# THE CORAL REEF CONSERVATION ACT OF 2000, EXECUTIVE ORDER 13089, AND THE OCEANIC CONDITIONS CONTRIBUTING TO CORAL REEF DECLINE

## OVERSIGHT HEARING

BEFORE THE

SUBCOMMITTEE ON FISHERIES CONSERVATION, WILDLIFE AND OCEANS

OF THE

COMMITTEE ON RESOURCES
U.S. HOUSE OF REPRESENTATIVES

ONE HUNDRED SEVENTH CONGRESS

SECOND SESSION

June 27, 2002

**Serial No. 107-134**

Printed for the use of the Committee on Resources

Available via the World Wide Web: http://www.access.gpo.gov/congress/house
or
Committee address: http://resourcescommittee.house.gov

U.S. GOVERNMENT PRINTING OFFICE

80-420 PS WASHINGTON : 2002

For sale by the Superintendent of Documents, U.S. Government Printing Office
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# C O N T E N T S

# OVERSIGHT HEARING ON THE CORAL REEF CONSERVATION ACT OF 2000, EXECUTIVE ORDER 13089, AND THE OCEANIC CONDITIONS CONTRIBUTING TO CORAL REEF DECLINE

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**Thursday, June 27, 2002**
**U.S. House of Representatives**
**Subcommittee on Fisheries Conservation, Wildlife and Oceans**
**Committee on Resources**
**Washington, DC**

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The Subcommittee met, pursuant to other business, at 10:24 a.m., in room 1324, Longworth House Office Building, Hon. Wayne Gilchrest [Chairman of the Subcommittee] presiding.

Mr. GILCHREST. We now turn our attention to the oversight hearing on coral reefs.

I would like to ask the Honorable Craig Manson, the Assistant Secretary for Fish, Wildlife and Parks, Department of Interior; Mr. Timothy Keeney, Deputy Assistant Secretary for Oceans and Atmosphere, National Oceanic and Atmospheric Administration, U.S. Department of Commerce; Mr. Jack Sobel, Senior Director, Ecosystem Protection Program, the Ocean Conservancy to come forward.

Thank you, gentlemen for being here this morning.

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

Mr. GILCHREST. Today, we are holding a hearing on a matter of great importance to all of us. Working with John Olver and a number of other members, we have a Climate Change Caucus which is working as hard as it can as a caucus in the Congress to inform members about some of the problems and the nature of the environmental variables that will spin out of control if there is no change in our energy policy.

One of those degrading environmental variables is the depletion of coral reefs and the food web and ecosystem that is disrupted and then fragmented and then what are the consequences of that along with a number of other things.

Just last week, two major articles were published that described coral diseases that have been inflicting significant mortality world-

wide. These articles focused on different diseases, but both made the same connection: coral diseases are increasing in prevalence and severity as ocean waters warm in response to global warming and climate change. One article reported that bacteria commonly associated with human waste were responsible for a lethal coral disease found in the Florida Keys. This is just another disturbing example of how far the reach of human activity extends into the natural world.

Today, we have two panels of experts testifying. The first panel is to testify on the implementation of the Coral Reef Conservation Act of 2000 and the Executive Order 13089 concerning coral reef protection by the Executive Agencies. Coral reef activities conducted by NOAA were funded last year at—it says at "over" $28 million. I guess the testimony should say "At only a small amount of $28 million, that should be increased." Change that line in the opening statement.

We are seeking to examine what activities have been conducted and, importantly, the level of success that they have achieved.

The second panel consists of experts in paleobiology, climatology, and oceanography. They will speak on the multiple impacts of climate change on coral reef ecosystems. I appreciate these scientists coming from across the U.S. to testify on this issue that is gravely important to our marine ecosystems.

We are at an important point in time, a time where historically unprecedented declines in the coral ecosystems are occurring. They are not just predicted or something that may happen; they are occurring right now.

This is also a time when scientists around the world have made connections between human impacts on climate and the die-offs of corals in the oceans. It would be a national tragedy and a monumental mistake if we lost our nation's coral reefs, our rain forests of the ocean, because we as policymakers failed to pay attention to the preponderance of evidence linking coral reef decline to climate change.

So, I look forward to your testimony this morning as to how effective U.S. policy has been up to this point and how we can communicate the importance of that so we can increase the appropriations to this effort.

Also, it may not be in your testimony today, but if you have any ideas on how we can communicate the kind of data that seems to be fairly prevalent among the scientific community that this great chasm apparently exists between that and policymakers, whether it is a local elected official or elected officials on the national level or those in the international community.

I was remarking this morning to one of my staff that it would be interesting to fund a GAO study to see what the percentage as a whole of dialog in Congress is based on merit or based on—I use the acronym or the term—BS. It would be interesting to see how that flowed. Of course, I guess you would have to establish some criteria or methodology to do that.

I am not impugning the integrity of my colleagues, because I am one of those members. But as we weave through this maze of policy in the U.S. Congress, your effort, I would say, needs to be quadrupled, not only at the hearings where we testify, but a challenge

to take what you know to the community so the Nation as a whole has a basic frame of reference for what is important as far as the climate is concerned.

One last comment: I just hope that our great, great grandchildren who will be young people in the 21st Century will look back on the policymakers and the judgments and decisions we made in the past and the next couple of years and either bless us for our prudence and our foresight, or be very disappointed because they bear the ramifications of those decisions.

At any rate, I guess I feel philosophical this morning. You don't need to bear the brunt of that.

[The prepared statement of Mr. Gilchrest follows:]

**Statement of The Honorable Wayne T. Gilchrest, a Representative in Congress from the State of Maryland**

Good morning, today we are holding a hearing on a matter of great importance to myself and many other Subcommittee members, the decline of coral reef ecosystems and whether Federal actions to protect them have been successful.

As the Co-Chair of the House Climate Caucus along with my colleague and friend from Massachusetts John Olver, I am particularly interested in the variety of ecological effects produced by climate change. This hearing will examine one of the most striking and disturbing, the effect of climate change on coral reefs.

World wide, coral reef ecosystems are in decline. Once vibrant colorful communities, many reefs are now bleached and depleted ruins. These magnificent ecosystems, that are so rich in life, diversity, and beauty are under a constant pressure from many fronts. Marine scientists have documented a series of ills responsible for killing the reefs. The problems range from destructive fishing practices like using dynamite, to new and undescribed diseases, and increases in sea temperatures that cause mass die-offs of corals.

Just last week, two major articles were published that describe coral diseases that have been inflicting significant mortality worldwide. These articles focused on different diseases, but both made the same connection—coral diseases are increasing in prevalence and severity as ocean waters warm in response to global warming and climate change. One article reported that bacteria commonly associated with human waste were responsible for a lethal coral disease found in the Florida Keys—another disturbing example of how far our reach extends.

Today, we have two panels of expert witnesses testifying. The first panel is to testify on the implementation of the Coral Reef Conservation Act of 2000 and Executive Order 13089 concerning coral reef protection by the Executive Agencies. Coral reef activities conducted by NOAA were funded last year at over $28 million. We are seeking to examine what activities have been conducted and importantly the level of success they have achieved.

The second panel, consists of experts in paleobiology, climatology, and oceanography. They will speak on the multiple impacts of climate change on coral reef ecosystems. I appreciate these scientists coming from across the U.S. to testify on this issue that is so gravely important to our marine ecosystems.

We are at an important point in time. A time where historically unprecedented declines in the coral ecosystems are occurring—they are not just predicted, or something that may happen—they are occurring right now. This is also a time when scientists around the world have made connections between human impacts on climate and the dieoffs of corals in ocean.

It would be a national tragedy and a monumental mistake if we lost our nation's coral reefs—our rainforests of the ocean—because we as policy makers failed to pay attention to the preponderance of evidence linking coral reef decline to climate change.

I appreciate our witnesses coming today, and I look forward to hearing what they have to say.

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Mr. GILCHREST. I would like to start this morning with the Honorable Craig Manson, Assistant Secretary for Fish, Wildlife and Parks. You may begin, sir.

**STATEMENT OF HON. CRAIG MANSON, ASSISTANT SECRETARY FOR FISH, WILDLIFE AND PARKS, U.S. DEPARTMENT OF THE INTERIOR**

Judge MANSON. Thank you, Mr. Chairman. I appreciate the opportunity to appear before you today. This is the first time that I have had the pleasure of appearing before this particular Subcommittee. Of course, it is on an issue of considerable interest to all of us.

As part of my duties as Assistant Secretary for Fish, Wildlife and Parks, Secretary Norton has delegated to me the role of Co-Chairman of the United States Coral Reef Task Force. The Task Force was established by Executive Order 4 years ago. It was directed to inventory, monitor and identify the major causes and consequences of degradation of coral reef ecosystems.

The chairmanship is shared jointly by the Departments of Interior and Commerce.

The task force has developed and approved a national action plan to carry out its Executive Order mandate and a charter to formalize its operations. The final text of an implementation policy, which was developed largely prior to my confirmation, is currently under review. I anticipate that we will go forward with the final policy following the next task force meeting, which is set for early October.

The Department of Interior is the nation's largest manager of coral reefs. The United States Fish and Wildlife Service manages 13 National Wildlife Refuges that include 2.9 million acres of coral reefs habitat and associated ocean habitat. Ten of these are in the Pacific. Three are in South Florida and the Caribbean.

The National Park Service has ten units that include about 275 acres of coral reef and associated ocean habitat mainly in the South Atlantic and the Caribbean. They host about 1.5 million visitors a year and generate millions of dollars for the local economies.

Other bureaus of the department are involved as well. The minerals management service conducts research into the effects of oil spills on coral reefs. The United States Geological Survey has conducted extensive research in all aspects of coral reef ecosystem health.

The Office of Insular Affairs which has responsibility for the territories such as American Samoa, Guam, the Commonwealth of the Northern Mariana Islands, and the Virgin Islands has assisted those territories and the associated States, the Federated States of Micronesia, the Republic of the Marshall Islands, and Palau in coordination with NOAA to obtain funding to care for their coral reefs.

There are a few issues that I would like to focus on today. The first is a frank admission that our coral reef activities in the department have not had the policy oversight during a rather prolonged transition at the Department of Interior. The career staffs of the Bureaus did an outstanding job in ensuring that nothing went backwards. But until recently, we had too few senior political appointees with too many issues for coral reefs to become a priority.

I am addressing this now and you will see considerably more attention toward and visibility from our coral reef activities in the future.

On a much more positive note, Dr. Robert Buddemeier, one of the world's leading coral researchers is, as you noted, testifying on the next panel. He is going to propose that our Pacific Island refuges, because of the longitudinal scale of the system and their protected status, serve as platforms for a long-range research project on the impacts of global climate change on coral reefs and the ocean generally.

These islands are either uninhabited or inhabited only by military or scientific personnel and commercial fishing is prohibited. Accordingly, they are essentially free of the non-climate related causes of stress found on coral reefs elsewhere.

A similar effort would be aimed at the Caribbean coral reefs which, in contrast, are highly stressed by human impacts. I want to advise the Subcommittee that we are enthusiastically supporting the use of our Pacific Island refuges for Dr. Buddemeier's proposal. Although we cannot afford to fund his research on our own, we will work closely with Dr. Buddemeier, the science agencies within Interior, our partners at NOAA and elsewhere on the Coral Reef Task Force and the academic community to make this work.

We will make appropriate park and refuge units in the Caribbean available as research sites also.

Dr. Buddemeier will explain his proposal during his testimony, and I won't further anticipate his comments. I have supplied the Committee with extensive written testimony that details the activities of the various Bureaus of the Department of Interior in the coral reef area. With the Chairman's permission, I would refer the Committee to those written remarks.

In closing, I would note that not only does the Department of Interior have the responsibility for the well-being of the coral reef resources under its jurisdiction, the department also has legal and enforcement authorities that we use in protection of these important ecosystems.

Through our Science and Resource Management Bureaus we conduct a wide variety of programs that directly or indirectly protect coral reefs for the benefit and enjoyment of the public.

We are committed to working toward more effective coordinated responses to coral reef protection both within the department, with our partners at NOAA and the other partners on the Coral Reef Task Force.

That concludes my statement, Mr. Chairman, and I would be pleased to respond to any questions that you may have.

Mr. GILCHREST. Thank you, Mr. Manson.

[The prepared statement of Judge Manson follows:]

**Statement of Craig Manson, Assistant Secretary for Fish and Wildlife and Parks, U.S. Department of the Interior**

Mr. Chairman, I appreciate the opportunity to appear before you today. As part of my duties as Assistant Secretary for Fish and Wildlife and Parks, the Secretary has delegated to me the role of Co–Chairman of the United States Coral Reef Task Force.

In an effort to prevent further loss of coral reef ecosystems, Executive Order 13089 on Coral Reef Protection was issued in June 1998. The executive order established the U.S. Coral Reef Task Force, and directed it to develop and implement a

comprehensive program of research and mapping to inventory, monitor, and "identify the major causes and consequences of degradation of coral reef ecosystems." The order directs Federal agencies to use their authorities to protect coral reef ecosystems and, to the extent permitted by law, prohibits them from authorizing funding or carrying out any actions that will degrade these ecosystems.

The chairmanship is shared jointly by the Departments of Interior and Commerce. The other Federal members are the Departments of Agriculture, Defense, Justice, State and Transportation, the Environmental Protection Agency, the National Aeronautics and Space Administration, the National Science Foundation and the U.S. Agency for International Development. Early in its existence the Task Force made the wise decision to invite the Governors of the States with coral reefs in their waters, and the Governors of the Territories and the Associated States to join, and they have played a valuable role with the Task Force.

The Task Force has developed and approved a National Action Plan to carry out its Executive Order mandate and a Charter to formalize its operations. The final text of an Implementation Policy, largely developed prior to my confirmation, is currently under review, and I anticipate we will go forward with the final policy following our next Task Force meeting in early October.

Within the Department of the Interior, we are working at more closely coordinating the coral reef activities of the several bureaus which have responsibilities for coral reef research and conservation. This includes the Fish and Wildlife Service, the National Park Service, the Minerals Management Service, the Geological Survey and the Office of Insular Affairs.

*The Department of the Interior and Coral Reefs*

Coral reefs and associated seagrass and mangrove communities are among the most biologically complex and diverse ecosystems on Earth. They provide habitat to one-third of all marine fish species, build tropical islands, protect coasts from waves and storms, contain an array of potential pharmaceuticals, and support U.S. tourism and fishing industries worth billions of dollars. Coral reefs are also fundamental to the fabric of local communities, providing a source of food, materials, and traditional activities.

Over the past few decades, public awareness of the outstanding yet fragile character of these ecosystems has grown, prompting increased state and Federal efforts to protect and preserve the Nation's coral reefs. The Department of the Interior protects these sensitive habitats at twenty-four National Parks and National Wildlife Refuges, collectively amounting to almost 3,600,000 acres of coral reefs and other submerged lands. In addition, the Department conducts pioneering scientific research to determine the structure, function, status, and condition of our Nation's coral reefs. However, most of the Nation's coral reefs have not been mapped nor have their conditions been assessed or characterized.

Studies by the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, and others indicate that coral reefs are deteriorating in many places worldwide, and many are in crisis. Symptoms include loss of hard corals, increased abundance of algae, diminished recruitment of coral larvae, reduced biological diversity, and a dramatic increase in bleaching episodes and disease outbreaks. Scientists and managers still lack critical information about the causes, but evidence suggests a variety of human forces, including population increases, shoreline development, increased sediments in the water, trampling by tourists and divers, ship groundings, poor water quality from runoff and inadequate sewage treatment, overfishing, and fishing with poisons and explosives that destroy coral habitat. These stresses act separately and in combination with natural factors, such as hurricanes and disease, to degrade reefs.

The Department also works with domestic and international partners through the International Coral Reef Initiative. Launched in 1994 with the support of the United States government, this initiative aims at concerted global action to protect and monitor coral reefs around the world by building and sustaining partnerships, programs, and institutional capacity at the local, national, regional, and international level. In carrying out E.O. 13089, the Department is now working to address duplication and lack of proper coordination where they occur.

*U.S. Fish and Wildlife Service*

The mission of the U.S. Fish and Wildlife Service (FWS) is to work with others to conserve, protect, and enhance fish and wildlife and their habitats for the continuing benefit of the American people. As threats mount to coral reefs worldwide, FWS is applying its unique expertise to protect these resources through a variety of management and operational programs. FWS manages 13 National Wildlife Refuges that include significant coral reefs. FWS also protects and restores reefs and

other species and habitats, enforces laws, and works with other countries to foster reef conservation worldwide. Virtually all of these approaches are founded upon partnerships—collaborative efforts with other Federal agencies, State, local, and Territorial governments, and concerned private groups. In combination, these dedicated partners can help reduce the threats to coral reefs and conserve these vital parts of our global heritage.

*Programs and Recent Accomplishments Related to Coral Reefs*

National Wildlife Refuges: FWS manages 10 National Wildlife Refuges (NWR) in the Pacific, which include approximately 2,164,000 acres of coral reefs and adjacent ocean habitat, and 3 refuges in South Florida and the Caribbean totaling more about 756,000 acres. Among these are two of the System's newest refuges—Palmyra Atoll NWR and Kingman Reef NWR. Established in 2001, these refuges contain some of the most extensive and biologically important reefs in the Pacific. The Refuge System administers a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats for the benefit of present and future generations of Americans. To ensure that long-term conservation goals are achieved, the FWS is developing and implementing Comprehensive Conservation Management Plans for all of its refuges with coral reefs. Refuges are also developing and employing innovative tools for managing coral reefs, including marine zoning, habitat restoration, education and outreach, law enforcement, research and monitoring, and improving the public's enjoyment of the refuges.

Coral Reef Conservation, Restoration, and Protection: One FWS goal is to ensure that human activities do not adversely affect coral reefs or species, such as endangered sea turtles, that rely on healthy reefs. FWS programs for endangered species protection, coastal habitat restoration, fisheries management, review of Federal actions, as well as direct assistance to States and Territories all help to conserve coral reefs. The FWS is also statutorily designated to comment on Clean Water Act section 404 permits and other water-related development activities under Federal authorization or permit. FWS biologists regularly coordinate with Federal, State, Territorial, and private groups to ensure that during project development, coral reef fish and wildlife are considered equally with other project-related features and adverse impacts to coral reef ecosystems from coastal and nearshore marine projects are avoided or reduced. When accidents harm reefs, FWS works with partners to assess the damage and expedite reef recovery.

Other coral conservation efforts are more proactive: for example, the coastal partnership program implements projects that protect coastal habitats before they are degraded. Examples of conservation efforts include conducting surveys of coral reefs near proposed development projects to assess potential impacts, developing recommendations to preserve the integrity of reefs, and deploying navigational aids in areas to prevent boat groundings and anchor damage.

Enforcing International Trade Laws: FWS enforces international fish and wildlife-related trade laws by inspecting coral imports, intercepting illegal shipments, and collecting and maintaining U.S. trade data for coral reef species. International efforts to control the trade of corals include development of the Guide to Indian and Pacific Corals Common in the Wildlife Trade, a reference to assist inspectors and enforcement officers. In 1989, concern about the effects of international coral trade prompted the countries involved with the Convention on International Trade in Endangered Species to list all stony corals in Appendix II, which allows enforcement agencies to monitor and regulate commercial imports.

In addition, E.O. 13089 required that the United States assess its role in the international trade in coral and coral reef species, and recommend appropriate actions to ensure sustainable use of coral reef resources. FWS, working with other Task Force members, completed an assessment which showed that the United States is the primary market for imported coral and live fish, which are used in jewelry and the aquarium trade. FWS is also working with partners to combat the use of sodium cyanide poisoning, a method for collecting live reef fish for food and the aquarium industry that causes widespread destruction of the living reef.

International Conservation of Coral Reefs: FWS is fostering the conservation of reefs in other countries through training and education programs, as well as projects that promote the conservation of species and habitats within a water-shed framework. Among the important habitats linked to coral reefs and targeted for conservation are seagrass beds and mangrove forests. The Western Hemisphere Program sponsors protected area manager training through two international programs, Mexico/RESERVA and Brazil/AMUC. The program also awards small grants to promote the involvement of local communities and organizations in coral reef conservation activities.

*National Park Service*

The National Park Service (NPS) manages 385 units in the National Park System, protecting many of our diverse natural, cultural, and recreational resources. NPS achieves these goals by working cooperatively with Federal, State, and local agencies, Native American authorities, user groups, and adjacent landowners. Ten Park units with coral reef habitats protect almost 275,000 acres (270,000 acres in the South Atlantic and Caribbean and 5,000 in the Pacific). Among these is Dry Tortugas National Park in South Florida, established in 1908 as the world's first marine protected area. On July 1, 2001, it became part of the largest fully protected underwater ecological reserve in North America with the creation of the Tortugas Ecological Reserve. Biscayne National Park, established in 1968 to protect and preserve a nationally significant marine ecosystem, is the largest NPS coral reef unit, with about 172,500 acres of coral reefs, mangrove shorelines, and coastal estuaries. The nearshore reefs at War in the Pacific NHP, Guam, are home to an estimated 3,500 to 4,000 species and are among the most diverse ecosystems within the National Park System. As a global leader in the management of underwater parks, NPS has long been involved in the development of innovative and improved coral reef monitoring and management tools. NPS works internationally to share expertise and knowledge with others and to improve the level of protection afforded coral reef parks in the United States and elsewhere.

*Programs and Recent Accomplishments Related to Coral Reefs:*

Education and Outreach: NPS recognizes that strengthening the capacity of communities and individuals to conserve and use coral reefs and related ecosystems in a sustainable manner requires effective public education. Each of the 10 NPS units with coral reef resources offers interpretive programs, augments school curricula, coordinates public workshops, and implements programs for both recreational and commercial user groups, including those engaged in fishing, boating, SCUBA diving, snorkeling, and underwater photography. Activities range from video presentations, to underwater trails, to extensive curriculum-based education programs. Other examples include the much-acclaimed underwater interpretive trails established at Virgin Islands National Park and Buck Island Reef National Monument. A new Center of Research and Learning, hosted by Biscayne National Park, has received NPS approval as part of a national network of Learning Centers funded by the NPS Natural Resource Challenge, an initiative to improve natural resource stewardship.

Natural Laboratories: National parks continue their long tradition of serving as coral reef research sites. Groundbreaking, innovative research was conducted from 1969–71 during the Tektite I and II underwater habitat projects at the Virgin Islands National Park. Early research at both Biscayne and Dry Tortugas National Parks revealed the level of human impact to reefs due to recreational diving and fishing. This research led to pioneering use of reef mooring buoys and designated ship anchorages to reduce impact to reefs. NPS currently administers and coordinates research on coral reefs with other government agencies and universities on topics ranging from long-term ecosystem monitoring of water quality, to fish landings, and to effects of hurricanes and coral diseases. At War in the Pacific National Historic Park, assessments of the effects of reef sedimentation caused by accelerated upland erosion from human-set savanna wildfires will result in the development of best management practices designed to alleviate this potentially serious coral reef impact. A 3-year joint effort with the National Oceanic and Atmospheric Administration and U.S. Geological Survey has completed mapping the coral reef ecosystems of Puerto Rico and the U.S. Virgin Islands. Other continuing efforts include long-term studies of endangered sea turtles.

Restoration and Recovery: Although coral reef resources within the National Park System receive protection as national parks, they are continually subjected to damage from both natural events and human stresses, such as fishing, recreational uses, environmental pollution, anchor damage, and ship and boat groundings. Six of the ten coral reef NPS units allow commercial fishing in accordance with their authorizing legislation. To protect these fragile resources, four parks, Buck Island Reef National Monument, Dry Tortugas National Park, Virgin Islands National Park, and Virgin Islands Coral Reef National Monument, have established fully protected zones for certain areas in which all forms of resource extraction are prohibited. In addition, NPS is responding to degradation or damage from impacts such as boat groundings. For example, Biscayne National Park suffers more than 200 reported boat and ship groundings yearly. To reverse widespread destruction of seagrass beds and coral reefs, NPS has taken the lead in applying Natural Resource Protection Act authorities to recover damages. Since 2000, Biscayne National Park has been awarded $2.1 million in damages to cover the costs of assessing, monitoring, and restoring injuries sustained from the Motor Tanker Igloo and the Tug Allie–B. In

2000, Virgin Islands National Park completed implementation of a Resource Protection Plan. Under the plan, 211 moorings and 111 resource protection buoys were installed to allow access to natural areas while preventing anchor damage to benthic habitats.

Monitoring: Since 1989, NPS and the USGS have jointly conducted coral reef monitoring programs for the Atlantic–Caribbean, focusing on natural and human disturbance to reefs around the U.S. Virgin Islands. The Coral Reef Monitoring Manual produced by NPS in 1994 has become an internationally recognized source of information on methods and techniques. The manual has been updated by USGS, translated into Spanish, and made available electronically over the Internet. An innovative approach to monitoring coral reefs was developed by the joint NPS/USGS Inventory & Monitoring Program. The method combines a SONAR-based underwater positioning system with digital videotape recordings to create the most scientifically rigorous reef-monitoring protocol in the world. This rigorous method has confirmed the continued decline of live coral documented by previous methods. Dedicated in 1997, the National Park of American Samoa contains over 2,500 acres of prime Indo–Pacific coral reefs and nearshore habitats. Scientists and resource managers at the Park are determining the "Vital Signs" of their coral reefs by developing new protocols that are appropriate to small-scale parks.

Resource Management: In 2001, more than 30,000 acres of seagrass beds, coral reefs, mangrove shorelines, and other vital marine areas were designated for protection and management by the NPS. Over 12,000 acres were designated under the new Virgin Island Coral Reef National Monument, and an additional 18,000 acres were added to the existing Buck Island National Monument. The addition of these areas to the NPS system will provide additional protection for the marine mammals, sea turtles, and seabirds that frequent these areas, as well as countless species of fish and invertebrates. Dry Tortugas National Park has adopted a zoning plan to protect and manage this outstanding area, which includes exceptional reef, spawning and nursery habitats, as well as shipwrecks and other cultural resources. General Management Plans for the other coral reef parks are also being updated to provide a road map for each park to meet its resource protection and management goals.

International Marine Protected Area Network: The NPS, in cooperation with the United Nations Environment Program in Jamaica, is working to improve communication among marine protected area mangers across the Caribbean through the Caribbean Marine Protected Area Management (CaMPAM) network. More than 350 CaMPAM members meet regularly to exchange information on emerging resource issues, management and research protocols, and other issues of concern to the resource management community.

*U.S. Geological Survey*

The U.S. Geological Survey is the Nation's primary provider of water, earth, and biological science information related to the environment, natural hazards, and mineral, energy, water, and biological resources. The agency provides world-class research and monitoring programs for volcanoes and earthquakes, monitors the status and trends of the Nation's biological resources, and is the Nation's principal civilian topographic mapping agency. With research centers and field stations in south Florida, the U.S. Virgin Islands, Hawaii, and elsewhere across the Nation, USGS is providing resource managers with information critical to the understanding of the ecology, health, structure, function, and management of coral reefs. USGS scientists are increasing our understanding of the structure and function of reef communities through their studies of the mechanisms governing reef health and disease, geologic growth and development, sediment and groundwater transport, and the effects of fishing and no-take zones on coral reef resources.

*Programs and Recent Accomplishments Related to Coral Reefs:*

Innovative Techniques for Determining Reef Health: Over the past decade, USGS scientists have been developing innovative techniques for monitoring coral reefs in the Virgin Islands National Park, Buck Island Reef National Monument, and Dry Tortugas National Park. A new technique developed by USGS and the NPS, combining a SONAR-based underwater positioning system with digital imaging, is the most scientifically rigorous reef-monitoring protocol in the world. These methods are being used by USGS scientists to develop indicators of reef health, such as the amount of live coral versus algae on the reef and the abundance of juvenile and adult reef fish. Results indicate that the health of coral reefs in a number of areas over the past decade has declined.

New protocols are also being used to map and assess the condition of elkhorn coral. Once a dominant reef-building species in the Caribbean, elkhorn coral has suf-

fered dramatic declines since the 1970s from White Band Disease and storm damage. USGS scientists are tracking recovery of elkhorn coral occurring in some areas and its relationship to reef community structure. USGS scientists have also developed a chamber for measuring metabolic rates (productivity) of benthic communities, such as coral reefs, seagrass beds, and other hard and sand bottom communities. The Submersible Habitat for Analyzing Reef Quality (SHARQ) is being tested to determine the potential for using benthic community metabolism as an indication of ecosystem health. By examining ecosystem health in terms of system processes or function, scientists can compare ecosystems in different geographic locations that might be characterized by different species of organisms. Monitoring efforts have begun in Biscayne National Park, Hawaii, Florida Bay, and Tampa Bay.

Hawaiian Reef Fish and Habitat: USGS studies of the relationships between Hawaiian reef fish assemblages and their coral reef habitats are providing better information to help improve management of reef areas and design of marine reserves.

Mapping in the Pacific: State-of-the-art multibeam mapping techniques are being used to map key areas around Hawaii; high-resolution bathymetric and backscatter data are being used to address questions related to environmental quality, hazards, and resources. Maps generated by USGS in 1998 are being used to characterize the condition of reef resources in the Humpback Whale National Marine Sanctuary. USGS scientists are mapping patch reefs in Hawaii and Indonesia, using satellite and aerial photography to obtain information on the location of reefs and the active sedimentary processes that affect reef conditions.

Mapping in South Florida: USGS scientists are mapping the surface and subsurface reef structures throughout the Florida Keys to establish the relationship between reef distribution and the underlying geology, and to evaluate factors controlling reef health within the Florida Keys National Marine Sanctuary and Biscayne National Park. USGS is also developing sediment composition data for the Florida Keys showing reef area and health, on the basis of a Sanctuary-wide assessment of the Florida Keys National Marine Sanctuary. These studies have documented changes in both sediment composition and coral reef development over the past few thousand years. Descriptive and interpretive maps of the Sanctuary will be produced through the use of seismic, sidescan, and core data. Such information is useful for future coral reef management.

Water Quality Studies: To address concerns about recent algal blooms in Florida Bay and coral diseases on the reef tract, USGS scientists are working with the State Department of Environmental Protection, the U.S. Environmental Protection Agency, and university scientists to carry out routine water quality assessments. A network of submarine monitoring wells have documented the flow of contaminated ground water in the extremely porous limestone that underlies the area. The limestone receives the effluent of approximately 30,000 septic tanks, 10,000 cesspools, and 1,000 shallow disposal wells. USGS scientists are also reconstructing the history of water quality in the bay during the past 100–150 years, using stable isotopes and trace elements in fossils and corals from well-dated cores.

Atmospheric Dust Studies: USGS geologists and coral biologists, along with researchers from the University of Miami Rosensteil School for Marine and Atmospheric Science, the University of South Florida Marine Center in St. Petersburg, and Duke University, are collaborating to determine if there is a relationship among global warming, deposition of dust, and Caribbean-wide outbreaks of coral diseases. Results indicate that during strong "African dust events," the numbers of microorganisms can be two to three times that found during "clear atmospheric conditions." These events may be linked to outbreaks of disease in Caribbean corals, toxic algal blooms such as the red tides along Florida's coasts, and asthma in humans. Increased quantities of atmospheric dust began blowing westward in the early 1970s (1 billion tons now cross the Atlantic each year) with desertification and expanding agriculture in northern Africa.

*Office of Insular Affairs*

The Department of the Interior has administrative responsibility for coordinating Federal policy in the territories of American Samoa, Guam, the U.S. Virgin Islands, and the Commonwealth of the Northern Mariana Islands, and oversight of Federal programs and funds in the freely associated states of the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau. The Office of Insular Affairs (OIA) works to develop more efficient and effective government in the insular areas by recommending policies, providing financial and technical assistance, and strengthening Federal-insular relationships.

*Programs and Recent Accomplishments Related to Coral Reefs:*

U.S. Islands Plan of Action: The majority of coral reefs in the United States are located in the insular areas. Since 1994, OIA has sponsored several workshops with island governments to identify local and regional priorities for the protection and sustainable use of their coral reefs. The priorities are summarized in the U.S. All Islands Coral Reef Initiative Strategy, available from OIA. The Strategy identifies a broad scope of action, from education and outreach to the establishment of marine protected areas and increased local enforcement. The Strategy is a corner-stone of the National Action Plan to Conserve Coral Reefs, adopted by the U.S. Coral Reef Task Force in March 2000.

Coral Reef Grants: OIA, in cooperation with the National Oceanic and Atmospheric Administration, annually provides technical and financial assistance to the insular areas to improve the management and protection of their marine resources. Grants support a broad range of projects designed to fill gaps in management capacity and to develop a comprehensive resource management program within each of the jurisdictions. Notable accomplishments include the declaration of new protected areas, status reports on reef health, the establishment of local coral reef advisory groups, the development of community-based management plans, expanded research on coral health and restoration, the development of GIS information and management tools, the development of culturally appropriate education materials, and increased public awareness and community support for the sustainable use and conservation of coral reefs. Recognizing that overfishing poses a particularly serious threat to their local reef fish stocks, American Samoa recently banned SCUBA-assisted fishing as well as the harvest of live rock. With support from OIA and NOAA, the first territorial parks have been established in the Commonwealth of the Northern Mariana Islands and the U.S. Virgin Islands.

Regional Cooperation: The Marine Resources Pacific Consortium (MAREPAC) was established in December 1999 with funding from OIA. MAREPAC is a model program that romotes regional cooperation on marine resource use, management, and preservation among the Pacific Islands of American Samoa, the Federated States of Micronesia, the Commonwealth of the Northern Marianas, the Republic of Palau, Guam, and the Republic of the Marshall Islands. MAREPAC now serves as the advisory group to the Association of Pacific Island Legislatures and is helping them craft effective legislation on the conservation and sustainable use of their marine resources.

Working with the Freely Associated States: The U.S.-affiliated islands total fewer that 2,000 square miles of land in aggregate but are distributed over more than 3,000,000 square miles of ocean—an area equivalent to the conterminous United States. These waters are home to some of the most extensive and biologically diverse coral reef ecosystems in the world. Islanders have depended on these resources for a wide range of utilitarian, symbolic, and ornamental functions since prehistoric times. OIA works with the freely associated states to improve the management and use of their marine resources. With funding from OIA, a team of stakeholders and technical experts is designing the first national system of protected areas in the Federated States of Micronesia. Using an ecoregional planning approach, the team is developing a portfolio of marine and terrestrial conservation areas that are representative of the full array of ecological communities.

Reef Recovery: OIA worked with other Federal and local partners to remove nine abandoned fishing vessels grounded by a storm on coral reefs in Pago Pago Harbor, American Samoa. Monitoring of the area indicates that some of the coral reefs are recovering. OIA also provided funds to the Government of Guam to assist with the recovery of their coral reefs following Typhoon Paka in 1997.

*Minerals Management Service*

As steward of our Federal offshore lands known as the Outer Continental Shelf, the Department of the Interior is responsible for balancing the Nation's search for petroleum energy and marine minerals with the protection of the human, marine, and coastal environments. The Minerals Management Service's (MMS) environmental programs serve this important mission by providing the information necessary for informed decisions on energy and non-energy mineral planning and development activities for the Outer Continental Shelf.

*Programs and Recent Accomplishments Related to Coral Reefs:*

Protection of Flower Garden Banks: Since the early 1970s, MMS has supported a comprehensive program of mapping and multidisciplinary study of the East and West Flower Garden Banks, located in a petroleum-rich area in the Gulf of Mexico. The Flower Garden

Banks are a pair of topographic features, topped by an array of reef-building corals and associated organisms. MMS is currently supporting a long-term monitoring effort, cosponsored by the National Marine Sanctuary Program, to assess the health of the coral reefs and evaluate changes in the coral community. MMS will use this information to evaluate the adequacy and effectiveness of current lease stipulations in protecting the important biological resources of the Flower Garden Banks. To date, scientific assessments show that the corals of the East and West Flower Garden Banks are healthy and growing. In 1996, MMS received the Federal Environmental Quality Award from the Council on Environmental Quality and the National Association of Environmental Professionals for environmental monitoring and research in the Flower Garden Banks National Marine Sanctuary.

Larval Dispersal Study: MMS is supporting a study of the long-distance dispersal of coral larvae originating from the Flower Garden Banks using satellite-tracked buoys. Information from this study will be used to establish the role of the Flower Garden Banks as a larval source for coral reefs of the Florida Keys and Mexico.

Effects of an Oil Spill on Coral Reefs: MMS sponsored a major study of the effects of spilled crude oil on coral reefs following the accidental rupture of a storage tank at a coastal refinery in Bahia Las Minas, Panama. This 5-year study examined habitats along more than 80 km of oiled shore, including intertidal reef flats, mangroves, seagrass beds, and coral reefs. A general decline in the health of coral reefs at control sites was observed during this study, consistent with trends observed across the Caribbean.

*Conclusion*

As the Nation's primary steward of natural resources, the Department of the Interior has responsibility for the well-being of the coral reef resources under its jurisdiction. The Department also has legal and enforcement authorities used in protection of these important ecosystems. Through its science and resource management bureaus, we conduct a wide variety of programs that directly or indirectly protect coral reefs for the benefit and enjoyment of the public. Coral reef habitats and their astounding biological diversity are in decline worldwide, even in many protected areas. In some instances, protection could be made more effective with better understanding of how factors interact to degrade these complex systems. In others, we are doing the right things, but compartmentalization and fragmentation of actions have led to less than full effectiveness. The Department's bureaus are committed to working toward more effective, coordinated responses to coral reef protection.

In response to Executive Order 13089, the Department is redoubling its efforts to protect coral reefs. We will inventory, map, and assess the condition of our coral reef resources; will support directed research that will give our managers the knowledge and tools they need to protect coral reefs effectively; and we will move forward with actions needed for conservation, mitigation, and restoration of these fragile ecosystems. As Co-Chair of the Coral Reef Task Force, the Department will be a leader in establishing linkages with other Federal and State agencies and other nations. Through these linkages, we hope to share information and technologies and ensure that protection efforts are coordinated to provide the maximum benefit for our world and for future generations.

This concludes my formal statement, and I will be pleased to respond to any questions you may have.

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Mr. GILCHREST. Mr. Keeney.

**STATEMENT OF TIMOTHY R.E. KEENEY, DEPUTY ASSISTANT SECRETARY FOR OCEANS AND ATMOSPHERE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, U.S. DEPARTMENT OF COMMERCE**

Mr. KEENEY. Chairman Gilchrest and members of the Subcommittee, I would like to thank you for the opportunity to appear before you today to discuss the implementation of the Coral Reef Conservation Act of 2000 and the Coral Reef Executive Order, 13089.

Before I start my remarks, I might just mention, to follow up on what Assistant Secretary Manson has stated, I have been designated by Vice Admiral Lautenbacher as his representative to Co-

Chair the U.S. Coral Reef Task Force. So, we will get to work together. I am looking forward to that.

The Department of Commerce and the National Oceanic and Atmospheric Administration appreciate the interest and support the Subcommittee has provided to address conservation of coral reefs and other ocean and cultural resources. Coral reefs are some of the most valuable and threatened ecosystems on the planet.

Under attack from multiple sources such as over-fishing and destructive fishing practices, pollution from land, sea and air, habitat destruction, diseases, invasive species and climate change, these ancient ecosystems are deteriorating worldwide.

The loss of these valuable resources has significant social, economic and environmental consequences here at home and abroad. To successfully addresses these complex issues, we need coordinated reef conservation efforts at all levels.

Recognizing this need, the Act and the Executive Order were designed to increase the coordination and effectiveness of U.S. Government actions to conserve coral reef ecosystems.

I have three main points today. First NOAA and other agencies have made significant progress to implement the Act and the Executive Order, which increase our capacity to conserve coral reefs both in the United States and with our international partners.

Second, continuing this progress will require increased action, coordination and evaluation by Federal agencies, State and territorial governments and others nations and non-governmental organizations.

Third, we need to focus on using all the management tools at our disposal for our success. This will means changing some practices on land and at sea so our actions sustain reefs rather than degrade them, because many coral reefs depend on reefs beyond our borders for reproduction and survival. Effective conservation of U.S. coral reefs also requires international action.

The good news is that many of the solutions already exist and if we act now we may be able to help mitigate the loss of these valuable resources. In fact, NOAA conducts a wide variety of activities related to coral reefs in fulfillment of its mission and authorities, including management of the nation's Federal fisheries, threatened and endangered species, marine mammals, coastal zone management, National Marine Sanctuaries, and National Estuary and Research Reserves, response and restoration, mapping and charting, and research and monitoring.

As you know, Mr. Chairman, in 1998, the U.S. Coral Reef Task Force was established by Executive Order 13089 and in March of 2000, the task force adopted the National Action Plan to Preserve Coral Reefs. Since then, NOAA and other agencies have taken action to implement the National Action Plan and coordination coral reef conservation efforts.

At its last meeting in December of 2001, the task force highlighted the need to improve efforts that will track progress to implement the National Action Plan and identify key areas still needing attention.

In 2000, NOAA received $8 million in funding specifically for coral reef conservation activities. In fiscal years 2001 and 2002, this funding increased to $27 million and $28 million respectively.

The President's 2003 budget request includes $28 million to continue NOAA's efforts. This funding will significantly increase the nation's capacity to conserve coral reefs.

Most of the funding is going directly to NOAA's partners at States and territories, universities and the private sector. In December of 2000 the Coral Reef Conservation Act authorized NOAA to undertake four specific actions to help preserve coral reefs. First, the Act charged NOAA with developing a national coral reef action strategy, including goals, objectives and implementation plans and a summary of Federal funding available to advance coral reef conservation.

NOAA will work with the task force to complete the 2002, 2003 strategy which will be available in July for public comment.

Today, I brought with me pre-publication copies of the strategy for the Subcommittee. It is designed to track progress in implementing the goals and objectives of the act and the National Action Plan.

Second, the Act authorizes NOAA to establish a Coral Reef Conservation Grant Program to support coral reef conservation activities. NOAA has established the program and together with the Department of Interior, will allocate $5.5 million to it this year. A significant portion of these funds will help support, manage and monitor efforts in State and territorial waters, which contain approximately half of the U.S. reefs.

Third, the Act authorizes establishment of a Coral Reef Conservation Fund to build public-private partnerships for coral reef conservation. NOAA established the fund in partnership with the National Fish and Wildlife Foundation in the year 2001.

Fifteen projects have been funded to date, leveraging $700,000 of NOAA funds with $1.1 million in matching resources for a total of $1.8 million for on-the-ground coral reef conservation.

Fourth, the Act authorizes implementation of a National Coral Reef Conservation Program to conduct a variety of activities to conserve coral reef ecosystems. Some of the major accomplishments to date include completion of coral reef maps in the U.S., Caribbean and 50 percent of the main Hawaiian Island Reefs and the launch of mapping efforts for the Northwest Hawaiian Islands.

Removal of nearly 100 tons of marine debris from the northwest Hawaiian Island coral reefs, implementation of the northwest Hawaiian Island coral reef ecosystem reserve, expansion of NOAA's coral reef watch early warning system to better predict and track coral reef bleaching.

I cite many other examples, Mr. Chairman, in my written statement.

Are these activities making a difference? I believe they are. By providing new funding tools and information, NOAA's program is increasing capacity at local, State, Federal and international levels to reduce adverse impacts and sustain coral reef ecosystems.

These are significant steps in the right direction, but we can't do it alone. The Executive Order of the Coral Reef Task Force and the Act are valuable tools to increase coordination among all parties and track progress toward these goals. The subsequent national action plan provides an excellent blueprint for U.S. action to conserve coral reefs.

Aided by this guidance, NOAA and other partners have taken significant action to implement portions of the plan and requirements of the act. These actions have strengthened U.S. capacity to conservation coral reefs, but continued long-term and sustained action is needed for success.

Some areas still need additional attention, such as reducing land-based sources of pollution, increasing assistance to international partners, and supporting education and enforcement efforts.

Ultimately, successful conservation of coral reefs will be determined by our ability to change the way people impact coral systems so that our actions on land and at sea sustain coral reefs rather than destroy them.

Thank you, Mr. Chairman, I would be happy to answer any questions.

Mr. GILCHREST. Thank you, Mr. Keeney.

[The prepared statement of Mr. Keeney follows:]

**Statement of Timothy R. E. Keeney, Deputy Assistant Secretary for Oceans and Atmosphere, National Oceanic and Atmospheric Administration, U.S. Department of Commerce**

Chairman Gilchrest and members of the Subcommittee, thank you for the opportunity to appear before you today to discuss implementation of the Coral Reef Conservation Act of 2000 (CRCA) and the Coral Reef Executive Order 13089. The Department of Commerce and National Oceanic and Atmospheric Administration (NOAA) greatly appreciate the interest and support the Subcommittee has provided to address conservation of coral reefs and other ocean and coastal resources. We look forward to working with you in the future to help sustain healthy ocean resources, and the communities and economies that depend on them.

Coral reefs are some of the most valuable, beautiful, and unfortunately, threatened ecosystems on the planet. Under attack from multiple sources such as overfishing, destructive fishing practices, pollution from land, sea and air, habitat degradation, diseases, and invasive species, these ancient ecosystems are deteriorating worldwide. At the same time, in the United States and around the world, rapidly growing coastal populations have increased the demand on reefs for food, jobs, income, recreation, tourism, and shoreline protection. Increased demands are also coming from markets far away from reefs. The international trade in coral to supply the aquarium industry has increased more than 400% since 1988, and the trade in live reef rock has increased 1700%. The U.S. is the world's largest importer of coral products and marine fishes for the aquarium industry. Scientists and businesses are searching the rich biological diversity of coral reefs for new cures for cancer, AIDS and other diseases. Reefs are critical to the million or more species that depend on them for some part of their life cycle. Healthy coral reefs are in high demand, and the loss of these valuable resources has significant social, economic and environmental consequences here at home and abroad.

To successfully address these serious and complex issues, we need coordinated reef conservation and management efforts at local, state, national, and international levels. Recognizing this need, the Coral Reef Conservation Act (CRCA) and Executive Order 13089 were designed to increase the coordination and effectiveness of U.S. government actions to conserve and manage coral reef ecosystems. In fact, NOAA conducts a wide variety of activities related to coral reefs in fulfillment of its mission and authorities. Many of NOAA's mandates include responsibilities for coral reef resources and activities in areas with coral reefs. Examples include: Federal fisheries management, threatened and endangered species, marine mammals, coastal zone management, National Marine Sanctuaries, National Estuarine Research Reserves, response and restoration, mapping and charting, and research and monitoring. Four of NOAA's five Line Offices have undertaken activities related to coral reefs for many years.

My remarks will briefly summarize NOAA's efforts to implement the CRCA and the Executive Order, and provide some suggestions for the future. I have three main points. First, NOAA and other agencies have made significant progress to implement the CRCA and the Executive Order. These actions have increased the capacity to conserve coral reefs, both in the United States and with international partners. Second, continuing this progress will require continued action, coordination, and

evaluation by Federal agencies, states, territorial governments, other nations, and non-governmental organizations. Given the scale and magnitude of the problem, no one entity can successfully address these issues alone, and we need to track our progress carefully to remain on course. Third, we need to focus on using all of the management tools at our disposal for success. This will mean changing some practices so our actions sustain reefs rather than degrade them. The good news is that many of the solutions already exist to reverse current trends and mitigate the loss of these valuable resources.

*The Challenge*

Coral reefs are complex ecosystems that provide many important products and services in the United States and around the world. Although, coral reefs cover less than 0.1 % of the ocean environment, they are home to at least a 100,000 described species, support 25% of all known global species of marine fish, and provide food, jobs, income, recreation, and other vital services for people world-wide. Coral reefs are found in over 100 countries, and many of these are developing nations where reefs contribute about one-quarter of the total fish catch. South East Asia has more coral reefs than any other region, the most diverse reef systems, and the world's most highly threatened reefs from over-fishing, destructive fishing practices, sedimentation, and pollution from land-based sources.

About 7% of the world's reefs are located within U.S. waters. Although many U.S. coral reefs have not been adequately mapped, it is estimated that shallow water U.S. coral reefs—those in less than 150 feet—cover about 7,500 square miles or about the size of Maryland. The majority of these shallow U.S. reefs are in the Pacific near Hawaii, Guam, American Samoa, and the Northern Marianas Islands. The remainder are located in the South Atlantic, the Gulf of Mexico, the U.S. Caribbean near Florida, Puerto Rico and the U.S. Virgin Islands. Although mapping efforts have not been completed, it is estimated that perhaps more than half of all U.S. reefs are located within state or territory waters, highlighting the important role states and territories have in managing the nation's coral reefs. Given this role, NOAA and other Federal agencies have made working with these partners and supporting their management efforts a top priority. Because many U.S. coral reefs often depend on reefs beyond our borders for reproduction and survival, effective conservation of U.S. coral reefs also requires international action.

Coral reef ecosystems are extremely valuable. For example, recent studies by NOAA, state and local partners in Florida show that in 2001, 28 million person-days were spent on recreational diving, fishing, viewing, and other reef-related activities in Southeast Florida's coral reefs. These activities generated about $4.4 billion in local sales, almost $2 billion in local income, and 71,300 full and part-time jobs. Overall, southeast Florida's coral reefs were estimated to have an asset value of $7.6 billion. Similar trends have been observed in other U.S. and international areas where tourism associated with coral reefs is a major economic sector. Healthy coral reefs are also vital to the commercial and recreational fishing sectors in this country. For example, approximately 50% of the Federally managed commercial fisheries species spend part of their life cycle in coral reef ecosystems.

These valuable ecosystems are in serious jeopardy. Before 1998, the Global Coral Reef Monitoring Network estimated that 11% of the world's coral reefs had been effectively lost, primarily due to pollution from land and sea, over-fishing, destructive fishing practices, ship groundings and other human impacts. By 2000, the estimate had grown to 27% due to massive coral bleaching and mortality events associated with climate events. The study suggests that if additional action is not taken to reduce these impacts, another third of the world's reefs could be lost in the next 10 to 30 years.

In 1998, a global assessment of threats to reefs by the World Resources Institute suggested that many U.S. reefs are at high to medium threat levels. Many U.S. reef systems have been degraded and need assistance, although there are few U.S. reefs that currently have the monitoring and assessment needed to track reef condition over time. One of the most studied areas is in the Florida Keys National Marine Sanctuary. Data from a number of studies shows deterioration of the Florida Keys reefs over the past 20 years. Included are significant losses in amount of coral cover, fish abundance and diversity, and other indicators. During this time, South Florida's population and the number of recreational vessels has doubled, water quality has declined in some areas, and diseases and coral bleaching events have increased. In many parts of Florida and the Caribbean, what used to be the most common and abundant shallow water coral species (elkhorn and staghorn coral) have been reduced by 50 to 90% due to diseases and other factors.

*NOAA Action: Executive Order 13089*

The U.S. has taken a number of significant actions over the past 5 years to help sustain coral reef ecosystems and the communities and economies that depend on them. In 1998, the U.S. Coral Reef Task Force (Task Force) was established by Executive Order 13089 to help lead and coordinate U.S. efforts to conserve coral reefs. The Task Force, co-chaired by the Secretary of Commerce through the Administrator of the National Oceanic and Atmospheric Administration (NOAA) and the Secretary of the Interior, includes the heads of eleven Federal agencies (Department of Agriculture, Department of Commerce, Department of Defense, Department of the Interior, Department of Justice, Department of State, Department of Transportation, Environmental Protection Agency, National Aeronautics and Space Administration, National Science Foundation, United States Agency for International Development), and the Governors of seven states, territories, and commonwealths (American Samoa, Florida, Guam, Hawaii, Northern Mariana Islands, Puerto Rico, United States Virgin Islands). Representatives of the Freely Associated States (Palau, Federated States of Micronesia and the Marshall Islands) were recently added to the Task Force, recognizing their rich coral reef resources.

In March 2000, the Task Force adopted The National Action Plan to Conserve Coral Reefs (National Action Plan), the first national blueprint for U.S. action to address the loss and degradation of coral reef ecosystems. Based on extensive input from government and non-government organizations, scientists, resource managers, Regional Fishery Management Councils, other stakeholders and the public, the National Action Plan: (1) identified key threats and issues driving the loss and degradation of coral reefs; (2) established thirteen major goals to address these threats; and, (3) outlined specific objectives and priority actions needed to achieve each goal.

Since then, significant action has been taken to implement the National Action Plan. The Task Force has provided a forum for exchanging information, building partnerships, coordinating efforts, tracking accomplishments, facilitating public input, and identifying key issues needing attention. In addition, it also provides a mechanism to evaluate efforts and adapt the national blueprint in response.

Working with many government and non-governmental partners, the Task Force has helped coordinate coral reef conservation and management efforts across Federal agencies and with state, territory, and commonwealth partners. New actions and new partnerships are underway, and there are clear signs that the capacity to conserve coral reefs is increasing at a variety of levels. There is much left to be done however. At its last meeting in December 2001, the Task Force highlighted the need to improve efforts that will track progress to implement the National Action Plan and identify key areas still needing attention. We agree that these actions need to be taken. The Task Force is a useful mechanism to increase coordination, track progress, and assess needs to implement and fulfill the goals of the National Action Plan.

*NOAA Action: Implementing the Coral Reef Conservation Act*

In 2000, NOAA received $8 million in funding specifically for coral reef conservation activities. In fiscal years (FYs) 2001 and 2002, this funding increased to $27 and $28 million respectively for activities specifically related to coral reef conservation and management. The President has requested $28 million for Fiscal Year 2003. In December 2000, the CRCA authorized NOAA to undertake four specific actions to help conserve coral reefs. This funding and authorization has significantly increased the Nation's capacity to conserve coral reefs. Much of the funding has gone directly to NOAA's partners in the states and territories, universities, and the private sector to strengthen their efforts and build capacity.. I will briefly summarize NOAA's actions to implement the CRCA, the goals and activities supported by the new coral funding, and progress made to achieve them.

First, the CRCA charged NOAA with developing a National Coral Reef Action Strategy (Strategy) consistent with the purposes of the CRCA, which includes goals, objectives, an implementation plan addressing a number of specific topics, and a summary of funding obligated each fiscal year to advance coral reef conservation. Because the Coral Reef Task Force had already developed a detailed National Action Plan laying out key goals, objectives and implementation plans, NOAA has worked with the Task Force over the past year to develop and complete the Strategy. I am very pleased to report that the 2002–2003 Strategy has been completed and provide you with the first prepublication copies. The document will be printed and made available for public comment through the Federal Register in July. The Strategy is designed to help track progress to implement the goals and objectives of the CRCA and the National Action Plan. It provides a cross-government accounting of accomplishments and an initial roadmap for what still needs to be done. This is an important first step and we are working with the Task Force and other

partners to improve upon this process. Ultimately we will be able to provide interested stakeholders with a regularly updated map of ongoing and future coral reef activities.

Second, the CRCA authorizes NOAA to establish a Coral Reef Conservation Grant Program to issue grants for broad-based coral reef conservation activities. In Fiscal Year 2002, NOAA formally established the Grant Program according to the provisions in the CRCA, and plans to distribute approximately $5.1 million through the program. In Fiscal Year 2001 and Fiscal Year 2002, the Grant Program has focused on increasing capacity in six major areas based on priorities identified by the National Action Plan, the CRCA, and our partners. These areas include: state and territorial coral reef management; monitoring and research; international coral reef conservation; general coral reef conservation; and improvements to coral reef fishery management plans. This year, NOAA received 96 proposals requesting nearly $8.5 million in total. The proposals are currently undergoing peer review from reviewers inside and outside of NOAA and we expect to make funding decisions by October 1. We think this is a very important mechanism to help leverage limited Federal dollars and support coral reef conservation efforts by states, territories, fishery management councils and other partners. We hope to streamline the grant process and continue this effort in the future.

Overall, it is important to note that in both Fiscal Year 2001 and Fiscal Year 2002, over 70% of the coral reef conservation funding in NOAA's budget will go to non–NOAA external partners including states, territories, local governments, fishery management councils, universities, and others. In Fiscal Year 2002, that is approximately $20 million of the $28.25 million in NOAA's budget for the Coral Reef Conservation Program.

Third, the CRCA authorizes establishment of a Coral Reef Conservation Fund (Fund) to build public-private partnerships for coral reef conservation. NOAA established the Fund in partnership with the National Fish and Wildlife Foundation in Fiscal Year 2001 to provide matching grants for on-the-ground projects. In the first year, the Foundation received 160 applications requesting over $6 million in Federal funding in response to two calls for proposals. During the first selection process, fifteen projects were awarded. By leveraging NOAA resources with matching dollars, a $1.8 million on-the-ground coral reef restoration effort was able to be completed. The second set of proposals is currently under review and final decisions are expected in July. The Foundation has taken steps to help find additional partners and support for the Fund. We think this is a unique and valuable tool to help engage the private sector and build community-based partnerships to support on-the-ground coral reef conservation efforts. We look forward to continuing this partnership in the future.

Fourth, the CRCA authorized implementation of a National Coral Reef Conservation Program to conduct a variety of activities to conserve coral reef ecosystems. Funding for coral reef conservation in Fiscal Year 2001 and Fiscal Year 2002 allowed NOAA to build on the agency's existing programs, management responsibilities, and technical strengths. It also allowed NOAA to implement new activities that address priorities identified by the National Action Plan, the Act, our state and territory partners, the scientific community, and others. Using these as guideposts, NOAA launched major new activities to fill critical gaps in the nation's ability to understand and conserve coral reefs. These activities include mapping shallow water U.S. coral reefs, building a national assessment and monitoring program, improving assessment and management of coral reef fisheries, removing marine debris, and implementing the Coral Reef Ecosystem Reserve in the Northwestern Hawaiian Islands.

Many of these activities focus on gathering and analyzing baseline information to evaluate the condition of reef resources, identifying key threats, and building capacity to address those threats. Will it make a difference? We believe it will. By providing new funding, tools, and information the program is increasing capacity at local, state, Federal and international levels to reduce adverse impacts and sustain coral reef ecosystems. These are significant steps in the right direction. However, this program alone will not reverse the decline of U.S. or international coral reefs, and it does not address all the critical needs identified by the National Action Plan and our partners. To reverse the decline of coral reefs, our partners must continue to do their part.

I will briefly review some of the major activities NOAA has supported in Fiscal Year 2002. These efforts address some of the primary goals and priorities identified by the National Action Plan, and continue many of the activities begun in Fiscal Year 2000 and Fiscal Year 2001. Many of these are long-term activities requiring sustained, multi-year efforts for success. With your support for the President's

Budget, we hope to fulfill these goals and address other critical needs that have not yet been met.

*Coral Reef Mapping*

The National Action Plan calls for mapping all shallow U.S. coral reefs by 2009. With the development of new technologies and additional partners, we think we can do it by 2007. Working with the Department of the Interior, NASA, other Federal agencies and state and territory partners, we helped develop an out-year implementation plan and began multi-agency mapping efforts in 2000. Mapping coral reefs is a multi-step process designed to characterize and assess current reef condition. The process involves acquiring images or other data on reefs from satellite, plane or boat, determining habitat types, classifying the habitats in the images, and producing the maps and other information for managers. The information provides managers and other users with a fundamental baseline for long-term monitoring and assessment of U.S. coral reefs. In Fiscal Year 2000, the Task Force estimated that less than 10 % of U.S. shallow reefs had been adequately mapped. New funding in Fiscal Year 2001, allowed us to complete mapping efforts already underway for the U.S. Virgin Islands and Puerto Rico, and launch initial efforts in the U.S. Pacific. In Fiscal Year 2001, we acquired mapping data for the main Hawaiian Islands and portions of the Northwestern Hawaiian Islands coral reef ecosystem. This year we will finalize maps for 30% of the main Hawaiian Island reefs, continue acquisition of mapping data in other U.S. Pacific areas, and conduct workshops with Federal, state and territory managers on using mapping data and techniques. Working with the U.S. Geological Survey and other partners, NOAA has just begun to map selected deeper coral reefs and banks that represent important commercial and recreational fisheries habitats.

*Monitoring and Research*

Monitoring and research help managers assess reef condition, diagnose problems, prioritize and implement solutions, evaluate results and forecast future conditions. The Coral Reef Task Force identified the need for better monitoring and regular assessment of the Nation's reefs, and called for building an integrated monitoring system by 2005. In Fiscal Year 2002, NOAA is expanding efforts begun in Fiscal Year 2001 and is continuing funding and technical support to states and territories to help increase their monitoring and assessment programs. We are working with them to develop "report cards" that will help track the condition and pressures on reefs. This information will be incorporated into a single nation-wide biennial report on the Status of U.S. Coral Reef Ecosystems that will integrate on-going monitoring and provide regular assessments of the condition and pressures on U.S. coral reefs. I am very pleased to report that NOAA will release the first biennial report on the Status of U.S. Coral Reef Ecosystems by late summer. The findings suggest that while many U.S. reefs have been significantly impacted by fishing and land-based pollution, all of the U.S. reef regions do contain some reefs that are in good to excellent condition.

Funding in Fiscal Year 2001 and Fiscal Year 2002 has also allowed the United States to: expand the "Coral Reef Watch" early warning system to better predict and track coral reef bleaching and other conditions around the world; launch major cruises to assess poorly known reefs in American Samoa and the Northwestern Hawaiian Islands; and, continue assessments of reefs and reef fish in the South Atlantic, U.S. Caribbean and Gulf of Mexico.

Research is critical to understanding the causes of and solutions to reef decline. In the past two years, NOAA's Coral Program has supported a variety of research efforts through the National Coral Reef Institute (NCRI) in Florida and the Hawaii Coral Reef Institute (HCRI) that provide information needed to manage reef ecosystems in the Western Atlantic and Hawaii. Funding also supported development of the National Coral Disease and Health Consortium and other partnerships to better understand the causes and solutions to coral diseases and reef decline. In January, an interdisciplinary team of experts identified key research areas and technologies to address the growing epidemic of diseases attacking coral reefs. Their findings should be available this fall.

One of the areas needing additional research is how people use and value reefs and the economic contributions from reef related activities. Understanding these values is essential to effective conservation of coral reefs because coral reef management is really about managing human interactions with the reef ecosystem. This year we will complete an inventory of the existing information on valuation of reefs and conduct workshops with managers on collecting and incorporating social and economic information in decisions. In the Virgin Islands, NOAA is working with fishermen to conduct the first comprehensive census of the coral reef commercial

fishery and to develop participatory co-management approaches with fishing communities. With all this new mapping, monitoring and research underway, we realized we needed a way to provide access to this information. At the next meeting of the Coral Reef Task Force in October, NOAA will unveil a new web site to provide "one-stop-shopping" for access to all of NOAA's coral reef data and information. The site will be a virtual library of coral reef data, from satellite images and reef maps, to diver surveys and fish counts. It will also provide access to many other products and services related to coral reef conservation, including information, tools and materials for teachers, students and managers.

*Increase Effectiveness of Existing Marine Protected Areas*

The National Action Plan calls for strengthening the use and effectiveness of marine protected areas as one of the tools in management of coral reefs. To support this goal in Fiscal Year 2002, NOAA has continued to work with states, territories, and other authorities at their request to help them evaluate the effectiveness of, and identify gaps in, the existing system of coral reef marine protected areas. NOAA's coral program also supported management of the Northwestern Hawaiian Island Coral Reef Ecosystem Reserve, including hiring staff to coordinate management and research activities, finalizing the proposed Reserve operations plan, continuing the Sanctuary designation process, and identifying priority issues to be addressed in the draft Sanctuary Management Plan and Environmental Impact Statement.

*Reduce the Adverse Impacts of Fishing and Support Fishery Management Plans*

In Fiscal Year 2002, over $2.3 million, or 8%, of NOAA's coral reef program funding is being used to address priority needs of managers responsible for Federal fisheries in coral reef ecosystems. Reducing over-fishing and destructive fishing practices, and supporting sustainable reef management efforts is one of the most important areas needing attention, both here in the United States and internationally. This includes support for reef conservation activities of the Regional Fisheries Management Councils through the NOAA Coral Reef Conservation Grant Program, and other efforts to understand and reduce the impacts of fishing on reefs. For example, funding is supporting: studies to evaluate the impacts of traps and other fishing gear on reefs in the Northwestern Hawaiian Islands and U.S. Caribbean; incorporating ecosystem approaches to fisheries management; and, completing the installation of radar surveillance equipment to improve enforcement of the new Tortugas Ecological Reserve in the Florida Keys National Marine Sanctuary, the Nation's largest coral reef reserve. At the request of our state and territory partners, NOAA is sponsoring a series of workshops on best practices in management of coral reef fisheries. In addition, in Fiscal Year 2001, funding also assisted the Western Pacific Fishery Management Council complete development of a Coral Reef Fishery Management Plan for Federally managed reef systems. The plan addresses reef resources not covered under other fishery management plans, and attempts to take more of an ecosystem-based approach to management. This plan is currently under review. Members of this Subcommittee have expressed the need to transition out fisheries management system away from a single-species focus and towards a more ecosystem-based management plan. We believe the process of developing this new plan will continue to provide valuable learning experiences about he types of information and infrastructure needed to complete that goal.

*Reduce Pollution*

Although the human impacts on coral reefs vary between locations and regions, many experts consider pollution and over-fishing as the leading drivers of coral reef loss and degradation in the U.S. and around the world. Land-based sources of pollution are considered a major threat. The flow of sediments, nutrients, and chemicals from land can devastate reefs. Through the Coral Reef Conservation Grant Program and the Coral Conservation Fund, NOAA has provided funding to help address some of these issues, but this is a significant area that needs to be fully addressed. Given the role of other Federal agencies in determining land use and water quality in coastal watersheds near reefs, increased and coordinated efforts will serve to benefit U.S. reefs.

Under the authorities provided in the Coastal Zone Management Act, states and territories that choose to participate are required to create non-point source pollution control programs. For areas adjacent to coral reefs, this can be a valuable tool in reducing the impact of sediment and nutrient runoff that can degrade coral reefs. Puerto Rico and the United States Virgin Islands have already provided non-point source pollution control programs and American Samoa's is nearly complete. Hawaii, the Commonwealth of the Northern Marianas Islands, and Puerto Rico have all included non-point source watershed or GIS projects in their Fiscal Year 2002 Coral Reef Conservation Act Grant applications.

In the Northwestern Hawaiian Islands, the major threat to the reef ecosystem is pollution originating from the sea. Many of the reefs are covered with literally, tons of debris that was carried by ocean currents from fishing activities and other remote sources. In Fiscal Year 2002, NOAA in cooperation with the State of Hawaii, U.S. Fish and Wildlife Service, and other partners funded year two of a three to four year campaign to remove this debris. Funding is also being used to find ways to prevent marine debris pollution from reaching the reefs, such as using remote sensing technologies to identify and remove derelict fishing gear at sea, and initiating an outreach program to stop the flow at its source.

*Response and Restoration*

NOAA has continued to support a variety of activities to help respond to damage events and to restore reefs following impacts. In Fiscal Year 2002, we will complete assessment restoration techniques and recovery models for coral reefs and associated ecosystems to help managers choose the most appropriate techniques for their situation. Restoration of coral reefs following major damage events is a very difficult and long-term process still requiring much research, development and testing. Funding will also be used to continue to monitor the recovery of reef fishes at restoration sites in the Florida Keys and Puerto Rico, and assist in seagrass restoration at a site in Puerto Rico. In addition, we are finalizing a database of abandoned vessels affecting U.S. reefs that will form the basis of a coordinated strategy to address the array of threats posed by grounded vessels. Coral program funding also is helping to build the capacity of coral reef managers to respond to vessel groundings, chemical spills and other events through training on enforcement, response, and restoration and through the publication of environmental sensitivity indices and standardized damage assessment protocols.

*Reduce Global Threats*

This year NOAA is continuing small-scale efforts to assist international partners in the conservation of coral reefs through the Coral Reef Conservation Grants Program. In collaboration with global partners, NOAA is providing support for publication of the 2002 Status of Coral Reefs of the World report by the Global Coral Reef Monitoring Network. The new report will be released this fall. NOAA is also helping draft international guidelines to help improve the effectiveness of management in existing marine protected areas, and working with coral reef managers in the Caribbean and Southeast Asia to establish protocols for monitoring socioeconomic factors. In Fiscal Year 2001 and Fiscal Year 2002, Coral Program funding is also being used to increase the collection and analysis of data on the U.S. imports of coral and reef fish for the aquarium industry.

*Conclusions*

Conserving coral reefs is an important and major task requiring coordinated effort from variety of Federal agencies, states and territories, other nations and nongovernmental organizations. The National Action Plan provides an excellent blueprint for U.S. action to conserve coral reefs. We must continually evaluate this blueprint and make changes to reflect current coral reef trends as well as new science. Fulfilling the Plan and helping reverse the decline of reefs will require sustained, coordinated efforts for many years, at multiple levels. NOAA and other partners have taken significant action to implement portions of the Plan and the requirements of the CRCA. These actions have strengthened U.S. capacity to conserve coral reefs, but continued action is needed for success. Finally, some areas still need additional attention, such as reducing land-based sources of pollution, working with international partners, and education efforts. We will need to use all the tools at our disposal if we are to successfully reduce the loss of these valuable resources. Ultimately, successful conservation of coral reefs will be determined by our ability to change the way people impact reef systems, so that our actions on land and at sea sustain reefs rather than destroy them. Thank you.

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Mr. GILCHREST. That is the second bell for the vote. So, this will be our first break. I will be back as soon as I can. We are adjourned for, hopefully, only 10 minutes.

[Recess]

Mr. GILCHREST. The Subcommittee will come to order. I appreciate your indulgence.

We will go right to our next witness, Mr. Sobel.

**STATEMENT OF JACK SOBEL, SENIOR DIRECTOR, ECOSYSTEM PROTECTION PROGRAM, THE OCEAN CONSERVANCY**

Mr. SOBEL. Thank you for this opportunity. I am happy to be here to testify on an issue that is very important and very close to my heart.

I am Jack Sobel. I am representing the Ocean Conservancy on behalf of our 900,000 members and volunteers. The Ocean Conservancy strives to be the world's foremost advocate for the oceans. We work to inform, inspire and empower people to speak and act for the oceans through science-based advocacy, research and public education.

Coral reefs are among the most biologically valuable, fragile and endangered ecosystems on earth. They are also among our most spectacular diverse marine ecosystems providing homes to nearly 100,000 organisms that we know about and a million more that are yet to be discovered.

Their remarkable diversity is rivaled by an extraordinary degree of complexity, interdependence and specialization among reef dwellers. Reef fish composition profoundly affects the entire reef community. Consequently, when fishing and other extractive activities remove critical living components of reefs, the reef community becomes less stable and losses its ability to respond to other natural and anthropogenic stresses.

Even moderate fishing levels can dramatically alter reef fish communities in remarkably short timeframes. Though full impact of these changes on reef health may be delayed for years. Therefore marine-protected area networks, including no-taking in reserves are increasingly recognized as essential to reef conservation.

The last three decades have brought an increasingly broad consensus that coral reefs are tremendously valuable, highly threatened by multiple stresses and rapidly declining.

In 2000, a large multinational group of coral reef scientists concluded that roughly two-thirds of the world's reefs had already been destroyed or would be destroyed within 30 years unless stronger action was taken to address human impacts quickly.

The U.S. has taken several key steps in recent years to address the growing coral reef crisis. In 1998, President Clinton issued Executive Order 13089 to establish a non-degradation policy for all Federal agency actions that might affect coral reef ecosystems in the U.S., required Federal agencies to implement conservation measures to protect and restore coral reefs and create the multi-agency Coral Reef Task Force for the purpose of addressing these impacts.

Congress reinforced the Federal commitment to coral reef conservation when it enacted the Coral Reef Conservation Act in December of 2000. The Federal Government has also taken steps to create coral reef protected areas and has supported State and territorial efforts to do likewise under several authorities.

The Coral Reef Executive Order, 13089, and the Coral Reef Conservation Act are both important steps in the right direction. To improve and build on these initiatives, I have the following recommendations:

First, the administration should recommit, with Congressional support to strong implementation of Executive Order 13089.

Executive Order 13089 elevated coral reef protection to a national issue. It also pledged to bring the full force of existing tools to bear on addressing threats to coral reefs.

It demonstrated Presidential and agency commitment to conservation of coral reefs by adhering to a no-degradation standard and adopting a multi-agency, multi-jurisdictional approach in the creation of the task force. It deserves your support.

Second, the administration should commit to and Congress should support a reinvigorated task force with a strong multi-agency approach and improved implementation of the National Action Plan. The release and adoption of the National Action Plan in March 2000 represents a high water mark in the task force's effort.

The plan does an excellent job of summarizing the importance, value and plight of coral reefs. It clearly and accurately identifies the major threats to coral reef ecosystems, including fishing and pollution. Its two fundamental themes, eight core conservation principles and identification of 13 individual conservation strategies are sound.

During its first 2 years, the Coral Reef Task Force was quite active, engaged and effective. It reached out to the public, across all levels of government through a variety of public meetings and public comment periods and expanded its membership and created working groups. It raised awareness in and outside of government regarding the coral reef crisis.

The Administration and Congress need to revitalize the task force by bringing strong multi-agency involvement to improve implementation, including devising benchmarks and monitoring progress with respect to the National Action Plan. The task force should also finalize its oversight policy and utilize it and the charter to improve reporting, tracking and monitoring of progress.

Third, strengthening improved implementation of individual action plans including marine protected areas, pollution abatement, international global threats and international trade. All of the elements identified in the plan are critically important to implement, some more so than others. I touched on some of the ones that we feel are the most important.

Fourth, the Coral Reef Conservation Act should be strengthened by providing additional new authority and determination to implement coral reef conservation measures including involving other Federal agencies and increasing funding levels.

Enactment of the Coral Reef Conservation Act was an important opportunity to build on the existing Coral Reef Executive Order. The act is a step in the right direction, but it has important limitations. It provides very limited new authority to protect coral reefs. It adopts more of a single agency focus versus a multi-agency approach. It authorizes only a modest level of new funding.

One of the primary shortcomings of the Act is that it relies almost exclusively on NOAA. NOAA has done great work to protect coral reefs, but there are other important agencies. NOAA cannot do it alone and there are other important agencies that need to be more involved in such legislation.

Finally, the current authorized levels are insufficient given the magnitude of the crisis facing coral reefs.

Fifth, although the Executive Order and the Coral Reef Conservation Act can be more effective, I believe more comprehensive legislation is ultimately going to be needed to protect coral reefs. Although it may be possible to amend the existing Coral Reef Conservation Act to expand and strengthen its existing authorities, provide an increased role for other agencies and increase funding, a new and separate act may be needed to fully and adequately address the crisis confronting our coral reefs.

One approach to this would be legislation that focuses exclusively on coral reefs and increases the protection afforded. Alternatively, it could provide new authority and funding for protection and restoration of a broad array of ecologically valuable and increasingly vulnerable marine ecosystems with specific protections tailored to coral reefs.

Mr. Chairman, in your opening remarks you mentioned the test of time and what our grandchildren will look back on. What is particularly important to me as a new father and an expectant father as well, I think you know probably better than I that 100 years ago in this region we also had great living reefs. They were not coral reefs. They were oyster reefs.

The test of time looking back has not been favorable on how those reefs were protected. The high three-dimensional oyster reefs that once existed in the bay are largely gone or completely gone. I hope that as you suggested we can look back 100 years from now, well probably not ourselves, but our children or grandchildren can look back on the coral reefs and have them healthier than they are today.

Thanks, that completes my testimony. I would be happy to answer any questions you may have.

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

[The prepared statement of Mr. Sobel follows:]

**Statement of Jack A. Sobel, Senior Director, Ecosystem Protection, The Ocean Conservancy**

Good Morning. I am Jack Sobel, Senior Director for Ecosystem Protection for The Ocean Conservancy (TOC), formerly the Center for Marine Conservation. The Ocean Conservancy strives to be the world's foremost advocate for the oceans. With a nearly–100 member staff serving 900,000 members and volunteers, we work to inform, inspire, and empower people to speak and act for the oceans through science-based advocacy, research, and public education. Headquartered in Washington D.C., The Ocean Conservancy has additional offices in Alaska, California, Florida, Maine, Virginia, and the U.S. Virgin Islands.

During my tenure with The Ocean Conservancy, I have directed its habitat, marine protected area, and ecosystem programs, and served as its Senior Ecosystem Scientist. These positions have provided opportunities to lead and participate in several coral reef conservation policy and science efforts. Prior to joining TOC, I acquired extensive coral reef field experience, first by working as a researcher at the West Indies Laboratory in the Virgin Islands, and then by establishing and directing a research program in Belize. Living in these island communities contributed greatly to my appreciation, understanding, and concern for not only the remarkable living systems we call coral reefs, but also for those who most directly depend on them. I am an angler, a diver, a conservationist, a scientist, and most recently a father. My introduction to and love for coral reefs dates back nearly four decades ago to family vacations and fishing with my father in the Florida Keys.

*Coral Reefs: Diverse, Complex, Valuable, Important, Endangered*

Coral reefs are among the most biologically valuable, fragile and endangered ecosystems on Earth. They are also among our most spectacular, diverse and complex marine systems, providing homes to nearly 100,000 known organisms and likely a million or more species yet to be discovered. These reefs are much more than just

corals. They are a myriad of interwoven and interdependent habitats and associated organisms. The coral reef community includes more than 4,000 species of fish, as well as extraordinary plant and algal diversity. Coral reefs and marine systems in general are much more diverse at higher taxonomic levels and consequently may harbor much more of the world's genetic diversity than terrestrial systems. For example, the diversity of photosynthetic machinery in green algae alone dwarfs that found in all terrestrial plants.

This remarkable diversity is rivaled by an extraordinary degree of complexity, interdependence, and specialization among reef dwellers. Amazing symbiotic relationships and fierce predator-prey, grazer-producer, and competitive interactions are commonplace on reefs. The remarkable relationships among species are critical to structuring reef communities, controlling energy and nutrient flow on reefs, and to maintaining the tight recycling of materials typical of reef systems. Corals, algae and other species constantly compete for space on a reef and fish grazing profoundly impacts the distribution and abundance of reef seaweeds, altering the balance among combatants. On shallow reefs, fish may consume from 50–100% of algal production and take 40,000–156,000 bites/square meter/day. Predators and herbivores are often highly specialized in their feeding preferences. Reef fish composition profoundly affects the whole reef community. Consequently, when fishing and other extractive activities remove critical living components of reefs, the reef community becomes less stable and loses its resistance and resilience to respond to change. Its ability to respond to other disturbances or withstand poor water quality, global change and other stresses may be markedly impaired.

The array of threats facing U.S. and global coral reefs is powerful and taking a heavy and increasing toll on them. Multiple stressors are affecting most, if not all of the world's reefs. There is strong recognition within the scientific community that fishing and pollution impacts are among the most critical threats to the health of coral reefs and that it is therefore imperative to address those impacts as immediately as possible. Fishing impacts are especially widespread, weaken the resistance and resilience of reefs to other natural and human stresses, and often act in consort with other threats to undermine the health of reefs. Fishing impacts can act synergistically with pollution, global change and other threats at the local, regional, and global levels to exacerbate the harm they cause. Global change may be among the greatest long-term threats to coral reef health, but many reefs may be gone before its impact is fully felt. Marine protected areas, especially marine "no-take" reserves are among the most critical, science-based tools available to address fishing impacts and protect coral reef ecosystem integrity.

Coral reefs have great economic and intrinsic value. In addition to their incalculable ecological value, studies have estimated that the world's reefs provide up to $375 billion per year in goods and services despite covering less than one percent of the Earth's service. On a more local scale, recent studies estimate the capitalized value of the reefs surrounding the Florida Keys alone at close to $2 billion. Guam's 69 square kilometers of reefs contribute greatly to a $1.5 million diving industry and support a $143 billion tourism industry. Admittedly, it is difficult to place a price tag on these natural systems, but such figures are still worth considering. Aesthetic, spiritual, biodiversity, and existence values are especially hard to calculate, but may be among the most important provided by reefs.

The last three decades have brought an increasingly broad consensus that coral reefs are tremendously valuable, rapidly declining and highly threatened due to multiple stressors, and that their decline has high human and ecological costs. In 2000, a large multi-national group of coral reef scientists concluded in the Status of Coral Reefs of the World: 2000 that roughly two-thirds of the world's reefs had already been destroyed or would be destroyed within 30 years unless strong action was taken to address human impacts quickly. Without additional effort and protection, we face the continued decline and loss of these complex, spectacular and fragile natural systems.

*Administrative and Legislative Tools for Coral Reef Protection*

*I. Executive Order 13089 on Coral Reef Protection*

In recent years, the United States Government has taken several key administrative and legislative steps to address the growing coral reef crisis. In 1998, President Clinton issued Executive Order 13089 on Coral Reef Protection to establish a "no-degradation" policy for all Federal agency actions that might affect U.S. coral reef ecosystems, and to require Federal agencies to implement conservation measures to protect and restore coral reefs from human impacts, such as fishing and pollution.

*II. Coral Reef Task Force*

The Executive Order also created the U.S. Coral Reef Task Force (CRTF), which is jointly chaired by the Secretaries of Commerce and Interior and includes the heads of at least thirteen other agencies. The Task Force is charged with addressing activities impacting reefs and developing plans and strategies for protecting coral reef resources. The CRTF's duties include: (a) Coral Reef Mapping and Monitoring, (b) Research, (c) Conservation, Mitigation, and Restoration, and (d) International Cooperation.

Between its inception and the close of last year, the Coral Reef Task Force met seven times. It created six working groups to help carry out its work and responsibilities: 1) Mapping & Information; 2) Coastal Uses; 3) Air & Water Quality; 4) Education & Outreach; 5) International; and 6) Ecosystem Science & Conservation. Members developed, finalized, and adopted a first-ever "U.S. National Action Plan to Conserve Coral Reefs" on March 2, 2000, and implemented various elements of the National Action Plan prior to and following its official adoption. The Task Force unanimously adopted a Charter in December of last year. An Oversight Policy, which was initially drafted on November 2, 1999, put out for public review, and subsequently revised was never formally adopted. The Task Force is next scheduled to meet in October.

*III. The Coral Reef Conservation Act*

Congress reinforced the Federal commitment to coral reef conservation when it enacted the Coral Reef Conservation Act (CRCA, P.L. 106–562) in December of 2000. The CRCA called for NOAA to develop a parallel National Coral Reef Action Strategy and submit it to Congress within six months. It also established a Coral Reef Conservation Program to fund coral reef conservation projects, enabled the creation of a Coral Reef Conservation Fund in cooperation with a non-profit organization to solicit donations and raise additional funding, and authorized a National Program to carry out activities to conserve coral reefs and coral reef ecosystems. Congress authorized $16 million dollars annually to carry out the Act.

*IV. The Northwestern Hawaiian Islands Coral Reef Reserve*

The Federal Government has also taken steps to protect special geographic areas. The Northwestern Hawaiian Islands contain a significant percentage of U.S. coral reefs, perhaps more than half. The Northwestern Hawaiian Islands Coral Reef Reserve (CRR) came into existence through a series of administrative and legislative actions. On May 28, 2000, President Clinton issued Executive Order 13158 on Marine Protected Areas (MPAs) and included direction to the Secretaries of Commerce and Interior to review and provide recommendations on protection for this area. Shortly thereafter, Congress passed the National Marine Sanctuaries Amendments Act of 2000 (P. L. 106–513), which specifically provided President Clinton with the authority to designate the Northwest Hawaiian Island Coral Reef Ecosystem Reserve, which he did on December 4, 2000 with the issuance of Executive Order 13178. The public was provided an opportunity to comment on the reserve designation, which was finalized by the issuance of Executive Order 13196 on January 18, 2001.

*Evaluation and Recommendations*

The Coral Reef Executive Order 13089 and the Coral Reef Conservation Act are both steps in the right direction. Each has had positive and significant impacts on the health of coral reef ecosystems. Although they have not succeeded in reversing the decline in coral reefs, this is not surprising given their short time frame, inherent limitations, and the extent of the problems facing coral reefs. To some extent, it may be possible to improve the effectiveness of these tools by strengthening their design and execution. In my opinion, however, new authorities will ultimately be necessary to arrest the degradation of coral reefs, either under a framework of regional marine protections or coral reef-specific directives.

*I. The Administration Should Recommit, with Congressional Support, to Strong Implementation of Executive Order 13089.*

Chief among the Executive Order 13089's strengths was the fact that it elevated coral reef protection to a national issue. It also reflected the need to address human impacts, including those due to fishing and pollution, and pledged to bring the full force of existing tools to bear on addressing threats to coral reefs. It demonstrated presidential and Federal agency commitment to conservation of coral reefs by adhering to a "no-degradation" standard and adopting a multi-agency, multi-jurisdictional approach in the creation of the Task Force.

Among its limitations was its necessary reliance on existing statutes, none of which were coral reef specific or provided a clear and overriding standard for the

level of protection. This translated into a dependency on continued Administration and Congressional support and commitment to execution. Finally, this approach lacked a formal legal mechanism for the public to hold government accountable for its implementation.

*II. The Administration Should Recommit to, and Congress Should Support, a Reinvigorated Task Force, a Strong Multi–Agency Approach, and Improved Implementation of the National Action Plan.*

During its first two years, the Coral Reef Task Force was quite active, engaged, and effective. It reached out to the public and across all levels of government through public meetings, opportunities for public comment, and by expanding its membership and creating Working Groups to address major issue areas. It raised awareness within and outside of government regarding the coral reef crisis and the need to address threats to coral reefs. It provided opportunities for academic, scientific, and other non-governmental institutions to exchange information with the Task Force itself, its Working Groups, and the public. For our part, The Ocean Conservancy sponsored two independent symposia/workshops, utilizing Task Force meeting venues, to highlight key threats to coral reefs and mechanisms for addressing them.

The release and adoption of The National Action Plan to Conserve Coral Reefs on March 2, 2000 represents a high-water mark in the Task Force's efforts. This first such U.S. plan is extraordinary in many ways and was a major positive achievement for the Task Force. The plan does an excellent job of summarizing the importance, value, and plight of coral reefs. It clearly and accurately identifies the major threats to coral reef systems, including fishing and pollution. Its two fundamental themes, eight core conservation principles, and identification of thirteen individual conservation strategies (action plans) are on-target, sound and strong. They provide an outstanding framework on which to build truly comprehensive coral reef protection.

The individual conservation strategies (action plans), however, are variable in degree of detail and inconsistent with respect to their level of specificity on measurable objectives and timelines for achieving them. The Mapping and Marine Protected Area plans were among the more detailed, specific and concrete. The Socioeconomic and Pollution plans were among the less specific. Although some progress has been made on implementation of individual action plans, plan implementation has slowed considerably over the past two years. In some cases, earlier accomplishments may be at risk of reversal. Not surprisingly, the more detailed, specific, and concrete plans have achieved the most.

In general, the Task Force seems unable to build on the momentum generated by the adoption of the generally strong National Action Plan and to maintain the energy and productivity of the Working Groups. In other words, follow-through has been disappointing. The Administration and Congress should revitalize the Task Force by bringing strong, multi-agency involvement to improved implementation, including devising benchmarks and monitoring progress with respect to the National Action Plan.

The Task Force spent considerable time on development of two other important items, a Charter and an Oversight Policy. Unfortunately, the Charter was not finalized and adopted until December 5th, 2001 and the Oversight Policy was never formally adopted. The Task Force should adopt the Oversight Policy at its next meeting in October and utilize it and the previously adopted Charter to improve reporting, tracking and monitoring of progress, implementation of conservation measures, and public responsiveness.

*III. The Coral Reef Conservation Act Should be Strengthened by Providing Additional New Authority and Direction to Implement Coral Reef Conservation, Mitigation and Restoration Measures, Involving Other Federal Agencies in Conservation of Coral Reefs, and Increasing Authorized Funding Levels.*

Enactment of the Coral Reef Conservation Act was an opportunity to build on the existing Coral Reef Executive Order, support and strengthen its underlying legislative mandate(s), provide a new legislative mandate and new authority for coral reef protection, and dramatically increase funding for coral reef conservation. As enacted, the Act is a step in the right direction, but it has important limitations to its effectiveness.

It contains a strong opening purposes section that includes "to preserve, sustain, and restore the condition of coral reef ecosystems," provides language to develop a National Coral Reef Action Strategy that mirrors language in the Executive Order and the National Action Plan, and authorizes some new funding for coral reef protection and mechanisms to raise additional funds. However, it provides very limited

new authority to protect coral reefs, adopts a single agency versus multi-agency approach, and authorizes only a modest amount of new funding (i.e. $16 million annually) relative to the magnitude of the coral reef crisis.

Although the Act requires the development of a National Coral Reef Action Strategy, authorizes the Secretary to carry out certain specified conservation activities, and establishes a grant program to assist others in carrying out coral reef conservation projects, the Act lacks adequate direction and authority, relying principally on existing Federal authorities and the help of local, state, and regional entities to achieve its objectives. Given the threats confronting our coral reefs and their ecological and economic importance, this approach is inadequate.

The Act should be amended to direct and provide the authority and funding necessary to the Secretary to implement the National Coral Reef Action Strategy Implementation Plan called for by section 6402. The National Program to conserve coral reefs and coral reef ecosystems authorized by section 6406 of the Act also lacks adequate direction and authority and needs to be strengthened. This section should be amended to require the Secretary, as well as other Federal agencies, to undertake activities to conserve coral reefs and coral reef ecosystems and should provide the necessary new authority and funding to undertake those activities.

One of the primary shortcomings of the Act is that it relies almost exclusively on the National Oceanic and Atmospheric Administration. To its credit, NOAA has apparently elected not to reinvent the wheel and has indicated it is largely adopting and building on the multi-agency National Action Plan and is working with other agencies to develop the new National Coral Reef Strategy. Nonetheless, tasking the development of this new National Coral Reef Strategy to a single agency after a multi-agency Task Force had developed the prior National Action Plan may have impeded collaboration, limited available staff resources, and slowed down its completion. (Although the Strategy is now long overdue, I understand that it is nearing completion.) In considering amendments to the Act, we urge the Committee to consider ways in which to better use the full resources of the Federal Government to achieve the Act's lofty and important objectives. Clearly, conservation of coral reefs cannot be accomplished without the support and active involvement of other Federal agencies and departments.

Finally, the authorized funding levels need to match or exceed the need. Although a total of $16 million annually is a significant down payment, this is not sufficient given the crisis confronting our coral reefs. Furthermore, authorized funding for coral reef conservation activities should not be restricted to activities carried out or funded by the Secretary of Commerce.

*V. Developing New Authorities*

Although the Executive Order and the Coral Reef Conservation Act are important steps in the right direction and, with your support and the support of the Administration, can be made more effective, more sweeping changes will be necessary for healthy coral reefs to persist in the future. A couple of weeks ago Gerry Davis from Guam testified before this Subcommittee that "[t]here is still no clear law that protects coral reefs Federally. There are many laws which are used to attempt to do this but this is a piecemeal approach to the issue." I believe he is right and that such comprehensive legislation is sorely needed if we are to protect coral reefs.

Although it may be possible to get there by amending the existing Coral Reef Conservation Act to expand and strengthen its existing authorities, providing an increased role for other Federal agencies in achieving its purposes, and significantly increasing Federal funding for coral reef conservation activities, a new and separate Act may be needed. Such legislation could focus exclusively on coral reefs or; alternatively, it could provide new authority and funding for protection and restoration of a broader array of ecologically valuable and increasingly vulnerable marine ecosystems.

*Conclusion: Safeguard Coral Reefs for Our Kids & Future Generations*

As we enter the 21st century, considerable attention concern and discussion revolves around the prior loss, continued degradation, and threatened future of valuable coral reefs around the world. Yet a century ago, similar attention, concern and discussion about then-valuable oyster reefs failed to avert their demise.

At the time, seeing the handwriting on the wall, biologist and oyster commissioner W.K. Brooks stated "We have wasted our inheritance by improvidence and mismanagement and blind confidence."

George Santayana once said: "Progress, far from consisting in change, depends on retentiveness. Those who do not remember the past are condemned to repeat it". The wholesale destruction of oyster reefs and concurrent decline of oyster populations in many parts of the world provides a stunning portrait of severe ecosystem

level damage due to intense fishing focused on critical ecosystem components and offers lessons for the future. Can we learn from the lessons of the past?

I hope we can learn and make the progress necessary to save our coral reefs, so that I can share the experience, awe, and wonder with my children that my father first shared with me.

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Mr. ABERCROMBIE. Mr. Chairman?

Mr. GILCHREST. Mr. Abercrombie, I didn't see you.

Mr. ABERCROMBIE. Before we proceed, may I ask your permission to submit three testimonies; that from a colleague and friend, Bob Underwood, a statement from him for the record.

Mr. GILCHREST. Without objection.

[The prepared statement of Mr. Underwood follows:]

**Statement of The Honorable Robert A. Underwood, a Delegate in Congress from Guam**

Thank you, Mr. Chairman, for scheduling this morning's hearing regarding the status of coral reefs and to review Federal activities to protect and conserve these precious marine ecosystems.

Former NOAA Administrator Dr. James Baker once said that the "sustainable use and conservation of our coral reef ecosystems is a goal that should be above partisan politics." I could not agree more with that admonition.

lt was in a genuine bipartisan spirit that the Congress passed, and President Clinton signed, the Coral Reef Conservation Act of 2000. This innovative legislation—the first of its kind to exclusively focus on the preservation and restoration of coral reef ecosystems—included several provisions important to members of this Subcommittee, including myself. I am eager to learn about NOAA's efforts to implement this important statute.

I will be particularly interested to hear about NOAA's success in providing grant assistance for local coral conservation projects authorized under the section 204, Coral Reef Conservation Program.

The value of a locally-driven coral reef grant program is especially beneficial for U.S. Pacific Island territories and freely associated states where village communities are tied culturally, economically, and ecologically to their coral reef resources.

Specific requirements to guide the distribution of grant assistance were included in the Act to ensure that no region is overlooked. I will be interested learn if applications for coral conservation projects in the Pacific region have received the level of financial assistance they are entitled to receive under this program.

The overall declining health of coral reef ecosystems also remains an overarching concern of mine. Unfortunately, the lack of historical research data on the health of "normal" reef ecosystems remains a persistent hindrance in our ability to assess the severity, or to understand the true significance, of new outbreaks of diseases or the recurrence and spread of bleaching events.

If we ever hope to be able to compare and assess future changes in coral reef health, progress must be made to develop a definitive ecological baseline for coral reef ecosystems.

To address this need, and in part, to fully identify and inventory all coral reef resources under U.S. jurisdiction, Congress authorized the National Program under section 207 of the Act. I will be interested in hearing the progress made by NOAA in implementing the National Program and the status of its activities.

I will also be interested to hear about the contributions of the other members of the U.S. Coral Reef Task Force towards fulfillment of the National Action Plan and conformance with the directives under Executive Order 13089.

In closing, the world's coral reef resources currently face of large-scale climate changes of a severity not seen in the last 300 years. And with only 10% of surface corals still living in some areas, we certainly don't have time to contemplate their fate.

That is why is it crucial that we hold this oversight hearing this morning. Together, we have recognized the threat, and together, we have engaged the Federal Government and their state and territorial partners in a great effort to conserve "the rainforests of the sea."

Yet it is also our responsibility in Congress to make sure that implementation of the Coral Reef Conservation Act fulfills its goal of restoring coral reef ecosystems, and to that end, our work remains far from over. Thank you.

Mr. ABERCROMBIE. I would also like to submit testimony submitted by Lelei Peau, who is the Chair of the U.S. All Islands Coral Reef Initiative Coordinating Committee.

Mr. GILCHREST. Without objection.

[The statement of Lelei Pea submitted for the record follows:]

**Statement submitted for the record by Lelei Peau, Chairman, The U.S. All Islands Coral Reef Initiative, Coordinating Committee**

On behalf of the U.S. All Island's Coral Reef Initiative, I provide this testimony to appeal for continued support by Congress of the Coral Reef Conservation Act of 2000 and Executive Order 13089.

A dramatic increase in efforts and implementation of projects aimed at protecting and enhancing coral reef resources in the United States has taken place since 1998. These activities had their roots in the International Coral Reef Initiative launched in 1994 at the United Nations Conference on Sustainable Development in Small Island Developing States in Barbados. At the time, Federal agencies were hoping to see as much as $10 million per year in new Federal funding for international and domestic coral reef management. The reality at this time was short lived as limited allocations were received.

The lack of funding did not deter the governments of American Samoa, Commonwealth of the Northern Mariana Islands, Guam and Hawaii who spearheaded the U.S. domestic component of the Coral Reef Initiative. In December 1994, they produced the first Coral Reef Initiative Management Strategy with support from the Pacific Basin Development Council, the Office of Ocean and Coastal Resources Management at NOAA and the Office of Insular Affairs at the Department of the Interior. This strategy assessed coral reef threats and existing efforts and identified a series of activities aimed at improving the management of coral reef ecosystems through public education and awareness, research and monitoring, and enhanced regulation and enforcement. When the strategy was originally developed, the island governments saw the prospects of new Federal funding as remote. But, they made a commitment to implement the island strategy with no new funding.

The Office of Ocean and Coastal Resource Management and the Office of Insular Affairs between 1995 and 1998 made a limited amount of Federal funding available to island governments but the vast majority of efforts to implement the Coral Reef Initiative Island Management Strategy came from existing sources of funding. In 1997, the island strategy was updated and expanded to include the Commonwealth of Puerto Rico and the U.S. Virgin Islands and it was published as the U.S. Islands Coral Reef Initiative Summary Report, sometimes know as "the Blue Book.

In 1998, President Clinton issued the Coral Reef Protection Executive Order 13089. It established the U.S. Coral Reef Task Force and mandated Federal agencies to "protect and enhance the conditions of (coral reef) ecosystems" and to ensure that their actions would not "degrade the conditions of those ecosystems." The President appointed the Governors of U.S. states, territories, and commonwealths with coral reef resources to be full members of the Task Force. The Administrator of NOAA also recognized the U.S. Island Coral Reef Initiative Summary Report at the National Ocean Conference as the kind of grass roots and cooperative effort that the Executive Order was intended to support.

A series of working groups were set up by the U.S. Coral Reef Task Force to develop a National Action Plan to implement the Presidential Coral Reef Protection Executive Order. At the urging of the All Islands Governors, the Task Force formally recognized what came to be known as the All Islands Coordinating Committee and resolved to give priority to the activities identified in the All Islands Coral Reef Initiative Strategy, which was further updated as "the Green Book" in 1999.

Since 1999, substantial amounts of Federal funding have been appropriated for coral reef management activities developed largely in response to priorities identified by the U.S. Coral Reef Task Force. These have included projects identified in the U.S. Islands Coral Reef Initiative Summery Report and the All Islands Coral Reef Initiative Strategy. Funds for All Island projects have been provided primarily through the Office of Ocean and Coastal Resources Management at NOAA and the Office of Insular Affairs at Department of the Interior. Other NOAA offices and programs have also cooperated closely with the All Islands Committee to develop and implement activities aimed at improving the management of coral reef ecosystems.

The majority of the funding appropriated for the management of coral reef ecosystems has been devoted to projects and programs planned and managed by Federal agencies. A total of $25 million in Federal funding was appropriated for coral reef management activities in 2001 of which $1.35 million was allocated to fund All

Island's activities. In 2002, a total of $34 million was appropriated for coral reef management activities and a portion of that is devoted to furthering All Islands projects.

Most of the Federal initiated activities have been aimed at science and research-based activities including resource assessments, monitoring, habitat classifications, and mapping. Almost no resources at the Federal level have been aimed at public education and awareness. Unfortunately, all of these science-based coral reef management activities at the Federal level will have little or no impact on the health of coral reef ecosystems without broad based public and political support at the state, territorial and commonwealth level.

The All Islands efforts have strong support from island Governors, attributing a tremendous success in terms of channeling local resources and new Federal funds into coral reef management activities at the state, territorial, and commonwealth level. Some of these activities have been aimed at public education and awareness. Unfortunately, given the already strained local budgets in Island Governments these efforts have not convinced local legislatures that significantly more local funds need to be appropriated for basic resource management activities including public education and awareness.

The monumental accomplishments to date would not have occurred without the partnerships between the Federal entities and states, commonwealths and territories and the supporting legislation and continued appropriation to commit to coral reef management as a collaborative domestic approach. This testimony is an appeal for your support to continue our efforts to support management of coral reef systems at the domestic level.

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Mr. ABERCROMBIE. With your permission as well, I would like to offer the testimony of the Chair of the Board of Land and Natural Resources of the State of Hawaii, Gilbert Coloma-Agaran.

Mr. GILCHREST. Without objection.

Mr. ABERCROMBIE. Thank you so much.

[The statement of Gilbert Coloma-Agaran submitted for the record follows:]

**Statement of Gilbert S. Coloma–Agaran, Chairperson, Department of Land and Natural Resources, State of Hawaii**

Thank you for the opportunity to present written testimony on this oversight hearing. My apologies for not being able to attend the hearing and testify in person. I provide testimony as the Chairperson of the Department of Land and Natural Resources on behalf of the State of Hawaii as the Governor's representative to the U.S. Coral Reef Task Force, and also offer observations that pertain to coral reef resource management throughout the U.S. insular Islands. It is clear that Hawaii and the other U.S. Islands in the Pacific and the Caribbean, Guam, America Samoa, the Commonwealth of the Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands share common problems regarding the decline in the health of their coral reef resources and the need to develop innovative solutions to address this decline.

*The Importance of Coral Reefs*

Hawaii's coral reefs are of critical importance to us, and our island neighbors. In the Hawaiian creation chant, the Kumulipo, coral was recognized as part of the foundation of emergent life. Corals are one of the principle building blocks of our islands and supply the sand for our world class beaches, protect our shores from storm and wave damage, and are a star attraction in the economic engine that drives our economy—tourism. Hawaii ranks on par with the most popular dive destinations worldwide due to our clear waters, coral reefs and unique marine life. Over 25 % of our reef species our found nowhere else on earth. The majority of the nations coral reefs are found in our waters.

*Executive Order 13089, Coral Reef )Protection*

Executive Order 13089 on Coral Reef Protection directed all Federal agencies whose actions may affect U.S. coral reefs to utilize their programs and authorities to protect and enhance the conditions of such ecosystems. The EO also created the U.S. Coral Reef Task Force and raised the importance of coral reefs to a national level. The Federal agencies for the first time were tasked to work together to develop strategies to better manage our nations coral reefs and to assess their actions and how they affect this ecosystem. The Co–Chairs of the Task Force recognizing

that the majority of the nation's coral reefs lie within the jurisdictions of the States and Territories took an innovative step forward and invited the Governor's of these jurisdictions to be full members of the Task Force. The Governors and their staff were able to obtain direct access to key members of the administration to address management of these resources on the local, regional and national level. The National Action Plan to Conserve Coral Reefs was a product of the Task Force, developed in a true Federal/State/Territorial partnership. Participation on the Task Force has resulted in agencies focusing on initiatives that cut across normal agency boundaries to target strategies to conserve our nations coral reefs.

*U.S. All Islands Coral Reef Initiative*

Even before the advent of the Task Force and Executive Order 13089, the resource managers in the islands had recognized the need to work together to address the growing impacts to our coral reefs—The issues and management concerns facing all our jurisdictions created a desire to share common ideas and work towards innovative solutions to addressing reef decline. In many islands, the concepts of the integration of coral reefs with the overall health and well being of their ecosystems have long been recognized. The islands have taken the lead in working together to develop a foundation for management including a long-term strategy, a vision, mission statement and goals. This initiative helped form the basis for the U.S. Coral Reef Task Force strategy and set the parameters for working collaboratively to develop solutions.

*Coral Reef Conservation Act of 2000*

The funding provided initially via appropriations to implement the strategies of the U.S. Coral Reef Task Force and subsequently via the Coral Reef Conservation Act of 2000 have been pivotal in bridging the gaps between a growing problem of reef decline and our collective ability to address this crisis. The funding allocated directly to the islands has provided significant opportunities to increase local management capacity, provide the foundations to leverage additional funds to address larger research questions regarding the status of the reefs and to begin to develop recommendations for management measures to address the issue of reef decline. The funding has brought several agencies within the State and numerous community groups together to collectively determine the needs and develop creative solutions to minimize impacts. However, the threats to our reefs have increased for several years, and coral reefs are complex and diverse ecosystems. Identifying solutions and raising awareness about these solutions will take time and will likely be measured in incremental changes to those circumstances that are causing the decline.

A focused strategy, adequate funding and coordinated Federal/state partnerships are all needed on a sustained basis to address the decline and initiate steps towards recovery. It is with this in mind that I would like to recommend the continued support for the Coral Reef Conservation Act of 2000. Using the model designed by the islands and addressing their needs on the local level in coordination with approaches, expertise and technology from the Federal level will provide solutions. The outcomes to date and the collaboration undertaken thus far have been outstanding and should be continued.

Thank you for the opportunity to provide testimony on these issues. The Department would be happy to work with your Committee Staff to provide additional State perspective on the proposed programs and their administration. The State Point of Contact for the U.S. Coral Reef Task Force and the coral reef initiative is Ms. Athline M. Clark of the Division of Aquatic Resources, and she can be reached at (808) 587–0099 to assist the Committee in their work..

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Mr. GILCHREST. We are talking about the Executive Order and this task force and implementing a whole series of coordinating efforts to deal with the degrading situation of coral reefs on an international basis.

The first question, though, which I would like all of you to respond to is: Can we save the coral reefs if the climate continues to warm even in the least predicted fashion? Can we save coral reefs, considering the increase in CO2, which has a degrading effect by increasing water temperature, which has a degrading effect in an increase in disease, because of the increase in water temperature that has a degrading effect on the change in composition of the salinity of the water which has a degrading effect?

So, can we save coral reefs if we don't move boldly to have a different energy policy?

Mr. KEENEY. Mr. Chairman, we at NOAA believe that if the warming trends in the tropics continue and sea surface temperatures are raised beyond the coral tolerance levels, there is a fairly narrow range there within which there is a tolerance for corals.

It could cause significant additional coral bleaching, events that result in coral mortality. So, I think we will hear more about it from Dr. Strong, who represents NOAA's National Environmental Data Information Service on the next panel. But, I believe there is a connection between global warming and the continued existence of coral reefs.

Judge MANSON. Mr. Chairman, in my written remarks I refer to several recent incidents of coral bleaching and some of the presumed causes of that. Your precise question, though, I think is one that is better left to the next panel.

In my oral testimony I made reference to Dr. Buddemeier's proposed study. As I indicated, he is one of the world's leading coral researchers. One of the reasons we are interested in his study is that it will give us some answers to the kinds of questions that you have asked.

Mr. GILCHREST. I will say, though, and this is partly my responsibility as well, is to take that information that we have and as government officials, assess it with all deliberate prudence which means we have a certain amount of speed attached to that.

I think we are due to make some bold statements about some of these problems. The administration needs to make a bold statement. The Congress needs to make a bold statement. The NGO's, I think, have been making bold statements but it never quite seems to get into a national deliberate policy.

So, I just throw that out there. I think Mr. Sobel will say—well, I shouldn't say what Mr. Sobel will say, but if you want to make a quick comment on "If we don't stop climate change, what can we do about coral reefs?"

Mr. SOBEL. I think you probably have the ability to read my mind on this. I think we clearly need a more enlightened response to global change and we need to move quickly in that direction, as you have mentioned.

I would also like to say that I have indicated in my written remarks that global change is not the only major threat that we are facing on coral reefs. And if we don't address some of the other issues, including the fishing issue and including the pollution issue, the reefs may not last even until the time that the global climate change impacts will really kick in.

So, we do need to address global change, but one of the best responses for that is also addressing the other threats because robust, healthy reefs with the full array of species in the natural abundances are much better equipped to response to changes in climate.

I think that that is really critical. That is why we have put an emphasis on the creation of highly protected, marine protected areas, so at least in a portion of our coral reefs we can see the full abundance of organisms that are supposed to be there and so that

they can respond not only to global climate change, but to the multiple stressors that our coral reefs are facing today.

Mr. GILCHREST. So, it is an all-encompassing, comprehensive approach which would include the elements of climate change, a major factor there, which I would assume would then include in the task force the Department of Energy and EPA and the State Department to coordinate that international effort and then also look at what would be CO2 and ultraviolet and climate change and weather patterns and coral disease, I suppose, and sea level, so that is a whole bailiwick in and of itself, all related to climate change.

Then land use is critical and fishing regulations are critical and the development of sanctuaries and marine-protected areas and some type of, I would assume, of marine-protected areas/sanctuaries in the nation's economic zones or certainly in the international arena.

I meant to ask that as a question instead of making a statement. I would like to continue to work, certainly, with Judge Manson and Mr. Keeney, specifically, on these issues. You may be light years ahead of me, but I would like to hook onto your star. It seems to me it is all interconnected, from the erosion due to increased weather patterns and storms and sea level to development pressures from hotels and subdivisions to gear type in the fisheries, all these things.

So, as we move forward, I hope we have this conciliates of effort with all the various aspects.

I yield to the gentleman from Hawaii, Mr. Abercrombie.

Mr. ABERCROMBIE. Thank you very much, Mr. Chairman. Judge and Mr. Keeney, perhaps you both can answer this. I had a concern for a long time that the harvesting, if you will, of coral is something that is almost impossible to regulate or measure.

I wonder whether you can speak authoritatively at all, either of you, on the effect of the high demand for coral on coral reef ecosystems and why this trade is allowed when corals appear to be in drastic decline or the possibility of drastic decline due to global warming and other factors that may be involved.

Do you have a view?

Judge MANSON. Well, I think that harvest is —

Mr. ABERCROMBIE. Other than simply an opinion?

Judge MANSON. Well, I have an opinion and a view. Again, I think the scientific facts are best left to the next panel. But it does seem to me that harvest is a factor in the degradation of coral reefs.

In terms of how we get our hands around that, that is an appropriate task —

Mr. ABERCROMBIE [presiding]. Well, we have closing, for example, in fisheries. I submitted a statement from our Board of Land and Natural Resources Chair. Off Waikiki, for example, the ancient Hawaiians themselves had periods of time in which it was a kapu, it was forbidden to fish for recovery's sake.

We had an extensive discussion yesterday about possible rolling closures that might take place in vast reaches of the ocean. So, it would not be unusual if we had a closure with respect to the reefs if we thought that made sense.

I don't want to get involved and I don't think the Committee wants to get involved in legislation that would simply be arbitrary on our part. It wouldn't be capricious, but it might be arbitrary, if it wasn't wanted. I don't mind doing arbitrary legislation in the sense that it's better to be safer about what we are doing than sorry about it afterwards, keeping in mind what was stated about oysters and reefs 100 years ago.

So, I am not concerned about being accused about being arbitrary, but I am concerned about whether or not we could legislate with respect to possible closures in regard to decline.

Judge MANSON. Right. Well, may I suggest that that is a fair subject for the task force to take a look at. Before the Congress would have to legislate, I think it would be a good idea for the task force to look at that and figure out some recommendations between the agencies. Of course, the task force involves more than just the agencies. The States are represented on the task force as well. That would be a great opportunity to get the input of all of the effected entities.

Mr. ABERCROMBIE. Thank you. Mr. Keeney?

Mr. KEENEY. Congressman Abercrombie, thank you for the question. With regards to the harvesting of corals in the U.S. waters, they are very strictly regulated. There is still some going on, but we are moving in the direction of prohibiting it entirely. Right now there is still some harvesting going on.

I think the bigger issue for the United States is one of trade. The U.S. is by far the world's largest importer of ornamental coral reef species, including 60 to 80 percent of live coral, 95 percent of the live rock, and an estimated 50 percent of all live reef fishes. So, we are definitely part of the problem and therefore need to be part of the solution.

Mr. ABERCROMBIE. Right. What about the reef fish question? You know I am very, very much concerned about CITES, you know, the Convention on International Trade in Endangered Species. That has had its fits and starts and all the rest of it. But the idea is good and it is taken seriously by people. What about reef fish in that context, if you feel competent to comment on it inasmuch as you raised it in conjunction with my question.

Mr. KEENEY. I know there is certainly concern about the taking of reef fish and the way that they are taken, which is one of the reasons why there is so much interest in holding significant portions of coral reefs apart from the ability to take any resources from those.

Mr. ABERCROMBIE. As you say, most of this is imported. Do you think what we might need is legislation that would forbid the importation if we thought that that would do it? We can't regulate overseas.

Mr. KEENEY. No, but there could be legislation that would have an impact on how it is taken. In other words, we could put restrictions on importations from areas where certain practices are used to harvest the coral. Therefore, I think it could have an impact.

Mr. ABERCROMBIE. And if we had evidence that the material was not being harvested in a manner that was acceptable to us that we could forbid its importation?

Mr. KEENEY. I believe we could.

Mr. ABERCROMBIE. OK, that is a good thing to know. Thank you.

Judge MANSON. Mr. Abercrombie, if I might add to that, Mr. Keeney mentioned CITES and you mentioned CITES in your question as well. Of course, the coral trade is regulated through CITES. The CITES Conference of the Parties will take place this November and I will be heading the U.S. delegation to that conference.

The Coral Reef Task Force meets in October, so we will have an opportunity to discuss it at the task force meeting in October.

Mr. ABERCROMBIE. Where will that be held?

Judge MANSON. That will be in San Juan on October 2nd and 3rd. Then the CITES conference will take place in Santiago in November 3rd through the 15th. So, there is an opportunity coming real soon to have the task force discuss the issue and although there is not a formal proposal in front of CITES, but certainly an opportunity to discuss it with all of the parties at the CITES conference as well.

Mr. ABERCROMBIE. I will follow up with you as well because there is interest in perhaps a delegation from this Committee going to the meeting in Santiago, I know that. Maybe we could follow up on that with each other.

Judge MANSON. Sure. We would be glad to assist the Committee in that respect.

Mr. ABERCROMBIE. Mr. Pombo has that responsibility.

Judge MANSON. Right.

Mr. ABERCROMBIE. Now, for the both of you also, in your testimony you mentioned the USGS scientists are mapping patch reefs in Hawaii and Indonesia. I presume this is part of a larger international effort that kind of follows up on what we just said. Where else in other countries are U.S. Federal agencies conducting research or are we? That is really my question. Are we conducting research then in any cooperative way with any other countries on the mapping of the reefs?

The reason I asked the question, I think it is fundamental to getting a perspective, a legislative perspective on what we need to do legislatively.

Judge MANSON. I am told, Mr. Abercrombie that we are not doing any more than just a very minimal amount.

Mr. ABERCROMBIE. But you are authorized to do so, are you not?

Judge MANSON. That would seem to be the case.

Mr. ABERCROMBIE. No, wait a second. It is Section 207. If we can do this, then we can get appropriations to do it. That is what I am saying. We are authorized and I am interested in whether or not this is progressing. Because if we don't get the other countries involved in this, we are going to have a problem making it work.

Judge MANSON. Well, we don't presently have funding to do it on a broad scale. There is some international effort ongoing that we participate in that is funded by grant monies primarily, but it is on a very, very low level.

Mr. ABERCROMBIE. Well, do we need to increase the USGS budget for this? Do we have scientists who can do it?

Judge MANSON. Well, we certainly have scientists who can do it. Of course, you are aware of how the budget process works. I certainly will discuss this with the USGS as we go forward.

Mr. KEENEY. Congressman, I have a couple of things I would like to mention. We put a priority first of all on our State areas and territory areas and also working closely with the freely associated States. We had, in the beginning part of this year, from January to February of 2002 NOAA major research crews to American Samoa to share assessment and monitoring approaches and techniques with local researchers and managers.

We had the NOAA research vessel, Townsend Cromwell and allowed Samoan researchers to conduct some of their first assessments on coral reef resources in remote outer islands and deployed several satellite linked coral monitoring stations to predict coral reef bleaching.

Mr. ABERCROMBIE. Do you think that needs to be expanded?

Mr. KEENEY. Well, we have expanded the dollars.

Mr. ABERCROMBIE. In other words, the NOAA budget is an appropriate vehicle for this, right?

Mr. KEENEY. It is. That is how we are able to do this work. We have expanded our international program from $81,000 in the year 2001 to $500,000 this year in the international arena.

Mr. ABERCROMBIE. For purposes of informing the Chair, could you go over what kind of a budget might be necessary in order to do as comprehensive a job as you think would be warranted under the circumstances and conditions of the perspective that you folks have outlined so far today?

Mr. KEENEY. Certainly. If we could, we would like to provide that for the record.

Mr. ABERCROMBIE. Sure.

Mr. ABERCROMBIE. Mr. Chairman.

Mr. GILCHREST [presiding]. Thank you very much, Mr. Abercrombie. I appreciate your help. I had a group from the Philippines in the back here.

Mr. ABERCROMBIE. Yes. For those of you who may not have realized it, Mr. Gilchrest had to leave for a little while, so theoretically I was in charge of this Committee for the moment. But if all of you promise not to tell Mr. Armey so that his heart doesn't have palpitations, why, we will just go on with the hearing at this point.

Mr. GILCHREST. I don't think it was in theory. It was in fact, Mr. Abercrombie. Thank you very much.

I guess I would have just one other quick follow up question. I will read the testimony and the report that you have given us here this morning. Can you point to, and maybe you related this to Mr. Abercrombie, and I appreciate the questions about the funding issues.

Those are, I think, a shared responsibility between the Administration and us as Members of Congress. We do the authorizing so we try to push it as far as we can for the appropriators. I'm sure it would be of great help if the Administration would put the number at a higher level. But all of us in this room, probably, have to deal with the mysterious entity of OMB.

I am always amazed when I see some live human being from OMB. I actually have to shake their hand and touch them because we don't get to do that very often. But I think the effort between the administration and the Congress would be helpful if we pushed some of these numbers up. We will on this side.

There were a number of comments made earlier about solutions to the coral reef problems, more aggressive implementation for a no-degradation standard? Can you point to an area where coral reefs are beginning to come back that were suffering the effects of bleaching or soil erosion or disease or something of this nature, partly so we can tell our colleagues that because of this program these coral reefs have been restored to a healthy State or are being restored?

Mr. KEENEY. Mr. Chairman, we are aware of certain areas in the Florida Keys that are especially protected areas that are recovering and improving because of their protection.

Mr. GILCHREST. Now that means that there are certain —

Mr. KEENEY. Areas set aside.

Mr. GILCHREST. Are those areas that are set aside also protected from degradating practices of land use? Has land use changed? Was it necessary to change land use to protect those coral reefs?

Mr. KEENEY. I think the protection is more so from the more direct impacts of fishing and diving, recreational uses, and the taking for specific commercial use.

Mr. GILCHREST. Of the coral?

Mr. KEENEY. Yes.

Mr. GILCHREST. Mr. Manson?

Judge MANSON. You asked about bleaching and the recovery from bleaching. The Howland Baker Jarvis Refuge suffered a bleaching incident. Department of Interior and NOAA scientists worked together on that issue. I understand that they are seeing some signs of recovery with respect to that.

On the Virgin Islands, DOI is currently monitoring the recovery of Elk Horn Coral there as well. I can certainly get some more specifics about that and provide them for the record.

Mr. GILCHREST. Well, we would appreciate that. It would help.

Mr. GILCHREST. Maybe I should ask the next panel how they come back if they were being bleached. What was the reason for the bleaching and what was the remediation technique used to restore that?

Do we have any idea how much coral is brought into the United States and might the Administration make a recommendation to prohibit the importation of coral into the United States?

Mr. SOBEL. Mr. Chairman, there have been some good reports put together on the volume of trade, including ones that were generated through the Coral Reef Task Force. I believe at least one report that came through the trade subgroup from the task force and there was a second one, I think, also done through AAAS addressing some of that. That information is available.

Mr. GILCHREST. Do the reports describe where it comes from and to whom it is sold?

Mr. SOBEL. I believe it does. It does identify the portion the U.S. is responsible for. I believe that Mr. Keeney covered some of those percentages in his testimony. That information is available and has been compiled in terms of where it comes from.

Mr. GILCHREST. Is that both live coral and dead coral?

Mr. SOBEL. I believe it goes to both the live rock issue and to the living coral that was removed and then became dead as it was

transported. I don't know all the specifics on that report, but I can get back to you and provide a copy if you would like.

Mr. GILCHREST. I would appreciate it.

Mr. GILCHREST. Is there any recommendation from the task force to prohibit or limit the sale of coral in the United States? Does the sale of coral have an impact on coral reefs?

Mr. SOBEL. I think it unquestionably does, particularly on foreign reefs.

Mr. GILCHREST. I guess I am asking too many questions.

Mr. SOBEL. No. In terms of foreign reefs, I think it is an important factor in some countries. In the U.S., as I think Mr. Keeney said previously, we don't allow much coral harvest in this country. So, that is not a big issue.

I think we were also asked about reef fish. There is a lot of harvest of reef fish and invertebrates and those practices have considerable impacts on U.S. reefs.

Mr. GILCHREST. And that is still allowed right now.

Mr. SOBEL. Yes, that is still around. We would not suggest that all of that be banned, but we would certainly suggest that we need some areas that are set aside so that you can protect those practices in the future to be sustainable and continuing, that you have those areas as reference points so you understand what the impact of that harvesting is.

Mr. GILCHREST. Mr. Keeney, are the coral reefs in the Florida Keys protected from any harvesting of any type?

Mr. KEENEY. There are certain areas. It is a zone management complex for the Florida Keys National Marine Sanctuary. There are certain areas where harvesting is allowed, but to a very limited extent.

Mr. Chairman, I also have with me some information which I would like to provide for the record, along with some additional information on your questions of live coral imports by the United States.

In the year 1988, there were 100,000 items imported of live coral into the United States. And in the year 2000, there were 400,000. So that is an increase of 300 percent.

Mr. GILCHREST. Did these come from a variety of places? Where did all that come from? Is there a syndicate that deals with this issue, buying and selling, or a few companies you look at? How does that work?

Mr. KEENEY. I believe most of this came from Indonesia and the Western Pacific. I am not aware of any particular companies, but we can provide additional information for the record.

Mr. GILCHREST. Would you say that those 400,000 pieces would have an minimal impact on coral reefs, a negligible impact on coral reefs, a major impact on coral reefs?

Judge MANSON. Mr. Chairman, if I could just add something that may help illuminate this, there is a group called the Marine Aquarium Council that tracks harvest and trade in coral items to determine if it is done in a sustainable manner. They have a recent report out. They have worked closely with the task force on that endeavor. We can certainly supply to the Committee the report of the Marine Aquarium Council.

Mr. GILCHREST. What is the Marine Aquarium Council? Is that a government entity or a private entity?

Judge MANSON. As far as I know, it is a non-governmental entity, but they track harvest and trade of coral with the goal of ensuring the sustainable harvest.

Mr. SOBEL. Mr. Chairman, if I could comment on two things quickly, just to be clear about some things, in the Florida Keys about 6 percent of the reefs are currently protected from harvest. Almost all of that is in the most remote area known as the Tortugas and resulted from a tremendous inter-agency process that developed a very strong consensus for setting that area aside.

There are also some other areas that through task force action or in relationship to the task force that have recently been developed in terms of monuments in the Virgin Islands, in terms of some of the big refuges in the Pacific and in terms of the Northwest Hawaiian Islands where there is a developing coral reef reserve. There is a coral reef reserve and a developing National Marine Sanctuary that would set aside some of those areas almost free of extraction. Those are the main areas that have been set aside.

With respect to the U.S. Virgin Islands and the two monuments there, the implementation of those has been slow because of some jurisdictional questions. There is a pending GAO report that I understand has largely been completed but has not been released that goes to that jurisdictional issue. We would urge you to get that information out if possible.

Mr. GILCHREST. What do you mean, jurisdictional issue? What are the conflicting jurisdictions?

Mr. SOBEL. When those monuments were set up there were some questions regarding Federal versus territorial control in some of those areas.

Mr. GILCHREST. I see. OK.

Mr. SOBEL. So, those monuments were set up. Some questions had been raised. We think the answers are available, but that report has not come out. As a consequence, we understand that the monuments are not moving forward to implementation the way they should be.

We would encourage you to at least get the information out and then let the cards fall where they may. On a more encouraging note in the Virgin Islands, I understand that there is also a territorial park plan that is moving forward and it looks like it is also going to set off some areas within the territory. So, you have the potential there for some good developments.

In Guam you have had a very long process, a 14-year process, which I think the gentleman from Guam has already reported to this Committee on testimony on Marine Protected Areas, about how they got to the point where they were setting aside, I believe it was 10 or 11 percent of their inshore coral reefs.

So, there is some progress being made in those areas and that progress needs to keep going.

One of the real potential areas is in the Northwest Hawaiian Islands where you have a very large reserve set up, some small areas that have been set up that are nearly fully protected. But there has been a delay in the implementation of those closed areas.

We would, again, seek to see those being implemented.

Mr. GILCHREST. We will take a look at what is causing the delay.

I have another assignment today and we have one more panel. I would like to spend the rest of the day here. But I appreciate, you have given us some good insight, Mr. Sobel, on many fronts. The jurisdictional issue and the delays will be a high priority of ours over the next couple of days.

Judge MANSON. If I could just add one thing, Mr. Chairman.

Mr. GILCHREST. Yes, sir, Judge.

Judge MANSON. I would like to add one thing about the jurisdictional issue in the Virgin Islands, Mr. Sobel is correct, there have been questions raised about that. I am told that the GAO, which was looking into the jurisdictional issue, has actually completed its report and may have in fact already transmitted it to the Member who requested it.

I am also told it may be publicly available within a very few days. So, we are looking forward to that as well so we can make some decisions about the planning process in the Virgin Islands.

Mr. GILCHREST. Well, thank you very much, Mr. Manson. We will follow up on that as well and get a copy of that GAO report.

Mr. Keeney?

Mr. KEENEY. Mr. Chairman, you asked a question at the beginning today's hearing with regard to the communication of scientific data, moving it from the scientific community to policymakers.

I just wanted to answer that Vice Admiral Lautenbacher had recently completed a program review for all of NOAA's programs. As part of that review, he placed a certain priority on environmental education and environmental literacy as well as improved communication with policymakers.

So, this is a report which is currently in the process of being completed. It should be available within the next few weeks. I think you might find it interesting.

Mr. GILCHREST. Thank you very much, Mr. Keeney. If there is any assistance we can provide in that area as far as cosponsoring an event or a breakfast or a dinner, or even having Judge Manson invite us up to Interior, a dozen or two dozen members for breakfast sometime, or even an evening meal. I say "meal" because we as Members are jumping around eating a hot dog at 3 o'clock in the afternoon after we missed breakfast. Well, I shouldn't say. We will bring the food.

I think Mr. Keeney, Vice Admiral Lautenbacher is to be praised for something like that. If there is any way that myself or other Members can connect with helping to cosponsor an event, we would like to do that so that we could also help with certain key Members on both sides of the aisle, come and help learn more about these issues.

Mr. KEENEY. Chairman Gilchrest, we did just have a NOAA fish fry about 3 weeks ago. If the Congress would have cosponsored it, we probably could have brought the price down to a more reasonable amount.

Mr. GILCHREST. Well, we would like to do the next one, help you with the next one.

Mr. KEENEY. Fine. Thank you.

Mr. GILCHREST. Mr. Keeney, Judge Manson, and Mr. Sobel, thank you all very much for coming this morning.

The next panel will be Dr. Anne Cohen, Woods Hole Oceanographic Institution; Dr. Alan Strong, Supervisory Physical Scientist, Oceanographer, for NOAA; Dr. Robert Buddemeier, Senior Scientist, Geological Survey, University of Kansas; and Dr. John Ogden, Director, Florida Institute of Oceanography.

Mr. GILCHREST. Welcome, folks. We appreciate your attendance here this morning. We look forward to your testimony.

Dr. Cohen, welcome to Maryland from Massachusetts. I hope it is not as hot in Massachusetts as it is in Maryland. You may begin.

**STATEMENT OF ANNE COHEN, RESEARCH ASSOCIATE, WOODS HOLE OCEANOGRAPHIC INSTITUTION**

Ms. COHEN. thank you, Mr. Chairman and members of the Subcommittee for this opportunity for me to talk about my work to you today. My name is Anne Cohen. I am a geochemist at the Woods Hole Oceanographic Institution in Massachusetts.

My work involves the chemical analysis of fossil coral skeletons. From those chemical analyses, we learn about the conditions in the ocean in which those corals grew.

My first slide shows a process in three photographs of coral bleaching. What you are seeing here is a vast area of pristine coral reef in June 1998, followed by a couple of months later the bleaching process which involves expulsion of the algasymbions on which the corals depend for life.

The process is called bleaching because the corals turn white in the process, following by a month later death and mortality of a vast area of that reef.

Over the past two decades, Mr. Chairman, we have seen —

Mr. GILCHREST. Could I just interrupt for a quick second and ask where that is.

Ms. COHEN. This the Red Sea.

Mr. GILCHREST. And what year was that?

Ms. COHEN. This is 1998.

Mr. GILCHREST. Thank you.

Ms. COHEN. Over the past two decades, at least since the late '70's, we have seen a dramatic increase in the frequencies of severity and geographic extent of coral bleaching events. In fact, only 2 percent of all known coral bleaching events occurred 1979 and 98 percent of those bleaching events have occurred since 1979 in the succeeding years.

This dramatic rise in coral bleaching has coincided with an increase in global temperatures. This slide shows the increase in the heat content of the global ocean since 1948. You can see that the coral bleaching in the 1970's coincides with the anomalous warming of the global oceans, which has continued since then.

The increase in global air temperatures and global ocean temperatures since the 1950's coincides with an increase in the carbon dioxide content of the atmosphere, which is directly related to the human consumption of fossil fuels.

This slide shows the direct correlation between increase in global temperatures in the blue line and the increase in the carbon dioxide concentration of the atmosphere in the red line.

We know, Mr. Chairman, that corals bleach when the ocean temperature exceeds approximately one degree Celsius, exceeds one degree above what they are used to, what the maximum summer temperature is in that region.

Thus, even at Bermuda which we once thought was immune from coral bleaching because it is situated in the middle latitudes and it is generally cooler than the tropical regions, we have seen since 1988 extensive bleaching events coincident with the anomalous warming of the surface ocean.

These arrows indicate coral bleaching events in 1988, in 1993 and in 1998, coincident with high temperatures at Bermuda.

So, the question is: Are the increased temperatures and the extensive coral bleaching that we are seeing, is this something that corals have seen before? Is this something anomalous, unprecedented or is it something to which the coral have adapted in their million year long history?

What I do is, I analyze the chemical composition of coral skeletons to allow me to reconstruct past oceanic conditions and attempt to answer this question.

What this slide is showing in the red is a history of the sea surface temperatures at Bermuda over the past 350 years, which we read from massive brain corals. What you can see is that the sea surface temperatures at Bermuda have indeed fluctuated quite dramatically over the past 300 years, since the early 1700's.

These fluctuations coincide with natural variations in the climate system. We know that there was a little ice age in the mid 1700's due to changes in the solar output of the sun. We know that in 1815 Mount Tambora in Indonesia erupted and that caused a dramatic cooling of the surface oceans. These are all natural climatory items that we expect in the record.

But the corals, as you can see since 1979 at Bermuda have seen nothing like the dramatic increase in the sea surface temperatures that prompted the first bleaching events in 1988.

Tree rings can take us even further back in history. What you are seeing here are the average temperatures between 30 degrees north and 30 degrees south, read from the rings of fossil trees, going back 1200 years ago.

The red line shows the air temperatures read from the trees. You can see that air temperatures are fluctuated over the past 1200 years due to natural climate variability. Indeed, about 1,000 years ago the temperatures were about as high as we recorded them in the 1950's.

However, if you look at the blue line, which is the instrumental record of temperatures over the same time period, you can see that in the last 20 years these trees have seen nothing like the dramatic rise in the air temperatures that we are recording today, at least over the past 1200 years.

So, in summary, Mr. Chairman and members of the Subcommittee, you can say that the magnitude of the global warming that we recorded since 1980 is unprecedented, at least in the past 1,000 years. It is probable that the extent of the coral bleaching and the severity in the global extent of the bleaching that we are seeing in the past 20 years is also unprecedented in the past 1,000 years.

We can say that the rate of change is probably too high to enable the corals to adapt. There is no sign now that the corals are actually adapting to the rapid rise in ocean temperatures. A long term target of one degree Celsius above the 1990 global temperatures may prevent eradication of the world's coral reefs because we know that this mass bleaching occurs when the ocean temperatures rise about one degree Celsius above what the corals are used to.

Therefore, CO2 emissions which we know are directly related to the rise in the global air temperatures must be stabilized accordingly.

Thank you very much.

[The prepared statement of Ms. Cohen follows:]

**Statement of Dr. Anne Cohen, Research Associate, Woods Hole Oceanographic Institution, Woods Hole, Massachusetts**

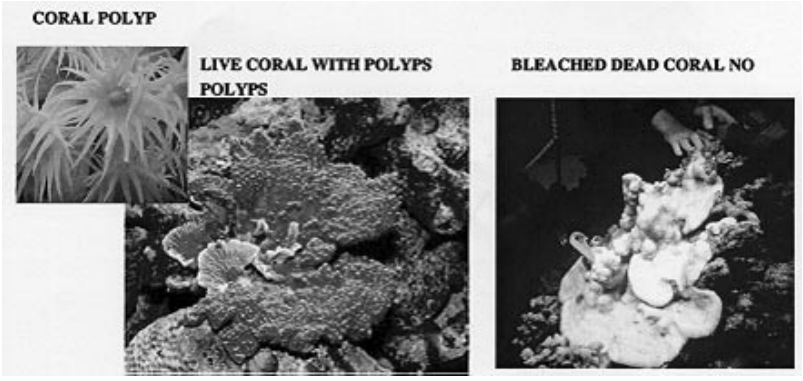
My name is Anne Cohen. I am a scientist at the Woods Hole Oceanographic Institution, in the Department of Geology and Geophysics. My research involves the reconstruction of climate variability over the past 1000 years. The goals of this research are threefold: first, to place our direct observations (i.e. experience) of climate over the past century within the context of longer term climatic variability; second, to enable recognition of the impact of human activity on climate and third, to enable assessment of the impact of climate variability on marine ecosystems, specifically on coral reefs.

The thrust of my comments today is that the climate change that we observe in the instrumental records since the middle of last century are unprecedented in the past 1000 years. The climate change to which I refer includes the observed increases in ocean and atmospheric temperature, changes in atmospheric circulation patterns and increases in atmospheric CO2. The increases that we have experienced during our lifetimes and which we have directly measured fall outside of the range of natural variability as we know it to have been prior to the industrial revolution.

Large-scale eradication of coral reef ecosystems is one of the risks of continued anthropogenic interference with the climate system. The two major threats of the current climate change to coral reef health are

(1) increased surface ocean temperature, which causes coral bleaching and death,
(2) increased atmospheric CO2, which may acidify the ocean causing reefs to dissolve, and reducing the ability of corals to make new skeleton.

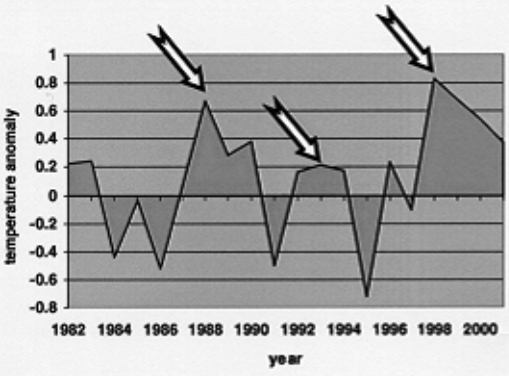
My testimony today will focus on the threat to coral reef ecosystems of increased surface ocean temperature due to greenhouse gas emissions. In the past two decades, frequent and severe episodes of coral reef bleaching (see figure below) have occurred on a scale that is unprecedented in the history of coral reef observations. These episodes are coincident with a rapid rise in global temperatures recorded since the mid–1970's. I will demonstrate, using several independently derived datasets, that the rate and magnitude of global warming observed in recent decades is unprecedented in the past 1000 years of Earth's climate history.



*Coral Death and Climate Change: Our Direct Observations*

Since the early 1980's we have witnessed extensive, basin-wide coral reef bleaching and mortality that have claimed, on some reefs, up to 90% of the living corals. While localized and reversible bleaching events had been recorded by scientists since the 1920's (Williams and Bunkley–Williams, 1990), these are dwarfed by the global extent, frequency and severity of the bleaching episodes of the past 20 years.

All major events in the past 2 decades coincide with extended periods of anomalous warming of the surface ocean. Although most of the damage thus far has been to tropical reefs, the cooler, more northerly reefs of Hawaii, Johnston Atoll and Bermuda (see below) first showed signs of bleaching in the late 80's and continued through the 90's.




(left) Extensive coral bleaching was recorded at Bermuda (32°N) in 1988 and 1998, and to a lesser extent in 1993. Bleaching events were coincident with warmer than usual ocean temperatures, indicated by the arrows. The warming of Bermuda waters is related to a change in the atmospheric circulation over the North Atlantic since 1960.

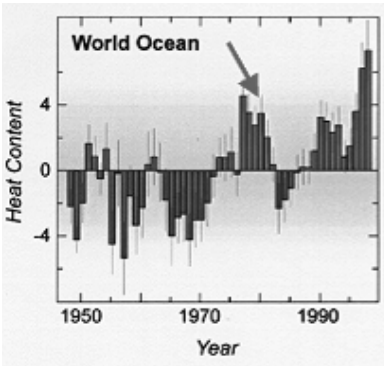
*Has This Happened Before?*

Intensive scientific monitoring of coral reefs and scientific understanding of the factors affecting coral reef health are relatively recent. Observations of extensive reef bleaching and mortality began in the early 1980's, following the 1982/1983 El Nino. From field observations and laboratory experiments we know that corals bleach when sea temperatures increase about 1δC above the normal summer ambient temperature for that region. We also know from information stored in coral skeletons (the work that I do), tree rings and other biological archives, that climatic conditions have fluctuated significantly in the geologic past. Ocean temperatures have oscillated between periods of cool and periods of warmth and coral reefs have survived these fluctuations. Is it possible that bleaching events of the severity and extent of the past 2 decades have occurred in the past in response to natural fluctuations in the climate system?

To answer this question we need to look into the distant past. Scientists have not yet developed a technique by which we can tell whether a fossil coral died from bleaching. However, we can tell what the ocean temperatures were at the time of death. We also know that the species found on reefs in the past 1000 years were the same as they are today and that they tolerated the same range of temperature. Therefore, to answer the question posed above, we need to address the question posed below:

Are the ocean temperature anomalies of the past 2 decades unprecedented in history or are they part of the natural cycle of climate variability to which corals have adapted?

The instrumental record of temperature indicates that the 1990's were certainly the warmest decade on record (see below). However, the instrumental record is short, giving us a limited perspective of variability through time. For example, a program to monitor ocean temperatures off Bermuda (Hydrographic Station S) began in 1954; global sea surface temperatures have been recorded remotely, by satellite, since 1981.



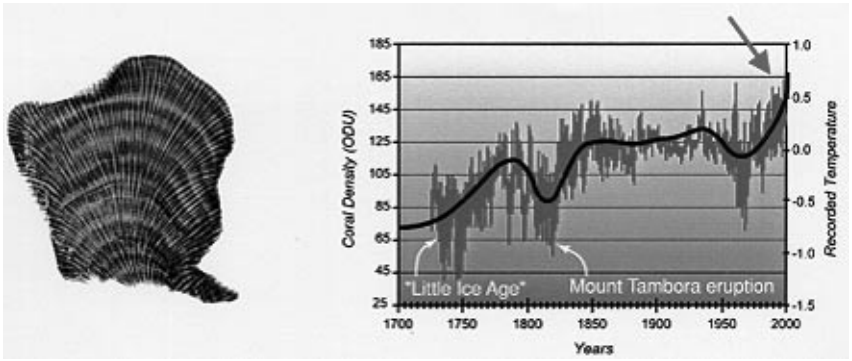

The figure at left shows the globally averaged surface ocean heat content since 1948. The data clearly show a net warming of the oceans since the late 1970's. The timing of the first observations of massive, basin wide coral reef bleaching is indicated by the arrow.

*Climate Change: The Past 1000 Years*

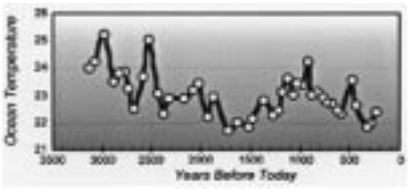
To gain some perspective on climate change over a longer period of time, we need an alternative source of climate information. Longer records of past climate are preserved in geological and biological archives—in deep ocean sediments, ice cores, in tree rings and in the skeletons of massive corals. These proxy records—many of which are based upon the biological response to climate change—enable us to see into the past, back beyond the start of instrumental recordings. While the sources of data, their resolution and their coverage in space and time are varied, they all show fairly large and consistent fluctuations in ocean and atmospheric temperatures over the past 1000 years. These fluctuations are associated with natural climate forcings including changes in solar output and volcanic eruptions.

However, all records show a large, rapid and unprecedented increase in temperature over the last half of the 20th century.

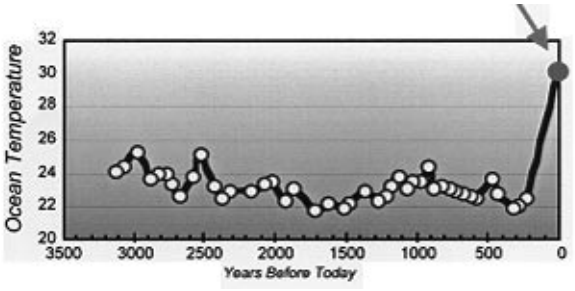
Past Ocean Temperatures: From brain corals at Bermuda, we get a record of ocean temperatures since 1725 AD. The density of the skeleton, shown by the x-radiograph below left, increases when it is warm and decreases when it is cool. The coral record (below right) shows that water temperatures on the Bermuda platform have fluctuated over the past 300 years, but the magnitude and persistence of the warm temperatures since 1980 are clearly a recent phenomenon. The timing of the first extensive reef bleaching at Bermuda is indicated by the arrow.



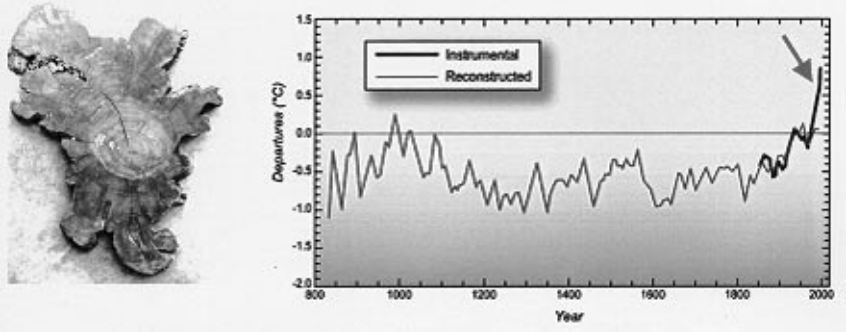

The temperature record from sediments cored nearby on the Bermuda Rise (from Keigwin 1997) enables us to see even further back into the past, although in less detail. The record shows that open ocean temperatures oscillated between generally warmer and generally cooler periods between 3500 and 250 AD (open circles, below).



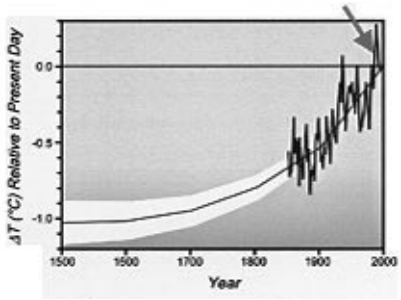

However, these historical fluctuations are small when seen against the most recent recorded summertime temperatures on Bermuda (below). The red circle indicates the temperature at which corals bleached at Bermuda in 1998. The temperature obtained at this time is unprecedented in the past 3500 years.




Past Atmospheric Temperatures: Tree rings (below left) preserve a record of atmospheric temperature. The combined northern and southern hemisphere tree ring record shows atmospheric temperature changes over the past 1800 years (red line, below right—from Cooke 2002). Oscillations between warmer and cooler periods are seen throughout the record, but the magnitude and rate of warming of the atmosphere in the past 2 decades clearly exceeds all previous warm events. The timing of the 1983 Pacific bleaching event is indicated by the arrow.




Underground Temperatures: Underground temperature measurements were examined from a database of over 350 bore holes in eastern North America, Central Europe, Southern Africa and Australia (from Pollack et al.) The data below show the 20th century to be the warmest of the past five centuries. The timing of the first observations of extensive coral reef bleaching is indicated by the arrow.




*Where to from Here?*

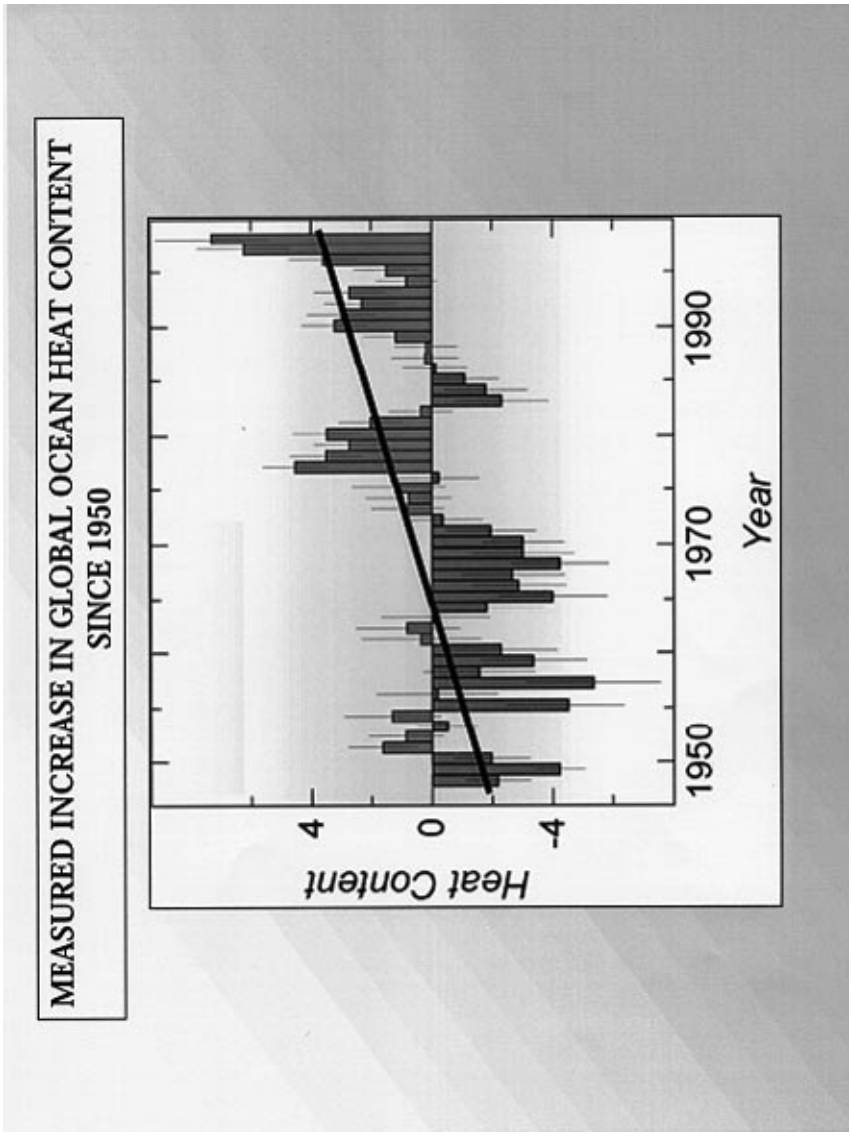
Coral reefs as we know them have been in existence for millions of years. They have survived major changes in the climate system, including oscillations between glacial and interglacial cycles that involved fluctuations in mean air temperature of 7–10 δC over fairly short periods of time. They have survived through periods of sea level rise and fall, meteor impacts, volcanic eruptions and changes in solar activity, and somehow the reefs have recovered. But the time scales of those recoveries were long, often many thousands of years and certainly outside of the time frame of our comparably short-term interests.

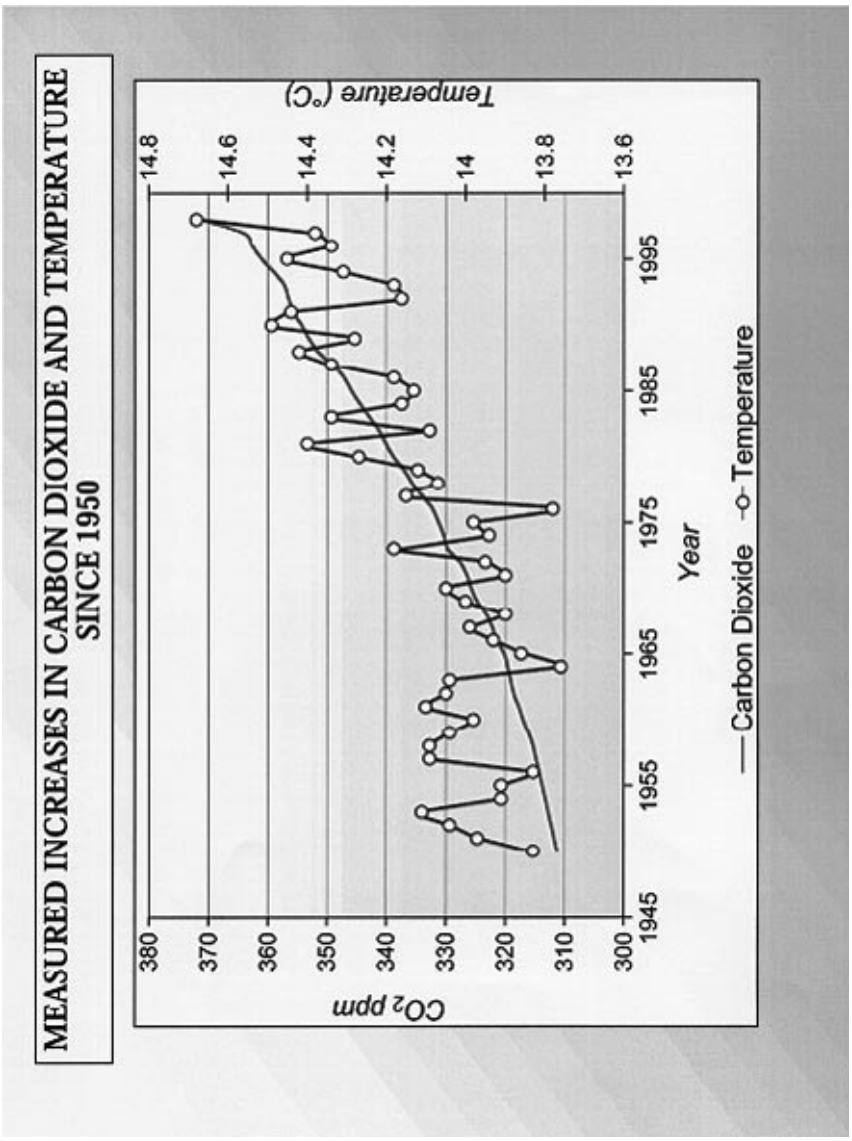
If we kill the reefs, the waiting time to get them back may be tens of thousands of years.

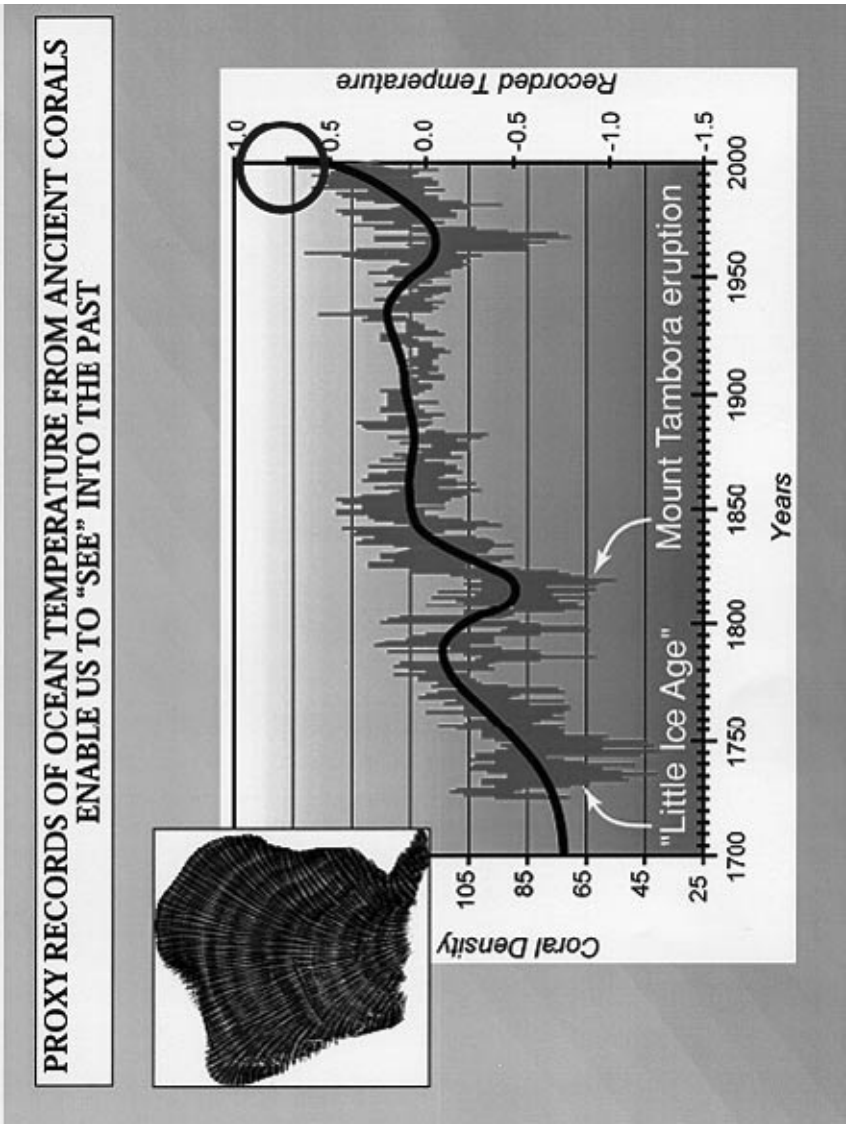
The frequency, severity and extent of coral reef bleaching and mortality that we have witnessed over the past 2 decades coincide with a rapid warming of the surface oceans. The evidence from proxy records over the past 1000 years indicates that atmospheric and oceanic temperatures have oscillated during this time between periods of relative warmth and periods of relative cooling. However, the rate and magnitude of the recent warming is unprecedented. Therefore, it is probable that the extent and severity of the observed coral reef bleaching is unprecedented as well, at least in the past 1000 years. Corals today show no signs of adapting to the rise in ocean temperatures and physiological constraints prevent corals from retreating to deeper waters or to higher latitudes to escape warming in the tropics. We can relieve coral reefs of the additional stresses imposed by pollution, development, exploitation and recreation that may slow the recovery from severe bleaching events. However, the evidence indicates that the impact of global warming affects coral reefs indiscriminately, independent of their health.

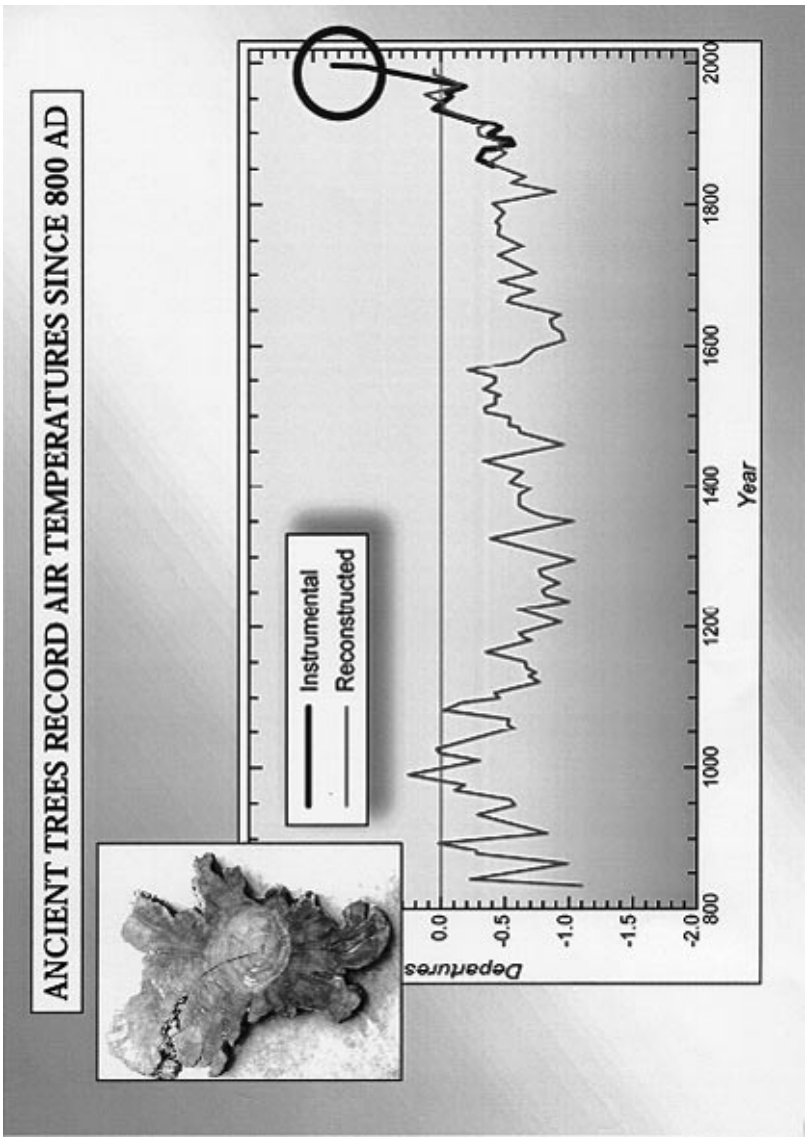
Modeling studies show that the warming of the past 2 decades is not due to natural forcing; it is anthropogenic in origin (Levitus et al., Science, 2002).

If preserving these unique and valuable ecosystems is considered to be in our best interest, then defining a long-term goal for climate change policy remains a critical international challenge. A long-term target of 1 δC above 1990 global temperatures would prevent severe damage to at least some reef ecosystems. However, the implications of this target for limiting CO2 emissions is uncertain because the extent to which biological uptake of CO2 will counteract the build-up is not predictable at this stage (O'Neill and Oppenheimer 2002). Model predictions for CO2 stabilization at 450 ppm by 2100, i.e. the Kyoto target, predict an average global warming of between 1.2 and 2.3 δC (Cubasch et al. 2001), insufficient to prevent loss of many reef systems and widespread reduction in reef health. Therefore, preservation of coral reef ecosystems requires immediate implementation of globally co-ordinated actions to stabilize greenhouse gas concentrations at a level that avoids dangerous anthropogenic interference with the climate system.


MEASURED INCREASE IN GLOBAL OCEAN HEAT CONTENT
SINCE 1950
Heat Content
4
0
-4
1950
1970
1990
Year


MEASURED INCREASES IN CARBON DIOXIDE AND TEMPERATURE SINCE 1950
CO2 ppm
380
370
360
350
340
330
320
310
300
Temperature (°C)
14.8
14.6
14.4
14.2
14
13.8
13.6
1945
1955
1965
1975
1985
1995
Year
Carbon Dioxide
Temperature


PROXY RECORDS OF OCEAN TEMPERATURE FROM ANCIENT CORALS ENABLE US TO "SEE" INTO THE PAST
Coral Density
105
85
65
45
25
Recorded Temperature
1.0
0.5
0.0
-0.5
-1.0
-1.5
1700
1750
1800
1850
1900
1950
2000
Years
"Little Ice Age"
Mount Tambora eruption




Mr. GILCHREST. Thank you very much, Dr. Cohen.
Dr. Strong.

**STATEMENT OF ALAN STRONG, SUPERVISORY PHYSICAL SCIENTIST, OCEANOGRAPHER, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION SCIENCE CENTER**

Dr. STRONG. Good morning, Mr. Chairman, and others on the Subcommittee and staffers. Thank you for the opportunity this

morning to give you some of our perspective at NOAA where we have been working with a program we call, "Coral Reef Watch."

This program has developed largely through many folks that had been working with our satellite data, not only globally, but internationally, concerned about bleaching, looking for early warnings, looking for insight from satellite, particularly sea surface temperature data, like Anne has just been referring to, that give you some insight as to the potential of getting information out quickly in the field that a bleaching event may be occurring.

People want this information. Information is power, you know, so not only reef managers but, as I say, internationally information is sought and now the Internet makes it a great vehicle to get these data out from satellite.

To move on to the next illustration, bleaching as we have already heard, obviously, there is background information, but more recently there has been this unprecedented El Nino that we had in 1998. We are look now, I know, for another one. Hopefully it won't be of the magnitude of that unprecedented El Nino in '98, but along with it, much bleaching, an extreme amount of bleaching that occurred, particularly in the Indian Ocean, but globally, where coral reefs saw more bleaching and more damage, more mortality than had ever been noted before.

I would like to say, obviously, with the satellite data we are now able to look at this information and to get information out to folks in the field and to warn them that there might be events like this. So, data are coming even out of drawers that had not been processed, realizing these events sometimes have a more massive overview, particularly like in the Indian Ocean, than they have been able to put together before because they saw that not only in Kenya, but over in Indonesia and other areas that bleaching was occurring.

Obviously, behind it all we have this underlying global rising baseline of temperatures. I am going to be showing you in the next slide in a second just what we have been seeing from our satellite data.

Fortunately, with the satellite data we can look at the total global oceans and we can see over the last two decades where these rises have been occurring, where any decreases have been occurring and it gives us a lot more insight about not only things like El Nino, but other things that oceanographers are becoming increasingly curious about.

I think we all are. As scientists, we want to understand Pacific Decadal Oscillation and how this plays into variability in the climate system. The North Atlantic Oscillation, the Conveyor Belt, these are all terms that have sprung up recently since I went to school. There is certainly a lot of us to learn. I am hopeful the satellite data will show us this because as we look at the next overview, the upper panel, we wanted to show you the most recent data that we put together.

We believe this a very accurate set of sea surface temperature data, reprocessed to take advantage of the latest techniques. So, what you are looking at here are trends in temperature tendencies over the last 16 years, a couple of years after El Nino, so that hopefully we have gotten statistically beyond that major event.

But we see areas in the ocean that I have colored in red where temperatures are increasing at a rate equal to or greater than two-tenths of a degree Celsius per decade or two degrees per. If this were to occur over a century, which is an alarming rate.

There are also areas as you can see in the central Pacific, for example, that are cooling. There are some reefs in these areas, maybe some promise for a while. Then there are the other areas that I have highlighted in green where it is not so alarming increase or decrease.

What this is contrasted with, though, and for those of us looking at these data sets always wondering why things keep changing, it is that as we look back at the earlier subset of this data where we only had 12 years to process before the past El Nino, in the Pacific Ocean I think you can very quickly see there is a very marked change. Whereas earlier temperatures off California had been rising dramatically, now that is not the case as we had the more recent data in. There has been enough of a cooling off California upwellings that that rate over all has diminished and now it is on the other side of the Pacific Ocean. We are thinking that this very likely to be part of the Pacific Decadal Oscillation that we are finally seeing that we can wrap our arms around and say, see the extent of the ocean that is involved.

We know it also involves the Southern Hemisphere, the Southern Pacific Ocean. We know very little about the oscillations there, even oceanically, it is much bigger than the North Pacific and certainly we expect to find a lot more interesting data there.

But you can see the Southern Hemisphere and why some of our colleagues like the folks we work with from Australia, for example, up until the last El Nino, they weren't really concerned about global temperature changes because you can see a lot of cooling in that hemisphere.

Now, that is changing. As you can note, off Australia, and I think I have an exhibit for you of the recent bleaching event in Australia that has just occurred in the Great Barrier Reef where they have seen unprecedented bleaching. It wasn't couple with El Nino. There was a weather event during the summer where a tremendous amount of bleaching occurred.

I'll move to the next illustration. We are putting out buoys. We have a number of towers that we are putting out as directed by the task force. These are sights where these towers are going in. Some have already gone in. You can see the dates where they are proposed.

For example, in Hawaii, midway already in place. These are the temperature trends that we are seeing presently with our satellite data. I have helped you out by colorizing those installations where we are going to get now long-term records in situ to keep the satellite on us and to also get other information that we need to get about our reefs that the satellite can't get. At least right now we haven't figured how to do nutrients and some of these other things.

Also, there is some hope. Some of these areas down here, Palmyra, Howland Baker are domestic reefs where we are seeing cooling trends. So, there is hope for at least continuing to learn more about the bleaching in those areas or the lack of bleaching and how

these reefs might protect the whole environment and ecosystem so we have a way to survive increasing bleaching events.

OK, to the next illustration, it is conclusions. I would just point out that climate changes are likely to alter existing reefs worldwide. I think we are all in agreement. There are going to be some changes. Things change. What we want to do is to obviously, hopefully help to negate or to keep these impacts at a minimum.

What can we do? We have seen since 1998 this massive bleaching event. This is coupled with El Nino and these other events and PDO changes. They are likely to be more severe as we go through the next few decades. But we need to monitor. We need to get better indices for looking at the health of the ecosystem, to understand it, to understand recovery, to understand adaptation.

We are being sought out now and asked to be involved in international efforts. We can look at other reefs other than domestic.

Finally, the following conclusion, what we are finding out that the practical steps are, we have to be able to work with the managers of these reef systems to get them information in a timely fashion. Before they were getting blind-sided and bleaching would happen and other events. They would be hearing from their constituents that something is happening, what can you do.

Obviously, people weren't too impressed with someone who was finding things out from them. Whereas now, we are able to get the information, as I say, from our products, get answers to the reef managers. They can go into the field and say, "Temperatures are warming. Please let us know when it is going to bleach."

Often we have even had comments back from the folks in the field, "Bleaching? It is not going to happen." Then it does a few weeks later. They start listening. Now that of course equips the reef managers so that they have more power, not only to manage the reef and hopefully during times of bleaching, to reduce other stresses.

Then their constituents are more impressed and they become more involved in their environment and they vote. So, we are happy to have them on board.

That concludes my oral testimony. I will be happy to take any questions. Thank you.

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

[The prepared statement of Dr. Strong follows:]

**Statement of Dr. Alan Strong, Project Manager, Coral Reef Watch Program, National Environmental Satellite, Data, and Information Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce**

Chairman Gilchrest and members of the Subcommittee, thank you for the opportunity to appear before you today. It is my privilege to spend a few minutes with you this morning to share what we have been learning at NOAA about recent climate events over the tropics and how they apply to our coral reefs. Our operational satellite data now make it possible to measure short-term trends, or tendencies, of sea surface temperatures (SST) at global scales since the mid–1980s.

Coral reefs flourish mainly in the tropical latitudes, extending beyond 30" north or south of the Equator in only a few cases. Every coral species, as well as numerous other reef inhabitants, maintains a special symbiotic relationship with a microscopic algae called zooxanthellae. These algae provide their hosts with oxygen and a portion of the food they produce through photosynthesis. When stressed, many reef inhabitants have been observed to expel their zooxanthellae en masse. Without the characteristic color the of the algae, the coral appear as a nearly transparent

layer over their white skeleton. This phenomenon is referred to as coral bleaching. The ability of the coral to feed itself in the absence of zooxanthellae may be very important to its survival during and after a bleaching event. Recovery rates appear to differ, however, by species and even by colony, and the time required to attain full recovery of symbiotic algae may vary from as little as two months to as much as one year. If the level of environmental stress is high and sustained the coral may die.

Although recently noted as occurring during El Nino or La Nina events, bleaching cannot be explained by localized stressors, natural variability, or El Nino alone. Nonetheless, mass bleaching is likely accentuated by an underlying rising baseline of global marine temperatures, and exacerbated by human-based activities such as overfishing, localized pollution and coastal land development. As oceanographers, we need to address other less known and poorly understood natural oceanic variations when attempting to understand our changing climate.

As you have heard, coral bleaching, and high SSTs, have been observed with increasing frequency in the last twenty years—the period of time recorded in NOAA's satellite data. Over most of the 20th Century, coral bleaching was an infrequent event, and certainly nothing had been witnessed as large as the recent worldwide bleaching event of 1998, or the unprecedented bleaching across the Great Barrier Reef earlier this year.

It should be noted that the coral bleaching events we have been witnessing with increased frequency during the past two decades are caused by weather events—clear skies and light winds occurring roughly at the time of highest overhead solar angle, causing anomalous increases in SST. Although bleaching has been around as long as corals themselves, the paleo-climate record (shown in coral cores) shows that corals have adapted surprisingly well to these infrequent events in the past. Climate change acts as a modulator of these weather events. Virtually all the climate models predict that if warming trends continue or increase these bleaching events will continue to increase in frequency, as well as severity.

The Pacific Decadal Oscillation (PDO) is a long-lived El Nino-like pattern of Pacific climate variability, whose fluctuations are generally believed most energetic in two general periods, one from 15-to–25 years, and the other from 50-to–70 years. The North Atlantic Oscillation (NAO) is the dominant mode of winter climate variability in the North Atlantic region ranging from central North America to Europe and much into Northern Asia. The NAO is a large-scale seesaw in atmospheric mass between the subtropical high and the polar low. The corresponding index varies from year to year, but also exhibits a tendency to remain in one phase for intervals lasting several years. The "Ocean Conveyor Belt" transports warm ocean water from the Pacific Ocean through the Indian Ocean and into the Atlantic Ocean. In the North Atlantic, the warm water, which turns very salty due to evaporation during the journey, runs into cold water coming down from the north. The warm water cools quickly, and sinks due to greater density. This creates a sub-surface countercurrent which carries the cool water back to the Indian and Pacific oceans.

To address coral bleaching we need to separate out, not only the shorter term variability of El Nino, but also the PDO, especially as it relates to Conveyor Belt variability of the global ocean and interactions between the tropics and the Southern Ocean. Our knowledge of these linkages to the tropics and potential involvement with coral reefs is still limited. Yet, it is critical that we enhance our knowledge of these links and put this recent upsurge of increased bleaching into proper perspective.

In an additional attempt to understand the linkages of bleaching, SST anomalies and short term variability, we have recently reprocessed all of NOAA's operational satellite SST data from 1985 through 2000. These data are the most complete and accurate means for assessing short term global SST trends. Viewed globally, the trends show some noteworthy regions of SST increases and decreases over the 16-year interval. Of concern for coral reefs, notable rises in SST (in excess of +0.2 deg C/decade—noted in red in Figure) are seen in the ocean area off the southern Caribbean and off SE Asia–Japan. Significant decreases in SST are being seen by satellite (in excess of–0.2 deg C/decade—noted in blue in Figure), over this time period, covering large portions of the central Pacific from Hawaii to American Samoa; falling SSTs are also shown over some of the more biologically diverse coral reefs of the southern Indian Ocean.

When these most recent satellite SST trends (1985 through 2000) are compared with a sub-set of the SST data from the 10 years just prior to the 1997/98 El Nino, what appears to be a late–1990s reversal in trend is suggested over large regions of the Pacific Ocean. This change in trend is most dramatic over the North Pacific, where many regions that prior to the 1997/98 El Nino had been (1985–1996) exhibiting increasing trends (red) have now (1985–2000) become regions where decreasing

trends (blue) are seen, and vice versa. This may be an early indication of a reversal underway in the PDO—only time will tell. (The last PDO reversal took place in the 1970s before satellite SSTs were available.) If this is a PDO reversal, it will only remain in this phase for a few decades (20–35 years) before flipping again. So, for many of those regions that are now experiencing a cooling trend, or a decreased warming trend, this must be viewed as only temporary.

An overview of the tropics (30N to 30S), based on our satellite SSTs, shows that northern hemisphere tropical SSTs, on average, are increasing at a rate of +0.16 deg C/decade (+0.016 deg C/yr). Over the southern hemisphere tropics, the rate of increase is gradually increasing, but presently this upward rise is merely a third of the rate in the northern hemisphere.

The best way to examine and understand these phenomena is to continually monitor the environment. NOAA's "Coral Reef Watch" program is a joint effort between the National Environmental Satellite, Data, and Information Service (NESDIS) and the Office of Oceanic and Atmospheric Research (OAR). Coral Reef Watch plans to install approximately 20 in situ Coral Reef Early Warning System (CREWS) towers to cover most domestic coral reef regions over the next five years (see Figure). Five of these systems will be located in regions where SSTs have been exhibiting notable (red) upward tendencies, namely the Commonwealth of the Northern Mariana Islands, U.S. Virgin Islands, and Puerto Rico, and two will be located in the central Pacific, a region presently demonstrating a cooling (blue) trend (Palmyra/Kingman & Howland/Baker). These stations continuously monitor key environmental parameters such as SST, UV, wind speed, salinity, and turbidity and provide "anchor points" to maintain satellite calibration throughout our domestic coral reefs. During fiscal year 02, NESDIS and OAR received $1.25M ($ 0.75M for NESDIS; $0.5M for OAR), via the NOAA coral reef program, to fund Coral Reef Watch and CREWS. Funding to continue these efforts are also included in the fiscal year 03 budget request.

Based on these reprocessed and globally complete SSTs along with other observations, it is my conclusion that:

- The first impacts of anomalous SSTs have already been seen in the 1998 bleaching and are likely to be more severe in the coming decade—only lessened in some regions (during the next two or three decades) by PDO;
- There is a need to monitor environmental indices, ecosystems, impacts, recovery, and adaptation;
- There are practical steps that reef managers can take, but to truly be effective they need timely information;
- Reef managers with timely and accurate information ("early warnings") gain credibility with their constituents enabling them to reduce ecosystem stress brought on by human pressures.
  * Remote Sensing—Products—Answers
  * Knowledge—Credibility—Empowerment

Once again, Chairman Gilchrest, thank you for the opportunity to testify before you today. As my testimony indicates, using NOAA's environmental satellites to observe and monitor climate trends in the world's oceans has yielded significant information on the health of our coral reefs on a global scale. We hope to continue these efforts, and enhance our ability to provide useful, timely and accurate information to coral reef managers, to assist them in maintaining the health of these vital ecosystems. I would be happy to respond to any questions the Committee may have.

Exhibits:

1. Annual Bleaching HotSpot Composites: 1985–2000
2. Coral Reef Watch - 2002
3. 2002 Great Barrier Reef Bleaching Event

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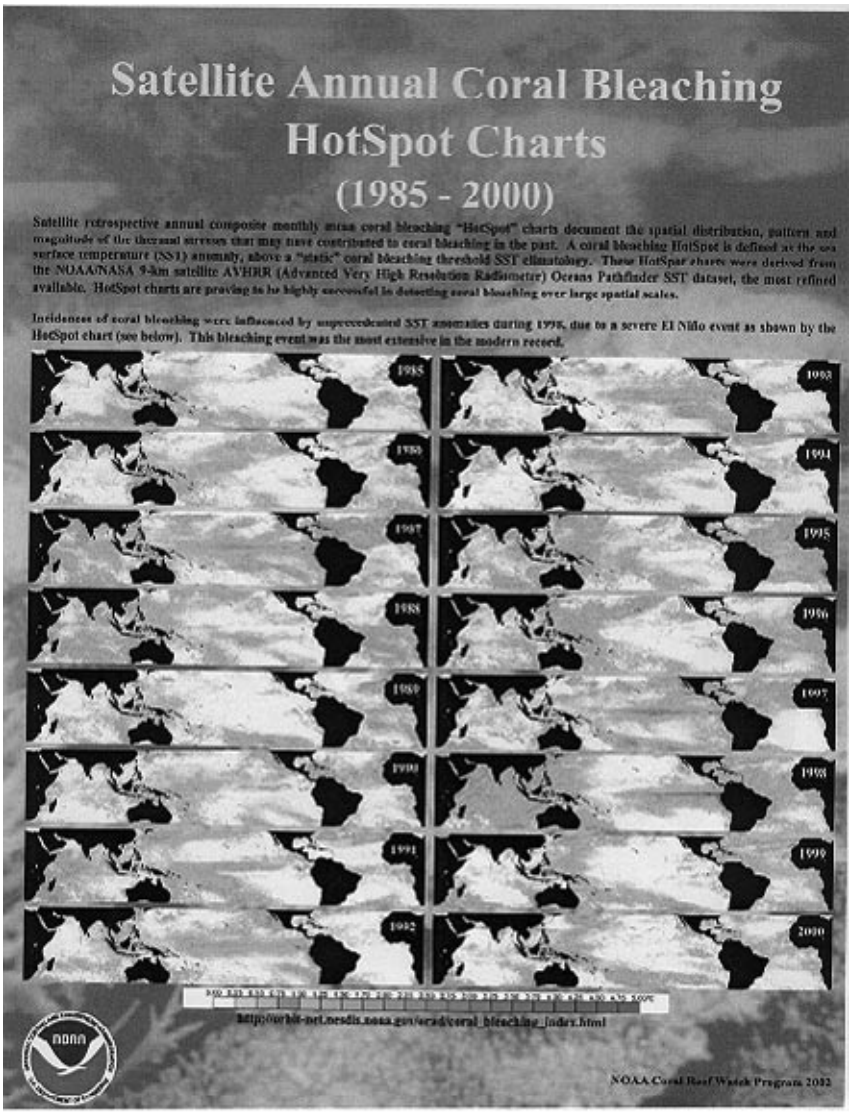
[The exhibits attached to Dr. Strong's statement follow:]


Satellite Annual Coral Bleaching
HotSpot Charts
(1985 - 2000)
Satellite retrospective annual composite monthly mean coral bleaching "HotSpot" charts document the spatial distribution, pattern and magnitude of the thermal stresses that may have contributed to coral bleaching in the past. A coral bleaching HotSpot is defined as the sea surface temperature (SST) anomaly, above a "static" coral bleaching threshold SST climatology. These HotSpot charts were derived from the NOAA/NASA 9-km satellite AVHRR (Advanced Very High Resolution Radiometer) Oceans Pathfinder SST dataset, the most refined available. HotSpot charts are proving to be highly successful in detecting coral bleaching over large spatial scales.
Incidences of coral bleaching were influenced by unprecedented SST anomalies during 1998, due to a severe El Niño event as shown by the HotSpot chart (see below). This bleaching event was the most extensive in the modern record.
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
http://orbit-net.nesdis.noaa.gov/orad/coral_bleaching_index.html
NOAA Coral Reef Watch Program 2002

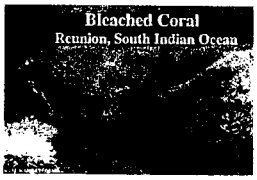
# *CORAL REEF WATCH 2002*

**National Environmental Satellite, Data, and Information Service (NESDIS)** - Office of Research and Applications (ORA), National Oceanographic Data Center (NODC), National Geophysical Data Center (NGDC), Office of Satellite Data Processing and Distribution (OSDPD) - **Oceanic and Atmospheric Research (OAR)** - Atlantic Oceanographic and Meteorological Laboratory (AOML)

***The NESDIS and OAR Coral Reef Watch program will strive to fully utilize NOAA coral resources to monitor and predict changes in coral reef ecosystems worldwide. A major objective is to discern the relationship between the magnitude and persistence of higher than normal sea surface temperatures in coral reef areas and coral reef bleaching and mortality. This program supports coral reef managers and researchers through Web-access to coral reef environmental data and coral bleaching alerts.***

**BACKGROUND:** Coral reefs are one of the most diverse ecosystems in the World, supporting essential coastal fisheries, offering potential medicines, protecting coasts from erosion, and supporting coastal tourism industries.

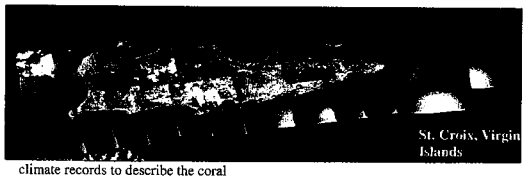
Over the past few years, anomalously warm sea surface temperatures have led to increased incidence of coral reef bleaching around the globe. This stress compounds those already incurred via natural factors such as hurricanes and factors associated with detrimental human activities, such as overfishing, anchor damage, sediment and nutrient run-off, and unregulated tourism. Increased deterioration of coral ecosystems is of major concern.




© M. Rard, 2001

Recognizing the need to protect these fragile ecosystems, the federal government called for increased research and monitoring of Coral Reefs for improved management.

Since 1995, NESDIS has been producing Web-accessible, satellite-derived, sea surface temperature products to monitor for potential coral reef bleaching. Additionally, NESDIS has been providing technical support for coral reef mapping efforts, developing a robust and comprehensive international coral reef data management system, using paleo-climate records to describe the coral reef environment in the past (>100 yrs), and building interagency and international collaborations in coral monitoring and research. Simultaneously, OAR/AOML has been developing the Coral Reef Early Warning System (CREWS), an international network of coral reef environmental monitoring stations placed at reef locations that monitor for conditions conducive to coral reef bleaching as well as provide data for coral reef ecosystem modeling and research efforts.

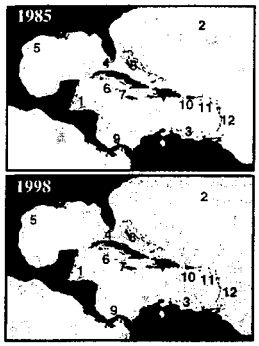



**CORAL REEF WATCH (CRW):** In an effort to expand NOAA's coral reef monitoring and bleaching alert capabilities NESDIS and OAR joined their complimentary coral activities under the Coral Reef Watch initiative (2000). CREWS data serve to validate NESDIS satellite derived monitoring products, while NESDIS satellite products extend coral reef bleaching monitoring to larger spatial scales and remote locations. Within NESDIS and within OAR, CRW maximizes coral reef resources by joining the existing coral reef strengths under a coordinated program.

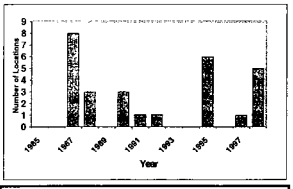
**BENEFITS:** For Coral Reef managers CRW near real time monitoring products permit immediacy in response to changing ecosystem character, which has allowed for improved regulation of access to the reefs in question. By reducing stress resulting from fishing and recreation activities during high water temperature periods coral mortality can be minimized and recovery maximized. CRW data and products have allowed researchers, for the first time, to be on site as soon as adverse environmental conditions are met thereby improving our understanding of coral bleaching phenomena. Moreover, the accumulation of CRW long-term data sets will aid in our understanding of coral reef's response to climate change as well as coral reef ecosystem function.

**Representative Reef Locations**

| | |
|---|---|
| Belize (1) | Jamaica (7) |
| Bermuda (2) | Lee Stocking, Bahamas (8) |
| Bonaire (3) | Panama - Atlantic (9) |
| Dry Tortugas, Fl (4) | Puerto Rico (10) |
| Flower Garden, TX (5) | St. Croix, US VI (11) |
| Grand Cayman (6) | St. Lucia (12) |




Satellite-derived **HotSpot Charts** highlighting regions of potential thermally- induced coral reef bleaching. Orange indicates bleaching potential and white indicates no bleaching potential. Numbers correspond to representative reef locations in the table above. A red number indicates a site that experienced temperatures conducive to coral reef bleaching during the specified year. Over the years 1985-1998, 1985 was a relatively cool year, while 1998 was relatively warm.




**Bar graph** highlighting the variability in the number of the 12 representative reef locations in the table above that experienced sea surface temperatures conducive to coral reef bleaching during each year from 1985-1998. (Based on HotSpot charts)

**PLANS**: In 2002, NESDIS and OAR seek to improve spatial coverage, reliability, quality, and accessibility of CRW data and products by:

~ Expanding the network of coral reef environmental monitoring stations to the U.S. Virgin Islands and American Samoa.

~ Adding pollutant indicator sensors to existing environmental monitoring stations to provide a more complete set of environmental parameters for monitoring and modeling coral reef ecosystems.

~ Improving national and international collaboration and information exchange in order to validate monitoring data and bleaching alert products as well as better understand the coral bleaching phenomena.

~ Securing technical support for near real time coral reef satellite bleaching and monitoring products to ensure their availability during critical seasons.

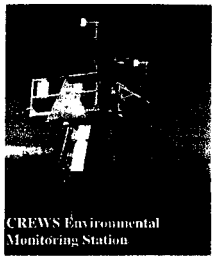
~ Increasing the spatial resolution of satellite monitoring and bleaching alert products, thus improving applicability and relevance to smaller scale ecosystems.

~ Performing temporal assessments of coral reef bleaching using high-resolution satellite data.

~ Providing automated bleaching event maps in user friendly formats (e.g. Geographic Information System formats).

~ Extending the sea surface temperature records using the coral paleo-climate proxy record, thereby promoting an understanding of corals response to environmental conditions in the past.

~ Continuing development of the NOAA international Coral Reef Information System that enhances access to NOAA, national, and international coral reef data and information World-wide.




**SUMMARY:** The Coral Reef Watch 2002 initiative embodies a coordinated NESDIS and OAR coral monitoring and bleaching research program that responds to a need for improved understanding of coral reef ecosystems and fulfills NOAA's mission to Sustain Healthy Coasts. The planned 2002 activities fully exploit NESDIS' and OAR's expertise in data management, satellite mapping, and monitoring to support coral reef research and management.

**CONTACT:** Dr. Alan Strong, NESDIS, Telephone: 301-763-8184. Dr. Jim Hendee, OAR, Telephone: 305-361-4396.

**RELATED WEB-SITES:**

*http://www.coral.noaa.gov/crw/*

*http://coral.aoml.noaa.gov/corvil/coral_regis/index.html*

*http://www.coral.noaa.gov/crw/*

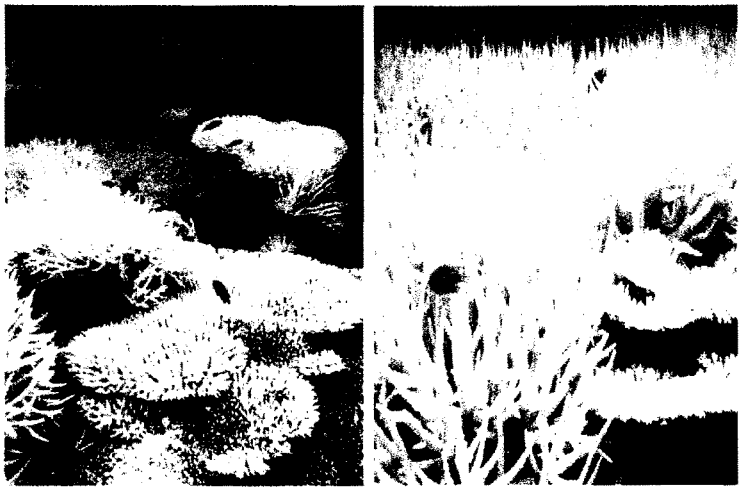
*http://www.ngdc.noaa.gov/paleo/paleo.html*

*http://www.nodc.noaa.gov/col/projects/coral/Coralbome.html*

*http://orbit-net.nesdis.noaa.gov/orad/coral_bleaching_index.html*

*http://orbit-net.nesdis.noaa.gov/orad/sub/dhw_dhww_2m.html*

# 2002 Coral Bleaching Episode in Great Barrier Reef, Australia



Australia's Great Barrier Reef experienced a severe coral bleaching event of record proportions over much of the area during the summer of 2002 (January through March). NOAA Coral Reef Watch's satellite near real-time monitoring system detected the initiation of anomalous high sea surface temperatures (SSTs) in the region and continued monitoring the development and movement of the thermal stress throughout the summer season. NOAA/NESDIS provided satellite data, per our collaborative work on the GBR with the Australians on coral reef health, to assist them in their monitoring of the serious situation. On January 24, 2002, NOAA and Australia issued a joint press release on the developing bleaching event engulfing much of the mid and northern Great Barrier Reef as their warm spell continued off Queensland, Australia.

Our satellite near real-time coral bleaching HotSpots showed that in the Great Barrier Reef region the coral bleaching related thermal stress presented in late December 2001, reached its maximum extent in mid-February, and dissipated in mid-March (Figure 1). HotSpot chart shows the SST anomalies compared to summertime maximum monthly mean SST climatology (MMM). The temperature at 1°C above MMM serves as a coral bleaching threshold. In the HotSpot charts, yellow to red colors denote regions where SSTs are 1 degree or more above MMM - reefs under these levels of thermal stress for several weeks will typically experience bleaching, which will manifest itself as a delayed response within another 3-4 weeks. The accumulation of the thermal stress over the summer season is demonstrated by our Degree Heating Weeks chart (Figure 2) showing the accumulation of Hotspot anomaly over the previous 12 week period. One DHW is equivalent to 1 week of SST at 1°C above the MMM-SST or 0.5 weeks of SST at 2°C above the MMM-SST.

Photos of bleached coral reefs shown above, were sent from Ray Berkelmans of the Great Barrier Reef Marine Park Authority.

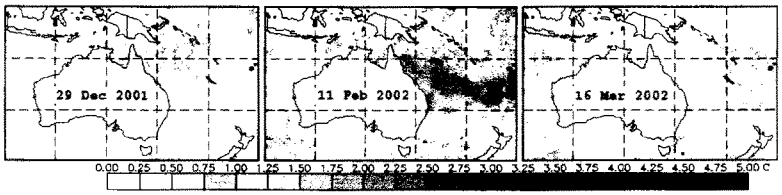



**Figure 1.** NOAA/NESDIS near real-time coral bleaching HotSpot charts.

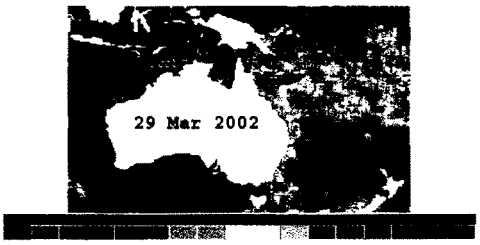



**Figure 2.** Degree Heating Week Chart of 29 Mar 2002 shows the accumulation of HotSpots over the summer season of 2002 (January through March).

The 2002 coral bleaching episode in the Great Barrier Reef was more severe and more extensive than the 1998 episode, although 1998 was a much warmer year compared to 2002. The comparison of the composite summer season (Jan - Mar) DHW charts (Figure 3) and HotSpot charts (Figure 4, using a different color scale) of the two years reveal that the difference in severity was caused by a change in the geographic location of the two warming events. In the summer of 1998, which was a much hotter year, the epicenter of the anomaly was in the south and away from the Great Barrier Reef, while in the summer of 2002, the epicenter was in the north and much closer to the Great Barrier Reef than in 1998. This meant that although the temperatures were not as high during 2002, the anomalously warm water persisted for a much longer period of time.

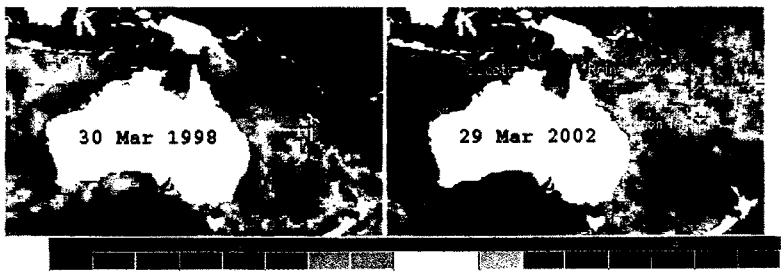



**Figure 3.** Degree Heating Weeks of the summer seasons of 1998 and 2002 showing the distribution and magnitude of the accumulation of the HotSpots over the summers (January through March). Unit is in °C week.

An analogy could be that in 1998 the Great Barrier Reef sat next to a bonfire made out of dry sticks, it burnt very fast and was very hot and even though it was out in a short period, the corals were exposed to such high temperatures that they were "burnt". In 2002 the bonfire was made out of logs and although it did not burn as hot as the 1998 bonfire, it burnt for a longer period. In this instance the corals were "burnt" from an extended exposure to high temperatures.

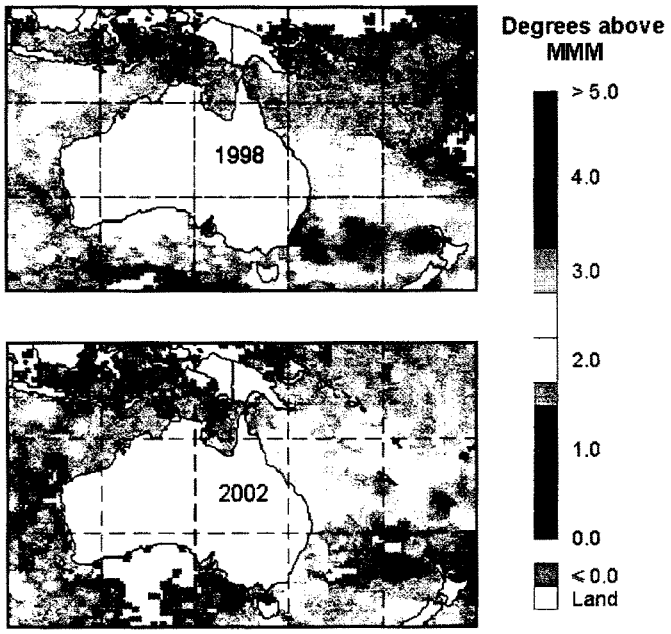



**Figure 4.** Composite HotSpot charts of the summer seasons of 1998 and 2002 showing the distribution and magnitude of the maximum HotSpots over the summers (January through March).

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http://orbit-net.nesdis.noaa.gov/orad/coral_bleaching_index.html

Exhibit for: Congressional Testimony – 27 June 2002
*House Subcommittee on Fisheries Conservation, Wildlife and Oceans*
*House Resources Committee*

Mr. GILCHREST. Dr. Buddemeier.

**STATEMENT OF ROBERT W. BUDDEMEIER, SENIOR SCIENTIST, KANSAS GEOLOGICAL SURVEY, UNIVERSITY OF KANSAS**

Dr. BUDDEMEIER. Thank you very much, Mr. Chairman and members of the Committee. As usually happens when you are next to last on a panel, a number of my points have been anticipated by my colleagues. With your permission, I will skip rather lightly through some of the presentation.

Mr. GILCHREST. Dr. Buddemeier, it wouldn't hurt to be repetitious in this place. You could repeat it a thousand times over and we could only benefit from it.

Dr. BUDDEMEIER. I won't miss any of the points, I promise you that. I have taken the tack of trying to answer some of the questions that were posed in the letter of invitation sent to me.

The first one was about the issues of the nature of the marine climate, coral ecosystems and the effects of interactions. I think you will have heard already the point I make here that human society has systematically altered both the chemical composition and dynamics of the atmosphere and the ocean on a global scale. I want to keep emphasizing the global scale of this issue.

At local levels there have been even more dramatic changes in terms of land use, hydrology and so on. The result has been that as the quality of the built environment has improved, the natural environment has suffered. We have lost productivity, diversity in ecosystem services.

The issues for the future in one sense are very easy. We are going to have more of the same. We are going to have continued climate change effects due to the lags in the system, committed warming. The population is going to continue to grow. The pressures for development are going to continue to exist.

Quantitative predictions are much harder to come by, in part because we are entering an era without precedent certainly in human experience and to a significant extent in earth history. We don'thave a model that we are working on. Our theoretical understanding is not up to the task of predicting unknown territory.

The issue of natural variations, they are, I think by now and increasingly in the future of not totally trivial, but they are small compared to the larger scale trends we are looking at. Those are not the issue.

Climate related stress, it is now, as we have heard, probably the dominated factor in areas not under heavy local stress. It is going to be a continuing contribution to combine stresses and it is going to increase in intensity and important over the coming decades, essentially no matter what we are able to do at a local level.

To underscore on a somewhat longer time scale some of the points Dr. Cohen made, if we look at the history for half a million years of atmospheric CO2 retrieved from the ice cores of Antarctica, we see that the earth has a natural range of stable oscillation that is repeated over and over.

We have in the course of a very few decades driven the atmospheric system outside of that natural range. We don't know what it means to be up here because nothing we can extract from the recent paleontological record tells us about that kind of condition.

Similarly, on a shorter time scale here I show the same sorts of things with respect here not to ocean, but general Northern Hemisphere temperature. The yellow line shows the range of natural variations. The blue fur around it shows the level of our uncertainty about those estimates of the yellow line and the most recent point being 1998 here, it shows you how far we have gone, not only away from what nature has been doing by itself, but even beyond the level of our own uncertainty about that. We are in unchartered territory.

If we add the projections from the IPCC onto these changes already noted, we see even at the low range of projected change, very substantial further increases in expected temperature, CO2 and other greenhouse gases.

We have entered a no-analog period of earth history that some are calling the "anthroposcene." These trends will continue for decades. They are not easily reversed. This does not mean we should not do our best to reverse them. But even if we do our best to reverse them, but even if we do our best, they are going to be with us for some time.

As I have noted, accelerated climate change is or soon will be the dominant global factor in coral reef stress.

What recommendations would I make? First, I think it is very important that we recognize that we are facing a situation that can't be reversed and can't probably be slowed down on a very short time scale, that the point has been made, and I repeat, adaptation of organisms or ecosystems to changing climate can be helped by minimizing the other stresses over which we do have short term control.

We need a more effective way of measuring the extent and nature of biological effects of climate change. The issue of preservation and protection for future generations is important for aesthetics, for science, for diversity. Because this is such a large issue at both national and global levels, cooperation among agencies, organizations and even countries is a critical step.

However, I think we have some real potentials here because as has been noted earlier, within the existing U.S. reef holdings, the refuge and sanctuary locations administered by Interior and by NOAA, there is the basis for a combined preservation and research and monitoring effort to deal with these issues.

I will quickly run through a few pictures. This color coding is for the carbonate saturation state. The greener it is, the more easy it is for corals to build their calcium carbonate skeleton. We calculate that 150 years ago all of the Pacific, at least all of the Pacific where we have the indicated reef locations, was in pretty happy shape.

If we go forward once to the present time—that is the next slide—things are not looking bad, but there has been a distinct decline in saturation state associated with rising atmospheric CO2, which is what drives this process.

Here we see some of the advantages of a monitoring transect. As this front has moved, it has moved across these islands. We can't go back and get as much information as we would like, although Dr. Cohen's techniques permit us to retrieve some of that.

But, next slide, we can be watching quite closely as we head toward what the modeled future is in terms of conditions in the Pa-

cific. Whether it actually gets here or not, we don't know, but it is headed in that direction and we need to know what it is doing.

So, if we can get the final slide, please. The suggestion that I urge upon the group is for an integrated network of research, conservation and monitoring sites providing complementary transects. I have focused on the Pacific because that area has the more wider latitudinal distribution and the less impacted sites. But I think a parallel set of studies in the Atlantic province in the Caribbean would permit us to work out human effects and their interactions with the climate.

We have the existing real estate. We have the programs. What we need is the integration, the will and probably some modest increase in funding.

Global community participation, this is very important. It has been alluded to. It is starting to happen. We need more of that. We can be leaders, but we can't do it alone.

Finally, the idea would provide not only the means for understanding what is going on, but implicit in this is also the conservation and protection approach.

I would suggest that this is something that is rapidly implementable because it builds on existing structures and programs. It is affordable for the same reason, and it is a way in which we could make some fairly rapid progress on what is a very large scale, large, but also urgent, problem.

Thank you very much.

Mr. GILCHREST. Thank you, Dr. Buddemeier.

[The prepared statement of Dr. Buddemeier follows:]

**Statement of Dr. Robert W. Buddemeier, Senior Scientist, Kansas Geological Survey, University of Kansas**

*1. Executive Summary*

In his letter of invitation, Chairman Gilchrist requested information on five questions or topical areas. These questions, quoted below, are used as the organizing theme for the testimony. This Executive Summary section presents capsule overview responses to the points, each of which subsequently is addressed in more depth in an individual section of the testimony. Key points are underlined.

*Requested topics of discussion:*

1.1 "...how the interplay between climate, the marine environment, and coral ecosystems has changed, and the resultant and predicted effects."

1.1.1 Humans have altered the carbon, nitrogen, phosphorus, water and sediment cycles in major ways, with effects at both local and global scales on systems that take hundreds to thousands of years to fully respond.

1.1.1 Overexploitation of fisheries and the ecosystems that support them have added a direct and immediate impact to the changes set in motion by larger-scale geochemical modifications.

1.1.2 Some of the results of these changes are understood and some predictions are possible, but the critical fact is that the combined changes have put the earth system on a trajectory for which there is no precedent or analog in evolutionary history, and from which we cannot turn back in any prompt or easy fashion.

1.2 "...whether the range of atmospheric and marine conditions and the extent and intensity of coral declines is expected to be from natural climatic cycles and variations or if these declines stem from human-driven factors."

1.2.1 There is undoubtedly a component of reef stress and decline that is related to natural cycles and variability; however, we are unable to determine that with any precision because it is being overwhelmed and reinforced by human factors.

1.2.2 In areas where local and regional human environmental degradation and overexploitation are significant, these factors far outweigh any effects of natural variability.

1.2.3 Human-driven, global-scale changes in climate and in ocean chemistry are becoming the dominant stress factors in areas removed from direct human impacts, and are also contributing significantly to the combined stresses elsewhere, and will increase in importance in the future.

1.3 "...of what importance compared to other factors are climate effects in coral reef declines."

1.3.1 Climate effects are almost certainly the dominant cause of massive, global-scale bleaching events, although vulnerability and mortality may be influenced by local factors in many locations.

1.3.2 Where reefs are close to, and exploited by, human populations, or where they are under stress from local or regional sources, climate factors will be a contributory but not necessarily primary factor in decline.

1.3.3 The relative importance of climate factors will continue to increase for decades, as present-day "commitments" to additional CO2 release and climate change play out in the earth system. Local-scale human impacts can be controlled and reversed in the short term; major climate and earth process changes cannot.

1.4 "...what recommendations would you provide for stopping and reversing these declines."

1.4.1 The first and most critical recommendation is that we must recognize that it will take at least a generation to "stop" (that is, stabilize conditions) the climate and global-scale changes we have set in motion, and that it is doubtful that we can ever "reverse" them (in the sense of getting back to baseline conditions of the past few thousand years).

1.4.2 We must work to reduce and reverse direct, local human impacts in order to preserve the natural robustness and resilience of reef organisms and ecosystems to survive the inevitable climate stress. This can be done with a combination of enforced regulation, education, and political and economic incentives, but it will not be adequate by itself.

1.4.3 We must do a far better job of protecting, monitoring, and understanding those coral reef systems that are NOT threatened by direct local stresses, both to ensure preservation of the genetic diversity and the natural heritage, and to develop a predictive understanding of how continuing climate change affects reefs so that we can make our protection and management strategies as effective and realistic as possible.

1.4.4 Finally, we should recognize that complex global problems cannot be addressed on a single issue basis. Not only is international cooperation critical, but we should not allow the obvious importance of coral reefs to divert us from holistic considerations that encompass global change effects on, and the interactions of, other coastal and marine systems.

1.5 "...other information...pertinent to the discussion."

1.5.1 The United States is one of only a few countries that has the possessions and resources to develop a comprehensive program of understanding, predicting, and mitigating the effects of climatic and other stresses on coral reefs and other marine systems.

1.5.1.1 The Caribbean and Gulf of Mexico is a relatively enclosed region with high population loads, and in almost all areas will reflect a combination of local and regional human stresses with climate-related stresses. It can serve as the "high-to-moderate local stress" component of an ecosystem-based research and monitoring program.

1.5.1.2 The diverse U.S. Islands and atolls in the central Pacific are among the most pristine and remote from direct human impacts, and provide both a natural laboratory for documenting the nature and mechanisms of climate change effects, and a potential bio-reserve of global importance.

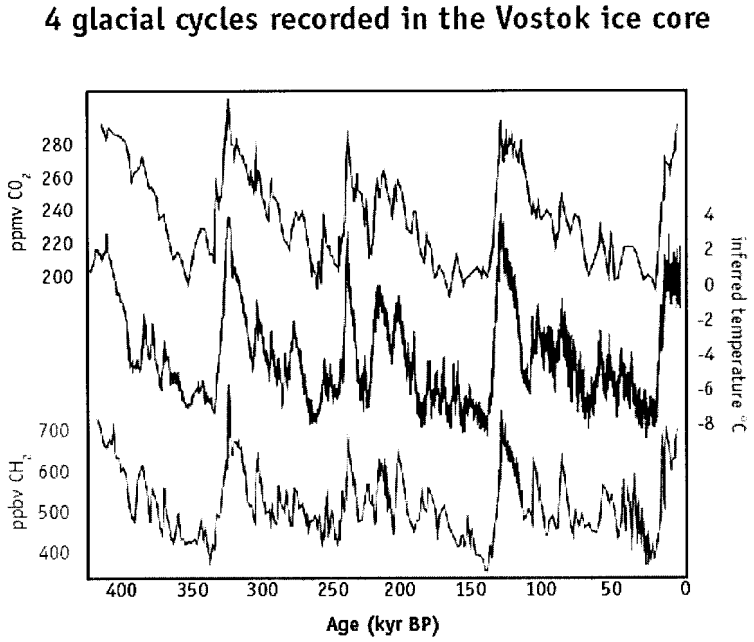
1.5.2 Relatively few new resources are needed to develop and implement a global-scale U.S. comparative program to understand and respond to the effects of climate change (alone or in concert with other stresses) on coral reefs and their related marine environments and associated ecosystems. Modest additional funding for the USFWS and NOAA for baseline studies, protective enforcement, and management of both the sites and the research and data, would have a major effect if combined with focused coordination of existing coral reef and global change research and funding programs.

*2. Earth system changes and interactions ("...how the interplay between climate, the marine environment, and coral ecosystems has changed, and the resultant and predicted effects.")*

*2.1 Climate change background—a reef perspective*

Climate change is not new; climate has changed between glacial conditions and interglacials (like the present) many times over the past several million years.

Figure 2.1 shows detailed records of temperature and the atmospheric concentrations of carbon dioxide and methane over the past 450,000 years, derived from analysis of glacial ice cores. A striking and important observation is that there are stable limits to the oscillations—a range of atmospheric CO2 values from about 180 to about 280 parts per million bounds the natural system, with similar behavior by temperature and other factors. Other evidence suggests that it has been millions and probably tens of millions of years since the earth system has operated outside of these boundaries.




J.R. Petit et al., *Nature,* **399,** 429–36, 1999.

Figure 2.1: Records of temperature, atmospheric carbon dioxide, and methane over the past 450,000 years derived from analysis of the Vostok ice core. Note the consistent highs and lows in the cyclic pattern. J. R. Petit et al. (1999) Nature 399: 429–436

Even within the natural range of variation, the past several thousand years have had a relatively "extreme" climate—it was warmer, with higher atmospheric CO2 and higher sea levels than all but a few percent of the period for which we have good records. The long-term average natural condition for geologically modern coral reefs is a tropical surface temperature 2–3 degrees Fahrenheit (1–2 degrees Celsius) lower than the recent past (with even lower temperatures at higher latitudes), with about two thirds of the present day atmospheric CO2 concentration, and sea level 125–250 feet (40–80 meters) below present. From an evolutionary standpoint, ecosystems and organisms were already living close to the global upper limit of past experience.

*2.2 Environmental changes and results*

The recent human-caused increase in atmospheric CO2 and the increasing temperature and variability is rapidly moving the environment outside of natural evolutionary experience. Figure 2.2 puts into perspective the dramatic "spike" in atmospheric CO2 associated with the growth and industrialization of human society. Figure 2.3 puts temperature records—measured and inferred—into perspective on a thousand-year time scale. Temperatures of the last few decades have risen well above not only the long-term pattern, but also above the estimated range of uncertainty about the values (displayed by the "fuzzy envelope" around the trend line).

Temperature and carbon dioxide concentration have been emphasized above because these are known or very probable coral reef stresses. Both field and laboratory studies implicate elevated temperatures (along with light and reduced water motion) in the dramatic increase in bleaching events. Elevated carbon dioxide concentration equilibrates with the surface ocean, making it more acidic and thus a less favorable environment for precipitating calcium carbonate—the building material of coral skeletons and reef structures. To these global changes we can add others; it is well-documented that human activities have very substantially altered the nitrogen, phosphorus, water, and sediment cycles as well as the carbon cycle and climate. These other alterations are not necessarily benign with respect to reefs and marine ecosystems—accelerated nutrient cycles are responsible for excessive algal growth and major community shifts.

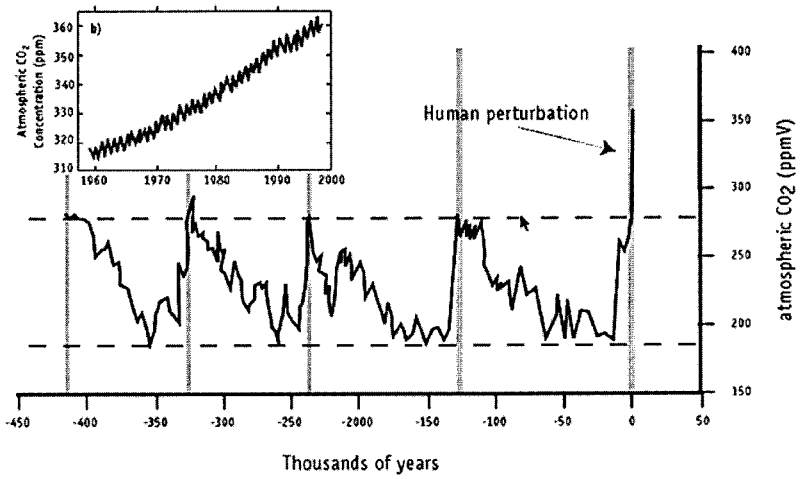
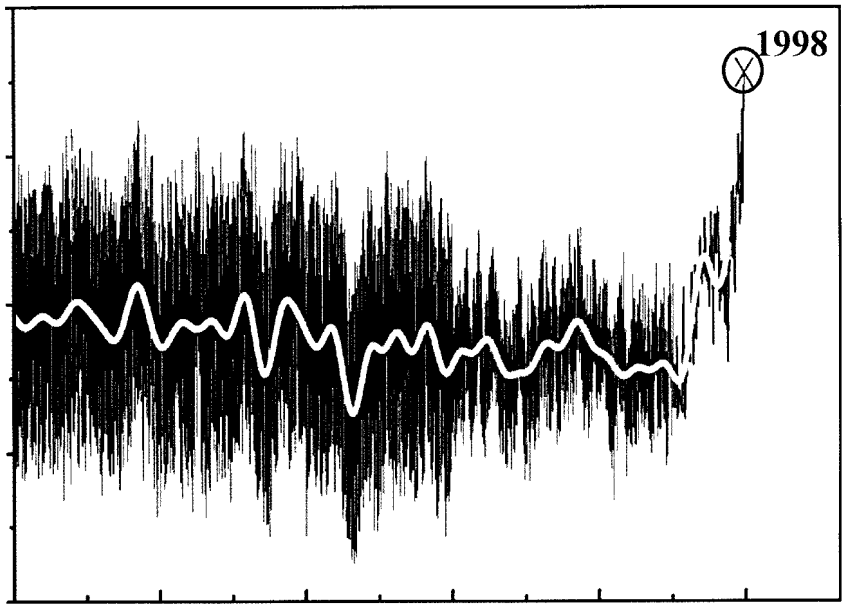



Figure 2.2 (above): long-term atmospheric CO2 oscillations, showing the recent human-caused upward trend upper left) that appears as an almost instantaneous spike on geologic time scales (upper right).

Figure 2.3 (below): 1000-year temperature record showing historic pattern, uncertainty, and recent trend.




*2.3 Problems of prediction*

This current and ongoing departure from "normal" conditions has been referred to as the "no analog" earth—we have nothing in either human experience or geologic history that we can reliably compare it with to assist us with understanding and predictions. This is further complicated by direct as well as indirect human alterations of the marine environment. The rapid growth of human population and the attendant pressures for development, especially in the coastal zone, have added local and regional stresses connected with overexploitation, pollution, and direct destruction. These are not alternatives to the global stresses on marine ecosystems; they are additive or synergistic, so that organisms weakened by one stress will be more vulnerable to others.

*3. Relative importance of natural variability and human impacts ("...whether the range of atmospheric and marine conditions and the extent and intensity of coral declines is expected to be from natural climatic cycles and variations or if these declines stem from human-driven factors.")*

The information, and especially the figures, presented in the preceding section contain the answer to the question around which this section is formulated. Figures 2.1 and 2.2 show natural cycles on thousand-year time scales, with Figure 2 illustrating the recent human-driven change in carbon dioxide. Figure 2.3 shows natural temperature variability at 10–100 year time scales, also with the recent displacements from the natural pattern.

These human-driven changes in the climate factors are not only large and rapid, but they take the atmosphere and oceans into 'unfamiliar territory'—combinations of conditions not experienced over recent evolutionary history. The changes are both large and abrupt compared to records of natural variations, and coincide very well with the onset of major large-scale coral reef declines.

While these comparisons do not prove that human-derived climate changes constitute the non-local causes of coral decline, the circumstantial evidence is extremely strong, and the argument can reasonably be reversed—if the substantial human-driven changes are not causing the decline, then it is very unlikely that the smaller and more modulated natural fluctuations would be imposing significant stresses.

This conclusion is further supported by results of coral and reef coring studies that indicate that the recent community shifts and mortality are unprecedented in the last several thousand years.

*4. Relative importance of climate and other factors ("...of what importance compared to other factors are climate effects in coral reef declines.")*

*4.1 Climate effects, past and present*

Local and regional human-induced stresses have taken a heavy and accelerating toll on reefs over the past half-century. nutrient loading, contamination, overfishing, sedimentation, and direct destruction have all been factors in general, but with large geographic variations and a variety of combinations. It seems likely that these local-to-regional human factors were the dominant factors in reef degradation and decline until about 10–20 years ago, although deteriorating climatic conditions may have contributed to overall vulnerability.

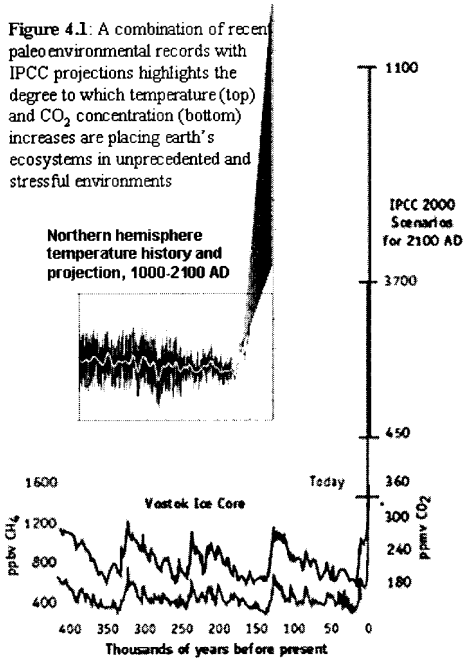
Recent past events strongly suggest that climatic factors are increasingly causing widespread degradation in areas remote from major local stresses. Local stresses will remain important, but we are in a transition period from dominance by local stresses with climate stress reinforcement, to predominance of climate related stress, with additional local impacts in many areas.

*4.2 Climate effects, present and future*

Figure 4.1 connects the record of evidence on past climates with the range of IPCC scenario projections to 2100, for both temperature and CO2. Even with the most optimistic view of the future, the trends that have already taken the planet outside of the natural environmental range of the recent geologic past will move it even farther into unknown territory in the coming decades.

An important aspect of these changes is the inertia of the trends. The changes that have been set in motion cannot be easily or quickly reversed; lags in both the earth's geochemical systems and human socioeconomic systems mean that temperature and CO2 levels will continue to increase for several decades no matter what action is taken to stabilize the earth system. Eventual stabilization is possible if greenhouse gas emissions are carefully controlled, but in the short- to intermediate term we have no alternative to trying to understand and adapt intelligently to the changes that have been set in motion.

A climate-driven future for earth's ecosystems—- Figure 4.1 illustrates the possible range of changes in temperature and greenhouse gas concentrations over the present century. Even with the greatest of effort and the best of luck, changes to the lower end of the projected range will probably occur, creating environmental conditions that are unprecedented in recent geologic history. Major challenges include: (1) measuring, understanding, and eventually predicting ecosystem and organism responses to extreme and rapid climate change; (2) separating these responses from other human-driven or independent stresses arising from development or environmental change; and (3) protecting ecosystems, their biodiversity, and the services that they provide to humans from avoidable stresses and insults, to maximize their chances of surviving the unavoidable climate stress. The U.S. is fortunate possess a system of reserves and sanctuaries that can be readily adapted to those ends.




*5. General recommendations related to coral reef declines ("...what recommendations would you provide for stopping and reversing these declines.")*

*5.1 Definition of issues and recommended actions*

We cannot expect to stop or reverse the effects of the global-scale changes we have set in motion on time scales of decades. In order to have a positive effect on the ability of all marine and coastal ecosystems (including coral reefs) to survive both increasing direct climatic stress and the much broader associated ecosystem and environmental changes, selective but extensive protection from other stresses (which can be controlled or eliminated) needs to be combined with a substantial improvement in our understanding of stress-response mechanisms and natural limits. (See section 6 below for a specific proposal)

*5.1.1 Critical needs*

5.1.1.1 Establishment and support of research sites and facilities that permit studies of relatively healthy, unimpacted reefs from a variety of natural environments. These areas are essential if we are to establish baselines and identify, understand, and mitigate the effects of climate change. Many marine labs and study sites are in areas so degraded that field research on stress-response physiology and ecology is done on moribund systems and stressed individuals rather than those that are responding normally and could effectively be protected.

5.1.1.2 Continued investigation of the nature and effects of non-climatic stresses, how these interact with climate-derived factors, and development of both fundamental and applied understanding of organism and ecosystem stress responses and how these may be applied to management.

5.1.1.3 Effective links to the larger global change and marine/coastal ecosystems communities, agencies and programs, both within the U.S. and internationally—coral reefs are a focal organism, but their problems illuminate larger issues, and any solutions will certainly draw on a broad base of knowledge, experience, and cooperation.

*5.1.2 Recommended actions*

5.1.2.1 Establish a genuinely cooperative, adequately supported interagency program that will develop a network of coral and related ecosystem research and monitoring sites along gradients of both climate change and human stress. Information assimilation and dissemination will be a critical component of this program and its

links to other recommended actions. Primary agencies would be the U.S. Fish and Wildlife Service and NOAA, but participation by NSF, ONR, EPA, USGCRP, relevant state governments, and private foundations and NGOs will ultimately be necessary for maximum effectiveness.

5.1.2.2 Link presentation of results, output, and new biological and environmental findings to the umbrella programs currently being developed to support such diverse efforts. A particularly promising example is the Ocean Biogeographic Information Systems (www.iobis.org) which links species-level taxonomic and occurrence data to geospatial environmental information.

5.1.2.3 Develop more effective links with international non-governmental programs that can serve as impartial networking agents and information brokers. One of the most potentially useful such programs is the Land–Ocean Interactions in the Coastal Zone (LOICZ; www.nioz.nl/loicz) project of the International Geosphere–Biosphere Programme (IGBP; http://www.igbp.kva.se/), which is currently seeking to develop a U.S. national program contact.

*5.2 Perspectives on planning and implementation*

The nature of the problem we face calls for some modification of the "business-as-usual" approach to both science and government. We are working on a constantly changing, as-yet-unpredictable problem with a time constant very long and a spatial scale very large compared to the problems our institutions were designed to solve. An open, "adaptive management" approach to both the scientific activities and the practical applications of the knowledge acquired is needed, and responsible, informed innovation will be at a premium.

*6. Other information and specific recommendations ("...other information...pertinent to the discussion.")*

This section is devoted primarily to further elaboration on the concept of developing a global-scale research park and biological reserve system based on U.S. territories containing coral reef ecosystems.

Such a system would have two conceptual and design components and two organizational components. The basic concept would be to establish a set of long-term research and monitoring transects and reserves along existing and expected gradients in human-driven local environmental stress and the progression of climate change. The organizational structure would be based on coordinated use of the refuge system of the U.S. Fish and Wildlife Service, and the NOAA Sanctuary program, with additional participation from the NOAA remote sensing and monitoring programs.

*6.1 Transect design*

6.1.1 Pacific climate transect: The nature of the world's oceans, the locations of U.S. territories, and the expected pattern of climate change dictate the establishment of two coordinated programs. In the Pacific, U.S. possessions include some of the most remote, unpopulated, and pristine coral reef systems, located in oceanic settings remote from both population and land effects. These cover a large latitudinal gradient, which is particularly important to monitoring climate change, since carbon-dioxide impacts on calcification are expected to move progressively from high to low latitudes and temperature changes will progress in the other direction. The available locations also grade from uninhabited and unimpacted to some regions of human impact and local degradation around the inhabited larger islands of Hawaii, Guam, and American Samoa. The Pacific holdings thus provide an excellent coverage of the climate change dimension, with some overlap into combined local impacts.

The primary components of the Pacific network would be the USFWS refuge system and the NOAA Northwest Hawaiian Islands (NWHI) Sanctuary. Figures 6.1, 6.2, and 6.3 show the island features of the central and eastern Pacific against a backdrop of the calcium carbonate saturation state in preindustrial (mid–1800s), present, and mid–21st century times. Saturation state is a measure of the ease with which calcium carbonate is precipitated from the water, and is reduced by rising atmospheric CO2. The contours show the expected progression of calcification stress on coral reef organisms over the course of time, and illustrate the opportunities for monitoring and studying similar systems concurrently at different stages of impact development.

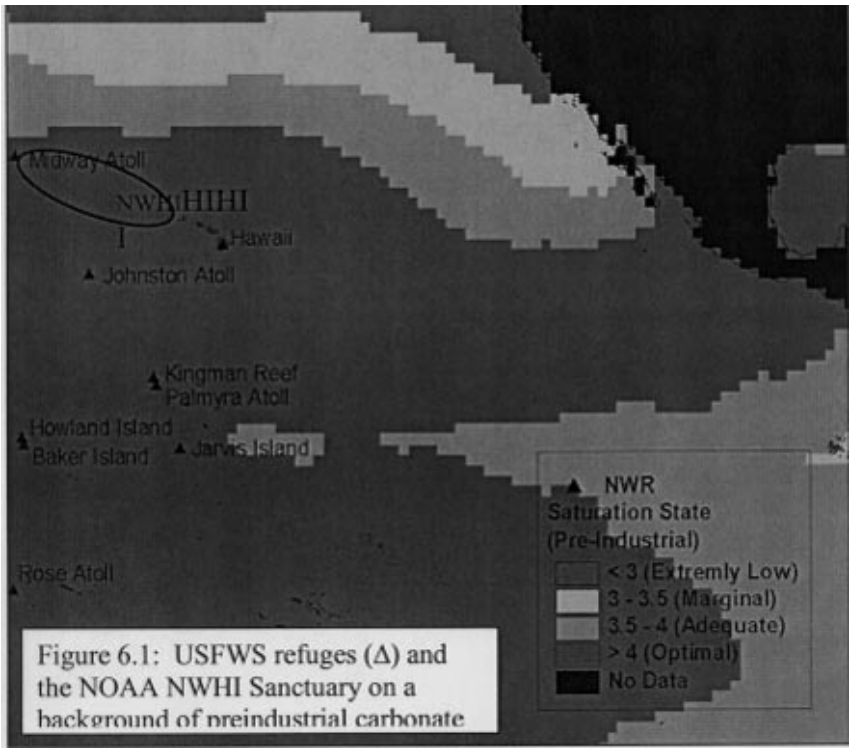



Figure 6.1: USFWS refuges (Δ) and the NOAA NWHI Sanctuary on a background of preindustrial carbonate

6.1.2 Caribbean/Gulf terrestrial impacts transect: In contrast to the Pacific, the Caribbean and Gulf of Mexico region is by its nature an interconnected, semi-enclosed basin with strong terrestrial influences, large populations on its coasts, and a high level of reef access and use. Because of the strong, and widely recognized, local human derived stresses, it is a particular challenge to discern the possible role of climate change or large-scale regional interactions, although these must be occurring.

However, the U.S. possessions in that area represent a transect complementary to the Pacific climate transect, in that there is a system of parks, refuges, and protected areas that extend from the high population-high-stress regions of the Florida Keys, Puerto Rico and the USVI to the relatively more isolated Dry Tortugas and the remote Flower Garden Banks. These sites grade from high local and regional impacts to low local and (possibly) moderate regional impacts, and provide a logical complement to the Pacific sites that grade from no local or regional impact to low or no regional, and moderate local effects. The combination permits systematic detection not only of climate change effects, but also of the nature of their interactions with other stresses.

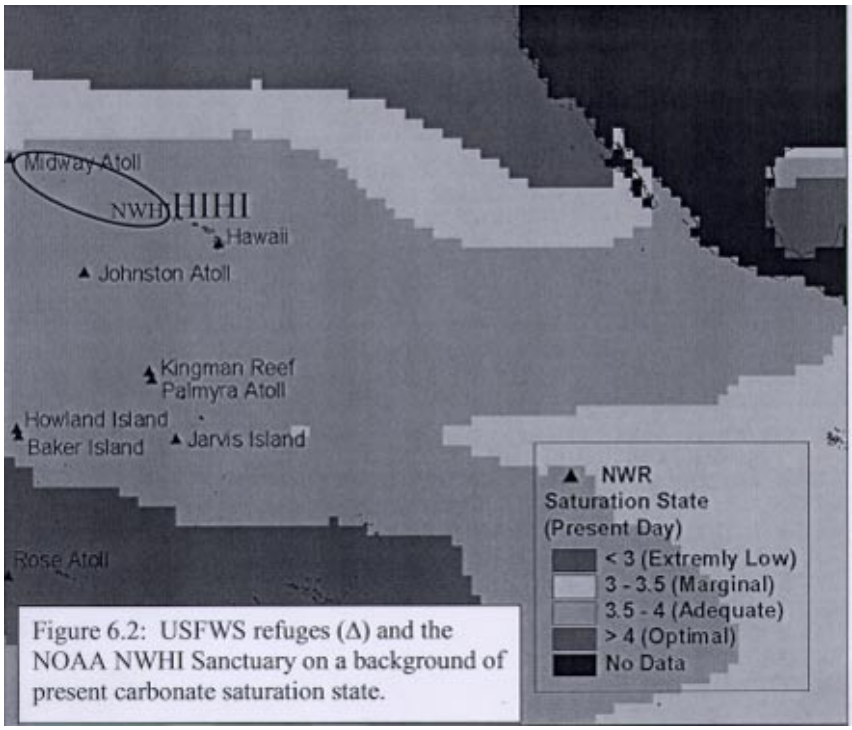



Figure 6.2: USFWS refuges (Δ) and the NOAA NWHI Sanctuary on a background of present carbonate saturation state.

6.1.3 Preservation and management issues: It needs to be stressed that in addition to a critical scientific role, the network of refuges, sanctuaries, and "science parks" would expand and enhance the preservation of biodiversity and living examples of natural ecosystems for future generations.

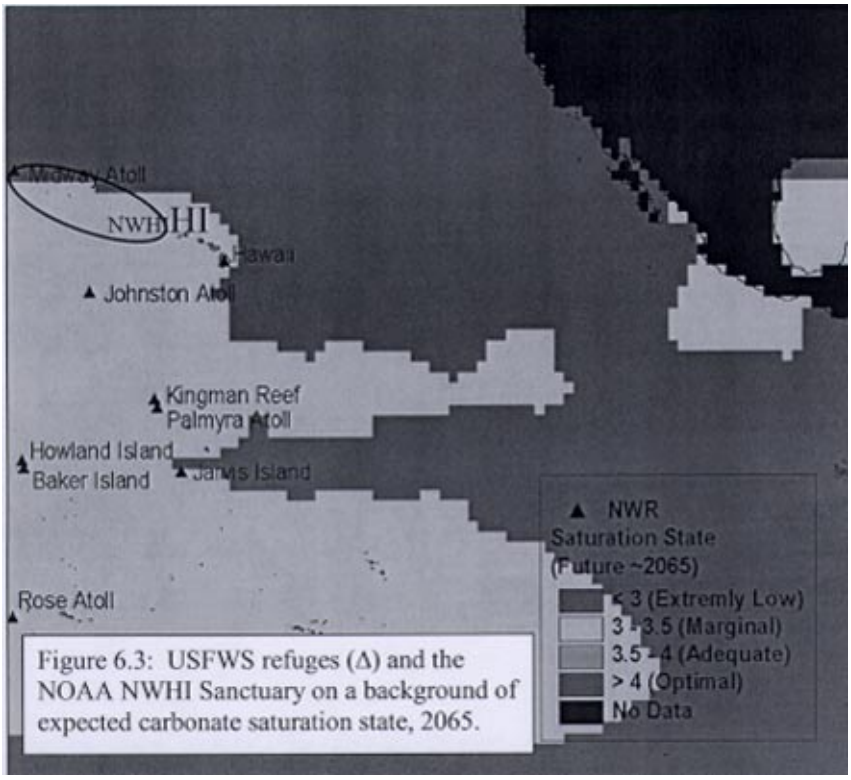



Figure 6.3: USFWS refuges (Δ) and the NOAA NWHI Sanctuary on a background of expected carbonate saturation state, 2065.

*6.2 Institutional and implementation issues*

The habitats, ecosystems and marine real estate that would be involved in the proposed development are already in the possession of the U.S. government or one of the states; no capital cost of acquisition would be required. In addition, nearly all of the areas of interest are already under the jurisdiction of an agency with a mission that includes preservation and understanding of the systems, so the basic goals and necessary administrative/legal framework is in place.

Substantial amounts of data, information, and experience are also available from the agency research plans and scientific personnel, although this is not necessarily as readily available to the larger scientific community as might be desired. NOAA projects have been proposed that fit within the overall approach, but as yet there is no programmatic home for these activities.

Integration of the existing facilities and programs into a two-ocean study of reef stress across natural and human gradients could be readily implemented, but would require some new resources and even more new administrative approaches:

- Enhanced budgets for monitoring, protection and enforcement would need to be provided to the lead agencies, along with development of measures of effectiveness, and effective means of communication of results.
- Incentives and mandates for effective cooperation within and between agencies are needed to ensure success; one possibility might be independent funding of a consortium program that would complement but not compete with or replace existing agency programs.
- Two scientific components are required—one that would operate within the lead agencies (either by staff activities or grants and contracts), and another that would require and assist the agencies to provide administrative and infrastructure support for external research programs (e.g., NSF, or possibly international consortia).
- Outreach beyond the conventional limits of the research, environmental management, or "coral reef" communities can provide both broader participation and

effectiveness, and political and educational benefits inside and outside the US. NGOs, international, and private partners have potentially important roles to play in realizing the full potential of the approach.

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Mr. GILCHREST. Dr. Ogden.

**STATEMENT OF JOHN OGDEN, DIRECTOR, FLORIDA INSTITUTE OF OCEANOGRAPHY**

Dr. OGDEN. Thank you, Mr. Chairman. My name is John Ogden. I am Director of the Florida Institute of Oceanography and a professor of Biology at the University of South Florida. You mentioned earlier at the start of the hearing, Mr. Chairman, the exclusive economic zone.

It is interesting to look at the maps of that zone and realize that while we tend to think here in Washington and elsewhere that coral reefs are distant and remote and exotic, a considerable amount of what we call our ocean is made up of areas which have coral reefs as their principal ecosystem. They are indeed a part of our national patrimony and well deserved of our attention and protection.

That map, I wish I had it with me but I was wary about the projection here today, having had an experience at Capital Hill's oceans week that was sort of negative in the projection department. But that is all right.

I first testified before Congress in 1987 at the time of the first major international episode of coral bleaching. The increasing concerns with global warming were, of course, on the table and that happened to be the hottest summer on record to date in Washington, D.C.

Since that time, we have seen through the testimony of my colleagues exactly what has happened to us. Coral bleaching, as a manifestation of this change, has increased in severity and frequency globally.

We established through various programs, one of them prominently at NOAA research programs in which corals were called the canary in the cage after the 19th Century canaries that were carried into the coalmines to detect poison gases. They were harbingers of global warming in the oceans.

Then came 1997 and 1998. Arguably, this was the most coherent response of a global ecosystem to a disturbance linked to human activities. Imagine, if you will, if all the puppy dogs across the band of the earth died or all the family cats. I mean essentially we have not seen a coherency of ecological response due to human disturbance before. I truly believe that.

Mr. GILCHREST. I should hesitate, but I won't hesitate to comment about all the domestic cats. The neotropical songbirds will be very happy about that, I am sure.

Dr. OGDEN. At any rate, having identified this canary in the cage, we ignored its fall from the perch and now it is sort of on the bottom of the cage twitching. And we are prevaricating about the human role in climate change.

Are coral reefs doomed? It is a fair question to ask. I don't believe that anybody knows the answer to that. But I do know that throughout our history as a nation we have often been in a position

where things seem hopeless and that exactly makes us rise to the occasion and be determined to make them otherwise.

I am convinced, for one, that good science, common sense integrated with good policies can make a difference for coral reefs.

As my colleagues have so eloquently stated, climate change is the umbrella under which a variety of human activities disturb coral reefs. The other principal ones are land-based sources of pollution, that whole panoply, including some of these emerging coral diseases that are linked to human enteric pathogens and over-fishing, the direct and indirect impacts of that.

Assessing the health of a coral reef is analogous to a patient with general ailments visiting a doctor in my view. We take note of history. We conduct a general examination of vital signs. We are informed by science, but we are guided as much by our experience as professionals, as managers, as scientists and by common sense. As stressors we know operate in synergy and with global climate change in this case, we accept the principle that reduction of stresses is good and that this will help reefs resist stresses that we cannot or will not manage, namely this enormous lag time in climate change.

So, I don't believe that the situation is hopeless. I believe science has already provided us with sufficient data to recognize a crisis in these respects and sufficient information to sort of craft the forms of a solution to it.

We have to sort of confront this scientific uncertainty, however, in doing this. My first recommendation is that we need to continue to ramp up the funding for the national action plan to conservation coral reefs and especially concentrating on partnerships between the principal agencies. I would name these as NOAA, the Department of Interior and the Environmental Protection Agency. I watched a partnership between NOAA and EPA work for 7 years in the creation of the Florida Keys National Marine Sanctuary and it is still working.

It is in many ways an uneasy fit between two agencies that don't share the same kind of culture, but it works and I believe particularly, NOAA, Interior and EPA could work together on these things.

I support the implementation of the integrated and sustained ocean observing system, which is a general U.S. target, but of course, directed at that significant portion of the EEZ which is coral reef.

Dr. Strong's dramatic visualizations of the power of this is space-based and in situ instrumentation cannot be denied. This is as basic to our future understanding and management of coral reefs as the map or the chart is itself.

We are all concerned with over-fishing. It has an object dramatic impact on coral reefs largely because coral reef fishes are so sedentary. It is hard to imagine a 600-pound Grouper being sedentary, but they are indeed very sedentary. So, when you fish them out and continue to remove these larger sized classes of fishes, you change the entire functioning of reefs.

This whole over-fishing crisis, and it extends to the rest of the Nation as well with very important lessons from coral reefs, has

driven this interest in marine reserves. I believe that that needs to be pushed forward clearly.

You mentioned networks and corridors of reserves. That is clearly the direction in which we have to go. It is important to note, though, that marine protected areas are for the whole system; they are not just about fishing.

The Nature Conservancy and World Wildlife, for example, have identified areas of the world that escaped serious impact from the 1997-1998 coral bleaching. These happen to be areas with particular oceanographic or/or latitudinal locations where corals did not bleach. The inclusion of places like this in networks of marine reserves is an obvious benefit for future reference.

Another thing about marine protected areas is that they are necessary, but they are not sufficient. We need to raise the scale, the geographic scale, at which we are approaching the whole problem of ocean management and by extension, coral reef management and science.

We need an equal regional approach. We have ample scientific data to show that coral reefs behave in an ecologically coherent way across large regions. The Greater Caribbean is the one that I am most familiar with, but this happens in other parts of the world as well.

This ecoregional approach sounds complicated, but we have excellent examples at various scale on how this might be done, in Florida, in Latin America and in the Great Barrier Reef of Australia.

So, my next recommendation is that we should use the Executive Order that we have on marine protected areas and the Coral Reef Conservation Act and the Oceans Act and the Essential Fish Habitat and Ecosystem Protection Provisions of our Fisheries Management Acts, all of which contain ample rationale to push forward with large ecoregional planning projects and zoning plans for significant areas.

I submit to you, as Bob has emphasized, that the Northwest Hawaiian Islands, which I love, is almost the size of the Great Barrier Reef. I have heard for years from my Australian colleagues that they own the reefs of the world. We will, we own a significant reef area ourselves and we ought to do as well as they have done over the last couple of decades in planning it. I think, of course, we can do that.

This ecoregional approach should include an inter-disciplinary research support program in what I call for want of a better term, "Ocean Conservation and Management Science." This is would encompass our major science agencies and the NSF. It would include appropriate elements of physical and chemical oceanography and also biologically concentrate on the issue of connectivity, which you mentioned in the idea of how connected are reefs and how close or far apart can marine reserves be and what I would call seascape ecology and also the whole issue of ecological resilience.

How many species can we afford to lose in the human footprint on the earth before we lose ecosystem function and, of course, climate change itself has been emphasized by my colleagues.

Finally, I urge, along with everyone else, that education is a key here. All of these programs should hold significant components that

are dedicated to education at all levels. Coral reefs have this extraordinary charisma. It is really a relatively easy manner for us to act individually in our areas to deal with this, but if we can act in a more programmatic way in terms of education using these examples from reefs, I think we will be way ahead of the game.

Thank you very much, Mr. Chairman.

Mr. GILCHREST. Thank you, D. Ogden.

[The prepared statement of Dr. Ogden follows:]

**Statement of John C. Ogden, Director, Florida Institute of Oceanography, and Professor of Biology, University of South Florida**

My name is John C. Ogden. I am Director of the Florida Institute of Oceanography (FIO) and Professor of Biology at the University of South Florida. We are a 17-member consortium of universities, agencies, and marine laboratories, which operates two ships and a marine laboratory and administers and leverages funding for inter-institutional projects in research and education on coral reefs and in coastal oceans in Florida and the greater Caribbean Sea. I have spent my career of over 30 years working on coral reefs all over the world, introducing students and the public to their beauty and their importance to science and society. I had a role in the design of the International Coral Reef Initiative and the implementation of the Global Coral Reef Monitoring Network. I served as the Secretary of Commerce's appointee for science on the founding Advisory Council of the Florida Keys National Marine Sanctuary. I am the ex-president of the International Society for Reef Studies, a 750-member organization of scientists, resources managers and conservationists from over 50 countries dedicated to the scientific understanding and protection of coral reefs. I currently serve on the Boards of the World Wildlife Fund and The Ocean Conservancy and am a Fellow of the American Association for the Advancement of Science.

I am honored to be here to testify on coral reefs before this Subcommittee for the second time. I remain acutely conscious that we have a narrow window of time in which to establish an integrated national strategy to conserve our nation's coral reefs and to influence other nations, with far more of the world's reefs, to do the same.

*Background: Are coral reefs doomed?*

I first testified before this Subcommittee in 1999 on the Coral Reef Conservation Act, which was our nation's response to the International Coral Reef Initiative, established under U.S. leadership in 1995. Since then, the Coral Reef Task Force has produced The National Action Plan to Conserve Coral Reefs—a comprehensive statement of the scope of coral reef problems. Under the Coral Reef Conservation Act of 2000, key agencies including NOAA and the Department of the Interior have action plans and statements of capability at various stages of preparation. This national effort has been backed up by international coral reef status reports and calls for action. Yet we still do not have a coherent national strategy of conservation, management, and research on coral reefs.

Against this background, coral reefs have continued to decline, most dramatically in the global coral bleaching event of 1997–98, coincident with the El Nino of the century. This event and the growing public concern with climate change is increasing the pressure for a long-term, comprehensive energy national policy including CO2 emissions into the atmosphere as outlined in the Kyoto Protocol. However, even if we implemented such a policy today the lag times are significant and there is considerable pessimism about the future of coral reefs even under the most optimistic scenarios of emissions control.

It is legitimate to ask the question: Are coral reefs doomed? No one knows the answer. However, through our history we as a nation have often been in the position of being able to see that things are hopeless and yet we remain determined to make them otherwise. I am convinced that good science, common sense, and integrated policy can make the difference for coral reefs.

*Recommendations*

- Implement with adequate funding the National Action Plan to Conserve Coral Reefs through the detailed action strategies of key agencies, particularly NOAA, the Department of the Interior, and the Environmental Protection Agency.
- Use the Executive Order on Marine Protected Areas, the Coral Reef Conservation Act, the Oceans Act, and the essential fish habitat and ecosystem protection provisions of the Fisheries Management Act to push forward with large,

ecoregional zoning and protection plans, particularly in the Northwest Hawaiian Islands Coral Reef Reserve, other Pacific territories, and in the Caribbean Sea.
- Support the implementation of the Integrated and Sustained Ocean Observing Network, now in the advanced planning stages, in conjunction with ecoregional coral reef zoning plans.
- Support a program of Ocean Conservation and Management Science within the NSF deliberately directed at the partnering of Federal agencies and academic scientists in the understanding of the impact of climate change and other human disturbances on large marine ecosystems.
- Use the extraordinary charisma of coral reefs to implement education programs informing people of the problem of human disturbances to coral reefs and to the oceans and their role in the solutions, including the need for a comprehensive national energy policy dealing directly with climate change.

*Coral Reefs in an Era of Climate Change*

The coral bleaching response to climate change first appeared on the policy stage in the summer of 1987, coincident with a major international episode of bleaching, increasing concern about global warming, and one of the warmest years on record in Washington, DC. The Senate held hearings on coral bleaching and testimony reported preliminary scientific evidence that linked bleaching with unusually warm seasonal seawater temperatures.

Corals bleach when stresses, including high temperatures, stimulate the coral animal to expel its intra-cellular single-celled plant symbionts, which are characteristic of all reef-building corals and critical to coral health. As the color of corals is determined in large part by the plant cells, the corals appear to bleach. Bleaching does not immediately kill corals and they are capable of recovery if the stress is removed, but if it is prolonged corals may die.

Since 1987 episodes of bleaching increased in geographic extent and severity. Bleaching was associated with the El Nino–Southern Oscillation (ENSO) which had come to be recognized as driving global climate patterns. Research in the late 1980's and 1990's strengthened the link between bleaching and seasonally warm seawater temperatures and corals were called "canaries in the cage" (after the canaries used by 19th century coal miners to detect poison gases)—harbingers of global warming in the oceans.

Coral bleaching isn't the only detrimental effect of climate change on coral reefs. Prolonged seasonally warm temperatures stress corals and can increase the growth rate of the potentially pathogenic microorganisms responsible for coral diseases. Increased CO2 in the atmosphere lowers the saturation state of calcium carbonate (CaCO3) in the ocean. This has been shown to decrease coral reef calcification and may over time be an even more important factor than bleaching in the global adjustment of coral reefs to climate change. Another recent hypothesis links long-term drought in the Sahel region of Sub–Saharan Africa with increased deposition of dust carried across the Atlantic to the Caribbean by prevailing westerly winds. The dust contains iron, which has been shown to stimulate planktonic algal blooms. It may also be inimical to coral health and stimulate the growth of benthic algae. The dust may also contain coral pathogens such as fungi and bacteria.

In 1997–98, coincident with the ENSO of the century, corals all across the world's tropics bleached and many died. This was arguably the most coherent response we have ever seen of a global ecosystem to a disturbance linked to human activities. This unprecedented episode of bleaching touched areas that had rarely experienced bleaching before, including parts of the Great Barrier Reef of Australia. The event was well covered by the global press and caused great concern. It is disturbing, however, that in spite of solid scientific evidence linking bleaching to ocean warming, we ignored the fall of the canary from its perch. Now, while it is twitching on the bottom of the cage, we prevaricate about the human role in climate change.

*Coral Reefs Under Multiple Stresses: A Thousand Cuts*

Human activities influence coral reefs in a variety of ways, but the general categories of disturbances make a remarkably short list:

1. Climate change including ocean warming, sea level rise, and increased atmospheric CO2..
2. Land-based sources of pollution, including land destabilization and sedimentation, sewage disposal, toxic pollution, and pathogens.
3. Over-fishing, including both the consequences of removal of fishes from reefs and the damage of fishing techniques and gears.

Note that these disturbances operate on distinctly different geographic scales. Climate change is the only global influence in the list and is the umbrella under which

all other stresses to reefs operate. Land-based sources of pollution are both regional and local. For example, a significant proportion of marine pollution is aerosols and runoff originating far from the ocean. Over-fishing is largely a local problem and responds to relatively simple if not easily implemented management regimes. Finally, note that these disturbances are characteristic not only of coral reefs but any coastal ocean area near human populations.

*A Human Health Analogy*

Imagine a coral reef as a patient with general ailments visiting the doctor. The doctor, whose degree is Medical Arts and Sciences, first takes a medical history and conducts a general examination of vital signs. The doctor is informed by science but, assuming the absence of an acute condition requiring immediate intervention, is guided as much by experience and common sense. The diagnosis might include a listing of the stresses of modern life: a high pressure job, not enough sleep, poor diet, too much coffee or alcohol, and so on. Medicine operates on the principle that reduction of stresses is good and that it helps the patient cope with stresses that she or he cannot or will not address.

I believe that the diagnosis of ecosystem health operates in the same way. I can think of no coral reef in the world where a few informed people, including, but not limited to scientists, could not come to reasonable conclusions as to the sources of disturbances to the reef and reasonable if not easy suggestions for conservation or management action. These actions will necessarily be limited to human disturbances that can be managed locally or regionally and will not address the umbrella stress of climate change. Nevertheless, the inference, perhaps an article of faith, is that reducing the impacts of pollution and fishing, for example, will make the reef better able to cope with climate change.

Science has already provided us with sufficient data and information to recognize a coral reef crisis. We must act by facing scientific uncertainty and using the precautionary principle. The National Action Plan to Conserve Coral Reefs implicitly assumes that future research on coral reefs should be done within the context of national programs of conservation, management, and education. A national research program, including but not limited to coral reefs, in Ocean Conservation and Management Science would include: (1) connectivity or seascape ecology at wide geographic scales; (2) ecological resilience and the functioning of biodiversity; and, (3) global climate change. This program could be based at the NSF with the cooperation of other agencies.

*The Ecoregional Approach: Reefs Do Not Live Alone*

Reefs are connected to the land and to other coastal ecosystems in a "seascape" of linked ecosystems (Figure 1). In addition to the exchange of energy and materials via transport processes and the movements of organisms, the ecosystems of the coastal seascape act as buffers. The landward seagrass beds and coastal forests buffer offshore coral reefs from the inimical influences of sedimentation and nutrients originating on land. In turn, offshore coral reefs buffer the nearshore ecosystems from the effects of ocean waves and erosion. Human interference with this buffering capacity has damaged coral reefs, smothering corals with destabilized sediments and promoting the growth of algae thorough excessive nutrients. Maintaining and restoring a fully functioning coastal seascape is a major goal of coral reef restoration.

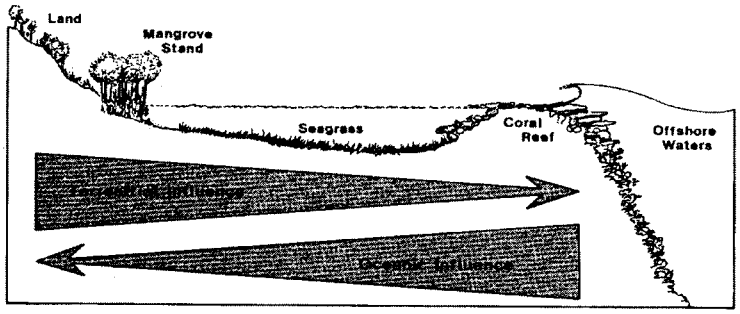


**Figure 1**: The Coral Reef Coastal Seascape

Not all land influences are local. So-called "dead zones" on coastal shelves off the mouths of major rivers have been reported around the world. For example, massive algal blooms fertilized by runoff from agricultural areas far inland create the seasonal dead zone off the mouth of the Mississippi River in the Gulf of Mexico. In addition, a major component of marine pollution (up to 50% in some estimates) is from aerosols, which may originate many miles away from where they are deposited.

Coral reefs are connected to each other over large regions by ocean currents (Figure 2). For example in the Caribbean, remote sensing has shown that the outflow of the Orinoco River in Venezuela seasonally moves across the entire Caribbean Sea as far as Puerto Rico and perhaps beyond. These currents can carry marine organisms, with larval lives ranging from several weeks to over a year, over long distances. Of course, currents can also carry pollutants.

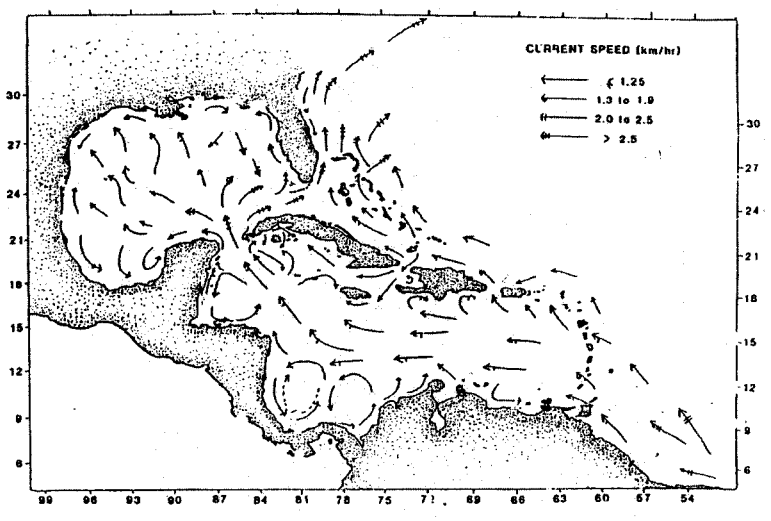


**Figure 2:** Ocean Currents in the Greater Caribbean Ecoregion

The importance of understanding ocean currents and other physical features of the ocean have driven the development of an Integrated and Sustained Ocean Observing System (IOOS) which should be supported by the Congress. While physical features are basic, we must include key features of the biology of the oceans, including coral reefs, in the national monitoring scheme.

*A Lesson in Ocean Zoning*

Over-fishing has grown in scientific and public concern. Recent work has suggested that fishing was the first human disturbance to coral reefs, altering their functioning long before the modern era. Coral reef fishes exert top-down control of reef ecosystems. The elimination of the larger size classes of predatory groupers and snappers, for example, causes population increases of fishes lower in the food chain, changing the natural functioning of the reef. Fishing has a major impact because most reef fishes are extraordinarily sedentary, associated with particular reef areas for their whole lives.

Fishing with explosives and toxic chemicals including bleach and cyanide has laid waste to huge regions of reefs in Indonesia and the Philippines and stimulated a variety of international management and conservation efforts. Fishing gears can damage reef areas and lost nets and line damage and destroy corals and entangle fishes and invertebrates.

These concerns have driven a rapidly increasing interest in marine protected areas, particularly marine reserves fully protected from all extractive human activities. In every case where fully protected marine reserves have been implemented, the result within a relatively short time has been more and larger fishes. Most of our current fully protected marine reserves in coral reefs areas are in the Florida Keys National Marine Sanctuary.

It is important to note, however, that marine protected areas are concerned about protection of the whole ecosystem, not just fishes. For example, The Nature Conservancy and World Wildlife Fund examined areas of the world which escaped the devastating impact of the 1997–98 coral bleaching episode. These include: areas where upwelling cools the water; areas of strong currents; regions where existing stresses have caused corals to adapt to extreme conditions; areas where corals are shaded by steep islands or by turbid waters. Strategically networked marine protected areas including these special situations might have the best possibility of mitigating the impact of climate change over time.

*Ecoregional Planning: A Vision of the Future*

Marine protected areas are necessary, but not sufficient. We should implement ecoregional plans to protect and manage coral reefs in which the whole country, not just fishing, has a stake. We have some excellent case studies of how this might be done. The Florida Keys National Marine Sanctuary management plan was a 7 year process involving a broad cross section of stakeholders in a plan that is based upon zoning, including but not limited to fully protected marine reserves. The plan includes water quality management and 8 other action plans dealing with everything from education, channel marking, recreational boat use, to high seas commercial ship traffic.

The Meso–American Coral Reef project of the World Wildlife Fund and the World Bank is the most advanced international ecoregional planning project involving coral reefs. The presidents of Mexico, Belize, Guatemala, and Honduras signed the Tulum Declaration in 1998, agreeing to co-manage the region. Subsequently, a series of major international planning exercises were held in which major features of the region including ocean currents, river drainages and key resources were mapped with population centers, industrial areas, marine discharges, existing protected areas and so on. Overlay maps provide the basis for decisions on protection and development which have every hope of leading to sustainable use of this major global coral reef region. It should not escape our attention that the Meso–American Coral Reef is directly upstream from Florida.

The Northwest Hawaiian Islands Coral Reef Ecosystem Reserve is a critical coral reef region for the nation. It is equivalent in size to the Great Barrier Reef Marine Park of Australia and far enough to the north to escape major coral bleaching episodes. It is virtually unpopulated and protected by distance from major fisheries. The Ocean Conservancy has identified it as a premier site for protection under their Ocean Wilderness campaign. Following on the examples of the Florida Keys and the Meso–American Coral Reef, the next steps should be involvement of the broad range of stakeholders in a major ocean use planning project.

*Conclusions*

Some scenarios for coral reefs in this era of climate change are not optimistic. However, there is a great deal of scientific uncertainty about the reef response and ample opportunity to implement local and regional reef protection schemes which may be our best prospect to mitigate climate change in the near term. At the same time, we should use the lessons of coral reefs to argue for implementation of a comprehensive, long-term national energy policy which directly addresses climate change. There is every reason to expect that this will have beneficial social and economic impacts even if there may be a considerable lag in reef mitigation. We have had over a decade of discussions, research, planning, meetings, workshops, and status reports. There is sufficient scientific information. We should act now.

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Mr. GILCHREST. The ecoregional approach —

Dr. OGDEN. Right. I apologize for that little bit of jargon.

Mr. GILCHREST. No. I had a question about it. As far as you say there is clearly enough data to pursue an ecoregional approach in certain areas of the ocean. I would guess inside our EEZ and in an international way.

Dr. OGDEN. Yes.

Mr. GILCHREST. When you use the term "ecoregional approach" in the way I think you described it, you are fairly comprehensive. I suppose that means the interaction of all of the variables in that region of the ocean at any given time, including currents, temperature, nutrients, phytoplankton and catching black sea bass.

Dr. OGDEN. Right. The sociological elements as well, exactly.

Mr. GILCHREST. So, you are saying that there is now sufficient data, let's say, for the National Marine Fisheries Service to work with the councils along with other aspects of NOAA and Interior and EPA and whoever to not only look at that as an ecoregion, but also manage the fisheries within that region from an ecosystem plan?

Dr. OGDEN. Absolutely. You know, I get so tired of hearing from people who ought to know better that we know more about the dark side of the moon or the surface of Mars than we do about our own ocean. This is absurd. We have a lot of scientific information about our oceans.

Do we have enough? Who knows what enough scientific information is? The point is that we need to gather it together within these regions of the world that can be called ecoregions that have a certain similarity.

Mr. GILCHREST. Can you give us an idea where you can identify a particular ecoregion where enough is know to implement this kind of a program?

Dr. OGDEN. I suggest in terms of what is in front of us today, the Northwest Hawaiian Islands are an ecoregion par excellence, linked by ocean currents in a particular latitudinal zone with a certain coherence of inhabitation by animals and plants and so on, a commonality of geologic history and so on and so on. Yes, indeed, I believe that.

Mr. GILCHREST. Would you say the South Atlantic is one?

Dr. OGDEN. The southern ocean do you mean?

Mr. GILCHREST. Actually, I am looking at eight regional fishery management areas as a curiosity, the South Atlantic Council or the Gulf Council.

Dr. OGDEN. I see. I see where you are going with it.

Mr. GILCHREST. Adapting that with your idea of an ecoregion.

Dr. OGDEN. Absolutely, absolutely.

Mr. GILCHREST. It would be ready this year, 3 years?

Dr. OGDEN. Well, I think at this level, Mr. Chairman, is a national goal of decadal strength. It is not going to be something that happens overnight. But I firmly believe that this is something that was intended by the ecosystem provisions of our Fisheries Management Act and is what is essentially required by some of the international law conventions which, of course, we have not firmly signed off on.

Mr. GILCHREST. Now, you didn't come in to testify about this, but I'll ask you one more question. We are sort of in a different Subcommittee now. Anybody can pitch in here. I'm going to stretch the prerogative of the Chairman, I guess, because we didn't ask you to come in and talk about management councils.

You don't have to answer, but if you have an idea in the coming week or so, give us a response. The question is: In the new reauthorization for the fisheries, the Magnuson-Stevens Act, we have a provision where we ask NOAA to do a 2-year study to collect data or to see what data is available to implement an ecosystem fisheries plan.

In the legislation there is a 1-year additional study which we assume there will be a data vacuum of certain pieces of information.

That 1 year additional study will be able to fill in that information about how to approach a fisheries plan from an ecosystem perspective.

The third year, though, after 3 years, the beginning of the fourth year, we would pursue two pilot projects for an ecosystem fisheries plan in the Pacific and the Atlantic. Is that too long a timeframe? I was told yesterday that I am going too slow on that.

Dr. OGDEN. I think it is a very ambitious idea. I think the 2-year time period is enough to assemble the existing information and put it in appropriately geo-referenced formats and so forth. This information that is alleged is larger than we suspect because it is so scattered in different places.

I think that would seem to me about the right timetable for what I would consider to be an ambitious, may I say, first step in what will be a much longer process, I think, to come to what I would call an ocean-use plan in the end by merging, let us say, regional plans which have at their core this sort of a design philosophy.

Mr. GILCHREST. Thank you. Anybody else? Yes, sir.

Dr. BUDDEMEIER. I agree with John's comment that that is about the right kind of time scale for an effort of this magnitude, but I would like to suggest that we have to be very careful about the usual problem that we run into that the best is the enemy of the good.

We are dealing with a very urgent issue, in spite of the long time horizons on it. The usual process of two or 3 years to study something, make a recommendation, sell it, fund it, start it, I think just doesn't cut it any more. I think part of the answer to that can lie with the examples that Alan Strong gave us.

We have been finding, I and some other related projects, that doing the assembly and the preliminary interpretation of these things in a public and transparent fashion, essentially of involving the community, by not waiting until you have it all done and reviewed and peer reviewed and published, but of responsibly putting up things as you go along to solicit other inputs, to solicit ideas, can greatly accelerate the process of coming to not only a conclusion, but consensus.

I think some modifications in the way we go about doing our planning and implementation business could have some very salutary effects. The example is the rapid information delivery over the Internet.

Mr. GILCHREST. You are saying the timeframe is right, but the manner in which the research is conducted is critical to include —

Dr. BUDDEMEIER. Yes. I am suggesting that to look, what was it, three or 4 years ahead on something like this is reasonable, but not for just getting the plan. The plan ought to be done in such a way that the result has been developed as a consensus and sort of presold and ready to move into actually implementation at the end of that time.

We haven't usually done that in the past, I don't think.

Mr. GILCHREST. We would like to move into implementation at the end of the third year. That is in the statute, or we hope it is in the statute if we can get the bill passed. But any input that you might have on moving in that direction, I would like to stay in touch. As I said in the beginning, the GAO report on what is merit

and what is hyperbole here in Congress, to get something passed, you need both, a lot of BS to get stuff passed around here and hope the underlying facts are correct.

I know everybody is anxious to get to lunch and we all have other things to do. I just have a series of quick questions that I would appreciate your response to. Anybody can jump in at any point.

Is there any evidence at all that coral reefs can adapt to what seems to be a predictable increasing warming ocean?

Dr. BUDDEMEIER. If I may jump in on this, yes, there is at least inference, if not evidence, in the geologic record and in the history of what we know about reefs. Whether they can adapt to the rates of change that are currently going on is a significant question.

I think one of the things that needs to be recognized, you asked it earlier. "Can they been saved?" is the way I think you put it to the previous panel. My answer to that is not all of them and probably almost certainly not in the exact form that we now see them.

However, we know that the organisms that make up the reefs have evolutionary histories that go back a long way, including even before the period of relative climate stability. So, there is some reasonable hope that these organisms and their communities in some form can survive. There are some mechanisms by which it might happen. We don't know whether it will or not.

Dr. STRONG. Mr. Chairman, if I may, we have been involved, as you are aware, I think, with the Great Barrier Reef and our colleagues through an MOU that we have with them at NOAA, in not only watching those reefs very carefully where they are managed, they would say, very well.

I am sure we look forward to how we can copy some of we had to they are doing there. In the most recent bleaching event, I think there is a press release that came out just a few days ago from them and I think NOAA, somebody was talking yesterday about echoing something over here in our country where there seems to be recovery. I mean these bleaching events we have had in the past, there has been recovery.

The take-home message, though, is that often, like in Belize, for example, when there is recovery it is often different. The diversity is frequently less than it had been in the past. And so there are some changes that we are having to look at.

Mr. GILCHREST. Once the bleaching starts, the recovery happens because the water turns a little cooler or if the water doesn't turn cooler, can they quickly adapt to bleaching or is it —

Dr. STRONG. As the water cooled and summer was no longer is South America in March and April, as the waters cooled and the mixing of the currents got robust again recovery was noted. The bleaching dissipated and many recovered. Now, we are going to hear over the next year or two, they say, this is a large area to monitor, just how well it recovered. They were surprised in 1998 just how well it recovered then. There was some reports that said it was almost better. But there was scientists that, of course, had different opinions. Obviously, to monitor the whole reef and every coral is virtually impossible.

But there is recovery. But as I say, the important thing to know is that the diversity often is less. In some of these reefs like Palau

where there is almost total devastation, they haven't gotten back to where they were.

Mr. GILCHREST. No. Dr. Cohen, I think made a comment earlier that the change is happening at such a rate that for the corals to adapt is not likely.

Dr. STRONG. And they need a recovery time. If another episode comes along from another weather event, coupled with an El Nino or however the next reversal in the Pacific Decadal Oscillation affects it, there may not be sufficient time to recover. That is the concern that we have. We haven't talked about a response team to try to get out there.

Mr. GILCHREST. What can a response team do once they go out there?

Dr. STRONG. Well, this was done, for example, in 1994 in Tahiti when we were first starting to report some of these downtown and on the Hill. Tahiti had an episode that was pretty dramatic at that time, nothing like '98. There was a way through, I believe it was the State Department where something was organized and they got people in the field quickly monitoring not only what had happened, but then afterwards the follow-up, so the scientists can learn which corals are resilient.

Mr. GILCHREST. You can't go down there with an iceberg or anything like that?

Dr. STRONG. That has often been my line, yeah, if we had some icebergs to bring in. What we need to know and what we are learning, too, is that the circulation is in these marine parks, these affected areas, to know that circulation. Because there will be some areas in the reef, as we found out from the Great Barrier Reef Example, the circulation from the tidal mixing which happens naturally thanks to the moon and the sun and where we are, there will be some areas in these reefs where the recovery is not only quick or maybe bleaching didn't occur because there was so much mixing and upwelling.

To know and to ID those areas and to make sure we protect those regions so they can enhance and seed the areas is very important and we are just learning this.

Mr. GILCHREST. Dr. Cohen, in the Red Sea, the slides that you showed where it was in good shape, bleaching was starting and in only a few months that whole coral reef apparently just died. Now, the reason, was that an exceptionally long period of time where the water stayed warm? Does that occur in other places? Was that different kinds of coral that had no chance of adapting to that or tidal fluctuations had no impact? Is that area now dead forever, I mean the next thousand years for coral?

Dr. COHEN. Mr. Chairman, as Dr. Strong was emphasizing in his last comment, there are a series of conditions that combine together to induce mortality on the reefs due to bleaching. While bleaching is a natural process and it has happened before, in isolated coral communities, isolated events in time.

It is almost an onslaught of bleaching events in the last two decades that is causing the level of concern that we have right now. The pictures that I showed were an extreme bleaching event in the Red Sea due to extremely high temperatures and prolonged high temperatures over a period of several months.

That final photograph in that series of slides, those corals were dead. They had lost their polyps and algae stopped growing over the corals and there is no chance of them recovering. There are certain species that Dr. Strong indicated. Some species, especially in shallow waters, are more vulnerable to bleaching than species which occupy deeper waters.

Mr. GILCHREST. Thank you. Are El Nino events becoming more frequent?

Dr. STRONG. In the '90's, as a NOAA representative here, they certainly were more frequent, I think than we had seen in a number of decades. I will remind you that when I first came aboard NOAA or soon afterwards, I was sent down to South America. We were talking to people down there because NOAA didn't know that much about El Ninos.

In fact, in the early '80's when we had a major El Nino, it was like, "El Nino, well that won't affect the weather. We don't need to worry about that."

Look where we are now.

Mr. GILCHREST. Is climate change having an effect on El Nino?

Dr. STRONG. That is the question of the day. El Nino has been noted, at least in reports I have read, to go through episodic behavior where it beats at a certain frequency for a while and then changes. It is sort of like paleo information tells us over the past.

Mr. GILCHREST. Does some of the information you gave us this morning show significant changes in the climate that have either never been recorded or haven't been recorded for a million years and using the principle of uncertainty, based on this brand new era that we are moving into where we could to some extent understand and predict the natural fluctuations of the natural environment, now we are moving into an arena where those predictions are virtually off the table because of the consequences of CO2 and those other greenhouse gases in the last 50 to 100 years.

The specific problems of El Nino or, I think, either Dr. Buddemeier or Dr. Strong mentioned the conveyor belt of the ocean, I would think that the government, which I guess I represent, my daughter will often say it is the government's fault and I will say, "You are looking at the government."

There seems to be a need for a bold statement by an integrated group of people to alert the people to, yes, there are some potential changes of big magnitude. So often we rally quickly to retain the Pledge of Allegiance and we get on the House steps and we do and we make these very distinct, bold statements, while the world is going to hell in a hand basket, because it is a little bit more complicated to make these other statements.

I apologize for rambling.

Dr. BUDDEMEIER. You have that permission.

Mr. GILCHREST. Thank you.

Dr. BUDDEMEIER. If I may, that is the question that all scientists are asking, how El Nino, what role does it play and how will it be affected in global change models over time? If we had those answers and if the global change models in fact could tell us when El Ninos were going to occur, wow, everybody would have a lot of confidence in exactly where we are going.

Right now we are still trying to understand how it relates. That is why NOAA finally, for the first time this year, has come out and is making a forecast for El Nino. It is not easy. You probably heard of chaos theory. The advocates of chaos theory say there is a lot of that that plays into it.

Again, it is back to intimately knowing everything that is going on in our ocean realm and as we get better at that through in situ and through satellite data, I think we are going to find those keys and we may find out that PDO has a major activity or a major input into insular events, which also then tie into the conveyor belt that may connect all the oceans that I knew as a kid when I was in grad school that there must be some connectivity or rhythm, but it was hardly addressed.

Mr. GILCHREST. Do you know or might you know as a result of some of these new research techniques—I am sorry. Were you going to say something, Dr. Cohen? Go ahead.

Dr. COHEN. Yes, Mr. Chairman, I do have a comment to make regarding the changing in the pattern of El Nino. At least in the instrumental record we can see that prior to 1975, exactly, El Nino would occur at a rate of between three and 7 years and last maybe a year or two. After 1975, the frequency of recurrence increased dramatically and the longevity of each individual event, that means the warming continued, lasts much longer.

We have a few, and I emphasize very few, paleoclimate records which can tell us about what El Nino was doing prior to the start of instrumental recordings. But we do have a record from the Galapagos, actually a coral-based record that shows us the past 400 years of El Nino behavior and at least in the past 400 years there has been nothing like what we have seen post-1975.

It is difficult at the moment. I guess our mathematical models, or we don't know enough, as Dr. Strong was saying, to predict on a year-to-year basis what El Nino is going to do next. But if we look at the record over a long period of time, we can definitely see that there is a trend, both in El Nino's pattern and in the Atlantic's El Nino, which we call the North Atlantic Oscillation. We see a definite trend and it is all since 1975.

Mr. GILCHREST. Is there any way to get a handle, now or in the near future, on climate change and the effect of the ocean conveyor belt?

Dr. COHEN. Mr. Chairman, I sat in a symposium just a week ago where climate modelers were actually suggesting that even if we switch off the conveyor belt, the impacts to global warming or global cooling may not be as massive as we expect. What we should be worried is melting over the west end ice sheet.

As far as coral reefs are concerned, the increase in the frequency of El Nino and the North Atlantic Oscillation events. What we are doing is we are increasing the mean baseline temperature on top of which the El Nino exacerbates those temperatures.

Mr. GILCHREST. So, El Nino and the North Atlantic oscillation, are they, and I would guess that they would be, changing because the earth is warming and then is that somehow connected or does that have a potential trigger for the conveyor belt, the ocean conveyor belt?

Dr. COHEN. Mr. Chairman, there appears to be a feedback. What we can say is that there is a correlation between the change in the pattern of behavior of El Nino and the North Atlantic Oscillation and global warming and CO2 emissions. There is a direct correlation. The timing of the atmospheric circulation patterns and the timing of the increasing global temperatures and the increasing CO2 directly connected.

But we also know that the more El Ninos there are, the higher the average global temperatures. So, there is a feedback between those processors.

Mr. GILCHREST. Then there is increasing degradation of coral reefs as a result of El Nino?

Dr. COHEN. As a result of El Nino superimposed upon an increase in the mean baseline temperatures. El Nino has been going on for a long time. Corals have seen El Ninos for thousands of years. What happens every time an El Nino hits the Pacific, we see an increase in the surface ocean temperature. The corals have lived through that.

What we have done is we have raised the baseline climate temperature. So, rather than having a mean average temperature of 20 degrees, for example, on top of which an El Nino would add a one degree temperature increase, we now have a mean temperature of 23 degrees. So, when an El Nino hits, we get a temperature of 24 degrees and that is why the corals die.

Mr. GILCHREST. That is extraordinary. I would like to, as we move through this process and see what we can do to increase appropriations, to see what we can do to further strengthen this Executive Order, to help establish money for new research techniques and ongoing research with the international community, and either establish or help go through a process to establish sanctuaries, corridors for marine protected areas, marine reserves and those kinds of things, and certainly try to understand the long term impacts of climate change and what we can do so that somebody in the future can benefit from us reversing that, working with our own Department of Energy.

You have given us some extraordinary testimony here this afternoon to chew on and continue to work on. I appreciate all that you have contributed here.

Is there any other comment that anyone would like to leave us with? Yes, sir.

Dr. BUDDEMEIER. If I may, I think that several points have come forward that respond potentially to some of your earlier questions that I have heard. You asked the agency representatives about budgetary issues.

Looking at what I have seen today, I would say that one of the things that Congress could do would be to assist NOAA in moving forward at a much faster pace of putting out these towers that Dr. Strong referred to. 2006 is a long time from now. I see no reason why, with adequate funding, we couldn't have those in place in an improved research park-sanctuary situation by 2004.

Similarly with respect to Interior and Fish and Wildlife, their capabilities of supporting the kind of monitoring and on-going activities at their widespread and very valuable facilities. Again, these

are not huge new initiatives. These are accelerations. These are augmentations.

I think that these are the kinds of things, especially combined with much more broad-reaching information, outreach and a strong encouragement for agency as well as international and organizational cooperation, could make a very rapid impact on the state of play in this issue.

Thank you.

Mr. GILCHREST. Yes, sir, Dr. Buddemeier, well noted. Dr. Cohen, Dr. Strong, Dr. Buddemeier and Dr. Ogden, thank you all very much for coming. The hearing is adjourned

[Whereupon, at 12:52 p.m. the Subcommittee was adjourned.]