



Climate Change Response Program Newsletter

Q3 | 2016



SCIENCE • ADAPTATION • MITIGATION • COMMUNICATION

SPECIAL EDITION: Ocean Acidification in National Parks

Human activities are accelerating the rate of global climate change. The atmospheric concentration of carbon dioxide (CO₂), worldwide, has doubled since pre-historic times due mainly to the combustion of fossil fuels. In the marine environment, a dominant manifestation of climate change is ocean acidification (OA), the reduction of seawater pH and an increased saturation of calcium carbonate. As atmospheric and seawater CO₂ concentrations come into equilibrium, CO₂ dissolves into seawater producing carbonic acid. Low pH levels and increased calcium carbonate solubility inhibit the formation and maintenance of shells and exoskeletons in a large number of marine organisms, such as barnacles and mussels. Additionally, the efficiency of basic metabolic processes conducted by all marine organisms may be compromised by a decrease in the pH of their environment.

Additional factors such as coastal upwelling, freshwater inputs, and nutrient enrichment create geographic and temporal variation in the strength of OA. Upwelling brings deep, naturally low pH seawater to the surface near the coast, exacerbating OA impacts on marine life. Similarly, freshwater inputs have lower pH relative to seawater, so areas that receive high runoff also have a higher OA vulnerability. Nutrient enrichment associated with human development increases CO₂ production in seawater via respiration, further lowering local seawater pH.

The intertidal zone — the area intermittently inundated and exposed by high and low tides — is particularly sensitive to climate change impacts. The organisms that inhabit this zone experience two low tides and two high tides each day. During this fluctuation in seawater height, marine invertebrates, seaweeds, and fish are forced to react to periods of extreme heat, desiccation, and low pH water. This familiarity with the extreme makes this suite of organisms well adapted to change; however, the rate at which the current climate is changing may outstrip their ability to adapt.

OA is already impacting marine organisms in the California Current Large Marine Ecosystem (CCLME). The harmful effects of OA on planktonic pteropods, a prime food source for Pacific salmonids and oyster aquaculture in the Pacific Northwest are well documented. The National Park Service is well positioned to characterize the geographic and temporal variation in OA intensity impacting the rich marine communities it protects.

Marine parks in the NPS inventory and monitoring networks that span the CCLME represent a gradient of oceanographic and human development regimes. Cabrillo National Monument is situated on the open mainland coast at the mouth of San Diego harbor, while Channel Islands National Park is a set of five islands located offshore of the greater Los Angeles metropolitan area. The remote coastline of Olympic National

In This Issue

Working Between the Tides.....	2
Restricted Circulation.....	3
Channel Islands Datasets.....	4
Measuring Impacts.....	5
Impacts and Action.....	6
Ocean Acidification Cruise.....	7
How Are We Responding?.....	8
Training Announcements.....	10
Amber Childress.....	10

Park is the longest stretch of congressionally designated Wilderness shoreline in the lower 48 states. San Juan Island National Historical Park is located in the San Juan archipelago in the inland Salish Sea, adjacent to the metropolitan areas of Seattle, WA and Vancouver, British Columbia. A pilot intertidal OA monitoring program established over recent years in 4 parks within the Mediterranean and North Coast and Cascades networks follows a consistent NPS protocol. Monitoring and use of protocols will help shape the management decisions of coastal parks across the service in light of ocean acidification and climate change.

Steven Fradkin
steven_fradkin@nps.gov

Ocean Acidification Updates

Working Between the Tides: Characterizing Ocean Acidification on the Open Coast of the Pacific Northwest

Located on the outer coast of Washington State's Olympic Peninsula, the coastline and offshore islands of Olympic National Park (OLYM) comprise over 95 miles of intertidal habitat. This rugged, wave-swept coastline is the longest stretch of congressionally designated wilderness shoreline in the lower 48 states, and hosts the highest biodiversity of marine invertebrates and seaweeds on the west coast of North America. OLYM has been designated by UNESCO as an International Biosphere Reserve and as a World Heritage Site.

The Pacific Northwest coast has a higher vulnerability to OA relative to the coastal waters of most of North America due to upwelling. Upwelling occurs when the wind blows parallel to a coastline, pushing surface waters offshore and resulting in deep water replacing the water pushed away. This process exacerbates the effects of OA by continually bringing lower pH, CO₂-rich water to the surface where it interacts with organisms. Over the past decade, seawater pH off the Olympic coast declined an order of magnitude faster than predicted by accepted conservative climate change models. Based on recommendations from a blue ribbon panel, these observations spurred the Governor of Washington to establish the Washington Ocean Acidification Center, a clearinghouse of OA research and information for the Pacific Northwest.

OLYM began a pilot program to monitor intertidal OA in 2010 and has continuously monitored two outer coast sites since then. These OA monitoring sites were initially instrumented with YSI multi-probe datasondes that measured pH, dissolved oxygen, temperature and salinity year-round every half hour. These sites are collocated with rocky intertidal monitoring sites established in 2007, which will facilitate interpretation of trends in community structure and species abundance.

In 2015, with support from the NPS Ocean and Coastal Resource Branch of the Water Resources Division and the Washington Ocean Acidification Center, the OLYM pH sensors were upgraded to SeaFET™ sensors. These sensors measure pH far more accurately than the glass-electrode sensors found in multi-probe datasondes. The new instrument packages, including Hobo dissolved oxygen and conductivity/salinity sensors, will operate concurrently with the YSI sensors until 2017 to ensure comparability of data between sensor types. In addition, monthly surface intertidal seawater bottle samples are collected for laboratory analysis.

In 2015, OLYM advanced the scope of its monitoring by establishing the Center for Ocean Acidification Monitoring (CFOAM) which serves as a central laboratory to conduct spectrophotometric pH and total alkalinity analyses of seawater samples for NPS OA monitoring sites. These analyses are used to calibrate the SeaFET pH sensors and to fully characterize the nearshore intertidal carbonate system. Such characterization provides a holistic description of OA dynamics.

Also during this time, OLYM hosted a research fellow through the George Melendez Wright initiative for Young Leaders in Climate Change. This internship was critical to advancing CFOAM operations and facilitated the transition between YSI and SeaFET field operations, an update that served to increase data accuracy and resolution.

Steven Fradkin
steven_fradkin@nps.gov



The wave-swept rocky intertidal zone of the outer Olympic coast at Sokol Point. NPS Photo



The OA monitoring instrument package installed in a tidepool at Sokol Point, OLYM. This package includes newer SeaFET™ instrumentation (inside cage), and the Collocated older multiprobe datasonde that will be phased out in 2017. NPS Photo

Ocean Acidification Updates

Restricted Circulation and Freshwater Inputs Make San Juan Island National Historical Park a Hotspot for Ocean Acidification Research

San Juan Island National Historical Park (SAJH), originally established in 1966 to commemorate events connected with the final settlement of the Oregon Territory's boundary, is located in the San Juan Islands archipelago in the heart of the Salish Sea in the Pacific Northwest. The Salish Sea is a biologically rich, oceanographically complex, inland sea that straddles the border of the United States and Canada.

The waters of the Salish Sea have an elevated OA vulnerability due to restricted circulation with the open ocean, and increased freshwater runoff and nutrient enrichment associated with intense human development along the shore. The Salish Sea is strongly influenced by the adjacent population centers of Tacoma, Seattle, and Bellingham (Washington), and Victoria and Vancouver (British Columbia, Canada). Substantial freshwater inputs flow into the Salish Sea from a multitude of rivers and municipalities in the rain-drenched Pacific Northwest. The Fraser River (B.C.) is a particularly significant freshwater input. Acidity increases in the Salish Sea have been precipitous, and the waters are frequently reported to be under-saturated with respect to calcium carbonate. These impacts to the Salish Sea over the last two decades have led to natural spawning failures at numerous oyster aquaculture operations.

The protected intertidal zone of the park is undeveloped and holds diverse, rich biological communities that are archetypes of the Salish Sea. The park shoreline is also considered critical habitat by the National Oceanic and Atmospheric Administration for the pinto abalone (*Haliotis kamtschatkana*), which is listed as a "species of concern". Increased OA observed in the Salish Sea is likely to currently impact the marine resources of SAJH now as well as into the future.

The NPS began monitoring OA in the intertidal zone of the American Camp unit of SAJH in June, 2015 following an established NPS OA monitoring protocol developed by Olympic National Park. An instrument package was installed in a large tidepool that consists of a SeaFET pH sensor, a Hobo dissolved oxygen sensor, and a Hobo conductivity/salinity sensor. These sensors take readings every half-hour. In addition, periodic seawater grab samples are collected and analyzed for spectrophotometric pH and total alkalinity at the CFOAM laboratory at OLYM. The discrete water samples are used dually for calibration of the SeaFET pH sensor and to further characterize the nearshore intertidal carbonate system.

The SAJH OA monitoring site is collocated with a rocky intertidal monitoring site established in 2008. The collocation of OA and rocky intertidal biological monitoring will facilitate interpretation of trends in community structure and species abundance.

Steven Fradkin
steven_fradkin@nps.gov



Overview of the SAJH intertidal zone with the OA monitoring package. NPS Photo



The OA monitoring instrument package installed in a tidepool in the American Camp unit of SAJH. NPS Photo

Ocean Acidification Updates

Channel Islands National Park: One of the Largest Datasets on Natural Coastal pH Variability

Marine ecosystems comprise approximately half of Channel Islands National Park (CHIS), and the park's enabling legislation identifies these nationally-significant resources as a key aspect for which the park was established. The extensive kelp forest, rocky intertidal, and soft-bottom communities at CHIS lie across the boundary of two major biogeographical provinces and near persistent upwelling features. These areas of high productivity support exceptionally diverse species assemblages, including large seabird and pinniped rookeries.

Funded in part through a George Melendez Wright Young Leaders in Climate Change fellowship, scientists from the University of California Santa Barbara have been collaborating with the NPS to study the patterns and dynamics of seawater pH at CHIS. Ocean pH sensors have been deployed along the Channel Islands in kelp forest, eelgrass meadow, and open water environments since 2012.

This summer, marine biologists from two NPS networks (North Coast and Cascades and Mediterranean Coast) will convene on Santa Cruz Island to deploy an additional OA sensor following an established NPS protocol. Unlike previous monitoring efforts at CHIS, this sensor will directly focus on the rocky intertidal zone and the resulting data will complement the nearshore sensors to create a more comprehensive mosaic of OA monitoring at CHIS. Particular emphasis will be placed on collocating the OA sensor with fixed plots used to assess and detect changes in the abundance of focal rocky intertidal species as part of the NPS Inventory & Monitoring Vital Signs Monitoring Plan. A significant ecosystem vital sign, the rocky intertidal community has been monitored at CHIS since 1982. Results from this OA characterization project will be highly useful for interpreting long-term trends in the biological monitoring data. Evaluation of trends in organism abundance, diversity, and community composition can support understanding of patterns in OA dynamics, both within parks, networks and across networks.

This project already generated one of the largest datasets on natural coastal ocean pH variability, providing scientists and coastal managers with a detailed description of how regional oceanographic and local biological processes drive pH dynamics. For example, both kelp forest (Anacapa Island) and eelgrass beds (Santa Cruz Island) induce daily pH fluctuations as they remove carbon dioxide (CO₂) from the water during the day and produce CO₂ again at night. Likewise, photosynthesis by phytoplankton blooms raises seawater pH levels for days to weeks at a time. Currently, the project supports time-series pH data collection at Anacapa Island and Santa Cruz Island to track annual changes in pH variability, while providing a basis for laboratory experiments to study the resilience or susceptibility of organisms to future ocean acidification given their environmental history. Understanding how unique oceanographic features and ecosystems drive different pH conditions along a coastline is an integral part of studying the resilience of marine species to global ocean change and assessing management strategies at a local scale.

The scientific publication associated with the UCSB-NPS collaboration is available open-access at

<http://onlinelibrary.wiley.com/doi/10.1002/lno.10264/full>

Stephen Whitaker
stephen_whitaker@nps.gov

Lydia Kapsenberg
lydia.kapsenberg@obs-vlfr.fr

Umihiko Hoshijima
umihiko.hoshijima@lifesci.ucsb.edu

Gretchen Hoffman
gretchen.hoffman@lifesci.ecsb.edu



SeaFET ocean pH sensor deployed on the pier at Anacapa Island. NPS photo by David Kushner



Scientist Lydia Kapsenberg deploying the first pH sensor in the Channel Islands National Park. NPS photo by David Kushner

Ocean Acidification Updates

Measuring impacts: Monitoring the Influence of Climate Change at Cabrillo National Monument

Cabrillo National Monument (CABR) is one of the best-protected intertidal areas in Southern California and acts as a nursery for the multitude of marine invertebrates and fishes that call the area home. A significant portion of the CABR coastline has been restricted from public access for research and preservation purposes since 1996 and due to its preservation, holds the largest diversity of invertebrates on the southern coast, including the rare green abalone (*Haliotis fulgens*). Additionally, the CABR coast is considered potential mainland critical habitat by the National Oceanic and Atmospheric Association for the recently federally listed endangered black abalone (*Haliotis cracherodii*).

CABR is concerned about the effects that climate change will have on its marine seascape, a place visited by a quarter of a million visitors each year, and a crown jewel of the greater San Diego area. Many marine organisms will be threatened by the warming and acidification of seawater globally as more carbon dioxide makes its way into the atmosphere and by extension, the surface ocean. In order to effectively manage its rocky intertidal habitat and prepare for anticipated ecosystem changes, CABR is working to better understand potential impacts by directly measuring water quality parameters that will be affected most in the years to come.

CABR began continuously monitoring the temperature, pH, dissolved oxygen, and salinity of the intertidal zone in May, 2016 following the operating procedure developed on the outer coast of Olympic National Park. This protocol allows park scientists to better understand the natural dynamics of intertidal chemistry and detect any deviations

outside of the current natural range. The oceanographic sensors used for monitoring are collocated with rocky intertidal monitoring sites established in 1990. This side by side comparison of water quality and biological data promotes a greater understanding of climate change and its downstream effects in the intertidal zone. This approach is preserved regionally through local agency and academic partnerships and across NPS networks in the Pacific West Region.

CABR is one of several park units along the west coast of North America that adopted this methodology to measure climate change in the intertidal zone. Park scientists previously shared biological data up and down the coast allowing them to detect regional and coast-wide changes in organism distribution and abundance. The addition of these oceanographic sensors will build on the biological data by capturing the environmental conditions that affect organism survivorship at the network and regional levels. By working together with other parks and sharing strategies to understand anticipated and realized changes, CABR is responding to the call to action to support landscape level conservation of life between the tides.

Jonathan Jones
jonathan_jones@nps.gov

Keith Lombardo
keith_lombardo@nps.gov

Alexandria Warneke
alexandria_warneke@nps.gov



Cabrillo National Monument intertidal zone featuring the iconic lighthouse. This particular stretch of coastline is the section set aside for preservation and research purposes only. NPS photo by Jonathan Jones



Installation of sea level pressure transducer (left), conductivity sensor (middle), and dissolved oxygen sensor (right) during low tide. Together, these instruments provide additional climate change data that complement the ocean acidification monitoring program. NPS photo by Jonathan Jones

Ocean Acidification Updates

Impacts & Action: Interpreting the Influence of Climate Change at Cabrillo National Monument

Over the past century, the influx of carbon dioxide into the earth's atmosphere from human industrial activities has increased exponentially. From drastic changes in weather patterns to sea level rise, ocean warming and acidification, the threats associated with climate change no longer remain distant predictions. Natural resource teams across the Pacific West Region currently collaborate to establish a shared long-term monitoring program to investigate the influence of climate change in intertidal ecosystems. This ongoing research will address many unknowns for coastal parks and contribute to the greater NPS climate change conversation.

To assist in this monumental endeavor, Cabrillo National Monument looks to lead the science interpretation charge by developing relevant educational programs and traveling interpretive displays that explain the climate monitoring challenge. These will act to connect our community to this cutting edge climate science research and provide tangible opportunities to take action. Specifically, this effort will engage and inform park visitors of the monitoring program and how we, as resource stewards, collaborate to shed light on questions we cannot answer individually.

The first of these programs consists of a mobile interpretive display that explains the tactics, techniques, and take home messages driving the monitoring program through the instruments we are using to collect the data. Non-operational models of the tools will be mounted to exhibit displays and presented to the public so that they can interact with them directly. Each tool will accompany interpretive information that explains how the tool is used and how the recorded data helps to answer individual pieces of the climate change puzzle. A larger exhibit

backdrop, along with a series of short films, will tell the overall climate change story and shed light on how the NPS is using this monitoring program to carry out our ongoing mission.

Additionally, in our partnership with the Climate Science Alliance and their Climate Kids program, Cabrillo is part of a larger bi-national effort focused on supporting youth engagement on climate change through action based science activities, storytelling, and art in conjunction with our southern neighbors in Baja California, Mexico. Climate Kids projects seek to inspire youth of all socioeconomic levels to become environmental stewards in their communities. To further contribute to this mission, we are currently developing hands-on curriculums based on the 10 Climate Action Items for Kids, as well as ocean acidification investigations. These programs will connect students directly to climate change topics as they relate to park research and include art-based activities that exemplify student commitment to climate action.

At Cabrillo National Monument, we are dedicated to advancing the conversation around climate science through these and other programs. Answering the **Centennial Call-to-Action** we hope to foster the current and next generation of global stewards in new and innovative ways. For the choices we make today, how we educate our communities, and ultimately how we change our collective behavior moving forward, will determine the sustainability of our future on

Alexandria Warneke
alexandria_warneke@nps.gov



Recycled shoe used as a planter for a native coastal plant. One of the many outreach products from Cabrillo National Monument's Climate Kids program. NPS photo by Alexandria Warneke



Logo for the climate kids program at Cabrillo National Monument. Logo courtesy of Alexandria Warneke.

Ocean Acidification Updates

National Parks Partner with NOAA During West Coast Ocean Acidification Cruise

Early on May 5, 2016, the research vessel *Ronald S. Brown* left San Diego Naval Base and headed south. On board, the crew and scientists prepared to collect water samples from 13 different transects along the California Current, from Baja California to British Columbia. Over the next 30+ days, representatives from 17 institutions and 5 countries collaborated on the fifth West Coast Ocean Acidification (WCOA) cruise, led by the National Oceanic Atmospheric Administration.

The researchers on board collected data for numerous projects, from pteropod experiments to algal bloom detection. They dropped 24 11-liter bottles deep into the ocean at 151 different stations, collecting seawater samples to be used in multiple studies. Additionally, scientists used spectrophotometers, satellite data, and three types of zooplankton nets to gather and analyze data on the journey. There was some serious science happening on this cruise. And, for the first time, the National Park Service participated in WCOA, too.

Science at Sea

On the very first day of the cruise, scientists at Cabrillo National Monument, assisted by U.S. Navy partners, collected water samples at two nearshore stations. Jonathan Jones and Dr. Keith Lombardo took additional water samples in the intertidal zone on shore. The data from these samples will supplement what the ship collected offshore, completing the transect from coastal ocean to intertidal zone.

As the *Ronald S. Brown* continued its voyage along the West Coast, scientists on board also collected samples near several other national park units: Channel Islands NP, Point Reyes NS, Golden Gate NRA, Redwood NSP, San Francisco Maritime NHP, and Lewis and Clark NHP. The data from these stations will help park staff better understand ocean acidification in local marine waters and inform management decisions at these parks.

On June 1, the West Coast Ocean Acidification Cruise ship arrived off the coast of Olympic National Park in Washington. Researchers on board took samples throughout the water column, from the surface to depths of 2,500 m on two transects stretching offshore. Researchers from the Olympic Coast National Marine Sanctuary did the same at near-shore transect points, while Dr. Steve Fradkin, and staff at Olympic National Park filled bottles with intertidal samples. When analyzed at NOAA's Pacific Marine Environmental Laboratory, these coordinated samples will give scientists a snapshot of the status of ocean acidification in the northeast Pacific. Replicate samples were also collected by park staff for analysis at the NPS Center for Ocean Acidification Monitoring laboratory at Olympic National Park to conduct cross-laboratory quality assurance.

Benefits of Collaboration

The WCOA cruise highlights the importance of the ongoing intertidal OA monitoring done at Olympic, San Juan, Cabrillo, and Channel Islands. We need both off-shore sampling and continuous on-shore data collection to understand the big picture of OA. When paired with additional monitoring data (i.e. marine invertebrates), park managers can better understand how OA is affecting resources. This understanding can lead to management strategies based on the most up-to-date, best available science, helping protect coastal resources for the enjoyment of future generations.

Kristy Burnett

McGill University



Dr. Keith Lombardo and Jonathan Jones monitor the intertidal zone at Cabrillo National Monument. NPS photo



Dr. Steven Fradkin takes an intertidal water sample using a Niskin bottle at Sokol Point, Olympic National Park. NPS Photo

Ocean Acidification Updates

Ocean Acidification and Our National Parks: How are We Responding?

The National Park Service (NPS) manages 88 ocean and Great Lakes parks across 22 states and four territories. Collectively, these parks conserve more than 11,000 miles of coastline and 2.5 million acres of ocean and Great Lakes waters, including coral reefs, kelp forests, tidewater glaciers, estuaries, beaches, wetlands, historic forts, and shipwrecks. These parks also have more than 89 million recreation visits each year and generate more than \$5 billion in economic benefits to local communities.

Ocean acidification (OA) is a clear and present danger to marine resources in the NPS ocean and coastal parks. The ocean presently stores 93% of the carbon CO₂ emitted to the atmosphere from human activities. Since the beginning of the industrial revolution in the 18th century, ocean acidity has increased by 30%. This reduction in available carbonate ions, which are essential to shell-building organisms, has shown negative side effects to many of the organisms that make up the very basis of the food chain, which could lead to greater issues.

In a recent Water Resource Division client survey, parks ranked emerging and cross-cutting issues that will affect or are already affecting park water resources. In ocean parks OA was identified as the second highest priority issue, coming in just under energy development. In fact, there are some parks that have taken the initiative to conduct OA work underway. Here we summarize the OA work that is underway in many of our ocean and coastal parks.

Alaska Region: *Modeling*

Supported by the NPS Ocean and Coastal Resources Program, the Alaska Region partnered with Glacier Bay National Park and the University of Alaska Fairbanks to develop an ocean acidification

model for the region. This is a systems based approach to a conceptual model of ocean acidification focusing on trophic linkages between nearshore coastal communities and nearshore coastal dynamics, with consideration for the physio-chemical characteristics and biology found in Alaska coastal national parks. Some areas of the Arctic are already corrosive to shells of marine organisms, and most surface waters will be within decades. This will affect ecosystems and people who depend on them.

Glacier Bay National Park: *Experimentation, Oceanography, & Trophic Ecology*

While increased CO₂ emissions and uptake by ocean surface waters are typically thought to be the major cause of OA in marine systems, this is only part of the story in Glacier Bay. Over the past two centuries, Glacier Bay has experienced rapid retreat and melting of its numerous glaciers, leading to an increase in the amount of fresh water entering the marine ecosystem. This input of low-alkalinity fresh water has reduced the surface water's ability to resist decreases in pH, especially during seasons when glacial runoff is high (summer/fall). Glacier Bay partnered with the University of Alaska Fairbanks to conduct a project from 2011 – 2013 investigating freshwater input effects on ocean acidification in a glacial fjord system. Building on the knowledge gained from this project, a new 2016 – 2018 project will investigate the potential correlation between ocean acidification to effects on zooplankton health within the same glacial fjord system in Glacier Bay.

Continued on page 9



Scientists in Alaska deploying a sonde to determine the conductivity, temperature, and depth of the ocean. NPS Photo



Park ecologist Lewis Sharman conducts regular oceanographic surveys in Glacier Bay. NPS Photo

Ocean Acidification Updates

Ocean Acidification and Our National Parks: How are We Responding?

Dry Tortugas and Biscayne National Parks: *Coral Reefs & Calcification Rate Monitoring*

The U.S. Geological Survey is monitoring calcification rates in coral reefs in both Dry Tortugas and Biscayne National Parks. The goal of this work is to establish baseline calcification rates for corals and calcareous algae and determine how they respond to increased OA. Laboratory experiments predict that rates of reef-building organism calcification will decline markedly in the first half of the 21st century.

Acadia National Park: *Monitoring Ocean Acidification, Experiments, & Citizen Science*

Acadia National Park is working with the Schoodic Institute and other partners to investigate the impacts of climate change and OA on our intertidal ecosystems. Acadia deploys sensors in the water and engages professional scientists and citizen science volunteers to study changes in physical parameters (pH, temperature, dissolved oxygen), in the abundance, distribution, and phenology of intertidal species, and in species interactions. Since it will take time to get results, the park is using scenario planning to identify best actions as monitoring information becomes available.

Ocean and Coastal Branch: *How is NPS Responding?*

The National Park Service has recently become a member of the Interagency Working Group on Ocean Acidification. This working group was initiated with the Federal Ocean Acidification Research and Monitoring Act passed by Congress in 2009. Included in this legislation is the requirement for federal agencies to work together to create a plan for effective monitoring and understanding consequences of OA on marine organisms and ecosystems, and develop adaptation strategies to conserve ecosystems vulnerable to OA.

Currently, the NPS does not have a national OA monitoring network. It would be beneficial to incorporate ocean acidification into long-term marine monitoring programs to document the degree of ocean acidification in park units and to interpret changes in biotic community structure monitored as part of these programs. This network would provide a better understanding of the temporal and spatial scales of variability in ocean carbon chemistry and biology and the observational basis for developing predictive models for future changes in ocean acidification and its consequences for marine ecosystems. National Parks are ideal sites for an ocean acidification demonstration project because of their natural resources, scientific staff, and support infrastructure. We look forward to building an OA monitoring program for parks in the near future.

Tracy Ziegler
tracy_ziegler@nps.gov



USGS diver working on the calcification blocks at Biscayne NP. A temperature logger is seen on the block in the foreground. Photo Credit: Ilsa Kuffner, USGS



Scientists measure the reefs surrounding Dry Tortugas National Park in Florida. NPS Photo

Training and Education Updates



Climate Change Response Program

Natural Resource Stewardship and Science

This quarterly newsletter celebrates the latest initiatives and accomplishments by National Park Service sites and programs in response to climate change.

Contacts

Cat Hawkins-Hoffman, Acting Climate Change Response Chief

Ryan Stubblebine, Editor and Interpretive Specialist

Email Address

climate_change@nps.gov

Website

www.nps.gov/climatechange

Intranet

www1.nrintra.nps.gov/climatechange

Mailing Address

1201 Oakridge Drive, Ste 200
Fort Collins, CO 80525

Social Media

[NPSClimateChange](#)



Training Announcement: Association of Climate Change Officers Climate Fundamentals Academy

The Association of Climate Change Officers (ACCO) is offering a series of 2-day training academies in Golden, Colorado to enable attendees to satisfy all course requirements for the **CCP® Designation**. These academies will provide curriculum on topics including understanding climate science and variability, identifying climate hazards and conducting vulnerability assessments, basics of greenhouse gas accounting, explanations of the food-water-energy nexus, and fundamental governance and stakeholder engagement strategies. The CCRP has funded a certain number of pre-paid registrations, provided on a first-come, first-served basis.

Held in partnership with the National Renewable Energy Laboratory, workshop participants will learn from experts about the implications of climate change with a regional focus added for Colorado and the Rockies region of the United States. Professionals from the public and private sectors, higher education and the NGO community will benefit from the classroom-style, interactive training activities.

[Register Here.](#)

Matt Holly
matt_holly@nps.gov

Climate Change Response Program Welcomes Amber Childress

Amber Childress-Runyon is the new Geoscientists-in-the-Park climate change adaptation assistant for the CCRP team. She is joining us from Colorado State University, where she is a PhD candidate in the Graduate Degree Program in Ecology. Amber specializes in methodologies to study interactions between human and environmental systems and her research focuses on understanding climate change impacts and adaptation through a social-ecological systems context. At CSU, Amber worked for the North Central Climate Science Center (USGS) on a number of climate change vulnerability-related projects. In 2012, she assisted in the creation of the **Great Plains Technical Report** for the National Climate Assessment, and in 2015 she authored the agriculture chapter for the **Colorado Climate Vulnerability Assessment**. Prior to graduate school, Amber worked on climate change mitigation policy for the Heinz Center for Science, Economics, and the Environment, in international project finance for Vinson & Elkins, LLP, and in the U.S. House of Representatives.

Amber's interest in climate adaptation began at a young age when she observed the impacts, growing up on a West Texas cotton farm. She loves spending as much time as she can outside, which created a love for nature and conservation, creating a desire to pursue a career in federal land management. Although it's difficult to choose, her favorite national park is Great Sand Dunes, because it's one of the few places on earth where you can be in three places at once: the mountains, desert, and plains. She will be working with the CCRP team to develop a database to capture climate change adaptations across all NPS parks. She will also assist with analysis and visualization of products from park vulnerability assessments. Contact Amber at 970-267-2166 or Amber_Childress@partner.nps.gov.

Ryan Stubblebine
ryan_stubblebine@nps.gov



Monthly Webinar Series

Join CCRP for presentations by leading climate change scientists and communicators on the second Tuesday of every month from 2:00 to 3:30 PM EST.

November 10 | Servicewide Sustainability: Revised Green Parks Plan and 2015 Performance
[Register for the webinar here](#)

