduct of a national program to monitor critical navigational areas and technology research is an integral partner to provide more and better ways to meet the four cornerstones. The maritime sector is the keystone in a program of hydrographic monitoring and modernization for the 21st century.

We thank you again for the opportunity to provide testimony at this oversight hearing and would be pleased to answer any questions. Contact: Helen A. Brohl, 973-345-2534, usglsa@cs.com. A list of coalition members is following.

## MARITIME NAVIGATION SAFETY COALITION

MEMBERSHIP

American Association of Port Authorities
American Great Lakes Ports Association
American Institute of Marine Underwriters
American Maritime Congress
American Petroleum Institute
American Pilots Association
American Waterways Operators
Aqua Survey, Inc.
Association of Ship Brokers and Agents
Boat Owners Association of the United States
Boston Shipping Association
C & C Technologies
Canaveral Port Authority
Chamber of Shipping of America
Columbia River Steamship Operators Association
Connecticut Maritime Association
Delaware River Port Authority
Dominion Terminal Associates
Duluth Seaway Port Authority
Great Lakes Commission
Greater Baton Rouge Port Commission
Greater Houston Port Bureau, Inc.
Hampton Roads Maritime Association
INTERTANKO
International Council of Cruise Lines
Jacksonville Maritime Association
Joint Institute for Marine Observations, Scripps Institution of Oceanography
Lake Carriers Association
LCMF Incorporated
Maritime Association of the Port of Charleston
Maritime Association of the Port of NY/NJ
Marine Exchange of Southern California
Marine Exchange of the West Gulf, Inc.
Maritime Exchange of the Delaware River and Bay
Maritime Information Service of North America
Marine Exchange of Puget Sound
Maryland Port Administration
Massachusetts Port Authority
Matson Navigation Company
Mississippi State Port Authority at Gulfport
National Association of Maritime Organizations
National Industrial Transportation League
National Mining Association
National Ocean Industries Association
National Waterways Conference, Inc.
Passenger Vessel Association
Pilot Association of the Bay and Delaware River

PORT OF GALVESTON
PORT OF HOUSTON AUTHORITY
PORT AUTHORITY OF NEW YORK & NEW JERSEY
PORT OF LOS ANGELES
PORT OF RICHMOND
PORT OF SACRAMENTO
PORT OF SAN FRANCISCO
PUGET SOUND STEAMSHIP OPERATORS ASSOCIATION
SAVANNAH MARITIME ASSOCIATION
SOUTH CAROLINA STATE PORTS AUTHORITY
SOUTH JERSEY PORT CORPORATION
STEAMSHIP ASSOCIATION OF LOUISIANA
TAMPA PORT AUTHORITY
TERRA SURVEYS, LLC
THALES GEOSOLUTIONS (PACIFIC)
THE FERTILIZER INSTITUTE
TRANSPORTATION INSTITUTE
UNITED STATES GREAT LAKES SHIPPING ASSOCIATION

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Mr. GILCHREST. Thank you very much, Ms. Brohl.

I have been trying to absorb your testimony so I can understand your perspective based on your comments dealing with the Hydrographic Services Improvement Act as we move forward with the whole ocean observing system to have it integrated. Do you see your role in this with the hydrographic survey system that is now in place being an integrated part of the ocean observing system that we have been discussing here with the previous panel and this panel? For example, Mr. Richert and a number of people here have talked about an ocean observing system which is pretty vitally important for surface windstream, flow, temperature, salinity, coastal sea level topography, waves, currents, habitat, plankton abundance, and all those other things. Do you see your part of this as a system being fully integrated in that ocean observing system? Or do you see the problems that you face with your kind of data as somewhat separate from the whole integration of this system?

Ms. BROHL. Thank you—

Mr. GILCHREST. And I will let you answer that, but I suppose—I want to ask Mr. Cooper a question about the oil platforms already there and his suggestion that you could use that platform to hold one of the systems for ocean observing technology or a buoy, but you have a platform out there, so some of these ocean observing systems could be placed right on that platform. And that particular buoy or piece of equipment would do the full range of things, from temperature to wind to algal blooms, to you name it. Do you see that also doing this hydrographic survey?

Ms. BROHL. I think there are two issues on the table in this discussion about an integrated ocean system. One is the need to integrate data so it can be made available to more users and stakeholders and become more value-added. It makes a lot of sense to integrate. You do avoid the duplication of effort. You perhaps spend your money more wisely. It makes a lot of sense in that regard, and we are all on the same page when it comes to wanting to integrate data, and integrate first the data within the government and then, I am sure, integrate data that private sector universities are doing. So, again, it becomes more valuable to a greater number of users and stakeholders.

I think where we diverge is the method by which we would create an integrated system. We heard a lot about research, and I think there is the research component in discussions of integrated systems and then there is the actual integration. We are very much interested in the actual integration of systems and creating a system that is available everywhere you need it.

In maritime right now, the only time we have, other than water level gauges—in the Great Lakes we are a little bit different. We have some added funding there to upgrade our water level gauges to be real-time. But around the country, the only place that you have, let's say, real-time in the physical oceanographic real-time system, more like a GoMOOS, is where we actually paid for it ourselves. And we have been proponents of full Federal funding for real-time systems. And we believe that you could have them around the country, and we believe that there could be a base of information that is provided from those. And then where you need additional information that feeds very special interest needs could be dealt with separately.

We believe that platforms that provide basic information could be done under the Hydrographic Services Improvement Act. We believe that data could be made available—would be made available because it is now under NOAA's standards. You can go online to get this information. But instead of getting perhaps 10 port sites online and the water level gauges around the country updated every 8 hours or 7 hours, and the Great Lakes updated every 6 minutes, you would have a more dynamic system around the country, and everybody could take advantage.

Now, I believe that probably research interests could use the maritime stuff more than we could use the research stuff because their needs are far greater. We do not necessarily need to know the invasive species—someone mentioned that. We do not want to—

Mr. GILCHREST. So do you think the example that—Mr. Richert in Maine described his system going from natural gas—location of natural gas plants to cod larvae to salmon tracking studies to shipping. Do you think his system, GoMOOS, is a good example for how we would want to proceed with integrating this whole ocean observing system and then funding it? Is that a good—

Ms. BROHL. Absolutely. As a matter of fact, his testimony was ideal because it does show you the multidimensional aspects of real-time oceanographic observing systems.

Mr. GILCHREST. Can you tap into Mr. Richert's system?

Ms. BROHL. I do understand that the pilots in Maine do tap into that information and are used for navigation safety, absolutely. And I do not know whether you might call that a port site, which frankly is a red flag in appropriations committees, or whether you call it real-time monitoring systems. And they have a lot of—perhaps more bells and whistles than everybody needs everywhere around the country because you do not need everything. You do not need every single bell and whistle on every single site, which I think is what you would want to do in finding out what your local needs are to tailor-make. But, yes, ideally we would love to have

GoMOOS at all the 300 critical areas around the country that estimates say could be done for $50 million total and $15 million per year to maintain.

Mr. GILCHREST. Does Mr. Richert have the right bells and whistles in Maine?

Ms. BROHL. As long as he has them for Maine, that is the important thing.

Mr. GILCHREST. Mr. Richert, do you in your system have data collection for salinity and freshwater inputs? Do you have some data on the kind of salinity that ebbs and flows in your system?

Mr. RICHERT. Yes, we measure salinity at all of our buoy sites. Now, we do need to integrate and are in the process of integrating into our information system data on freshwater flows that might come from stream gauges and the like. You know, the big challenge is integrating all these data sources, distributed data sources into a synthesized product. And we are in the process of doing that. That is what our Ocean Data Partnership is all about.

Mr. GILCHREST. Does the maritime industry, the shipping industry, use that data?

Mr. RICHERT. Yes.

Mr. GILCHREST. I am almost—actually, I am pretty over my time because we did not turn the light on until I was talking already for about 10 minutes, so I have a few other questions, but I will yield to the gentleman from New Jersey.

Mr. PALLONE. Thank you, Mr. Chairman.

I wanted to ask about the need to authorize a national ocean observation system, again about the funding, which I think we have to constantly address and also the U.S. Ocean Commission recommendations. And anybody can answer this.

All of you testified as participants or users of existing regional ocean observation programs or comparable Federal, State, or university-based observation programs. And, in general, all of you are very enthusiastic about the potential benefits that an integrated national ocean observation system might produce. But that said, if the Congress were to take no action to authorize a national ocean observation system, what would be the effect on existing programs, either those established and operating today or those on the planning board? And along with that, what can be done to better inform the Congress of the multiple benefits of an integrated ocean observation system?

Again, I go back to why there is not more support for that kind of initiative. You do not all have to answer. I mean whoever—

Mr. RICHERT. I will give it a first shot. If we continue as we have over the last 5 or 7 years, some longer and many shorter, with building ocean observing systems based on earmarks, year-to-year earmarks, we will not have a system, period. We must have authorizing legislation, hopefully leading to appropriations. We need to get away from the funding methodology of earmarks. It would be—imagine the National Weather Service living on year-to-year earmarks. We would not have a system. The system depends on long-term reliability, the ability for people to know with certainty that the data are there day in, day out, year in, year out. And you cannot build a system based on the way that we are doing it now. It is a very high-risk way of doing it. So we have got to have authorizing legislation and hopefully leading quickly to appropriations.

Mr. GILCHREST. Dr. Grassle?

Dr. GRASSLE. Our system is not supported by earmarks. We have been supporting it by research projects where we compete nationally for funding for specific research projects. This means that our system, the part of our system which we try to maintain throughout the year in real-time is something that we support on the side, university funds and bits and pieces of the systems that are needed to support research.

This cannot be sustained. We have been very lucky in our ability to compete for research funds, but we cannot run a year-round system. My colleagues tell me that the high-frequency radar system that we have been running for the entire continental shelf, which the Coast Guard finds useful and I believe the maritime industry finds very useful. We have had two workshops with the maritime industry associated with the Port of New York and New Jersey, and they have talked to us about the various systems that they need. And that is one technology which gives currents in real-time that is generally useful both for ocean prediction, improving weather forecasts, and more specifically related to transport within the harbor.

We also make available satellite data out over the Internet for a constellation of satellites. These data are also useful for a wide variety of users. We cannot sustain that without some support for operational systems. It is not possible to maintain the systems that are needed by industry, by the public, on the basis of research funds, and so in that sense I agree with Ms. Brohl that the issue is not funding research. The issue is trying to provide the operational systems that are called for by industry and the general public.

Mr. PALLONE. You know, I might go on to the second set of questions because it relates to a lot of what you are saying, and then ask Ms. Brohl to cut. But I was going to ask, in addition, in terms of the funding aspect, you know, whether or not we can talk about creating a national system without first determining whether a dedicated source of revenue would be available. And then, you know, the question gets to be, you know, do you really think that we can sustain a national system based on regional programs with annual appropriations, you know, which is constantly competing with other Federal programs as opposed to a dedicated source of funding. You do not have to comment on that, but that was sort of my next question.

And then, of course, the third part of that is, you know, whether user fees could be used to generate funds to operate a national system. These are just different possible funding sources in the overall context of whether we should be authorizing a national system.

Ms. BROHL. Thank you for letting me jump in. We really appreciate the discussion about how to be more effective in providing real-time systems. The coalition believes there is already authorizing language, is authorizing law that does provide for this. In fact, the Hydrographic Services Improvement Act Amendments of 2002 includes that the—under Section 103(a)(4) says clearly, “The

Administrator of NOAA shall"—subject to availability of appropriations, of course—"design, install, maintain, and operate real-time hydrographic monitoring systems." It also provides it under the Tides and Currents line item under NOAA.

Now, the numbers are not large. The authorized amount for 2005 is $30 million. It was $27.5 million in 2004. We received $21.97 million.

The problem has laid in the fact that it clearly says that the Administrator shall fund these, but it has been NOAA's policy, the Department of Commerce's policy, OMB's policy, that they will not do that, that they will not design, install, maintain. They design them. They help install them under a "partnership," but the partnership is one of quality control and being able to funnel that information into a central source, which is great, but in effect, it is local pay will oversee.

It is the coalition's position that, in fact, the Federal Government should provide this information, because we do not believe that safe navigation should be a privilege by whoever can pay locally, but it should be a right. And, in fact, in maritime, you have navigation byways that are critical navigation areas, but they are not necessarily run by a port authority or there is not a coalition nearby. They may be along a major river, but who is going to be responsible for getting the money together for that major river?

And we have long felt that this should be something funded by the Federal Government. And in terms of not having money, the port site, which is the real-time oceanographic site that a lot of people use in the Philadelphia-Delaware region, is now not working. It got shut down because they could no longer come up with their money to pay for it because it is a couple hundred thousand dollars a year.

So it is not just building them. It is creating them. And we believe that if NOAA would take it upon themselves to implement a national plan to integrate through creating systems around the country similar to the GoMOOS platform or PORTS or real-time monitoring systems, however you want to describe it, it could be done in a very logical sense without huge—without these hundreds of millions of dollars. And then locally you determine where you add more bells and whistles to meet local needs, whether it is for resource management or whether it is for navigation or whether it is for research.

Mr. PALLONE. OK. I can go on in the second round after you, Mr. Chairman.

Mr. GILCHREST. All right. Thanks, Mr. Pallone.

Mr. Richert, can you give us some examples of how you fund your ongoing program? Is it through members that pay dues?

Mr. RICHERT. It has been primarily through the generosity of Congress.

Mr. GILCHREST. The people that use your information—

Mr. RICHERT. It is a free and open basis.

Mr. GILCHREST. Free and open basis.

Mr. RICHERT. All across the Internet. We have a membership base. We came together as a membership organization, users, educators, and others who wanted to use this data, and they all pay a fee, from $500, to $10,000 a year, to be members. But they—we—

all understand that we do not have any proprietary rights to the data collected as a result of that.

Mr. GILCHREST. How many people—I do not know. I guess I do not want to call that "dues," but you have people that pay from $500 to several thousands of dollars?

Mr. RICHERT. Ten thousand dollars a year.

Mr. GILCHREST. Ten thousand, and—

Mr. RICHERT. To be members of developing an ocean observing system.

Mr. GILCHREST. Why did they pay the money?

Mr. RICHERT. They paid because they knew that they had to have data that no one of them could provide, that by paying those dues they could create an organizational structure that could seek the funds to create the system.

Mr. GILCHREST. So they originally came in to pay those dues to create the structure of GoMOOS.

Mr. RICHERT. That is right.

Mr. GILCHREST. Which then subsequently received money from the Federal Government.

Mr. RICHERT. And to be part of this governance, so they helped to design the system.

Mr. GILCHREST. I see.

Mr. RICHERT. But we then—we get 90 percent of our funds—we have gotten 90 percent of our funds from earmarks over the last 4 years.

Mr. GILCHREST. So you could not function without Federal earmarks.

Mr. RICHERT. We could not, absolutely not. We also get funds from States. Our State, my State of Maine, has now provided us funding for some near-shore buoys, and we are working with the State government on a bond issue for marine infrastructure, of which we will be a part. I was director of the State Planning Office at the time that the system was being created, and my office provided through State dollars all of the planning money so that, you know, for the 18 months necessary to research the marketplace, to understand feasibility, to put together contracts—all of the logistics leading up to establishing the Gulf of Maine Ocean Observing System.

So, you know, a fair amount of resources come from other places, but the actual operations, which are $3 to $4 million a year, there is no place to turn other than the Federal Government for this. And since it is serving a purpose that is very consistent with a nationwide coastal environment, very much like the Weather Service, we think that it is money well spent.

Mr. GILCHREST. So you are comparing this to the National Weather Service as far as data to the general public, and you receive some monies from membership, which, as you said, makes up about 10 percent of the entire budget. And I am just trying to figure out how we are going to proceed here because a national program is going to be pretty tough to push through this peculiar mesh of members.

Mr. RICHERT. I understand.

Mr. GILCHREST. There are people who pay for membership.

Mr. RICHERT. Yes.

Mr. RICHERT. And I guess I am trying to figure out a way if it is possible to expand the number of people that use the system, whether it is lobstermen or a Greek ship coming in, or whoever, to bring in a few more dollars on the local level to add to the Federal dollars which are probably going to be inevitable.

Mr. RICHERT. Yes.

Mr. GILCHREST. Is it technically feasible since this information is on the Internet, is it technically feasible—

Mr. RICHERT. It is probably technically feasible, but it would be a great discouragement to the lobsterman who is out, you know, 2 miles and needs some data now, and now can call Dial-A-Buoy through the NOAA system and get the data they need.

It is certainly important, I think, as Dr. Spinrad said earlier, to think in terms of the value-added products that private industry is and will create out of this data to sell in a proprietary manner to all manner of industry. And that is great. But what we are producing really is a public good, just as the National Weather Service data is a public good. And by public good, I do not mean simply it is in the public interest; rather, I mean it is a good that is out there that, when consumed by somebody, is left in as good a condition for the next person to consume. And under those circumstances, you will not get one sector paying for it because of all the free riders that will be in the system.

If that were the system that worked, we would have the agricultural industry and the air industry paying for the entire National Weather Service. And, of course, that is not—that would be ludicrous, and it is not happening.

So this is a public good. We need to recognize it as a public good which has a Federal backbone component. It has a regional enhancement component to be customized to various regional needs. And there needs to be—and the Federal Government simply is going to, if we value this—and I hope that the return on investment will demonstrate how important it is. There will, in fact, be Federal authorizations and appropriations.

Now, I think, you know, over the last year, if you added up what is coming through earmarks primarily to the various nascent observing systems, it is beginning to approach $50 million, from NOAA and from ONR primarily, you know, somewhere in the $40 to $50 million range. I would just strongly recommend consideration of consolidating all those earmarks.

Mr. GILCHREST. You are saying the potential costs for a national integrated ocean system would be in the neighborhood, at least to start off with, the same level of earmarks, which is about $50 million?

Mr. RICHERT. No, it is going to be more than that.

Mr. GILCHREST. Could you do it for $100 million? We are having an auction here.

[Laughter.]

Mr. RICHERT. The initial estimate was about $138 million.

Mr. GILCHREST. I see.

Mr. RICHERT. For the first year, and then it ramps up. But I do think that it would be possible, if we need to start small, to start in the $50 to $100 million range, to have competitive programs for which the aspiring regional associations might compete, to define some pilot kinds of efforts in different parts of the country, at different stages of maturity, and see what we can learn out of those things as we aim toward more complete funding on the out-years.

Mr. GILCHREST. So that sounds like an interesting proposal, an evolving process to get the kinks out, a few pilot projects, see how the system would work.

I think another thing you all might want to think about, as we will try to think about it here along with everything else that we do with Iraq and Afghanistan and prescription drugs for seniors and funding highway projects—God knows what else. On a number of issues that we deal with here, we have a dedicated source of revenue that helps with that. I know it would be a little difficult for this, but is it possible to have a dedicated revenue stream that would be part of the resources made available to create this pilot project for an ocean observing system?

I want to ask Ms. Brohl one other question. This is not a loaded question. Would your association be willing to pay for some of this information on an ongoing basis as members of some sort?

Ms. BROHL. Our members already pay for it. As a matter of fact, because NOAA has specifically denied—or has specifically made it their policy not to fund real-time monitoring systems, those 10 port sites around the country which were created by maritime are paid for by maritime to maintain.

Mr. GILCHREST. Annual dues of some sort?

Ms. BROHL. No. Basically, everybody goes into the pockets. It might be a port authority put up a major chunk of the money. And it could be the marine exchanges. But the fact of the matter is that the—I think the one in Tampa was languishing. The hardware was falling apart. They could not maintain it. The one in the Delaware River is now shut down because they cannot come up with the money locally anymore. It really is like trying to squeeze blood.

From the maritime vessel side, GAO did an analysis on how many user fees are already paid by the commercial cargo ships that provide 95 percent of the trade to the United States, and they pay over 120 user fees already, not the least of which is hundreds of millions of dollars that go into the Harbor Maintenance Trust Fund that are just sitting there. That is supposed to go for dredging, but we know that there are ports on the west coast that do not really have dredging needs and would like to see fund used for other uses

We from the coalition have dabbled with the idea of trying to get consideration of those hundreds of millions of dollars for these kind of things that impact the safety, the navigation safety of a harbor. And, of course, it becomes this—it is a very difficult subject as soon as you gets ports with different needs involved in the issue. However, maritime does pay for—ultimately pay for the dredging. They pay for all these things. And with all due respect, I know that more port sites are going online. One just came on in Tacoma. I know that the individual who directs the PORTS effort in NOAA is out every day on the road, almost, bringing in people all the time who are interested in participating.

The long-term prognosis, though, for that I think is grim, and I think that Mr. Richert said it very well, that if in the end in the long run you are doing it individually, piecemeal, is it as effective? Can you maintain it? Are you really then going toward an integrated system? And isn't that the point of this discussion, that we really want an integrated system and we are all on the same page?

We already have in place a mechanism to do that. That is under the COOPS program. We really believe that the GoMOOS program should be incorporated into that. They get their earmark from ONR. The Great Lakes gets their earmark from the Hydrographic Services line item. In the end, we have so many good examples. We have models in place. We have—I think it is really basically a go, and all it needs is a nod from OMB in the budget—

Mr. GILCHREST. A nod from OMB.

[Laughter.]

Ms. BROHL. No minor detail, I know.

Mr. GILCHREST. Remember when we said earlier that we know more about the surface of the moon than we do about the oceans?

Ms. BROHL. Yes, sir.

Mr. GILCHREST. Well, we know more about the surface of the moon than we know about OMB. That mystery entity up there on the other side of town. Very rarely do we see an actual human being from OMB.

Ms. BROHL. We hear there are some, rumor has it.

Mr. GILCHREST. We will do our best to get their nod.

I have another question, and we are really trying to find out the best pieces of information to put this puzzle together so we can make a go of it up here with our colleagues on the House side. And your testimony so far has been very helpful, very beneficial to that end.

I wanted to ask Ms. McCammon a question that you mentioned and you also commented in your testimony, which is on the same wavelength as we are here as far as trying to get funding for an integrated system nationally. You mentioned a cost/benefit analysis for planning and developing a number of the components with the system. Are you currently now doing a cost/benefit analysis? Have you collected any of that data? Do you have the results of it?

Ms. MCCAMMON. Mr. Chairman, not yet. What we are doing right now is identifying what the needs are, and then we will go and start doing the cost/benefit analysis to determine what priorities we give those needs.

You look at Alaska and 47,000 miles of coastline, and they are huge. You could just do a complete laundry list and go on for pages and pages and pages documenting the needs up there. But, obviously, no matter how well funded the program ultimately is, we are going to have to prioritize. And so we are going to have to see how we can get the biggest bang for our buck.

I think Ms. Brohl actually made a very compelling case for the need for an integrated system. She argued about the difficulty for getting funding for the port systems in the Federal budget. But I believe that the more you work with the various user groups so that you have multiple users using the same system, then you are building a larger constituency.

When you look at the demographics of this country, where are people living? They are living on the coast. They are moving to the coast. They are living within 25 miles of the coast. If you look at Alaska, it is a coastal State. That is where people are. They are using the coast.

I think you would need to respond to your constituents. That is where the constituents are living in this country. So I think there is a very compelling case there.

The problem that we have had in kind of selling this program is that I think it is a natural human tendency to respond to crises. And so the tendency is to fund—we call it the crisis of the day in Alaska, and we always have lots of them. If you look at the $160 million that have been spent on stellar sea lion research in the last 5 years alone, trying to figure out what is causing the decline of the stellar sea lion, if you had spent that on long-term research, on long-term monitoring over the prior 20 years, I would guess that we probably would know more about what is happening with stellar sea lions than trying to spend it all in a few short years.

It is sometimes a hard argument to make to people because you have a tendency to want to respond and do something today. But I think it really calls out for this long-term commitment to monitoring. And there are a number of cases that are being made now in pilot projects across the country that I think we have the ability to sell that case to Congress and to the people who live along the coast.

Mr. GILCHREST. Well, we are buying into it right now, at least two members.

I wanted to ask a question of Ms. McCammon and Mr. Richert. On your systems, to some extent—and I guess also Dr. Grassle, your systems are underway now, California, Alaska, and in Maine, in various ways. As we pursue this nationally, there will be other issues as well, more interest in fisheries issues, and then more interest as we move along in global warming issues, especially with increasing storms, rain events, coastal erosion, coastal communities, and things like that.

So as your system is now developed to meet various user needs and as you are moving forward with these systems, are you including or is there a potential to include in your systems an ecosystem approach to fishery management plans, for example, or an understanding that there is or there may be actual global warming underway, so what is the impact in coastal areas and what does that mean for the change in freshwater versus salinity, the temperature, ocean currents and so on? Are the two things being implemented, integrated, an ecosystem approach and global warming?

Ms. MCCAMMON. Mr. Chairman, I will start with that. Absolutely. I mean, one of our—two of our largest user groups or clients of a system like this would be resource managers, and certainly fisheries is a huge component of resource management in the State of Alaska. So we have to incorporate those kinds of things.

The fisheries managers want these kinds of long-term observations. They want to know: Is it the effect of fishing that is causing changes in populations, or is it natural variability or is it some kind of a Pacific decadal oscillation? Are these short-term changes? Are they long-term changes?

Just 2 weeks ago, the Senate Appropriations Committee held a hearing in Anchorage on coastal erosion. We know that there are increased extreme storm events in Alaska that are affecting the communities of Kivalina, Shishmaref, Barrow, and others on the west coast of Alaska. To move these communities would cost—I think the estimates they were using is $1 million per person in these villages, to move these communities. This is a huge potential cost. And so the better we can predict what is going to happen with climate change and coastal effects, the better prepared these communities can be. Can they use some kind of new technology? Can they start moving more slowly? What does this mean for building airports and things like that in these communities? This is the kind of information that we do not need 50 years from now. We need it now.

So, yes, to both your questions.

Mr. GILCHREST. Thank you.

Mr. RICHERT. I will follow, and then I will let the dean of this topic, Dr. Grassle, bat cleanup.

This is a great question, and thank you, and it is the kind of thing that we are just very passionate about and could talk for hours about. So I am just going to give you two pieces of information about how we are, in fact, very consciously integrating our system into the world of ecosystem-based management.

One is that we now are striking up a relationship, we now have a formal relationship through a memorandum of understanding with the National Marine Fisheries Service and with the Maine Department of Marine Resources and Massachusetts and New Hampshire and their Canadian counterparts, because we are now recognizing that their fisheries surveys—bottom trawl surveys—are every bit as much critical observations as our real-time observations of sea surface temperature, currents, and so forth. And the real treasure lies when we are able to bring the biological surveys that have been going on for decades together with the physical oceanographic kind of monitoring that we do.

To do that, we have established a formal Gulf of Maine Ocean Data Partnership, which has brought together 15 of the largest marine data generators, geological, physical, and biological and cultural, together and in which we are committed to creating a system of data exchange, real-time, on the fly, continually updated data exchange so that users out there can get the benefit of these multiple sets of data without having to go try to track each one of them down individually, very difficult, and, in fact, something not done.

There is a technical challenge here that we are trying to overcome, and there is an institutional one, and the purpose of the partnership is to overcome especially the institutional one. So that is happening.

But, second, we are already experimenting at GoMOOS and have a pilot project in which we have, probably with the help of the Census of Marine Life, which I am involved with and which Dr. Grassle is involved with as well, been able on a small basis to bring in—this was a project needed by the Northern Shrimp Council, which is trying to understand the abundance and fate of the Northern shrimp, which are very sensitive to bottom-water temperatures.

And so what we have done is set up a system which brings in data from NMFS on shrimp and then brings an entirely different data base in from the State agencies and then joins that to an entirely third data base, which is the GoMOOS data from buoys that are situated in a place that is relevant to the species.

When you go onto www.gomoos.org, you will see Northern shrimp project, and you will see how that tool is being made available to the decisionmakers on the Shrimp Council because this fall they have to make decisions about catch limitations and so forth for the coming year.

So we are in the primitive stages of this, but we are moving toward it, and it is a very exciting arena for us to be in.

Mr. GILCHREST. Thank you very much.

Mr. RICHERT. Dr. Grassle really is the expert.

Dr. GRASSLE. I am very involved in the Census of Marine Life internationally because it is an international program that aims to study life in the oceans in greater depth than ever before. As Evan said, a major part of it is understanding fish populations, because if you cannot understand the fish populations, and particularly the commercial fish, you are not doing a very good job of understanding life in the oceans in general. So some of the major parts of that are a tagging program which tags large pelagic organisms and tracks them throughout the Pacific.

You heard earlier that there is a global ocean observing system that depends on argo floats. Some of those same transmitters go on to tuna and turtles and elephant seals and albatross. They carry the same kinds of measuring systems that would be used in the normal observing system, but you get the bonus that you see where the animals are going.

Mr. GILCHREST. How do you track the albatross?

Dr. GRASSLE. I should not have said albatross. Excuse me. I should not have referred to albatross, sorry.

Mr. GILCHREST. Oh, you should not have included albatross?

Dr. GRASSLE. Well, they are tracking albatross, but they give less underwater information.

Mr. GILCHREST. I see. But you can follow those albatross.

Dr. GRASSLE. Tracking the flights of the albatross, yes.

Mr. GILCHREST. Were you involved in the recent race of the albatross that I read in the paper?

Dr. GRASSLE. No. But this work is being done from California. Barbara Block is the leader of that program. But there is also studies of tracking salmon from the estuaries, and this really will be a part of the observing system, putting in listening posts that are little bit like the gates that are used for tracking cars. If you space the posts, each tagged animal when it passes through those gets recorded. And there are extraordinary findings about the migrations of fish. We have a system of that off our own coast. In New Jersey, we have set up a system for fish tagged in Casco Bay in Maine. One of them turned up in our estuary.

Mr. GILCHREST. What kind of fish was it?

Dr. GRASSLE. It was a striped bass. We are focusing right now on—

Mr. GILCHREST. I think he was heading to the Chesapeake Bay.

Dr. GRASSLE. Well, it turns out we find that out because our colleagues in Casco found him up in Casco Bay again. So that is the kind of thing we—you know, that kind of technology has tremendous consequences for really understanding our fish stocks. And related to that, we have put in—we have been working with the National Marine Fisheries Service and our fishing industry in New

Jersey, which is quite well organized, and they have been interested in improving stock assessment, and in some cases they have put up some of their own funds to help supplement the regular stock assessment the National Marine Fisheries does.

Part of the stock assessment depends on repeating the same kinds of sampling program year after year, but NMFS and the fishing industry and Rutgers University have been working together to supplement that and try to improve the stock assessment approach. And part of that is to use the observing system to adaptively sample where the fish might be. In other words, you go back to the same place every year and look at the stocks, but the fish do not pay attention to geographic points. They respond to the ocean. And so you use the observing system to adaptively sample where the fish might be. Then you can increase the accuracy of the stock assessments.

Mr. GILCHREST. I see. Thank you very much.

Dr. Garfield?

Dr. GARFIELD. Mr. Chairman, you mentioned California when you stated the question, so if I can just add one point here.

I think Ms. Brohl did an excellent job stating some of the navigation needs, but I would like to come back and remind everyone that coastal navigation is only one of the goals of IOOS. It is not the only one. So there is a whole list of national priorities. In our program, we are trying to—in our various programs in California, we are trying to recognize those and plan for these additions as you come on. And one factor that I would just like to get into the record because I think it is very pertinent to this argument, some of our beachgoers has major economic impact along the coast. But not only that, the looming impact of sea level rise. We need some of these ocean observing systems to ensure that we understand what is going on, because I don't know who should pay for it, but the economic impact of what is going to happen along our coasts if we do not understand this and plan for it is going to be pretty high.

Mr. GILCHREST. Thank you very much.

I know this hearing is going on, but I am just pretending that every member has shown up today and we are giving them all a chance to ask questions.

[Laughter.]

Mr. GILCHREST. I may close with this one, and I appreciate all of you staying for this length of time, but I wanted to focus on sort of the technical aspects of this. Mr. Cooper, we mentioned earlier and you mentioned that the potential exists for the platforms to be used for this whole ocean observing system. What type of technology would be put on platforms, oil platforms, either off California in the gulf, to collect data?

Mr. COOPER. Well, we have had quite a lot of experience in collecting physical oceanographic data off of platforms. As I mentioned to you, we have got about 15 sites in the deepwater Gulf of Mexico that are active now. They use what is known as an acoustic Doppler current profiler. It basically sends out a sonar beam and can sample ocean currents down to about 1,000 meters in the water column.

Mr. GILCHREST. Now, who uses that data?

Mr. COOPER. We use it a lot for our operational purposes. For example, I mentioned to you the loop current. It generates very strong currents in the gulf, and those currents can shut down drill rigs for weeks at a time.

Mr. GILCHREST. Now, are those loop currents predictable? Are they variable? Have you seen them change in recent years?

Mr. COOPER. The loop basically does vary a lot over the span of about a year. You know, at its southern extreme, it will be just off the tip of Cuba. At its northern extreme, it will be nearly to Pensacola. And about once a year it pinches off an eddy, and then that eddy migrates out into the western gulf.

Mr. GILCHREST. What do you mean it pinches off an eddy? The eddy causes it to happen?

Mr. COOPER. No. The loop itself becomes basically unstable, much as—I do not know if you recall, Bob Weller showed a picture of the Gulf Stream. It does the same kinds of things. It will pinch off large eddies that then migrate over and eventually hit—

Mr. GILCHREST. What causes a loop current? Just the geological feature of the Gulf of Mexico?

Mr. COOPER. It is partially that. It is partially the trade winds coming in from the east that then pile the water up against the Mexican coast. And then, of course, you have got to Yucatan Straits there that offer an outlet and essentially then it loops up into the eastern gulf and then out through the Florida Straits. It is essentially the precursor of the Gulf Stream.

Now, in terms of whether we have seen long-term changes, I would say we do not have enough data really to say one way or another. And basically we have been working on forecast models. We would love to be able to forecast the loop current incursion, you know, a month ahead of time so that we could modify our operational plans. But so far we have not been successful with that.

Mr. GILCHREST. Is this loop current more likely the result of just the geography of the Gulf of Mexico as opposed to warming sea surface temperatures?

Mr. COOPER. Yes. For all we know, it has been there for millennia. It is essentially the precursor of the Gulf Stream, so, you know, as the Gulf Stream goes and comes, so would the—

Mr. GILCHREST. If the Gulf Stream changes, that conveyor belt that forces the Gulf Stream to be there, would that change the loop current?

Mr. COOPER. It certainly could.

Mr. GILCHREST. Well, we almost escaped with that as the last question, but our colleague is back from the Indian gaming hearing. And he was betting we would still be here. I yield to the gentleman from New Jersey.

Mr. PALLONE. Thank you. I do not know if I explained that, you know, the full committee is having a hearing at the same time down the hall.

Anyway, I just wanted to ask Dr. Toby Garfield a question, because you commented on how—or could you comment I should say, because I know that the State of California has moved ahead to provide State funding for the development of two regional programs. What was behind the support for this public investment? I mean, obviously, it is another funding source that maybe we should have commented on at the committee today.

Dr. GARFIELD. Yes, thank you, Mr. Pallone. The funding source for that was State propositions. The voters in California can put forward a proposition; if they get enough signatures, it goes on the ballot. And so this was part of a Water Quality Act—actually, two Water Quality Acts. The total I think was $5.8 billion. Of that amount of money that was voted in and authorized, $21 million was authorized for coastal circulation.

Mr. PALLONE. And so it was voted on by the whole State, the voters.

Dr. GARFIELD. By the whole State.

Mr. PALLONE. See, we do not have that type of initiative in most States, though. That does not exist in most States.

Dr. GARFIELD. Right. I recognize that.

Mr. PALLONE. Some people would say, "Good," but—

[Laughter.]

Dr. GARFIELD. When it comes to recalls on things, it provides some interesting days.

Mr. PALLONE. All right. Let me just—

Dr. GARFIELD. Could I just add one more comment?

Mr. PALLONE. Sure.

Dr. GARFIELD. One other reason, I think, that I thank this committee for looking at authorizing this is the question of liability that Mr. Cooper raised and that was raised earlier, that as we develop these systems, if we do not address that question about liability, it could be very hard for a lot of these operations to keep going because it is a big looming question for all of us.

Mr. PALLONE. OK. And then I just wanted to ask a couple questions, Mr. Chairman, about the U.S. Ocean Commission recommendations. You are all familiar, I think, with the—

Mr. GILCHREST. Should we turn the light on?

Mr. PALLONE. You want to turn it on or off?

[Laughter.]

Mr. PALLONE. I am sorry.

Mr. GILCHREST. That is all right. Go ahead.

Mr. PALLONE. I will be fast. You know, they, of course, recommended the integrated ocean observing system. Are all of you in support of the Commission's recommendations? In other words, in general, are you in agreement with the various organizational recommendations, especially leadership through NOAA and Ocean.US. You do not have to all—if anybody would like to comment on that? Dr. Grassle?

Dr. GRASSLE. Yes, I was on the Science Advisory Board to the Commission, and I strongly support their recommendations. I was surprised that the Administration did not embrace the idea of the National Ocean Council. I think that would be a useful complement to the Congress' effort to build an observing system for the oceans and, in general, be a complement to the development of a national ocean policy.

There are quite a number of recommendations that relate to the observing system throughout the report, and my written testimony goes into that. But, in general, I think that the recommendations are consistent with those that are in the latest, very lengthy description of IOOS which is on the website.

Mr. PALLONE. Does anybody else want to comment on that?

Mr. RICHERT. I will just say that we support the recommendations in general. There was some difference in language and terminology with respect, for example, to regional associations. But, by and large, the meaning is the same, and we were very pleased with the report.

Mr. PALLONE. Well, that was sort of my second question, you know, whether or not the process implemented by Ocean.US to develop a national implementation plan adequately involved existing regional programs. Maybe you can comment on that, too, in the context of it.

Mr. RICHERT. They have been terrific. Ocean.US has been extremely dutiful and conscientious in making this a grass-roots effort and bringing in a lot of interests and stakeholders and regions.

Mr. PALLONE. OK. Go ahead. Anybody else? Ms. Brohl had a comment. You can go ahead.

Dr. GRASSLE. One of the important parts of the Ocean Commission recommendations is that they recommend funding NOAA, but they also—that is a vehicle for funding what will be the equivalent of a national ocean partnership. They changed the name of the National Ocean Research Leadership Council to a different name, and that is a coordinating mechanism for funding in other agencies as well. And so I think that an essential part of the observing system funding is that all agencies are involved, and there has to be some cross-cutting structure for ocean science to do that.

Mr. PALLONE. Do you want to comment?

Ms. BROHL. It is as close to a loaded question as there has been today. From our perspective, we kind of keep asking ourselves what came first, the Ocean.US vision of IOOS or the Ocean Commission's vision of IOOS. And I think they all become kind of blended at some point. And it does not really matter whether you say, gee, do you like the recommendations of the Ocean Commission or do you like how NOAA has a vision for IOOS through the Ocean.US, because Ocean.US and NOAA are very intertwined.

At no time so far has commercial maritime been engaged in Ocean.US or IOOS development. Now, the GoMOOS is an exception. They started before this whole regional association concept got some funding. The coalition has met with Dr. Spinrad to say there is something wrong with this picture, because we are intimately tied to the whole development of real-time monitoring systems. We have funded them. We have been in partnership with NOAA on them. Ad we find it just amazing that there is not one commercial maritime in any of the development boards for any of the regional associations.

However, we have been assured by Dr. Spinrad that, to quote him, "the train is not out of the station" with regard to regional associations, that they are merely in development, and that their goal is, in fact, not just to receive research funding and that, in fact, they do have commercial maritime interests in mind.

That has not really happened yet. We are still in that process of discussion. And to give Dr. Spinrad credit, he has created on behalf of commercial maritime interests through the coalition. There is going to be a public meeting to brief commercial maritime on what IOOS is and the NOAA vision, this Ocean.US vision of maritime, and that will be held on July 30th in New York City. And we will be glad to get you that information and make sure that information is forwarded to the Subcommittee.

But the vision right now of IOOS from our perspective is very narrowly channeled toward universities and research funding, and we see a gap between that and the idea of really integrating data and creating systems by which we can read data.

The Chairman asked me a question before, where do we stand on this? And we see two very separate issues on the table here. One is this vision of let's integrate data. We need to do it. We heard lots of good reasons why you have got so many different people creating systems. Let's integrate that. Let's standardize it. Let's make sure it can all be channeled through perhaps COOPS and their online access. That would be terrific. Then we all benefit.

We can enhance that through existing authorization by increasing more water level—excuse me, real-time water hydro monitoring platforms, let's say, enhance them based upon maritime and resource management and research needs.

Now, the whole concept of a big huge process in regional associations, because of the way they have been presented so far and organized so far and the fact that commercial maritime has not been a part of the process at all so far, we just have a lot of questions and wonder whether the train is really way ahead of us and whether there is a possibility of chasing it and catching up, which we would like to do.

Mr. PALLONE. OK. Just one more thing. The Commission recommended funding an integrated ocean observing system through one line item in NOAA's budget. Now, you know, given that that would eliminate the congressional earmarks for specific programs, does that pose a problem? Or what would your reaction be to that? And I promise not to ask anything else.

Dr. GARFIELD. In California, we really would like to promote a broad interagency approach.

Mr. PALLONE. OK.

Ms. MCCAMMON. I would agree with that in Alaska. I know there was some concern expressed about having all the funding go through NOAA because the idea is that there would be this plan that was developed in conjunction with regional associations expressing the needs for other agencies other than NOAA, such as Interior, USGS, NASA, the Navy. And so there was some concern about the funding going through NOAA because the idea is that it goes to NOAA, but then it would go out to those other agencies according to a plan recommended by Ocean.US and adopted by NORLC, the National Ocean Research Leadership Council. So as long as it followed kind of that strategy, we would support it.

Mr. RICHERT. I agree with Molly. I have no problem with the money going through NOAA. I think that in the end may be the practical thing to do, as long as that money then is disbursed according to a plan adopted by the National Ocean Research Leadership Council and that there was monitoring and enforcement of that disbursement in that manner.

Mr. GILCHREST. So instead of saying NOAA may distribute this money, we will put "NOAA shall distribute this money."

Mr. RICHERT. Yes.

Mr. GILCHREST. I just want to say, Ms. Brohl, that this is not about a train leaving the station, which is usually accelerating at a high speed in a short period of time. It is about a ship leaving the harbor.

[Laughter.]

Mr. GILCHREST. It has not left the harbor yet. It is still tied up. Of course, we do not want to keep it tied up, but we will make sure you will all be included in these discussions in the coming weeks and months ahead.

I do have another appointment at 2 o'clock. I had one at 1:30. I am not sure if the gaming hearing is over yet, Mr. Pallone.

Mr. PALLONE. It is over.

Mr. GILCHREST. It is over. Anyway, I truly want to thank all of you, we want to thank all of you for your vital input this afternoon. It has been exceptional, and we will take your testimony and blend it in with legislation that we hope will come up in the not too distant future.

Thank you all very, very much. This hearing is adjourned.

[Whereupon, at 1:52 p.m., the Subcommittee was adjourned.]

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