

PROCEEDINGS OF THE ACADIA NATIONAL PARK SCIENCE SYMPOSIUM

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Summary

The 2016 Acadia National Park Science Symposium, held at the Schoodic Education and Research Center (SERC), brought together over 100 researchers, students, and park staff to discuss science taking place in and beyond park boundaries. The symposium featured five invited speakers and 45 posters describing results and plans for research in a range of disciplines, including natural sciences, social sciences, and humanities.

The speakers at the event were:

Andrew Pershing - Gulf of Maine Research Institute - Climate lessons from the rapidly warming Gulf of Maine

Michelle Baumflek - Virginia Tech, and **Suzanne Greenlaw** - University of Maine - Wabanaki plant gathering in Acadia National Park: Weaving traditional ecological knowledge and scientific knowledge to restore traditional resource harvesting

Fred Bianchi - Worcester Polytechnic Institute - Creativity at the intersection of science, technology, and society

Rick Bonney - Cornell Lab of Ornithology - The emergence and future of public engagement in science

Speed presentations: Vision for the future of science and science communication in national parks

Stephanie Toothman - National Park Service

Julia Washburn - National Park Service

Tim Watkins - National Park Service

For more information on Schoodic Institute and research in Acadia National Park and surrounding areas, please see:

<http://www.schoodicinstitute.org/>

Speaker Abstracts

Climate lessons from the rapidly warming Gulf of Maine

Andrew J. Pershing

Gulf of Maine Research Institute

While all ocean regions are warming, few are warming as fast as the Gulf of Maine. The challenges facing Gulf of Maine communities from changes in the ecosystem are not unique, but we are seeing them sooner and more intensely than other regions. Thus, solutions that we develop here have the potential to help increase the climate resiliency of ecosystems around the world.

Wabanaki plant gathering in Acadia NP: Weaving Traditional Ecological Knowledge and Scientific Knowledge to restore traditional resource harvesting

Michelle Baumflek

Virginia Tech

and

Suzanne Greenlaw

University of Maine

The NPS Code of Federal Regulations has recently been changed to provide opportunities for Native Americans to gather traditional plants within park lands. Using sweetgrass (*Hierochloe odorata*) as an example, this presentation will describe our emerging process to facilitate plant gathering in Acadia National Park that incorporates both Wabanaki gatherer knowledge and scientific knowledge into the monitoring and management of culturally-important species.

Creativity at the intersection of science, technology, and society

Fred Bianchi

Worcester Polytechnic Institute

The presentation will chronicle the ongoing research collaboration between the Acadia National Park and the Worcester Polytechnic Institute, in Massachusetts. Since 2012, student teams from WPI have targeted important Park issues and applied innovative research methods based on interdisciplinary problem solving. The approach calls for a broad understanding of not only the scientific and technological components under investigation, but for a comprehensive understanding and awareness of the cultural and social impact of the research.

The emergence and future of public engagement in science

Rick Bonney

Cornell Lab of Ornithology

Poster Abstracts

Research permits at Acadia National Park: The numbers

Emma Albee¹ and Abraham Miller-Rushing²

1 Schoodic Institute at Acadia National Park, Winter Harbor, Maine

2 National Park Service, Acadia National Park, Bar Harbor, Maine

A breakdown of Acadia National Park's research permits from 2001 through 2016: where are the researchers from, what are they researching, how many years do they have a permit, when are they publishing reports?

How to submit an application for a research permit in Acadia

Emma Albee¹ and Abe Miller-Rushing²

1 Schoodic Institute at Acadia National Park, Winter Harbor, Maine

2 National Park Service, Acadia National Park, Bar Harbor, Maine

A brief overview of how to apply for a research permit at Acadia National Park.

Anecdota.org: Closing the citizen science “data loop”

Duncan Bailey and Jane Disney, Ph.D

MDI Biological Laboratory, Bar Harbor, ME

Anecdota.org, developed at the MDI Biological Laboratory, is a free online platform where citizen scientists can host their projects and collect, view, analyze and download

a wide range of geo-referenced environmental data. Since launching in 2014, Anecdota is used by over 400 citizen scientists and is now home to 30 projects ranging from the Gulf of Maine to the Caribbean to the Pacific Northwest. Needs assessments with project coordinators show us that showcasing and analyzing data can be as important as data collection; citizen scientists enjoy being able to see their data in the context of the project's data as a whole. We believe that the continued development of tools allowing citizen scientists to explore, pivot, analyze, and ask questions about data will be of great use in further closing the citizen science "data loop", providing an avenue for citizens to turn knowledge into action.

Southbound waterbird migration observations from Schoodic Point and Otter Cliffs in Acadia National Park, Maine

Seth Benz and Jason Bojczyk

Schoodic Institute at Acadia National Park, Winter Harbor, Maine

Many waterbirds migrate along the Maine coast, flying over the Gulf of Maine itself. Geography brings many water birds relatively close to shore at Schoodic Point and Otter Cliffs. Fall migration, in particular, is quite spectacular, as thousands of birds are counted flying in a southwesterly direction past these observation points. Since 2011, Schoodic Institute in Acadia National Park's "SeaWatch" has counted the autumn coastal migration of southbound waterbirds such as loons, grebes, cormorants, gannets, ducks, geese, gulls, terns, and other birds. This poster presents results and details of the migration monitoring effort which begins in late August and continues into November each year.

Monitoring ocean acidification through sediment pH in eelgrass areas in Frenchman Bay, Maine

Berry-Sandelin, L.¹, Farrell, A.², Disney, J.E.²

1 Bard College, Annandale-on-Hudson, New York

2 MDI Biological Laboratory, Salisbury Cove, Maine

Eelgrass (*Zostera marina*) is an inter-tidal marine ecosystem that can prevent erosion, mitigate wave action, provide a nursery areas and shelter for commercially important species, and act as a carbon sink. We are interested in the ability of eelgrass to mitigate climate change and ocean acidification. During photosynthesis eelgrass removes carbon dioxide from the surrounding water column and deposits carbon into the sediment. When anthropogenic carbon is taken out of the water column, it is unable to bond with carbonate to form carbonic acid, therefore raising water column pH, and allowing organisms with calcium carbonate structures to grow more easily. This has potential implications for commercially important species including: clams, mussels and oysters. We have made comparisons of pH levels within and around eelgrass beds and found that pH is higher in the vicinity of eelgrass than in un-vegetated areas. These data provide a compelling argument for protection and restoration of eelgrass beds, which may be conferring some protection for shellfish from impacts of near shore ocean acidification.

Geologic mapping of MDI and the Schoodic Peninsula

Duane D. Braun

Maine Geologic Survey, Augusta, Maine

Since the mapping began in the spring of 2012, field work has been completed on MDI, the MDI Surficial Geology (glacial deposits) map has been completed and is available from the Maine Geologic Survey, the MDI bedrock map is one-half complete, and field mapping has begun on the Schoodic Peninsula. New features on the MDI Surficial map include about 300 moraine ridges, a number of beach ridge areas outside of previously known ones, and large scale rock slides on the mountain sides. New features on the MDI bedrock map include 100 or so basalt dikes traced across MDI, the inter fingering of the layered gabbro complex with the granite on the western side of the island, and several previously unknown small granite intrusions on the southwest part of MDI.

Using pellet collection and chick regurgitation to determine the diet of herring gulls (*Larus smithsonianus*) on Great Duck Island

Caroline Brown

College of the Atlantic, Bar Harbor, Maine

The Gulf of Maine in the western North Atlantic is home to a broad range of habitats and includes a number of nesting seabird islands. Among these is Great Duck Island, (Lat. 44.14 N, Long 68.24 W.) The island is home to several species of nesting seabirds including Herring Gulls. Gulls can access intertidal zones, farm fields, and fishing vessels, and are exposed to a variety of food sources. During the summer of 2016 I collected prey samples from both adult and juvenile gulls in the form of regurgitate and pellets within and near nests. I sampled chick regurgitate during daily visits into the colony throughout the pre-fledging period to assess what adults fed their offspring. Pellet contents suggest that Herring gull adults feed primarily on crustaceans, focusing their efforts on Rock (*Cancer irroratus*) and Jonah Crab (*C. borealis*). The next most abundant food found was fish, including bait fish and local sources. Gull chicks were fed a similar diet to that indicated by adult pellets, with somewhat greater variety including species of North Atlantic shrimp. My results differ from previous studies of near-shore colonies in that they included a lower proportion of anthropogenic food.

Using citizen science to study the effects of ocean acidification and warming (OAW) on the rocky intertidal communities of the Schoodic Peninsula of Acadia National Park, Maine

John A. Cigliano

Environmental Conservation Program, Department of Biological Sciences, Cedar Crest College, Allentown, Pennsylvania
Schoodic Institute at Acadia National Park, Winter Harbor, Maine

The increase in the concentration of atmospheric carbon dioxide (CO₂) from the

burning of fossil fuels is not only causing global warming and climate change, it is also causing ocean acidification: the decrease in pH of the ocean due to the uptake of atmospheric CO₂ (together, they are referred to as OAW – ocean acidification and warming). Our understanding of the effects of OAW on marine organisms and communities is limited but evidence is growing that it will have significant, but variable, effects on the growth, reproduction, and survival of individuals across taxa and on the structure and function of ecological communities through its effect on ecological interactions (e.g., competition for resources). The purpose of this poster is to discuss how citizen science is being used to study the effects of OAW on rocky intertidal communities of the Schoodic Peninsula of Acadia National Park. The Gulf of Maine is considered to be especially vulnerable to OAW and this study will provide needed information to help the U.S. National Park Service manage the intertidal resources of Acadia National Park, as well as contributing to our understanding of the effects of OAW on rocky intertidal communities.

Relative frequencies of seal wounds: A case study on Mount Desert Rock, Maine

Kaitlyn R. Clark, Dan DenDanto, and Christopher W. Petersen

College of the Atlantic, Bar Harbor, Maine

Seal populations in the Gulf of Maine have been gradually increasing in recent years. This has led to both grey seals (*Halichoerus grypus*) and harbor seals (*Phoca vitulina*) hauling out in large numbers on Mount Desert Rock (MDR), a small island about 45 km off the coast of Mount Desert Island, ME. In an area of high fishing activity, the population dynamics of *H. grypus* and *P. vitulina* are particularly interesting in relation to the potential for interactions with boats and fishing gear. These interactions sometimes result in wounds, and the seals that haul out on MDR often display wounds severe enough to be viewed with binoculars from the light tower on the island. This summer, I conducted research on MDR that focused on the relative frequencies of different wounds in the seal populations as well as the differences in behavior between wounded and unwounded individuals. The study results show some differences in the percentage of wounds in each species and at different tidal heights. Of particular interest relating to human involvement, 0.50% of the *P. vitulina* population and 2.59% of the *H. grypus* population hauled out at low tide were entangled with line around the neck. These percentages place both populations within the range of entanglement rates in other pinniped populations around the world. These data could provide baseline information for monitoring the health of Gulf of Maine seal populations in the future.

Monitoring marine sediment as an indicator of a changing ocean

Alison Clift^{1,2}, Zachary Steele¹, Mark Whiting¹

1 Hancock County Soil and Water Conservation District, Ellsworth, Maine

2 Maine Conservation Corps, Augusta, Maine

The purpose of this study is to monitor intertidal marine sediment pH and shellfish recruitment within Hancock and Washington Counties as indicators of ocean acidification. Shell-producing species are a vital commercial resource to the State of Maine and are especially important to the local economies in Hancock and Washington Counties. The protocol is designed to engage nonprofits, citizen scientists, and academics in the monitoring of local resources. The data will inform local, state, and federal government agency resource management decisions. Preliminary data shows: (1) sediment pH is low, (2) there are temporal and intertidal variations, (3) higher pH is present at sites with eelgrass compared to bare mudflats, and (4) clam recruitment is poor at all sites investigated.

Using A commercially-available UAS to count nesting gulls on Great Duck Island, Maine

Michael. R. Cornish

College of the Atlantic, Bar Harbor, Maine

UAS (unmanned aerial systems), or “drones”, are aerial vehicles of many uses. While the technology is new, UAS are becoming increasingly common as a tool for aerial imagery. Prior annual or decadal counts in Maine, USA, have used a variety of methods to count Herring (*Larus smithsonianus*) and Great black-back gulls (*L. marinus*) including ground counts and aerial photography from small aircraft. Both these techniques are costly and/or labor intensive. In addition, ground counts may be a major source of disturbance to nesting birds. A small UAS was deployed on Great Duck Island, ME (Lat. 44.14 N, Long 68.24 W.) that generated imagery of the gull colony on the island’s southern coast. From these images the nests were counted and compared to an intensive ground count. The UAS photographed the colony in sections, flying a

grid pattern autonomously using an IOS autopilot program. Photographs are automatically geo-referenced and can be stitched into a single ortho-photo. To measure disturbance during flights, birds off-nest or in the air were counted and showed no difference from preflight conditions. While using full-scale aircraft has shown to be effective for estimating colony size, high costs and the availability of suitable aircraft limit the frequency of this activity. Ground counts are time-intensive and landing on some islands may be nearly impossible except under ideal sea states. With reduced disturbance, time, cost, and resource requirements, the use of UAS to count gull colonies appears to be an attractive alternative to traditional census methods.

The interaction of age/size and crown position in regulating photosystem physiology of red spruce and linkages to stem hydraulics

Michael Day, Alisha Autio, Michael Greenwood, and Stephanie Adams

School of Forest Resources, University of Maine

The foliage of forest trees shows predictable heterophyllic patterns of development due to light environment and heteroblastic patterns regulated by tree age/size. Typically, upper crown, sun-adapted foliage is morphologically more robust and physiologically allocates more resources to photosynthetic carboxylation capacity. In contrast, lower crown, shade-adapted foliage has lower leaf mass per area and allocates more resources to light harvesting. Regulation of the morphological and anatomical aspects of sun-shade adaptation have been associated with light quality through phytochrome sensing pathways and light intensity through sugar metabolism. Previous research, including long-term reciprocal grafting studies, demonstrated that foliage increased in robustness with tree age/size but also was influenced by meristem-intrinsic factors. Photosystem physiology, in contrast, showed regulation by factors extrinsic to meristems. This study compared allocation to photosynthetic pigments in sapling and old-growth red spruce. While photosynthetic pigments in the younger age class followed patterns similar to that of their sun-shade morphology, those in old trees showed a distinct lack of plasticity between sun- and shade-adapted foliage. The authors propose a phytohormonal mechanism based on hydraulic flow to needles at shoot apices to explain this incongruity. In this model, the distribution of cytokinins that regulate genes for chlorophyll synthesis are dispersed through a longer, more complex hydraulic pathway in old trees, producing similar effects in both upper and lower crown foliage. As cytokinin regulation of chlorophyll has not been verified in conifers, the effect of cytokinins on down-regulating chlorophyll synthesis in red

spruce was ascertained through exogenous applications on foliage from both tree age/size classes.

The effects of climate change on phenology and migrating birds

Dr. Richard Feldman and Sarah Deckel

National Park Service, Schoodic Institute, University of Maine (Orono)

Understanding the relationship between climate change and phenology is important because it can affect food availability for birds that are migrating to their wintering grounds. We are concerned with when shrubs are flowering and fruiting, what the insect biomass is in each site, and relating this to what species of birds are migrating through the peninsula. We conduct fruit surveys and collect insect samples at 2 sites on the Schoodic Peninsula once a week from late July to early October. Our eight target fruit species are black huckleberry (*Gaylussacia baccata*), shadbush (*Amelanchier* spp.), winterberry (*Ilex verticillata*), mountain holly (*Ilex mucronata*), wild raisin (*Viburnum cassinoides*), raspberry and blackberry (*Rubus* spp.), northern bayberry (*Myrica pensylvanica*), and American mountain ash (*Sorbus americana*). This study is currently still being researched, and data will be collected until mid-October. We predict the abundance of shrubs to be fruiting in early to mid-September based on the data that was collected in 2015.

Interannual carbon stocks in eelgrass areas around Mt. Desert Island: Implications for eelgrass protection and restoration in Maine

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2 University of Maine, Orono, Maine

3 Bates College, Lewiston, Maine

4 MDI Biological Laboratory Salisbury Cove, Maine

Zostera marina, commonly known as eelgrass, is an important part of marine ecosystems around the world. This plant sequesters carbon by removing carbon from the atmosphere and storing it in plant tissue and sediments. Eelgrass has experienced a significant worldwide decline, including the area around Mt. Desert Island, ME. In 2015, we determined the percent total carbon and dry bulk density in the above ground biomass, below ground biomass, and sediments in five remaining eelgrass areas. The majority of stored carbon was found in sediment. There were significantly larger carbon stocks in sediments from sites that had never lost eelgrass than sites that had lost eelgrass in the recent past. In 2016, we resampled sediment in these same five areas to determine interannual variation in carbon stocks and found no significant difference, except in eelgrass restoration areas where the carbon stock is significantly increasing. These data indicate that carbon stocks are restored where eelgrass is restored.

Climate change is advancing spring onset at Acadia and across the National Park System

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4 Schoodic Institute at Acadia National Park, Winter Harbor, Maine

5 Cornell University, Department of Earth and Atmospheric Sciences, Ithaca, New York

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7 National Park Service, Natural Resource Stewardship & Science, Climate Change Response Program, Fort Collins, Colorado

8 U.S. Geological Survey, Tucson, Arizona

US national parks - from Alaska and the South Pacific across the conterminous states and the Caribbean - are already experiencing climate change. Changes in phenology - the timing of seasonal biological events (e.g., leaf-out, migration, and reproduction) - constitute one of the most proximate responses to climate change. Information on phenological changes will support managers in adjusting the timing of activities, such as treating invasive species, operating visitor facilities, and scheduling seasonal events. Here, we evaluate the recent timing of spring onset (past 10-30 years) in Acadia National Park and 275 other parks relative to their historical range of conditions across

the past 112 years (1901-2012). Of the 276 parks examined, spring is advancing in three-quarters, and half are experiencing an “extreme” early spring exceeding 95% of historical conditions, as measured by first leaf index and/or first bloom index from indicator plant species. No parks are experiencing extreme delays in spring onset. Acadia National Park is one of the extreme early spring parks, with both first leaf and first bloom indices earlier than 95% of historical conditions. Managers at Acadia and other “extreme” early parks have already been working under relatively anomalous conditions for the past 10-30 years. Our results demonstrate how changes in climate seasonality are important for understanding ecological responses, and how spatial variability in effects of climate change necessitates localized adaptation approaches.

Second Century Stewardship: Science for America's National Parks

Mark Berry¹, Nicholas Fisichelli¹, Suzanne Thurston², Bob Hirshon², Abraham Miller-Rushing³

1 Schoodic Institute at Acadia National Park, Winter Harbor, Maine

2 American Association for the Advancement of Science

3 National Park Service, Acadia National Park, Bar Harbor, Maine

At the dawn of the U.S. National Park Service's second century, opportunities exist to engage in science for the benefit of parks and society. Second Century Stewardship explores that science through partnerships with AAAS, Acadia National Park, Schoodic Institute, and the National Park Service.

Where do they all go? Counting cars on Cadillac Mountain

Rebecca Flesh¹ and Charlie Jacobi²

1 Friends of Acadia

2 National Park Service, Acadia National Park, Bar Harbor, Maine

Cadillac Mountain is the number one visitor destination in Acadia National Park and a key issue in the ongoing Transportation Plan. From sunrise to sunset cars stream up to the summit on the motor road. Congestion and gridlock occur more frequently and

rangers now close the road when traffic backs up. How many cars are too many cars? It's not an easy question to answer and it depends on the objective. We measured traffic to and from the summit from 2013 - 2016 and share the results here. The rest is up to you. Participate in the Transportation Planning process.

Ecosystem service values as a participatory model for stakeholder engagement? A case study in Maine's Frenchman Bay

Emma Fox (M.S. student)¹, Bridie McGreavy², Caroline Noblet¹, Kathleen Bell¹, Jane Disney³

1 University of Maine School of Economics

2 University of Maine Department of Communication and Journalism

3 MDI Biological Laboratory

Ecosystem services are valuable to natural systems (e.g. habitat) and human systems alike (e.g. resources). However, the value which humans attribute to ecosystem services is rarely accounted for through traditional market transactions, which may lead to natural resource overexploitation and environmental degradation. While there is a growing literature on ecosystem services valuation (ESV) tools, there is a paucity of research on the use of those tools by stakeholders making decisions about sustainable natural resource management. We examine the use of the ESV workshops in stakeholder engagement through a case study based on a series of workshops, hosted by the Frenchman Bay Partners, a group of stakeholders sharing the vision of an ecologically, economically, and socially sustainable future for Frenchman Bay. Using mixed social science methods, we review researcher observation notes, participant workshop evaluations, and interview data to address use of ESV in engaging stakeholders in sustainability work. We discuss the implications for participatory ESV practices and conclude with a set of recommendations for future valuation work with community groups.

The use of iNaturalist in Acadia National Park

Nicole Gallup, Seth Benz, and Hannah Webber

Schoodic Institute at Acadia National Park, Winter Harbor, Maine

iNaturalist is a website and phone application, that curates observations people make of the natural world – mammals, insects, vegetation et cetera – along with the observation's GPS location. iNaturalist allows for a community of naturalists – casual and skilled observers, as well as expert and novice identifiers, to share observations and aid in identifying the observations. This community contributes to a large, expansive, multifaceted data source that is accessible to anyone. For National Parks knowing which plants, animals or fungi are present within their borders is important. The knowledge allows for parks to better manage their resources. With very few park employees it would be impossible to survey every part of the park. But with a team of naturalists and the iNaturalist platform there can be more eyes in the field, more area can be covered and more species can be located and identified. These data can provide information about how diverse the parks species are, how species have changed in the park, and allow for the monitoring of invasive species within the park. This poster presents a summary of iNaturalist use in Acadia National Park and includes species found and identified and patterns in iNaturalist use.

Investigating changes in water quality in Jordan Pond, Mount Desert Island, Maine

William G. Gawley¹, Shannon P. Wiggin¹, Adam R. Thime¹, Rachel A. Fowler², Jasmine Saros², and Nora Theodore²

1 National Park Service, Acadia National Park, Bar Harbor, Maine

2 University of Maine, Climate Change Institute, Orono, Maine

With over 30 years of historic water monitoring data from Jordan Pond, National Park Service and University of Maine scientists have a rich source of information about how the pond responds to annual and seasonal changes in climate and other global and local influences. Access to advanced monitoring technology and 10 years of participation in the NPS Inventory and Monitoring Program have enhanced our ability to collect quality, high-resolution data and better understand this iconic Maine lake.

A new look at the geologic history of Great Duck Island and Mount Desert Rock through high resolution aerial imagery, geologic mapping, geochemistry, and geochronology

Spencer E. Gray III¹, Sarah R. Hall¹, David G. Bailey², and Melanie J. Michalak³

1 College of the Atlantic

2 Hamilton College

3 Humboldt State University

Great Duck Island and Mount Desert Rock are two remote islands off the southern coast of Mount Desert Island (MDI), Maine. Both islands are working field stations maintained by College of the Atlantic. Each island has been host to many ecological research projects during the last decade, although none have specifically focused on the bedrock and surficial geology. Maine Geological Survey maps show both islands as composed dominantly of Devonian granite, similar to nearby islands including MDI. The goal of this project is to map the dominant fractures, dikes, bedrock types, glacial features, and sediments of both islands and create geologic maps in ArcGIS software, as well as to obtain geochemical and chronological data for each island. We will be reporting new geochemical data for both Great Duck Island and Mount Desert Rock. In addition, Mount Desert Rock lacks a topographic dataset and is beyond the range of available high-resolution aerial satellite and LiDAR data. By processing new drone imagery using Agisoft Photoscan, an aerial orthomosaic was created of the entire island. Preliminary results show fracture sets and minor fault zones on both Mount Desert Rock and Great Duck Island follow dominant north-south and east-west regional trends. The entire ~7 acre island of Mt. Desert Rock is composed of a fine to medium-grained light gray, phaneritic granite with less than ~5% mafic minerals. Conversely, Great Duck Island is underlain by a fine-grained, felsic, bright pink granite, also quite low in mafic minerals, a welded flow banded rhyolite, as well as a zone of highly altered metasedimentary rocks similar to the Bar Harbor Fm of MDI. Preliminary U238-Pb206 zircon ages of the granites from both islands suggest that they are significantly younger than the Silurian and Devonian granites of nearby MDI and Swans Island with Great Duck Island, yielding ages of 313.3 +/- 3.0 Ma (Carboniferous) and Mount Desert Rock, 296.5 +/- 2.9 Ma (Permian). Taken together, these new geochronologic, geochemical and field and remote-based spatial data enable us to refine the volcanic and tectonic history of this portion of the easternmost edge of North America.

Stream discharge monitoring in seven watersheds on Mt. Desert Island, Maine

William Minogue¹, Sarah Hall¹, Brian Henkel²

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Continuous stream discharge measurements are necessary to answer questions about a watershed at a range of scales, from the entire drainage basin to a single stream reach or even an indirect location such as beach or near-shore environment. Similarly, discharge datasets are required to address the diverse needs and questions of many different social institutions: municipalities/government, academia, conservation groups, the private sector, around topics such as: water quality, long-term trends, non-point source pollution, watershed conservation, restoration projects, infrastructure planning, erosion and weathering processes, or land-use impacts. Ongoing and past surface water monitoring and sampling has been conducted on Mt. Desert Island (MDI) by the National Park Service at Acadia National Park (ANP), the United States Geological Survey (USGS), College of the Atlantic (COA), and by researchers from other academic institutions (e.g. University of Maine, Orono (UMO)). These groups have monitored rivers for various reasons including assessment of drinking water quality, watershed-scale studies, conservation projects, and also strictly for educational purposes. Through a recent student project, seven stream discharge monitoring stations were installed along streams within some of the major drainage basins of MDI, Cromwell/Kebo Brook, Duck Brook, Jordan Stream, Mill Brook, and Stanley Brook, in order to establish a baseline dataset of river discharge. Current students are working with COA faculty and Friends of Acadia personnel to continue collection and synthesis of the data, which will be available to the public through Acadia National Park. Preliminary discharge data collected during ~May-Sept 2016 from each watershed allow us to look with higher resolution at the seasonal and annual fluxes in discharge across the island. Further, when coupled with water chemistry data, the local precipitation record, and existing spatial datasets (e.g. permeability, lithology, soils, vegetation, land-use) we can isolate some watershed specific characteristics and temporal variations, often related to human activities within the watershed.

Compliance surveys for *Myotis septentrionalis* increases opportunity for long term bat monitoring at Acadia National Park

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The listing of the northern long-eared bat, *Myotis septentrionalis*, requires Acadia National Park to assess how our cyclical trail and facility maintenance could be affecting the habitat and the incidental taking of this listed species. Ultrasound detectors were placed at three long-term monitoring sites throughout the summer to assess when bat species were beginning to emerge and arrive on Mount Desert Island. A series of ultrasound detectors were then used during the maternity period to chart presence and absence of species at specific locations. Before trailwork, building, and road maintenance projects this summer, wildlife technicians screened project sites using visual and ultrasonic acoustic data to ensure the absence of bats before work started, or consulted with project managers if bats were present. From this data, the park hopes to create a better understanding of how bats are using the landscape of Acadia National Park and how we can mitigate any negative effects on this listed species.

Whither Schoodic: Monitoring visitor numbers and activities in a time of change

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A 100 car parking lot, a 97 site campground, seven miles of bike paths, and five miles of hiking trails were added to the Schoodic section of Acadia National Park in 2015. How are visitors using Schoodic now? How will visitation change in 2016? We collected

vehicle traffic and bicycle data and observed parking and more and describe the results here.

Multidecadal response in soil carbon, nitrogen, and mercury to the Mt. Desert Island Fire of 1947 using paired watersheds in Acadia National Park, Maine

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In 1996, Acadia National Park (NP) was chosen as one of fourteen parks to research stressors and ecological effects. This collection of park monitoring sites became known as the Park Research and Intensive Monitoring of Ecosystems Network (PRIMENet). The original PRIMENet program in Acadia determined the response of Hadlock and Cadillac watersheds to an ecosystem-changing disturbance represented by the 1947 wildfire, with particular attention on the fate and cycling of atmospherically derived nitrogen (N) and mercury (Hg) pollutants. The Hadlock and Cadillac forested stream watersheds represent a long-term paired whole-watershed study, with Hadlock as an unburned reference and Cadillac having been severely burned. This research, representing a return campaign to the Acadia PRIMENet watersheds after an approximate 15 year hiatus, focuses on defining current carbon (C), N, and Hg soil burdens. This sampling campaign allows us to evaluate the trajectory of recovery of these two watersheds to atmospheric deposition and fire disturbance. This research will provide insights into the temporal evolution of chemical changes (C, N, Hg) in the soil of these two watersheds, help identify current risks due to pollutant burdens, and inform management considerations of ecosystem resilience to these and other stressors.

Managing exotic plants on Bar Island, Acadia National Park, Maine

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National Park Service, Acadia National Park, Bar Harbor, Maine

The 67 acre Bar Island is connected to the town of Bar Harbor by an exposed bar at low tide, allowing for high visitor use during short windows of time. The island has dense invasive exotic plants and in 2015 the Exotic Plant Management Team started treating these populations. In 2015 treatments were focused to reduce reproductive woody plants and to reduce the presence of Canada and bull thistles (*Cirsium arvense* and *Cirsium vulgare*). The brush created from cutting large Asiatic bittersweet (*Celastrus orbiculatus*) and exotic bush honeysuckle (*Lonicera* spp.) was dispersed out of sight to reduce aesthetic effects. The focus of 2016 management was primarily early spring foliar herbicide treatment of Japanese barberry (*Berberis thunbergii*) throughout the island then cut and herbicide treatment for dense privet (*Ligustrum* spp.) populations on the south bank of the island; thistle management continued in the meadow portion of the island. Management in 2017 will focus on young sprouts from the seedbank.

Effects of predation risk on an intertidal snail (*Nucella lapillus*) depend on predator identity and predator feeding activity

Catherine M. Matassa

Northeastern University, Boston MA

The risk of predation can drive trophic cascades by causing prey to engage in anti-predator behaviors such as reduced foraging activity or increased use of refuge habitats. However, such reductions in foraging activity can limit prey energy intake, growth, and fitness. Prey foraging decisions should therefore be sensitive to the degree of predation risk prey perceive (e.g., detection of risk cues) so as to balance the relative costs and benefits of anti-predator behaviors. For example, prey may engage in more anti-predator behavior if they detect the presence of a predator that is actively feeding on conspecific prey, indicating greater risk of predation. However, the ability of prey to detect/evaluate predator risk cues and fine-tune their responses relative to perceived threats may depend on how the prey and predator have coevolved. On rocky shores in the Gulf of Maine, intertidal gastropods have a variety of predators, including native *Cancer* spp. crabs (*C. borealis* and *C. irroratus*) and the invasive green crab, *Carcinus maenas*. Using a mesocosm experiment, I examined how waterborne risk cues from each of these three predatory crabs affected the foraging and growth rates of their prey, the carnivorous gastropod *Nucella lapillus*, and if these effects depended on

whether the crab was actively feeding on conspecific snails. The presence of a predatory crab actively feeding on conspecific prey caused the foraging rates, growth, and growth efficiency of *N. lapillus* to decline, regardless of crab identity. The presence of crushed conspecific snails alone had no effect on *N. lapillus*. When crabs were not actively feeding on *N. lapillus*, the negative effects of both *Cancer borealis* and *C. irroratus* declined, but the negative effects of *Carcinus maenas* persisted. These results suggest that *N. lapillus* may exhibit more finely-tuned responses to *Cancer* spp., which are native, than to *Carcinus maenas*, which is invasive. However, there are several alternative explanations for these results, including differences in each crab's habitat overlap with *N. lapillus*, their relative predation rates on *N. lapillus*, and the historical ecology of these predator-prey interactions in the North Atlantic. Despite these alternative explanations, this study highlights the context-dependent nature of prey responses to predation risk and the emergent indirect effects of predation risk on ecological communities.

Phenology and vulnerability assessments in the plant communities of Acadia National Park, Maine

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Changes in plant phenology are a simple, straightforward signal of the ecological effects of climate change. Moreover, inflexible phenology has been linked to declines in species performance and increased vulnerability to local extinction. Taxa that do not track warmer temperatures with earlier leaf out or flowering may struggle to survive in a changing climate. In Acadia National Park, Maine, plant communities on the subalpine summits do not have space to migrate to higher elevations in the face of climate change. To test the phenological flexibility and potential vulnerability of three plant species, we established three reciprocal transplant gardens in the park along an elevation gradient and monitored leaf out phenology over three growing seasons.

Research in parks is ...

Allen, L1, Hristov, N1, Merson, M2

1 Winston-Salem State University, Winston-Salem, North Carolina

2 TERC, Cambridge, Massachusetts

Scientific research in parks is often invisible and as such undervalued. Collecting quotes from researchers and the public on what research in parks means to them and why it matters is part of documenting the importance of this work for funders and legislators. We will showcase quotes collected from attendees at an evening about research in and around Acadia and collect attendees' thoughts as well.

Permanent freshwater wetland monitoring in Acadia National Park

Kate M. Miller and E. Hale Morrell

NPS Northeast Temperate Network, Bar Harbor, ME

Starting in 2011, the Northeast Temperate Network (NETN) of the National Park Service has monitored permanent freshwater wetlands in Acadia National Park (NP) using a 3-tiered sampling approach. Level 1 is GIS-based monitoring of landscape condition. Level 2 is a rapid field assessment. Level 3 involves intensive sampling of soil, water chemistry, hydrology and vegetation, and follows methods developed for the Environmental Protection Agency's National Wetland Condition Assessment (NWCA). NETN currently monitors 40 randomly located sites in Acadia NP using Level 1 and 2 methods. The 10 sites receiving Level 3 monitoring are sentinel sites that were hand-picked to represent best condition for a range of wetland types and sizes in Acadia NP. Sentinel sites are also potential reference sites that are used to characterize the condition of wetlands for NWCA. The overall goal of the NETN monitoring program is to monitor status and trends in wetland condition relative to vegetation, soil, hydrology, and water quality in ACAD. We developed Multi-metric indicators (MMIs) for vegetation, soil, and water chemistry using the EPA NWCA data to assess condition in Acadia NP wetlands. Here we present preliminary results from 5 years of wetland monitoring in Acadia NP.

Ant biodiversity near American Mountain Ash (*Sorbus americana*) trees on the Schoodic Education and Research Center campus, Schoodic peninsula, Maine

Elizabeth Orcutt

Schoodic Institute at Acadia National Park, Winter Harbor, Maine

Ants perform many critical functions in forested ecosystems—they eat other insects, move nutrients, increase turnover in the soil, and distribute seeds. Diversity of ant species on the Schoodic Peninsula is not yet well studied. The purpose of this study is to determine what ant species are found around select American Mountain Ash (*Sorbus americana*) trees on the Schoodic Education and Research Center (SERC) campus on the Schoodic peninsula. This will provide the first stepping stone to 1) determine what species are present and if those species are interacting with the trees (i.e. flowers, fruits) or other animals utilizing the trees and 2) the start of a complete ant species list and potential abundance/richness of ants on the Schoodic Peninsula.

An initial survey of Tardigrada in Acadia National Park

Joshua Pittendreigh, Briana Rago, and Emma Perry

Unity College, Unity, Maine

Maine is the easternmost state in the United States with an extensive tidal coastline and numerous small islands. Although the first tardigrade in North America was found in Maine, only two other papers have documented tardigrades in Maine. Acadia National Park is nestled along the Gulf of Maine. It encompasses 47,748 acres comprised of three different areas: Mount Desert Island, Schoodic Peninsula, and Isle Au Haut. Acadia National Park includes diverse habitats ranging from rocky coastlines to evergreen forests and freshwater lakes. Mount Desert Island is mostly made up of several forested granite mountains. Numerous hiking trails span these mountains and are found throughout the park. Samples were taken from near-trail locations on mountains along eight different hiking trails within the park. In total 93 samples of leaf

litter, moss and lichen were collected. From these samples we found 402 tardigrades of least nine species in the genera: *Milnesium*, *Macrobiotus*, *Minibiotus*, *Diphascon*, *Ramazzotius*, *Hypsibius*. These tardigrades were examined using brightfield, phase contrast, Nomarski differential interference contrast and autofluorescence microscopy to aid in their identification. Their distribution around and across the island is examined.

Understanding the macroalgal microbiome in the North Atlantic intertidal zone

Charlotte T.C. Quigley, Rémy Luthringer, Charlotte J. Royer, Hilary G. Morrison, and Susan H. Brawley

Intertidal macroalgae are exposed to stressful and variable thermal environments. Some bacteria associated with macroalgae affect their development, morphogenesis, and survival, but little is known about their specific identities and roles, and how the stressful intertidal environment shapes these relationships. We extracted DNA for identification of the bacteria associated with *Fucus vesiculosus* (a brown rockweed) and *Porphyra umbilicalis* (laver, a red alga) throughout their biogeographical ranges in the North Atlantic. In order to understand the effect of temperature on the microbiome of these algae, we have described associated thermal habitats from Greenland to North Carolina and from Norway to Spain, using iButton sensors (Maxim, Ltd), with deeper sampling at Schoodic Point (ANP), Maine. These data allow us to characterize the bacterial diversity on these ecologically-important species and to examine the relationship between abiotic stress (e.g. water and air temperature) and the stability of the algal microbiome across the North Atlantic. It is important to understand which bacteria are essential to algal development and function. To accomplish this, we are establishing sterile cultures of *F. vesiculosus* and *P. umbilicalis* for future inoculation experiments, where early development and gene expression of each alga will be studied following exposure to different core bacteria. Characterization of the bacteria associated with macroalgae across a broad range of temperatures will help to predict how future warming may affect algalmicrobial interactions, while the inoculation experiments will improve our understanding of the mutualistic relationships between macroalgae and their microbiomes. (Supported by NSF Awards #1442231 and 1442106; Dimensions of Biodiversity).

Copepod abundance in relation to megafauna presence off of Mount Desert Rock

Leah Davis Rubin

College of the Atlantic

13 Plankton tows were taken over the course of this study, during which megafauna presence was recorded both visually and acoustically. Acoustics were recorded by a digital acoustic monitoring (DMON) buoy deployed by Woods Hole Oceanographic Institution and analyzed by researchers from the Naval Facilities Engineering Command and Northeast Fisheries Science Center. Whale data was also collected visually by researchers from the Mount Desert Rock lighthouse. Plankton tows were conducted from an inflatable boat at two separate locations, a coast guard mooring to the west of the island and the DMON buoy to the east. Samples were analyzed using a compound microscope for total copepods, and copepod density was calculated. There was no linear correlation between the density of copepods and megafauna presence. Knowledge about the distribution of whales is pertinent to the tourism industry, conservationists, and scientists. Therefore, factors such as food availability offer important insight into megafaunal distribution. Multiple studies support the correlation between food availability and marine megafaunal distribution by individual species, including "Surface Foraging Behaviour of the North Atlantic Right Whale, *Eubalaena Glacialis*, and Associated Zooplankton Characteristics" by Mayo and Marx (1990), "Foraging Habits of Large Whales in the Gulf of Maine" by Beblowski (2014), and "Determination of Zooplankton Characteristics in the Presence of Surface Feeding Basking Sharks *Cetorhinus Maximus*" by Sims and Merrett (1997). This study aimed to reinforce previous work and attempt to expand knowledge about the Gulf of Maine.

Protecting seaweed habitat for fisheries and wildlife in Downeast Maine: which approach works best?

Robin Hadlock Seeley

Shoals Marine Laboratory, Appledore Island, Maine

Cornell University, Ithaca, New York

Rockweed (*Ascophyllum nodosum*) beds provides diverse and important ecological services to commercially important or ecologically-important marine species and wildlife. This habitat has been listed as Significant Wildlife Habitat (MDIFW/DEP), is Essential Fish Habitat (NOAA-NMFS), is listed as a high ranking species (above salmon and minke whales) in the Gulf of Maine, a “priority species” in Northern Ireland (Morton, 2011) and a “high-sensitivity species” in the UK (Hill and White, 2008). Efforts to protect rockweed habitat in Maine are 17 years old and have included diverse approaches to the conservation challenge: public education (including short documentary films and presentations), traditional hard-copy flyers, an oral history project, working with fishermen and land trusts, advocacy at the state level, and legal challenges. Which of these approaches works best, and where are we now in our protection efforts?

Eastern National Parks protect regionally significant older forest habitat

Camilla E. Seirup, Kate M. Miller, and Aaron S. Weed

Northeast Temperate Network, National Park Service

Forests in the eastern United States perform essential ecosystem services, provide food and habitat for countless organisms, and generate significant economic benefits to the region. In this study, we asked whether the protection status of parks (i.e. protected from logging) has resulted in structural forest differences compared with surrounding unprotected forests, which we refer to as matrix forests. We analyzed land-cover and forest vegetation data from nearly 25,000 permanent plots distributed across 50 national parks in the eastern United States, along with the matrix around each park, to examine structural characteristics of park forests in relation to their surrounding landscape. Over 2,000 of these plots are part of the National Park Service (NPS) Inventory and Monitoring Program (I&M), and the remaining 22,500+ plots are part of the US Forest Service (USFS) Forest Inventory and Analysis (FIA) Program. Results of this study indicate that, regardless of the type of national park (National Historical Park, National Monument, National Park, etc.), the majority of park forests are distinct from surrounding matrix forests. Park forests consistently had greater proportions of late-successional forest, greater live tree basal area, greater densities of live and dead large trees, and considerably larger volume of coarse woody debris. Park forests also had lower tree growth and mortality rates than matrix forests, which is also suggestive of older forests. Based on studies of habitat requirements for late successional bird

species and organisms dependent on dead wood, the differences in park and matrix forests are ecologically significant, with park forests protecting critical habitats that are otherwise deficient on the landscape. We therefore recommend that park managers continue to allow for natural disturbances and the development of complex forest structure in park forests despite potential outside pressure from the public or other park decision-makers to “clean up” the forest after disturbances such as windthrow or ice storms. Moving forward, eastern forests will continue to respond to climate change and other stressors, and the trends captured by long-term NPS I&M monitoring programs will provide valuable scientific insights into forest dynamics and important guidance for land managers.

A runoff-based vulnerability analysis to examine and communicate bacteria pollution dynamics along the Gulf of Maine coast

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The livelihoods and economies of coastal Maine residents are linked to the fate of water quality. Besides its obvious impacts on health, bacterial pollution in estuaries and beaches has major negative impacts on the multi-million dollar tourism and shell-fishing industries in the state. Local stakeholder groups recognize the need for a decision support system that would provide better informed regulations for contamination-related beach and clam flat closure and reopening. The New England Sustainability Consortium (NEST) is an interdisciplinary NSF EPSCoR funded project organized to strengthen the connection between science and decision-making and to advance the practice of sustainability science. Our objectives are to improve predictions of the magnitude and time interval of contamination events based on quantitative model scenarios and to improve lines of communication between stakeholders and researchers to provide a workable solution on issues of health and lost revenue. We use several analytical techniques to identify the common watershed and estuary characteristics of highly vulnerable locations on Maine’s coast, including the Frenchman Bay area surrounding Acadia National Park. Hydraulic models are used to determine the magnitude and the time-dependent pattern of discharge from the watersheds to the coastal estuaries and an estuary mixing model is used to determine the amount of time necessary to dilute bacteria-bearing surface runoff. By combining our statistical model results with fecal coliform count data, we find that the

primary trigger for high levels of bacterial contamination is building structure density (a proxy for the magnitude of human bacteria sources), while metrics that describe the delivery and residence time of water and pollutants have secondary influence. Results from our hydraulic models suggest that current regional closure policies can overestimate the time interval of contamination for some watershed and that new approaches for management based on quantitative models can provide greater economic stability while addressing public health risks.

The hydrologic signature of Acadia National Park

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The University of Maine's Watershed Process and Sustainability Research Group (WPS) initiated an effort to simulate runoff patterns in the Cromwell Brook watershed in 2014. The inspiration for the research is tied to establishment of a reference watershed for the New England Sustainability Consortium's (NEST) Safe Beaches and Shellfish Project. The NSF-funded NEST project is centered on strengthening the scientific basis for decision-making related to management of coupled socio-biophysical coastal systems. The research focuses on rules for closure of beaches and shellfish areas in response to bacterial pollution. One coupling that is important to the coastal systems is between precipitation, groundwater, and runoff because the rate of freshwater discharge from the watershed partly determines pollution loadings that affect estuary conditions. To quantify coastal conditions linked to the pollutant delivery, WPS has created a distributed hydrologic model for the Cromwell Brook watershed. The model integrates groundwater, surface water, recharge, and evapotranspiration processes. Parameterization of the model domain has required the creation of new watershed boundary and drainage network delineations. For model calibration we constructed discharge monitoring stations at the outlets of Cromwell Brook and its largest tributary, Kebo Brook. Results from the simulations provide new capacity to evaluate surface flows and water quality loads over varied time spans and watershed scenarios. The distributed model allows for quantification of the hydrologic effects from specific features such as upland ponds and lowland wetlands, and the implications of human-induced watershed alterations such as storm drains, culverts and dams. The model provides a platform for hind-casting and forecasting hydrologic conditions, and

comparison of the conditions in Acadia with national parks in other physiographic settings.

Sources, delivery and residence time of bacteria pollution along the Gulf of Maine Coast

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The New England Sustainability Consortium is an interdisciplinary NSF EPSCoR funded project organized to strengthen the connections between science and decision making and to advance the practice of sustainability science. The project uses complementary research capacity at several institutions to examine watershed and estuarine processes linked to bacteria pollution affecting shellfish harvesting and beach water quality in the Gulf of Maine. The effort is driving towards the development of decision support tools for the prediction of coastal bacteria pollution events that cause losses in tourism and shellfishery revenue for states along the Gulf of Maine. Enhanced prediction and communication of the events require a simultaneous examination of watershed runoff and pollution sources, drainage delivery systems, estuarine residence times and bacterial survival. Our presentation will summarize initial observations from our biophysical investigations and stakeholder engagement activities at two project reference sites located in Wells and Bar Harbor, Maine. These include field measurements, watershed and estuarine modeling outcomes, and stakeholder engagement results framed to quantify and explain land-sea interactions linked to bacterial pollution events in locations with varied relief, hydrodynamics, and stakeholder communities. At the scale of the entire Maine coastline, we highlight the pollution source, delivery, and residence time measurements and proxies that we use to predict vulnerability to bacteria problems in localized areas.

Habitat selection in the Leach's Storm Petrel on Great Duck Island

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The Leach's Storm Petrel (*Oceanodroma leucorhoa*) is a pelagic bird that breeds on islands. One of the largest known Storm Petrel colonies in the eastern United States is on Great Duck Island, (Lat. 44.14 N, Long 68.24 W). Great Duck is a 95 hectare granitic island, oriented due north to south with a long axis of 1,928 m, and a maximum width of 764 m. Approximately 5000 pairs of petrels share the island with Herring and Great Black-backed Gulls (*Larus smithsonianus* and *L. marinus*) The island's vegetation is dominated by spruce forest at its center and open meadow at the south end and along portions of the west side. During the summer of 2016 I identified habitat types on Great Duck preferred by the Leach's Storm Petrel based on burrow occupancy, density, hatching success, and breeding success measured within a grid composed of 20 by 20 m squares. Habitat type was divided into three main categories - forest, forest edge, and meadow. Areas within these categories were then described by factors including soil moisture, soil density, and distance to gull nests. I also examined differences and similarities between burrows in different habitats including burrow aperture and depth below the surface. Preliminary results suggest that the Leach's Storm Petrel prefers forest and forest edge to meadow habitats. These habitats were also furthest from nesting gull sub-colonies. My results are of particular concern due to the on-going decline of the island's spruce forest.

Implications of rapid climate change on lake algal ecology in Acadia National Park, U.S.A.

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Recent work has shown that average water clarity of lakes in Acadia has been decreasing since 1995. This decline corresponds to an increase in dissolved organic carbon (DOC) concentrations across the same set of lakes. It is believed that rapid

changes in climate conditions and patterns of atmospheric deposition have resulted in these shifts in DOC and subsequent declines in water clarity. In particular, extreme precipitation events are correlated with elevated lake water DOC concentrations. While much work has been done to document physical and chemical trends in Acadia lakes in recent decades, less is understood about associated biological trends. We have selected six important Acadia lakes with long-term biogeochemical data records on which to focus our study. Our goals are to: 1) evaluate changes in algal ecology and key water quality metrics seasonally and in response to extreme precipitation events; 2) create a catalog of current algal taxa in the six study lakes; and 3) quantify longer-term climate-driven changes in algal ecology. Beginning in the Spring of 2016 we have collected data from a spring, summer, and single storm sampling and evaluated some of these key water quality metrics. It is our goal that these results will be useful for informing resource management plans for lakes and ponds in Acadia National Park.

National Parks and America's scientific heritage

Tim Watkins¹, Jill Baron² and Noel B. Pavlovic²

1 National Park Service

2 U.S. Geological Survey

Some national parks protect places that have played important roles in the development of major scientific ideas and practices. For instance, in the late 1890s the dunes at the southern end of Lake Michigan, which are now protected within Indiana Dunes National Lakeshore, provided the first evidence for succession in plant communities. Succession has been one of the most important and influential concepts in ecology ever since. Parks such as INDU are valuable not only for protecting natural and cultural resources, but also for revealing our intellectual heritage and the development of scientific ideas. We are starting a project to find and tell digital stories of such intellectual heritage, and we invite your participation.

Hot rocks, hot water: Northeastern Coastal Stations Alliance intertidal temperature data, Summer 2016

Hannah Webber¹ and Caitlin Cleaver²

1 Schoodic Institute at Acadia National Park, Winter Harbor, Maine

2 Hurricane Island Foundation

From 2004 to 2013 the sea surface temperature in the Gulf of Maine rose faster than 99% of the global ocean (Pershing et al. 2015). The data for the Pershing et al. analysis came from satellite-derived sea surface temperatures. Data from intertidal locations around the edge of the Gulf can add to our understanding of change in the coastal zone. The Northeastern Coastal Stations Alliance (NeCSA) is a newly formed network of small field stations spanning the Gulf of Maine—from the Maine/New Hampshire border to Nova Scotia. All stations are committed to using and leveraging existing resources (location, personnel, equipment) to contribute coupled abiotic and biotic data to each other and to the larger community to understand change in the Gulf of Maine. The stations range in capacity, structure and mission. Coordinating and sustaining data collection and sharing efforts that fit across a range of capacities requires good communication and iteration. In Summer 2016 we distributed autonomous temperature loggers (Onset® TidbiT® v2 Temp Data Loggers) and a simple, low cost deployment protocol to ten NeCSA field stations to explore standardized methodologies and best practices for data sharing, and to inform our growth as an alliance. We share intertidal temperature data from the summer and insights into the development of our alliance.

Managing glossy buckthorn in the Cromwell Brook watershed of Acadia National Park, Maine

Jesse Wheeler, Joseph Kelley, James Burka and Alexander Fetgatter

National Park Service, Acadia National Park, Bar Harbor, Maine

Glossy (alder) buckthorn, *Rhamnus frangula*, was identified as an exotic invasive plant and deemed a major threat to the natural areas of Great Meadow within the Cromwell Brook Watershed in 2008. The 115-acre Great Meadow is one of the largest palustrine wetlands in Acadia National Park. The Wild Acadia initiative, led by Friends of Acadia and supported by Canon, USA Inc., has allowed the NPS to rehabilitate and protect ecosystem function in the Cromwell Brook Watershed. After nine years of management, including multiple treatments in most areas, vegetative stems of glossy buckthorn have decreased by 88% and most of the reproductive individuals have been eliminated from the wetland.

Using seabirds to track ecosystem change in the Gulf of Maine

Linda Welch, Sara Williams, and Michael Langlois

Maine Coastal Islands NWR, Milbridge, Maine

For the past 30 years, Maine Coastal Islands NWR, National Audubon Society, and Maine Department of Inland Fisheries and Wildlife have documented annual population levels, productivity rates, diet composition and feeding rates on 11 managed seabird colonies in Maine. While extensive data has been collected at the colonies, we know very little about the at-sea ecology of birds in the Gulf of Maine. While seabird must return to land to raise their young, they spend the majority of their time at sea foraging for themselves and their chicks. As a result, seabirds are intimately linked to physical and biological characteristics of marine ecosystems. Seabirds need persistent aggregations of prey to be located within commuting distance of their breeding colonies. Recently, seabird managers have observed what appear to be significant changes in forage fish abundance and availability for breeding seabirds. Several colonies have abandoned or experienced complete reproductive failure due to lack of available forage fish. We have also observed declines in chick growth and productivity rates. Seabirds are more easily observed, counted, and studied than other marine organisms and changes in ecosystem function will be evident in these upper trophic level predators. We believe that our long-term monitoring efforts at the breeding colonies provide critical evidence that the productivity of the Gulf of Maine has significantly decreased in recent years. We are currently collaborating with several integrated ecosystem based projects to insure that seabirds remain a viable component of the Gulf of Maine ecosystem.
