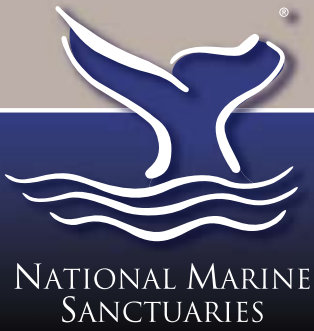


SPRING 2009



NATIONAL MARINE  
SANCTUARIES

# SANCTUARY WATCH



Sanctuary Voices:  
**Dr. Jane  
Lubchenco**  
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**CLIMATE CHANGE**  
& SANCTUARIES (SPECIAL ISSUE)



## ON THE COVER



### Special Issue:

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Cover: NASA's "Blue Marble" is the most detailed true-color image of the entire Earth to date.

Photo: Reto Stöckli & Robert Simmon/NASA

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## DIRECTOR'S LETTER

Climate change has emerged as a keystone issue in our society and into the foreseeable future. It may well be the overall compelling driver of change in our lifetime. A great need exists for more information to fully understand the types and rates of change and the potential implications, particularly for our ocean ecosystems.

The National Marine Sanctuary System has already begun to develop meaningful ways to inform and engage the public on this critical issue. Across our system of special marine places, and the communities associated with them, we are working to foster awareness, advocate solutions and promote action among government agencies, public organizations, private corporations and citizens.

Last year, all of our community-based sanctuary advisory councils were asked to establish a "greening" committee as a way to involve our communities in creating meaningful activities related to addressing climate change.

We also sponsored the First Biennial Ocean Climate Summit for the San Francisco Bay Area's coast and ocean environment. The event, which provided a forum for thoughtful discussion of climate change impacts and strategies, attracted over 100 participants representing government, non-profit organizations and foundations, academic institutions, and the private sector.

Additionally, we signed an agreement with the Department of Energy that allows us access to their programs that demonstrate how marine sanctuaries – which have been proposed as locations for long-term monitoring of climate – can showcase green technologies. Meanwhile, reviews of site-specific management plans are underway at several sanctuaries.

In this special "climate change" edition of Sanctuary Watch, you'll glimpse some of the initiatives, partnerships, individuals and leading-edge thinking that is crucial in how we as a nation come to grips with this issue.

While we in the sanctuary system recognize there are no quick fixes, we know we cannot proceed with business as usual and hope to influence the monumental challenge that climate change presents. Leveraging our communication, education and outreach capabilities, we can galvanize and inspire the public so that future generations will continue to enjoy the nation's marine treasures. Failure to do so is not an option.

Sincerely,

Daniel J. Basta, Director  
Office of National Marine Sanctuaries

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**SANCTUARY CELEBRATES OPENING OF NEW LEARNING CENTER ON MAUI**



Photo: HIFWIMS

Dr. Jane Lubchenco, newly appointed administrator of NOAA, joined officials and community leaders at the grand opening of the Sanctuary Learning Center for the Hawaiian Islands Humpback Whale National Marine Sanctuary on April 13. Senator Daniel K. Inouye, Senator Daniel K. Akaka and Kimokeo Kapahulehua were recognized at the event for their support of the sanctuary and the new facility, located in Kihei, Maui. The new \$6.5 million, 4,600 square-foot learning center is located next to the sanctuary office building adjacent to the historic Ko'ie'ie Hawaiian fishpond and sanctuary waters. The Sanctuary Learning Center provides facilities for offices and classroom space for school groups and public programs.



Photo: NOAA

**FIRST INTERNATIONAL CONFERENCE ON MARINE MAMMAL PROTECTED AREAS HELD IN HAWAII**

NOAA's Hawaiian Islands Humpback Whale National Marine Sanctuary recently hosted the First Conference on Marine Mammal Protected Areas, bringing together more than 200 managers, scientists and educators from 40 countries to share challenges and solutions. NOAA Assistant Administrator for the National Ocean Service Jack Dunnigan and Office of National Marine Sanctuaries Director Dan Basta were keynote speakers at the conference, which took place from March 29 - April 4, 2009. There are more than 500 existing or proposed marine protected areas (MPAs) for marine mammals in some 90 countries, yet this meeting was the first-ever gathering of marine mammal and MPA experts and practitioners. For more information, visit <http://www.ICMMPA.org>.



Photo: Claire Fackler

**PAPAHĀNAUMOKUĀKEA MONUMENT NOMINATED TO WORLD HERITAGE LIST**

In January, the United States announced the nomination of the Papahānaumokuākea Marine National Monument for consideration as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site for its extraordinary natural and cultural significance. The monument is the first U.S. site to be nominated to the UNESCO World Heritage List in over 15 years, as well as the first-ever marine area the nation has nominated. If

accepted, the monument, which spans nearly 140,000 square miles of waters surrounding the remote Northwestern Hawaiian Islands, would join 878 current World Heritage Sites in 144 countries. Monument staff worked closely with other agencies, including the U.S. Fish & Wildlife Service, state of Hawaii and Office of Hawaiian Affairs, to develop the nomination package. The World Heritage Committee will vote on the nomination in July 2010.

**CALIFORNIA ACADEMY OF SCIENCES DEBUTS MAJOR FARALLONES SANCTUARY EXHIBIT**



Photo: Cal. Academy of Sciences

At the California Academy of Sciences' grand re-opening late last year, the Academy unveiled a new three-story, 100,000-gallon "California Coast" tank highlighting the habitats of Gulf of the Farallones National Marine Sanctuary. Constructed in partnership with the Office of National Marine Sanctuaries, the exhibit showcases the marine animals and plants of the California Current ecosystem, focusing on the Farallones sanctuary's rich and diverse rocky intertidal zone. An estimated 1.2 million people are expected to visit the Academy every year and learn how the sanctuary system protects its valuable natural, cultural and historical resources.

**SANCTUARIES LAUNCH ONLINE MEDIA LIBRARY**



The National Marine Sanctuaries Media Library, an online vault featuring a comprehensive collection of high-resolution still images and video clips from across the National Marine Sanctuary System, was unveiled to the public in February. The Media Library provides sanctuary staff, partners and the general public with instant access to a searchable database of media files for a variety of purposes, ranging from education and outreach and PowerPoint presentations to media B-roll and commercial use. The Media Library contains thousands of images captured by NOAA scientists, educators, divers and archaeologists. Visit <http://sanctuaries.noaa.gov/photos>.



## DR. JANE LUBCHENCO

**Under Secretary of Commerce for Oceans and Atmosphere and NOAA Administrator**

I first discovered my love of the ocean as a college student in Woods Hole, Massachusetts, setting in motion a lifetime of work dedicated to the understanding and protection of the marine environment. More than 30 years of teaching marine biology and environmental science only increased my fascination with the wonders of the sea, and has made me keenly aware of the need for responsible stewardship of our underwater treasures.

Today, as the new administrator of the National Oceanic and Atmospheric Administration, I am both deeply concerned and galvanized by the challenges we face in being good stewards of the marine environment.

Our climate is changing. Sea levels are rising, the ocean is acidifying, seawater temperatures are warming, and some of our most precious marine resources are in danger. Indeed, climate change is one of the most significant issues of our time, with potentially severe consequences for our environment, our economy and our national security.

In the face of these daunting challenges, I am inspired by our opportunity to make meaningful changes for our nation and environment. As symbols of the ocean's beauty and wonder, NOAA's national marine sanctuaries and other marine protected areas play a crucial role in driving these changes. Sanctuaries help protect some of the nation's most treasured ecological, cultural and historical underwater resources, and provide us with places to focus the importance of ocean conservation efforts.

The ocean is vast, covering nearly three-quarters of the Earth's surface, but by breaking it down into smaller geographical and ecologically cohesive areas, it can be studied, managed and protected. National marine sanctuaries serve as "sentinel sites" where diverse research and monitoring efforts contribute to our knowledge of the ocean on a larger scale.

The sanctuaries provide ideal places to conduct the critical science necessary to understand and address the changes taking place in our oceans and atmosphere. For us to be able to make informed policy and management decisions, we urgently need to gain a more comprehensive understanding of how ocean ecosystems work, especially in light of climate change and ocean acidification.

I have found that Americans want five main things from the sea: clean beaches, safe and healthy seafood, stable fisheries, abundant wildlife, and vibrant coastal communities. If we are to ensure that our grandchildren will be able to enjoy those and other basic benefits, we need to take decisive action to protect the marine environment.

We have reached a pivotal moment in the struggle to protect the health of our underwater treasures for future generations. I am hopeful that through a combination of strong science, effective management and dedicated leadership, NOAA and the national marine sanctuaries will be able to help restore the ocean's health and productivity so that we can continue to benefit from its bounty for years to come.



Photo: Oregon State University

Jane Lubchenco, Ph.D., was recently confirmed as the new administrator of NOAA. Dr. Lubchenco, a marine ecologist and former professor at Oregon State University, is the first female NOAA administrator.



## CLIMATE CHANGE SCIENCE & RESEARCH

The full extent of global climate change's effects on marine ecosystems is difficult to predict, making further study and monitoring extremely important for all users of the ocean, and especially vital for marine protected area managers.

Since the ocean is so vast, understanding and protecting it can be a challenge. Marine protected areas like the national marine sanctuaries have a special role to play, providing us with distinct areas or places that can be studied and managed on a regional and local scale.

The fragile ecosystems and marine life within the sanctuaries face potentially severe impacts from global warming, but these unique underwater places also provide opportunities for scientists to study the way our ocean is changing with the climate.

Sanctuaries serve as “sentinels of the sea” — places of tremendous ecological value and diversity where scientists can observe and monitor changes to marine ecosystems over time. The Office of National Marine Sanctuaries is currently working to develop a Climate Change Impact Sentinel Site Network, which would provide a framework for NOAA scientists to use sanctuaries as a venue for conducting research with regional, national and global significance.

Throughout the National Marine Sanctuary System, sanctuary staff and numerous partner organizations are working to gain a better understanding of climate change's influence on marine life and habitats. 🐠

Flower Garden Banks sanctuary staff survey damage to coral reefs (above) caused by Hurricane Ike. Research like this helps reveal the impacts of climate change on ecosystem resilience.

Photo: Emma Hickerson/FGBNMS

### CLIMATE CHANGE RESEARCH IN THE SANCTUARIES

> **FLORIDA KEYS:** Numerous partner agencies and organizations study coral bleaching, disease and resilience in the sanctuary, providing valuable information about the impact of changing environmental conditions on coral reef ecosystems.

> **FLOWER GARDEN BANKS:** Surveys of sanctuary reefs following strong storms like Hurricane Ike in 2008 provide insight into how climate change affects ecosystem recovery.

> **GRAY'S REEF:** Sanctuary staff are collaborating with NOAA's Pacific Marine Environmental Laboratory and National Data Buoy Center to monitor ocean acidification using CO<sub>2</sub> sensors in the sanctuary.

> **GULF OF THE FARALLONES:** The Sanctuary Ecosystem Assessment Surveys (SEAS) Rocky Intertidal monitoring program analyzes changes in invertebrate and algae species distribution at the Farallon Islands for impacts from ocean acidification.

> **OLYMPIC COAST:** Staff are working with the Marine Conservation Biology Institute and Monterey Bay Aquarium Research Institute to collect live samples of deepwater corals in order to conduct tests on the effects of seawater CO<sub>2</sub> levels on coral growth or calcification.

> **PAPAHĀNAUMOKUĀKEA:** Studies conducted on the low-lying islands of the monument have analyzed the potential impacts of sea level rise on Hawaiian monk seal and green sea turtle habitat.



A researcher studies coral bleaching in St. Croix, U.S. Virgin Islands.

Photo: NOAA

Changing Climate,

# CHANGING SANCTUARIES

**A**s the body of research on the impacts of global climate change continues to expand, marine resource managers — including those in the National Marine Sanctuary System — have found themselves faced with a growing list of causes for concern.

Climate change's effects on the marine environment, including warming seawater temperatures, ocean acidification, sea level rise, and changes in currents, upwelling and weather patterns, have the potential to cause fundamental changes in the nature and character of marine and coastal ecosystems.

One of the immediate concerns of climate change from a marine resource manager's standpoint is its potential for intensifying the effects of "traditional" threats to marine resources. The added stress from global warming can worsen already severe impacts on marine ecosystems from factors like pollution, overfishing, habitat destruction, invasive species and disease.

Marine protected areas like NOAA's national marine sanctuaries are home to some of the richest and most diverse collections of marine life and habitats on the planet, providing a natural venue for researchers to study the impacts of climate change. Sanctuaries are also important places for communicating the marine effects of climate change to the public.

## Ocean Acidification

It has become clear that the ocean plays a critical role in regulating the amount of carbon dioxide (CO<sub>2</sub>) in Earth's atmosphere, absorbing nearly a third of the CO<sub>2</sub> produced by humans since the Industrial Revolution. In 2007, the International Panel on Climate Change (IPCC) reported that atmospheric CO<sub>2</sub> has increased by 31 percent since 1750, primarily due to human activities like burning fossil fuels and deforestation.

As the ocean is absorbing increasing amounts of CO<sub>2</sub> from the atmosphere, a related reduction in seawater pH is taking place. The IPCC 2007 report stated that this process, known as ocean acidification, can hurt the ability of corals, plankton, shellfish and other invertebrates to build the calcium carbonate shells or skeletons they need to survive. Across the sanctuary system, ecologically and economically important species like corals, coralline algae, sea urchins, starfish, lobsters, crabs, oysters, mussels, clams and scallops are directly threatened by ocean acidification.

Declines in certain types of plankton due to decreased ocean pH could have a cascading effect in marine ecosystems throughout all levels of the food web — including affecting higher-level species like fish, seabirds, and large marine mammals such as whales. The resulting losses in biodiversity could have disastrous consequences for coastal economies and communities. It has been proposed that national marine sanctuaries can serve as "sentinel sites" for monitoring and communicating information on changes caused by ocean acidification.

## Warming Seawater Temperatures

In the past several decades, the global ocean temperature from the surface to a depth of 700 meters has been rising steadily — by about 0.1°C from 1961 to 2003, according to the IPCC 2007 report — and is expected to increase further in the coming centuries.

It might seem like a minor increase, but even small changes in water temperature can affect the growth, feeding behavior and

reproduction of marine organisms, many of which are sensitive to thermal increases of just a degree or two above normal. Confronted with continued ocean warming, these species may be forced to adapt or relocate to cooler waters, or even face possible extinction. Conversely, rising ocean temperature can also make it easier for invasive species that favor warmer waters to expand into new areas, displacing native marine life and disrupting ecosystem structure.

Ocean warming has also been linked with outbreaks of marine disease. According to a 2002 study by University of California researchers, populations of black abalone in the warmer southern waters of Channel Islands National Marine Sanctuary were decimated by a bacterial disease known as “withering syndrome” between 1986 and 2001, while cooler waters appear to have suppressed the disease in abalone populations farther north along the California coast.

Corals have long been viewed as “canaries in the coal mine,” alerting us to changes in our oceans. For example, in places like Florida Keys National Marine Sanctuary and the Papahānaumokuākea Marine National Monument, studies by sanctuary staff and partners have seen rising seawater temperatures coincide with increased coral bleaching. Bleaching causes corals to lose their symbiotic algae, drastically slowing their growth, and can make them more susceptible to disease.

Historically, corals stricken by bleaching during natural, temporary periods of warming have been able to recover once temperatures return to normal, but the combined pressures of global warming and other factors like pollution and habitat degradation can stress coral populations to the point that they experience reproductive failure or die-offs.

Storms are common throughout the sanctuary system. Storm intensity and frequency

is likely to increase in some places with climate change, according to the IPCC, and although ecosystems are naturally resilient to damage from these events, the recovery process can be slow. Key ecological components like corals and kelp forests are particularly vulnerable to frequent, severe storms, which can overwhelm their ability to regenerate. As recently as September 2008, Hurricane Ike caused severe damage to portions of Flower Garden Banks National Marine Sanctuary’s coral reefs, which were still in the process of recovering from Hurricane Rita in 2005.

### Sea Level Rise

Global sea level has risen at an average rate of 0.18 centimeters per year from 1961 to 2003, with this rate increasing between the years 1993 to 2003 to about 0.31 centimeters per year, according to the IPCC 2007 report.

For the national marine sanctuaries, sea level rise has several potential consequences. In coastal sanctuaries, marine life in the intertidal zone is likely to experience shifts in abundance and distribution, and possibly widespread habitat loss as the shoreline moves inland. Animals like sea turtles could suffer serious population declines if rising sea level causes the sandy beaches where they nest to shrink or even disappear.

The tiny atolls and islets of the Northwestern Hawaiian Islands, encompassed by the Papahānaumokuākea Marine National Monument, are particularly at risk from sea level rise. A 2006 study published in the journal “Endangered Species Research” predicted that these small volcanic islands may shrink by as much as 65 percent with a 48-centimeter rise in sea level, threatening the survival of the endangered Hawaiian monk seal, which requires sandy beach areas to rest and recuperate, and numerous other species found nowhere else on Earth.

### Changes in Currents and Upwelling

Scientists have found that ocean temperature has a major influence on currents and upwelling activity, which are fundamentally important to marine ecosystems around the world. Upwelling — circulation of cool water from the deep ocean to warmer areas near the surface — is especially crucial in places such as Cordell Bank National Marine Sanctuary off the Northern California coast and Stellwagen Bank National Marine Sanctuary off Massachusetts, where thriving communities of marine life depend on the nutrients it pulls up from the depths.

It is difficult to predict how warming sea surface temperatures will alter upwelling and currents, but any changes in ocean circulation are likely to have serious consequences for marine life. Without the influx of nutrients from deep water, sites like Cordell Bank and Stellwagen Bank could see devastating collapses in marine communities, with declines in tiny organisms like plankton and krill at the bottom of the food web leading to starvation for fish, seabirds, whales and other high-level consumers.


### Looking to the Future

The Office of National Marine Sanctuaries is looking ahead as climate change poses an increasingly grave threat to the health of the world’s oceans. Through sound science, public outreach and partnerships, sanctuary staff are working to develop management strategies that will help us to adapt to the changing marine environment, and perhaps more importantly, will help all Americans better understand the consequences of climate change. ♻️

**A Hawaiian monk seal rests on a sandbar in the Northwestern Hawaiian Islands. Sea level rise threatens to remove the sandy beach habitat that these endangered mammals need to survive.**

Photo: Paulo Maurin





Gulf of the Farallones National Marine Sanctuary, which lies just beyond San Francisco's Golden Gate, has started an initiative to address climate change impacts throughout the Bay Area.

## CLIMATE CHANGE

Photo: © Ivan Malkarov

# Rising to the Challenge

## *Managing Climate Impacts in the Sanctuaries*

Global climate change has been identified as one of the most formidable threats to our ocean and to life on our planet. Scientists report that the level of carbon dioxide in the atmosphere is higher than it has been for hundreds of thousands of years, and the planet's temperatures are rising faster than any other time in recorded history.

The potential effects of climate change, including ocean acidification, increasing global sea surface temperatures, and sea level rise, carry dramatic implications for marine and coastal ecosystems.

In response, the National Marine Sanctuary System is working to understand these global changes and their effects at a local level, and developing tailored strategies to manage impacts to sanctuary marine life and habitats.

Daniel J. Basta, director of NOAA's Office of National Marine Sanctuaries, said the location and special value of the sanctuaries make them ideal sites for detecting short- and long-term impacts

from natural and human events, including climate change. Moreover, the scientific expertise and ongoing research and monitoring efforts at the sites provide a credible platform to raise awareness and engage local communities in climate change response.

"Climate change is here," Basta said. "It's real. It's impacting sanctuary resources. We are stepping up and taking action."

Gulf of the Farallones National Marine Sanctuary in California is the pilot site for the Climate Action Initiative, which addresses climate change impacts within the San Francisco Bay Area's coast and ocean environment. The initiative's goal is to provide solutions on a local, state, and federal level through partnerships, research collaborations, outreach and education, and policy reform.

"Climate change is the greatest threat to the ocean and coasts and will drastically change the environment as we know it," said Maria Brown, Gulf of the Farallones sanctuary superintendent. "Now,



“Climate change is here, it’s real. It’s impacting sanctuary resources. We are stepping up and taking action.”

more than ever, there is an urgent need to develop management strategies that help people as well as wildlife and habitats adapt to climate change.”

Gulf of the Farallones sanctuary staff have convened a group of 25 scientists to develop a report on the observed and predicted effects of climate change. Brown said this will be the first document of its kind that focuses on a specific region and will serve as a national model for natural resource managers, local and state government, and communities in determining how to respond to the effects of climate change on the marine environment.

In addition to developing the site scenario report, the Gulf of the Farallones Sanctuary Advisory Council has established a “Green Operations” working group to recommend strategies to reduce the sanctuary’s carbon footprint. The working group’s recommendations will focus on setting targets to reduce energy use, waste, and transportation emissions.

The first draft of the climate action plan has been completed and will be submitted for peer review in June, with the final document scheduled to be released in December 2009.

Around the globe, ocean acidification and warming sea surface temperatures have been identified as major contributors to the decline of coral reefs.


Since 1983, Florida Keys National Marine Sanctuary has been a leader in drawing attention to the impacts of climate change on coral reefs. Observations from coral bleaching events in the Florida Keys have been used by NOAA to prepare models that now allow for early warning and prediction of coral bleaching events on a global scale.

“Actions to address the impacts of climate change have to occur at the local, regional and global scales,” said Billy Causey, southeast regional director for the sanctuary program. “Climate change is a global problem, but solutions can be applied at the local scale.”

Florida Keys scientists and managers have also worked with The Nature Conservancy and other partners to develop the Florida Reef Resilience Program, a multi-year effort to develop management approaches and tools to better cope with climate change and other stresses to south Florida’s coral reefs.

In the Pacific, staff from the Papahānaumokuākea Marine National Monument, working with NOAA’s Coral Reef Conservation Program, have partnered with the Hawaii Institute of Marine Biology to train coral reef managers, scientists and community members to address coral bleaching and climate change in their communities.

A new NOAA report on the monument’s health notes that marine life and habitats are in good overall condition but face emerging threats including debris, invasive species and climate change. The monument is home to almost 70 percent of U.S. tropical near-shore corals, endangered monk seals and sea turtles.

“Climate change is an emerging threat to our marine managed areas and the training is designed to support managers in protecting coral reefs in the Pacific,” said Aulani Wilhelm, NOAA’s superintendent for the Papahānaumokuākea monument. 

## ACTION STEPS

### THE OFFICE OF NATIONAL MARINE SANCTUARIES IS RESPONDING TO CLIMATE CHANGE:



#### 1. PAPA HĀNAUMOKUĀKEA Marine National Monument

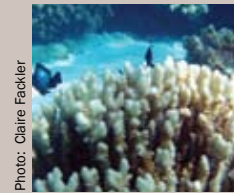


Photo: Claire Fackler

- > Hosted community workshops about coral bleaching.
- > Incorporating indigenous people’s methods of monitoring.

#### 2. GULF OF THE FARALLONES National Marine Sanctuary

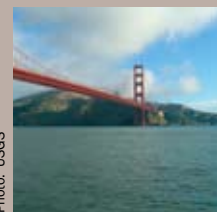


Photo: USGS

- > Assessing climate change impacts in San Francisco Bay Area.
- > Looking for ways to reduce sanctuary’s carbon footprint.

#### 3. FLORIDA KEYS National Marine Sanctuary

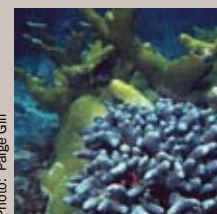


Photo: Paige Gill

- > Developed response protocols for coral bleaching events.
- > Worked with partners to establish Florida Reef Resilience Program.



## Valuing Cost

# SANCTUARY

Our nation's marine sanctuaries are treasured as sites for research, recreation, and their cultural and natural resources. Calculating the monetary value of these natural and societal resources is difficult, but for Wall Street to champion conservation efforts in the face of major threats such as climate change and economic uncertainty, a case must be made in dollars and cents.



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How can natural and social value be determined? How many dollars is your sense of wonder worth? How do you put a price on the promise of your children spending a life near a healthy and productive sea? The Office of National Marine Sanctuaries is working with researchers around the globe to determine just that.

In the Florida Keys, a comprehensive socioeconomic assessment was completed in 1995 and then repeated in 2005, giving us unprecedented insight into how the area has changed over 10 years. Recreation-tourism is the top money-maker in Monroe County, accounting for more

than 35,000 jobs and \$1.28 billion in spending by residents and visitors in 1995. With this in mind, the socioeconomic researchers worked to determine the value of the resources of Florida Keys National Marine Sanctuary by monitoring and assigning a dollar amount to the resources tourists use, such as coral reefs. Their research indicated that in 1995 alone, the value of visitor use of the natural resources in the Florida Keys was about \$910 million, while the total asset value (what someone would be willing to pay to own the natural resource) was much higher — about \$30.4 billion.

Several national marine sanctuaries contain areas set aside for non-fishing activity, which raises the question, “What will be the dollar value tomorrow of not fishing a resource today?” Economic models suggest that the value of protecting no-take areas, like the Tortugas Ecological Reserve in the Florida Keys National Marine Sanctuary, is far greater than the benefits of consuming their resources. In 2005, the 10-year Florida Keys socioeconomic study found that even commercial fishermen in the Keys supported the conclusion that no-take areas in the sanctuary have had an economic benefit for the region.

# the of Our Changing

# TOWARDS

Insights from user groups such as these will prove invaluable in future management and zoning of our national marine sanctuaries and other areas of our ever-changing ocean.

In light of the importance of considering the socioeconomic value of places like national marine sanctuaries, Dr. Robert Costanza, a renowned economist with the University of Vermont, advocates redefining our standard measure of economic success – the Gross Domestic Product. GDP measures the products of a country without consideration of cost in terms of natural or human capital, but Dr. Costanza and other economists support a “full world ecological economic system” where these values are not ignored.

One such model, discussed by respected economists such as Herman Daly, John Cobb and Phillip Lawn, has been dubbed the Genuine Progress Indicator, or GPI. GPI factors in the depletion of natural resources as a cost, as if we are borrowing from future generations, helping illustrate the true value of conserving and protecting those resources.

Climate change further complicates this challenge of assessing the worth of our natural resources, adding a great deal of uncertainty to economists’ efforts to predict their changing value over time. Warming seawater temperatures, ocean acidification, sea level rise and other factors are likely to impact economies and communities in ways we do not yet fully understand.

Consequently, by managing and protecting the nation’s special marine places, sanctuaries can also act as buffers to mitigate impacts of climate change on ecosystems and the economies and communities that depend on them. Sanctuaries both increase the economic value of these special places to the nation and help communicate their importance in solving the crucial economic issues of our time. 🐟



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Researchers are working to determine the socioeconomic worth of marine protected areas, which is an important but poorly understood measure of their value to the public. Climate change is a key factor in analyzing the future economic benefits of places like national marine sanctuaries.

Coral are special, not just because of their beauty and critical role in building reefs, but because of the way they symbolize the delicate balance of life in our ocean ecosystem.

Every coral colony is composed of many tiny animals called polyps, each with a life of its own but inextricably part of the whole. Within those polyps lives a type of symbiotic algae called zooxanthellae, which provides the coral with nutrients to live and grow in exchange for a safe home.

Even small environmental changes can stress corals and cause the polyps to lose their zooxanthellae. This process, called

“bleaching,” leaves the animal susceptible to disease and unable to grow quickly. Coral bleaching is usually temporary, and corals will often regain their zooxanthellae once conditions return to normal, but long periods of stress can cause polyps — and thus, the coral — to die.

Staghorn corals, which got their name from their resemblance of the antlers of a deer, are the most diverse genus of reef-building corals in the world today. Like all coral species, staghorns are highly sensitive to changes in temperature and salinity, and can be smothered by excessive sediment or broken apart in storms or by boat anchors.

*Acropora cervicornis*, a species of staghorn coral found in the Florida Keys National Marine Sanctuary, grows the fastest out of all known corals in the western Atlantic. Its branches can increase in length by up to 4-8 inches per year. However, disease outbreaks in recent years have caused massive losses of this species in the Florida Keys, and further damage has been caused by hurricanes, algae overgrowth, and human impacts. NOAA is working with partner universities and research institutes to expand our knowledge of corals in an effort to better understand and manage these delicate yet vital pieces of marine ecosystems worldwide.



Photo: © George Cathcart

**COMMON NAME:** ..... Staghorn coral  
**SCIENTIFIC NAME:** ..... *Acropora cervicornis*  
 (more than 120 living species of *Acropora* worldwide)  
**MAX. HEIGHT:** ..... 6.5 feet  
**DISTRIBUTION:** ..... Tropical ocean worldwide  
**DIET:** ..... Use symbiotic bacteria called zooxanthellae to generate food from sunlight  
**STATUS:** ..... Threatened



Staghorn coral can be found in all three major oceans; restricted to latitudes 31° N–31° S, where most coral reefs occur.

The Twin Otter supports NOAA research, monitoring and enforcement efforts along the West Coast.



Photo: NOAA

# Soaring *over the* SANCTUARIES

Sanctuary operations staff have their eyes on the skies, and their work to provide marine resource managers with new aerial support is leading to innovative and cost-effective solutions for research, enforcement and emergency response.

One of the most significant developments in the National Marine Sanctuary System's aircraft operations is the recent arrival of NOAA's twin-engine DeHavilland DHC-6 Twin Otter aircraft, now based in Monterey, Calif. The Twin Otter, which supports the sanctuaries and other NOAA offices along the West Coast, is a highly maneuverable plane that can be flown at low speeds and in tight circles — making it ideally suited for aerial monitoring and enforcement work.

Matt Pickett, aviation operations coordinator for the sanctuary system, said aircraft like the Twin Otter greatly enhance the capability of staff to gather crucial information about the marine environment, ranging from visitor use statistics to coastal mapping to marine life population data.

"It's so much quicker and more cost-effective than vessel surveys," Pickett said. "The Twin Otter allows us to visually monitor large areas of marine ecosystems and get a snapshot at any moment in time, while developing a critical long-term database vital for sanctuary management."



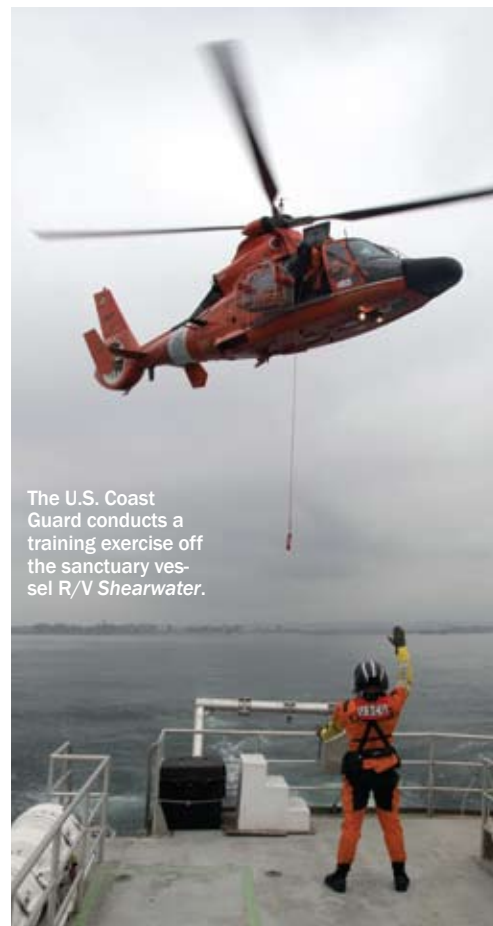
Photo: Sarah Marquis

Among its wide variety of missions, the aircraft has been used to support research with implications for climate change, including monitoring for sea level rise in coastal areas and tracking shifts in the distribution of marine mammals like humpback whales.

Pickett said other aerial operations have also helped guide sanctuary management in the past. During the creation of a network of marine reserves in Channel Islands National Marine Sanctuary off southern California, managers used data from aircraft surveys of visitor use and vessel traffic to minimize the reserves' economic impact on recreational and commercial fishing.

The sanctuaries are also partnering with the U.S. Coast Guard on several innovative projects, including the development of "patrol guides" for Coast Guard pilots conducting enforcement flights in or near national marine sanctuaries. Additionally, in an effort to provide Coast Guard personnel with diverse training experience, sanctuary staff aboard the R/V *Shearwater* hosted a recent evacuation training exercise at the Channel Islands sanctuary. 🦅

Twin Otter Technical Info	
<b>Wing Span</b> .....	65 feet
<b>Total Length</b> .....	52 feet
<b>Crew</b> .....	2 pilots + 6 scientists
<b>Airspeed</b> .....	80-160 knots
<b>Max. Range</b> .....	~650 miles
<b>Rate of Climb</b> .....	1,600 feet/minute
<b>Ceiling</b> .....	12,500 feet
<b>Equipment</b> .....	Weather and altimeter, dual GPS/Loran-C navigation system, HF radio, camera and instrumentation ports



The U.S. Coast Guard conducts a training exercise off the sanctuary vessel R/V *Shearwater*.

Photo: Robert Schwemmer



**CORY WALTER** | BleachWatch Coordinator, Mote Marine Laboratory  
**Keeping Watch over Corals in the Keys**

When Cory Walter moved to the Florida Keys after graduating from college with a degree in marine biology, she took a job with a marine life collection company that supplies marine organisms for public aquariums around the world. It was interesting work, she said, but something was missing.

“I was ready for more of the science aspect,” Cory said. “I wanted to give something back to the ocean, instead of taking from it.”

In 2004, she did just that, going to work for Mote Marine’s Tropical Research Laboratory in Summerland Key, Fla. There, Cory helped start the Florida Keys BleachWatch program in 2005, which involves the local community in monitoring and predicting coral bleaching in the reefs of Florida Keys National Marine Sanctuary.

“I love working with the community,” Cory said. “It’s exciting, and there are so many people who are interested in getting involved and making a difference.”

Coral bleaching is what happens when corals get stressed and lose the tiny algae that live inside their tissue, called zooxanthellae. Zooxanthellae provide corals with food and give them their color, and losing them leaves coral colonies pale white in color and susceptible to disease. Bleaching has been closely linked to rising seawater temperatures, and while some annual bleaching is normal, long periods of warming can cause extensive bleaching throughout the sanctuary.

“If we have a mass coral bleaching event, we can lose corals, we

can lose entire reefs,” Cory said. “It can seriously impact the whole ecosystem.”

As the BleachWatch program coordinator, Cory organizes over 100 volunteers from the local community, school groups, nonprofit organizations and area businesses, and teaches them how to record their observations of coral reef health on the water. She enters the data they collect into the BleachWatch database, which helps provide scientists and resource managers with an “early warning system” for major coral bleaching events.

“The goal of early warning is to notify resource managers and scientists as soon as possible when we are going to see a lot of bleaching, so they can take action.” Cory said.

The link between warming ocean temperatures and coral bleaching also makes it an important focus for climate change research efforts.

“Mass coral bleaching is a good indicator of climate change, because it’s something you can see,” Cory said. “It’s something you can point to and say, ‘Look, this is happening.’”

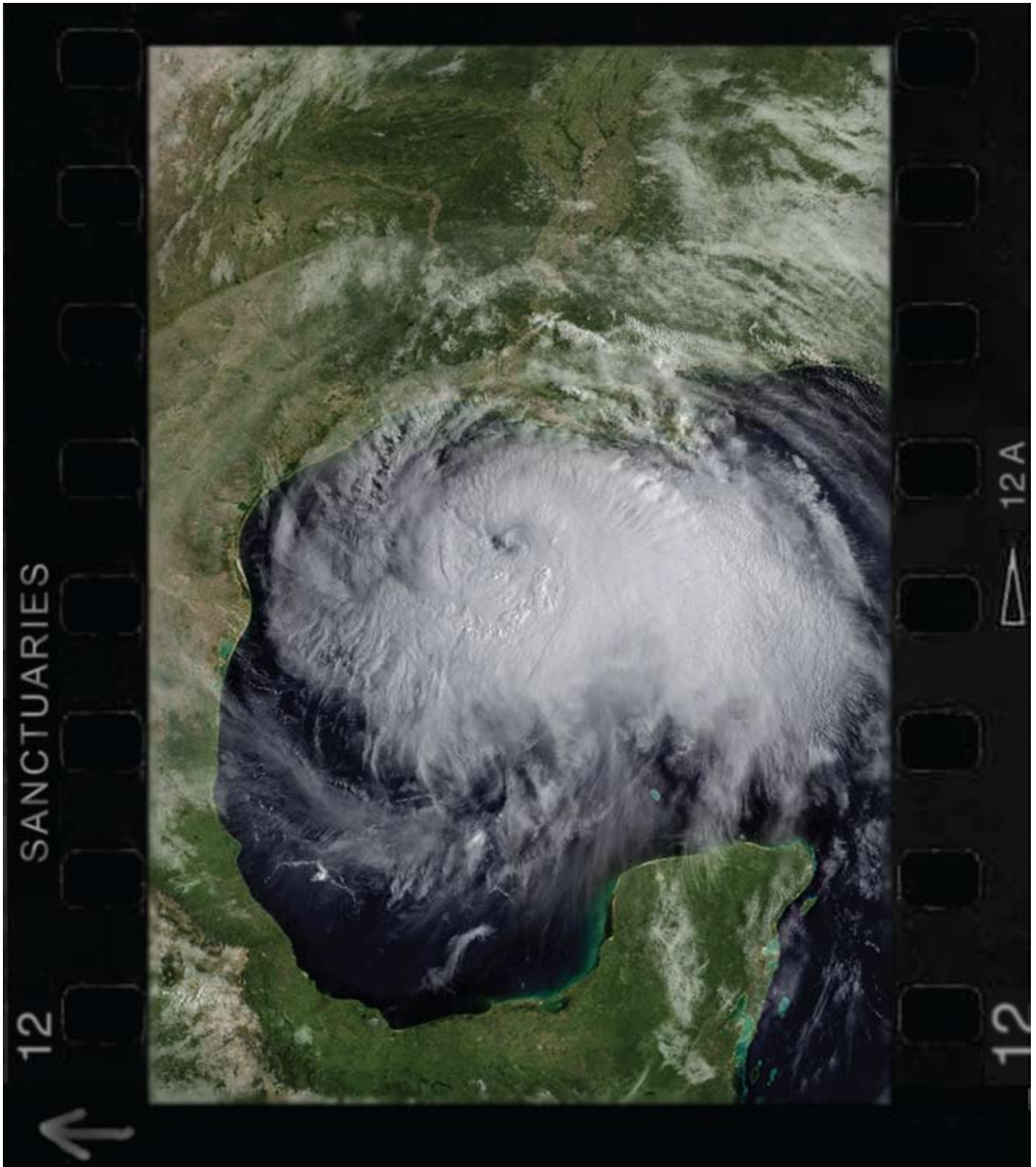
Cory said she tries to involve a wide range of participants in the program, from Boy Scout troops to dive shops. In addition to research and monitoring, she said, a major priority for the program is educating the community about the sanctuary and its rich marine ecosystems.

“It’s rewarding to see our efforts helping encourage community members to take an interest in the local environment,” she said. “They provide us with eyes out on the water, and at the same time they are learning more about the reefs.”

**BY THE NUMBERS:** Management Plans

In the past year, the Office of National Marine Sanctuaries has released new management plans for Monterey Bay, Cordell Bank, Gulf of the Farallones and Channel Islands national marine sanctuaries, and the Papahānaumokuākea Marine National Monument. The management plans are the product of years of intensive study and public input, providing a detailed vision for the stewardship of each of the sites.

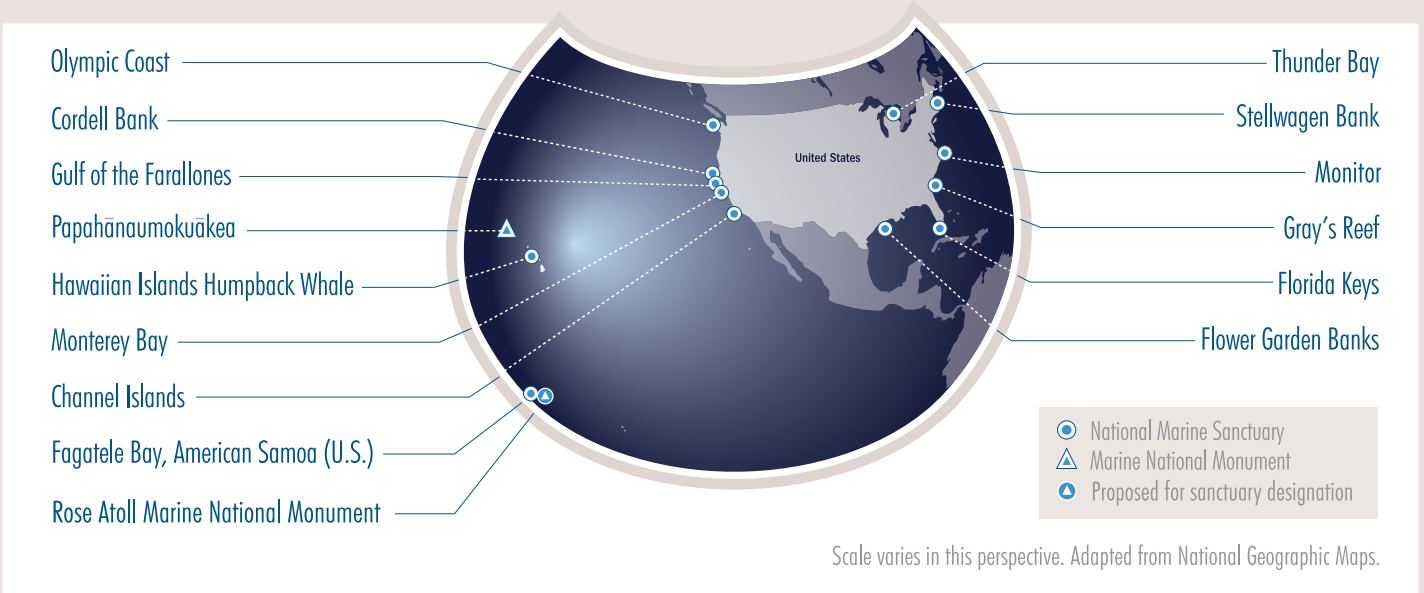
<p><b>5</b></p>	<p><b>775</b></p>	<p><b>24,297</b></p>	<p><b>149,169</b></p>
<p><b>NEW MANAGEMENT PLANS</b> released for the National Marine Sanctuary System in 2008</p>	<p><b>SQUARE MILES</b> of ocean added to Monterey Bay National Marine Sanctuary, protecting the pristine underwater Davidson Seamount</p>	<p><b>COMMENTS RECEIVED</b> during the public input phase of management plan reviews in 2008</p>	<p><b>TOTAL SQUARE MILES</b> of ocean and coastal waters covered by the new management plans — an area larger than the state of Montana</p>



**SANCTUARY SNAPSHOT** This image of Hurricane Ike passing over Flower Garden Banks National Marine Sanctuary in September 2008 was captured by a NOAA GOES-12 satellite and enhanced by the NOAA Environmental Visualization Laboratory. With the 2009 hurricane season starting June 1, NOAA is the leader in predicting and tracking storms across the country. The International Panel on Climate Change has reported that hurricanes are likely to become stronger and more frequent as global warming increases.

# SANCTUARY SYSTEM

The Office of National Marine Sanctuaries serves as the trustee for a system of 14 marine protected areas, encompassing more than 150,000 square miles of ocean and Great Lakes waters. The system includes 13 national marine sanctuaries and the Papahānaumokuākea Marine National Monument. The sanctuary system is part of the National Oceanic and Atmospheric Administration (NOAA), which manages sanctuaries by working cooperatively with the public to protect sanctuaries while maintaining compatible recreational and commercial activities. Sanctuary staff work to enhance public awareness of our nation's marine resources and maritime heritage through scientific research, monitoring, exploration, educational programs and outreach.



The Office of National Marine Sanctuaries is part of NOAA's National Ocean Service.

**VISION** - People value marine sanctuaries as treasured places protected for future generations.

**MISSION** - To serve as the trustee for the nation's system of marine protected areas to conserve, protect and enhance their biodiversity, ecological integrity and cultural legacy.



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