National Park Service
U.S. Department of the Interior

Climate Change Response Program

Climate Change Response Program Newsletter

Q2 | 2016

SCIENCE • ADAPTATION • MITIGATION • COMMUNICATION

Every Kid in a Park: Climate Change Boot Camps

The National Park Service (NPS) Climate Change Response Program partnered with non-profit No Barriers Youth to present the first of two inaugural *Every Kid in a Park: Climate Change Boot Camps* at Cape Cod National Seashore from May 17–20, 2016. In keeping with the goal of the Every Kid in a Park initiative, this novel program encouraged students to find and explore their parks, and discover how these special places are being influenced by climate change.

The boot camp brought 24 high school students from Minuteman High School in Lexington, MA to Cape Cod for 3 days and 2 nights. During their stay, students became familiar with the climate change issues and impacts currently affecting the national seashore, and how the seashore is responding. Guest speakers included scientists from the NPS, Sea Grant, and the Massachusetts Institute of Technology.

The students observed many of these effects first hand by joining subject matter experts in the field for sessions that explored: plants as biological indicators in salt marshes, peat and carbon storage in local salt marshes, coastal vulnerability and resilience, coastal erosion, greenhouse gases, the water cycle, and albedo.

On the final day of the boot camp, 75 fourth grade students from nearby Teaticket Elementary School joined the high school students for a day-long exploration of the seashore. The fourth grade students cycled through field stations exploring the relationship between the park and climate change, during which the high school students assumed the role of subject matter expert. Thus, the students became the teachers as they imparted the skills and knowledge they had previously acquired.

A second boot camp was held at Indiana Dunes National Lakeshore from May 21–23, 2016. The park hosted 19 students from Phoenix Military Academy in South Chicago at the Dunes Learning Center in Gary, Indiana. Similar to the model used at Cape Cod, the high school students spent two days exploring the implications of climate change on the lakeshore and—on the final day—the park hosted 73 fourth grade students from John Ivan Meister Elementary to learn about climate change from the newly-minted climate change "student scientists."

The model of cooperative student learning piloted in these inaugural bootcamps proved surprisingly powerful. Indiana Dunes is currently looking to incoporate a similar model into several of their existing education programs. Photos from the Cape Cod and Indiana Dunes boot camps can be viewed on the Climate Change Response Program Flickr page.

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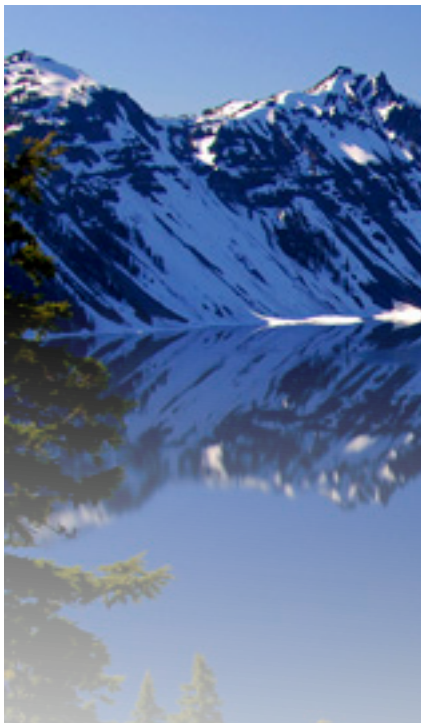

Warming Temperatures Could Alter the Ecology of Crater Lake

Crater Lake is one of the clearest lakes in the world and is renowned for its remarkable deep blue color. Park scientists initiated long-term monitoring of the lake in 1982. Increases in surface water temperature resulting from rising air temperature prompted the park to partner with scientists from the U.S. Geological Survey and the University of Trento in Italy to investigate what could happen to the ecology of the lake in a warming climate. Research results indicate that atmospheric warming caused by climate change could significantly disrupt deep lake mixing which is critical to the distribution of nutrients and oxygen throughout the lake. Under the most severe climate change scenario, deep lake mixing could stop completely, resulting in "dead zones" on the lake bottom due to the lack of oxygen. You can learn more about the results of this research at: https://www.usgs.gov/news/warming-climate-could-alter-ecology-deepest-lake-united-states.

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Above: Crater Lake NPS Photo

Scaling Climate Adaptation in the Northern Great Plains

Managers, scientists, and adaptation specialists for parks and neighboring lands are examining potential future conditions and management options in the northern Great Plains. Funded in part by the Department of the Interior North Central Climate Science Center, the project includes investigators from the NPS, United States Geological Survey (USGS), National Oceanic and Atmospheric Administration, Wildlife Conservation Society, and the Schoodic Institute at Acadia National Park. Focal management issues include erosion and cultural resource protection, and grassland and grazing dynamics.

This project has three goals: synthesize climate data into 3-5 distinct but plausible climate scenarios for the northern Great Plains region, craft summaries of these climate futures that are relevant to local land management units, and apply these local summaries to further develop quantitative resource-management scenarios through participatory workshops and simulation models.

The partnership effort engages multiple stakeholders in two focal areas within the region: southwestern South Dakota in the vicinity of Badlands National Park, and central North Dakota in the vicinity of Knife River Indian Villages National Historic Site.

Two-day participatory scenario planning workshops were held for each focal site (November 2015 and January 2016). Workshop reports will be available in fall of 2016. Quantitative simulation modeling of grassland and grazing dynamics in southwestern South Dakota is ongoing. This project is also informing riverbank erosion monitoring, archeological management planning, and cottonwood riparian forest restoration efforts. Regional climate scenarios, to aid other managers in the northern Great Plains, will be available in 2017.

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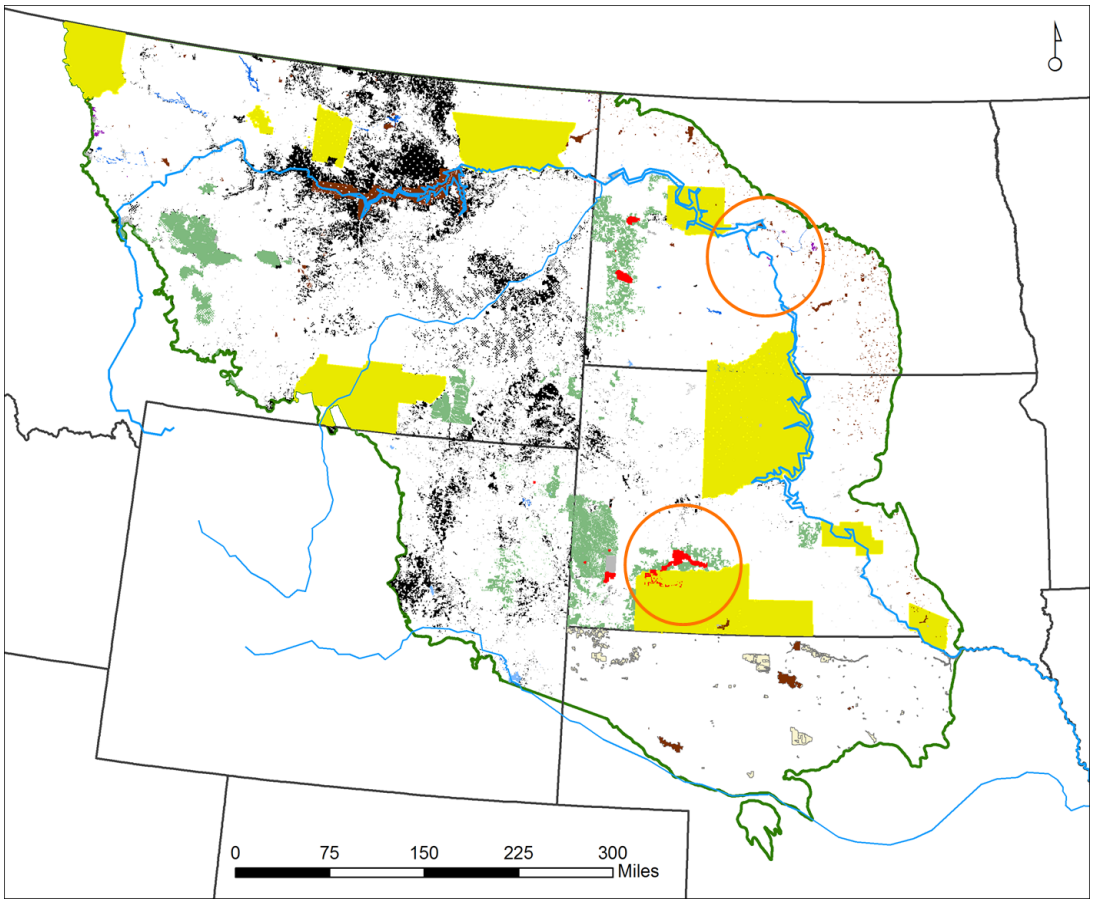

The northern Great Plains ecoregion (green line) and central North Dakota and southwest South Dakota focal areas (red circles).

Past Forest Response to Climate Change Driven by Soils and Local Climate

Climate change impacts to North American forests are already evident in the form of larger and more frequent droughts and wildfires. These stressors act alongside—and sometimes amplify—impacts from nonnative pests and disease, pollution, and habitat fragmentation.

Stewarding natural resources in an ever-changing climate will require a long-term, strategic view that adapts management goals and approaches to the effects of both shifting climate baselines and increased variability. Better understanding of how local factors at the management-unit level influence climate change impacts can inform stewardship decisions.

Paleoecological studies based on pollen and charcoal records from lake-sediment cores can be used to reconstruct past responses to climate variability, and suggest where and how to focus monitoring, management, and research. In this recently published article (**Tweiten et al. 2015**), we characterized soils, modern climate, and differences in past fire regime around 12 lakes in northwestern Wisconsin to determine whether observed landscape patterns in geophysical factors or local climate correspond to differences in past variability in forest composition

Local factors—specifically soils and local climate—strongly influenced forest response to past climate change, and these influences were clearly evident despite the fact that study sites all occur within a small area (660 mi^2) on a relatively homogeneous glacial outwash landscape. Sites with finer-textured soils and higher water-holding capacity experienced greater long-term (century-to-century) forest community change, whereas forests on sites with poorer soils (coarser texture and lower capacity to hold water and nutrients) changed much less overall and were more consistently dominated by a single forest type (see Figures 1 & 2).

Soils and local climate also strongly influenced forest response to the warm/dry-to-cool/moist climatic transition 750 years ago from the Medieval Climate Anomaly to the Little Ice Age.

A landscape-wide increase in white pine during the Little Ice Age was most pronounced on sites with soils of greater water-holding capacity and on sites further from Lake Superior with a warmer, drier local climate, suggesting that a moisture-related establishment threshold for white pine may have been crossed at these sites during the Little Ice Age.

Similarly, local geophysical factors influenced fire frequency and intensity. Fires became generally more frequent and less intense during the Little Ice Age. Fire frequency increased most on sites with lower water-holding capacity, where they were associated with rapid pollen assemblage shifts over a few decades and high rates of short-term (decadal to century) forest composition change within the same overall jack pine-dominated forest type. A related study (Lynch et al. 2014 Canadian J. Forest Research 44:1331-1343) found less change in vegetation at sites with less protection from fire spread by surrounding lakes and wetlands (fire breaks), when compared with paired sites with similar soil textures but greater protection from fire.

This study of historical change shows that soil attributes and local climate shape forest response to climate changes and disturbance at very local scales, even within a sandy glacial outwash plain with limited soil variation. The prominence of these relationships on a relatively homogenous geological landscape suggests that this understanding may be relevant to resource management on a broad range of landscapes.

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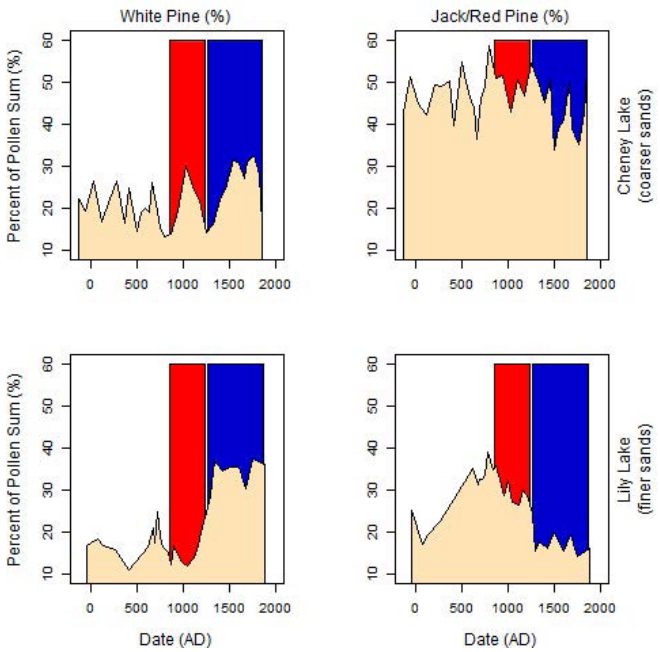

Figure 1. Change in the abundance of white pine (left) and jack/red pine (right), expressed as a percentage of the pollen sum, in two contexts – a sandy, well drained site and a site with finer-textured soil and higher soil moisture. The red polygon in each graph indicates the relatively warm Medieval Climate Anomaly (~850-1250 AD) and the blue polygon indicates the subsequent relatively cool Little Ice Age (~1250-1875 AD).

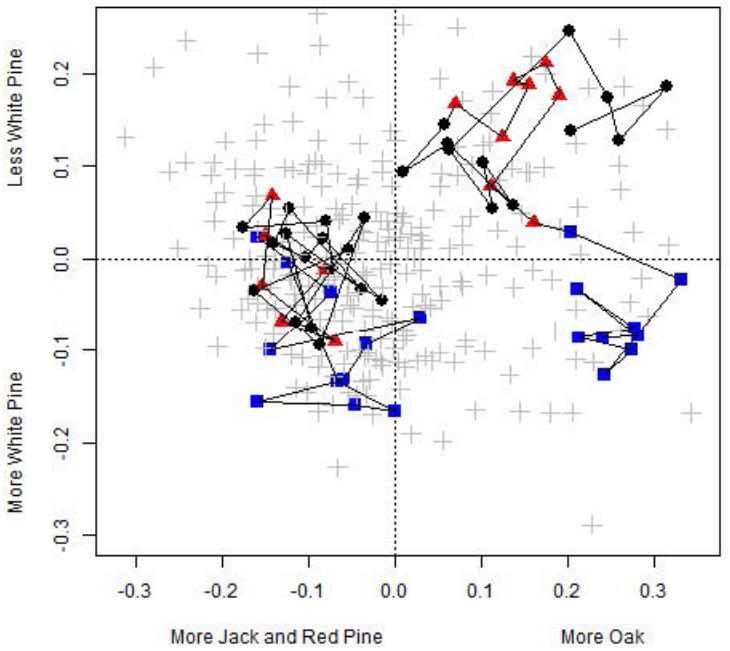

Figure 2. Forest compositional variability in two contexts (see Figure 1 caption) over the past two millennia, expressed in terms of placement of each sample in each record as a dot within a non-metric multidimensional scaling of all samples from all 12 records. Cheney Lake is on the lower left of the diagram and Lily Lake is on the upper right. Samples plotted closer to each other in the diagram are more similar in pollen assemblage than samples plotted further away from each other.

New Climate Change Wayside at Jean Lafitte

Staff from JELA in front of the new wayside. NPS Photo

A new wayside about climate change and sea level rise was recently installed at Jean Lafitte National Historical Park and Preserve. Park staff Julie Whitbeck, Aleutia Scott, and Kristy Wallisch helped design and install the wayside in collaboration with University of Colorado researcher Dr. Maria Caffrey.

This is the third wayside to be installed as part of a University of Colorado project looking at the impact of sea level change and storm surge on 118 coastal units. Keep your eyes peeled for other waysides that have been installed at Gulf Islands National Seashore and a fourth wayside that will be installed this summer at Fire Island National Seashore.

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Valuing Terrestrial Carbon Sequestration in National Parks

NPS lands play an important role in mitigating climate change impacts by protecting healthy ecosystems that function as a carbon sink. This net carbon uptake benefits society by helping to reduce costly economic damages associated with long-term atmospheric concentrations of CO_2 (e.g., impacts on agricultural productivity, human health, and damages from flooding).

The NPS partnered with the USGS to better understand the societal value of climate regulation from terrestrial carbon sequestration across the National Park System. Annual net carbon balance data were combined with spatially explicit NPS land unit boundaries and social cost of carbon estimates to determine the quantity and economic value of CO_2 sequestered by park units.

Results from the first phase of this work reveal that, in aggregate, NPS lands in the lower 48 states sequester more than 14.8 million metric tons of CO_2 annually, valued at approximately $582.5 million with a 3% discount rate.*

It is anticipated that these estimates will be updated as additional data become available. The current report can be found at: **http://www.nature.nps.gov/socialscience/docs/CarbonSequestration.pdf**

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*Individuals place a higher value on avoided damages that occur closer to the present than impacts that occur futher into the future. Therefore, the economic cost of cumulative damages that occur in future years must be discounted to obtain its present value.

Junior Conservationist Program

Though parks in the Southeast Region (SER) illustrate their dedication to sustainability in a variety of ways, a cohesive regional vision for interpreting sustainability has been a long-time need. To fill this gap, regional staff from the Facility Support and Interpretation divisions collaborated with park interpreters to create the SER Sustainability Interpretive Action Plan, which the regional director introduced in March 2013. Since then, parks have been working hard to find new and interesting ways of engaging visitors.

One of the novels ways in which this vision is being met has been through the creation of the Junior Conservationist Program. The booklet was developed by a local educator participating in the Teacher-Ranger-Teacher program at Cowpens National Battlefield, who worked closely with the park to advance mutual goals for sustainability education.

The Junior Conservationist Program helps kids take ownership of their environmental footprints and realize that there are practical ways to take sustainable action. One activity in the booklet asks participants to walk around their own homes and look for ways to save energy and be more environmentally friendly. Junior high school students and other young visitors can become Junior Conservationists by completing the booklet.

The Junior Conservationist Program is not only valuable to the kids completing the booklet, but also to park staff. One activity requires participants to interview a park staff member. As Don Wollenhaupt, SER Chief of Interpretation, explains, this direct communication with park staff, "instills in the park employee a mind-set of sustainability. They understand they need to be more knowledgeable about what it means to be green. It makes park staff more aware, and they become models for sustainability."

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The "Take a Step" patch, earned for the completion of the Junior Conservationist Program.

Short-Term Forecasting of Vegetation Condition: Potential Management Uses of Satellite and Climate Data

Soil and vegetation are the foundation for wildlife habitat, food webs, and nutrient, energy and water cycles. Many factors influence these functions, including the composition and diversity of native plants, relative dominance of invasive exotic species, disturbances (such as fire or certain land uses), and plant productivity. These interacting factors present NPS managers with challenges that may become more urgent with climate change. As managers plan for the hotter, drier conditions that the future will likely bring, long-range vegetation goals (which vary by park and by context) will be achieved via short-term management actions that respond to current conditions. Access to information that could help managers see even a short distance into the future could make short-term decisions easier and more effective.

Many park managers have access to data on weather and long-term vegetation change. What they don't always have is information on how climate affects vegetation from month to month and year to year. Traditional monitoring—which typically involves visiting vegetation plots just once each year—can help answer questions about long-term change and spatial patterns in composition and diversity. But traditional monitoring is generally too infrequent for understanding dynamic, within-year response to wet and dry periods.

A recently completed study demonstrates how monthly satellite measurements of large landscapes, together with climate data and creative modeling, can help fill in some of these information gaps. An interagency group of scientists, led by a hydrologist with the Northern Colorado Plateau Network, has developed a way to forecast vegetation response to recent weather events at landscape scales on the Colorado Plateau.

The study connects three elements: annual, plot-level data collected on the ground; high-frequency, broad-scale measurements from NASA satellites; and weather data. The result is a quantitative model that is able to forecast short-term vegetation condition—that is, it has been shown to reliably predict what vegetation condition will be a few months into the future.

The model is based on the understanding that vegetation response lags weather. Plants don't drink water when it falls from the sky; they drink it from the soil (which stores water between precipitation events.) So plant response to precipitation might come a day, a week, or a month after the precipitation falls. The result is that vegetation shows a stronger response to soil moisture than to precipitation, and that soil moisture conditions beginning in February are useful for predicting vegetation abundance in October.

At Capitol Reef National Park, where the model was tested using two large grassland sites (1 grazed, 1 ungrazed), the authors of the study also found that the ability of vegetation to grow in one year is partly related to what happened during the previous year. If a dry year precedes a wet year, for example, then the reduced biomass levels caused by the dry year limit the potential for vegetation to respond to good conditions in the following wet year.

Along with other information, park managers can use this model to help plan projects that depend on good growing conditions. At Capitol Reef, this model might help managers to set grazing levels that are protective of park resources. It could also be used to predict the months and years in which restoration activities might be most likely to succeed. The model may also help park managers by predicting the short-term consequences of worsening conditions. Ultimately, this study adds a broad-scale perspective, at high temporal frequency, to the suite of available information and may expand the ability of managers to apply science to management questions in a timely, cost-effective manner.

For more information, visit **http://onlinelibrary.wiley.com/doi/10.1111/avsc.12232/abstract**

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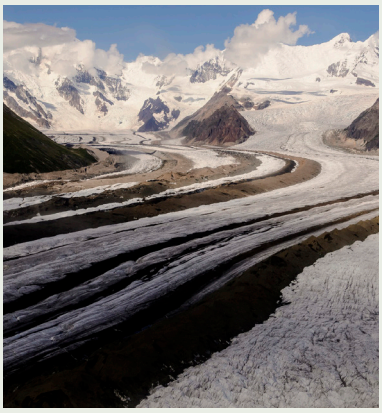
Fruita Historic District from Cohab trail in Capitol Reef National Park. NPS Photo.



Kennicott and Gates Glaciers in WrangellSt. Elias National Park and Preserve. NPS Photo/Bryan Petrtyl

Shrinking Glaciers — YouTube Stars

A man who keeps company with glaciers comes to feel tolerably insignificant by and by. [The glaciers] are able to take every bit of conceit out of a man and reduce his self-importance to zero if he will only remain within the influence of their sublime presence long enough to give it a fair and reasonable chance to do its work. – Mark Twain

Glaciers are enormous and dynamic features of Alaska's parks and something many visitors hope to see. Recently, Mike Loso, Wrangell St. Elias National Park and Preserve/Central Alaska Network Inventory and Monitoring Program, collaborated with partners at University of Alaska Fairbanks to complete a comprehensive inventory (*http://science.nature.nps.gov/IM/units/swan/index.cfm*) of the glaciers in our parks to understand how they are changing. Many glaciers are shrinking — retreating from their terminus — while some appear surprisingly stable and a few are actually advancing.

Given that roughly one quarter of Alaska's glacial area occurs within national parks, you might want to keep company with Alaska's glaciers on the Alaskan NPS YouTube Channel (*http://bit.ly/AKParkGlaciers*). There you can see for yourself how glaciers in Alaska's parks are changing and hear from those who recognize and are affected by these changes.

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Warmer Than Normal in Alaska's Northern Parks: Above and Below

Based on data from 21 climate monitoring stations across Alaska's five northern parks—the Arctic Network (ARCN) — air and soil mean annual temperatures increased significantly from 2011 to 2015. The warmest year on record for Alaska was 2014, with the warmest temperatures and greatest departures from normal in the northwest region of the state. The average annual air temperature was 1.3°C warmer than normal for land north of 60° between October 2014 and September 2015; the warmest period in recorded history .

The seasonal snowfall totals for the region were below normal on the western coast, just above normal in the interior, and well above normal on the northern coast. The Pacific Decadal Oscillation, an index of sea surface temperatures in the North Pacific, has been positive since the beginning of 2014, which translates to warmer temperatures over Alaska. In addition, a strong El Niño event also developed in the fall of 2015 while the Pacific Ocean temperatures off the coast of Alaska continue to be well above normal. If these warm temperatures were to persist, they would fulfill the predicted increase in the mean annual temperature for 2046-2065, based on global circulation models (**IPCC 2013**). The next few years will be crucial to determining if the present warm spell is just a temporary cyclical phenomenon or a significant warming trend.

The regional climate is cold enough over most of ARCN to keep permafrost frozen in spite of the recent warming. Both the regional climate and the local soil conditions control permafrost stability. Soil-site conditions result in local permafrost temperatures that range from about 0° C to 5° C above mean annual air temperatures (MAAT). However, if current warm conditions persist, permafrost will start to degrade in the portions of ARCN with the warmest MAATs combined with the warmest local soil conditions.

According to a **recent study**, co-authored by Jon O'Donnell (ARCN ecologist), "the fate of carbon stored in permafrost upon thaw [is that it] will contribute to climate warming". Permafrost stores about half of all soil organic carbon on Earth. When permafrost warms and thaws, this carbon can be released from soils to the atmosphere as carbon dioxide or methane – potent greenhouse gases. Permafrost scientists are currently working to determine the timing and magnitude of this carbon release, as it could impact the global climate.

In this study, the team found that most of the permafrost carbon was in dissolved forms that are easy for soil bacteria to break down and convert to greenhouse gases upon thaw. This finding suggests that permafrost thaw may result in the rapid release of carbon to the atmosphere, due in part to the chemistry of carbon in ancient ice.

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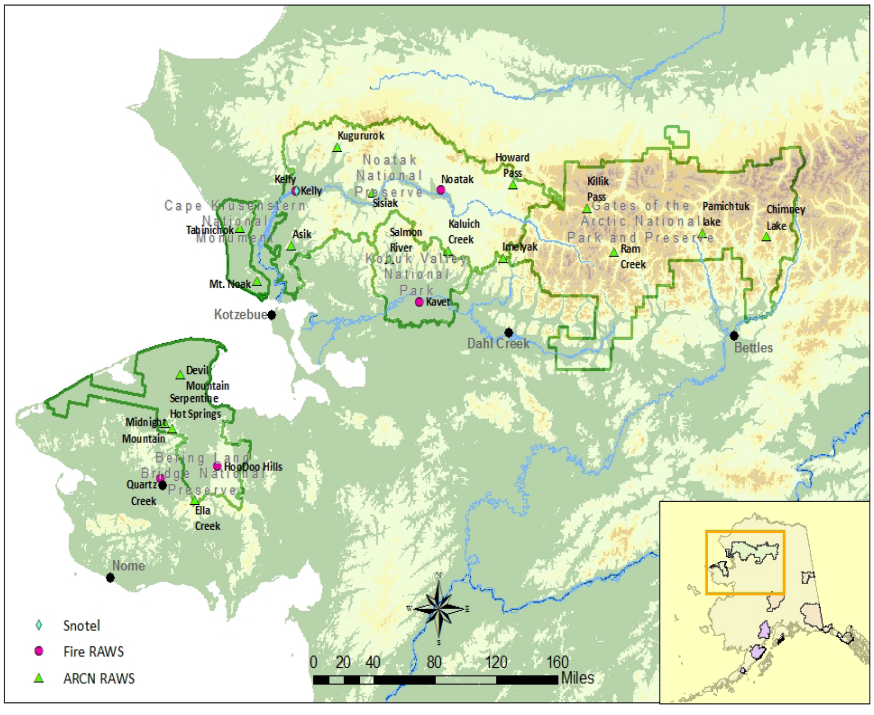

Map of NPS Climate Monitoring Stations in Alaska.

Earth to Sky - Pacific West

Participants of the 2016 Pacific West Earth To Sky training held at Golden Gate National Recreation Area. NPS Photo

More than 60 scientists and science communicators gathered in San Francisco in May, to talk and learn about changing climate in the Pacific West. This was the second instance of a new regionally-focused training model that Earth to Sky hopes to take to many other regions of the country over the coming years. For three days, at the General's Residence at Fort Mason, presenters from NASA and many other organizations discussed the latest news about climate impacts and their implications to the Pacific Coast. Funding and support for the course was made possible by the NPS Climate Change Response Program, Mather Training Center, and by continuing leadership and generous support from NASA.

Participants came from all across the region representing numerous governmental, non-government, and community organizations—one of the most diverse audiences ever assembled for Earth to Sky. Discussions continued over 3 days during plenaries, concurrent sessions, field trips, and group exercises. The training culminated in panel discussions about adaptation and mitigation strategies that led to an intriguing conclusion: how we adapt our communities and environment will be more about visioning the future than protecting the past.

Through this course, Earth to Sky expanded its effort to forge new partnerships and share new research specifically within a locally-based and engaged community of communicators and scientists. We are delighted with its successful launch, and look forward to the many future opportunities and new products about our changing climate that will surely result.

For more information and to access course presentations and materials online, go to **www.earthtosky.org**. (You'll need to register a free account on the site to access the many resources. Click on Professional Development and look for "EtS @ PW 2016.")

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Earth to Sky attendees participated in an activity called "Magic Window" at Rodeo Beach. The activity is used during curriculum-based education programs to encourage students to consider how our changing climate has influenced the landscape. NPS Photos

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.

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Social Media
NPSClimateChange

Upcoming Training

Interpreting Climate Change Course- September 13-15, 2016 **Register Here**

This course provides an overview of the practical knowledge and skills that will enable interpreters to develop effective, engaging climate change programming for both natural and cultural sites. Participants will consider a range of engagement techniques such as facilitated dialogue, skills for dealing with controversy, and presenting multiple perspectives. These and other techniques will be applied to an overview of climate science and audience research. Participants will engage in group discussions to share best practices, build confidence and identify meaningful site connections

Fish & Wildlife Service Climate Academy - 2017 **Register Here**

This 6-month online course is designed to cover the fundamentals of climate science, provide an overview of tools and resources for climate adaptation, and increase climate literacy and communication skills. Beginning in January 2017, a webinar session with leading experts in these topics will be held every other week for 5 months, for a total of 10 sessions.

ACCO Climate Fundamentals Academy Workshops - Multiple Upcoming

Through a standing agreement between the Climate Change Response Program and the Association of Climate Change Officers (ACCO) NPS employees are invited to attend upcoming Climate Fundamental Academy workshops free of charge. The Climate Fundamentals Academy is a three-part series of two-day training workshops presented by the ACCO that explores climate science and variability, climate hazards and vulnerability assessments, greenhouse gas accounting, the food-water-energy nexus, and fundamental governance and stakeholder engagement strategies.

Upcoming Climate Fundamentals Academies are currently scheduled for the **South Florida**, **Colorado**, and **Washington DC**. All NPS employees are invited to apply through **DOI Learn** by searching the course catalog for "Climate Fundamentals Academy." Available seats will be awarded on a first-come, first-serve basis, so early registration is highly encouraged. Supervisory approval is required, and any associated travel will be paid by the benefiting account. (Contact: Larry Perez, 970-267-2136)

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.

September 8| 2016 Young Leaders in Climate Change (YLCC). Join a select panel of YLCC participants from the 2016 summer season to hear how their projects advanced climate science, adaptation, and communication at their host parks. Please follow this **link to register**.

YLCC Interns, Summer 2016.