Monitoring During a Climate of Change

Long-term monitoring documents ecological and physical responses to climate change

Background

In a 2010 interview, National Park Service Director Jon Jarvis stated that climate change is "the greatest threat to the integrity of the National Park System that we've ever faced." Climate impacts related to human activities are being felt across the planet, and the Northeast is no exception. Since 1970 the annual average temperature in the Northeast has increased by 2°F, with winter temperatures rising twice as much. This warming has resulted in many other climate-related changes, including more summer days with temperatures above 90°F, more winter precipitation falling as rain, earlier snow melt resulting in earlier peak river flows, and rising sea surface temperatures and sea level in coastal states [1]. Heat influences many aspects of Earth's hydrologic systems, such as precipitation, snow, ice, and permafrost, which in turn affects plant and animal life and natural processes such as fire, phenological cycles, and the severity of weather events. A warm atmosphere holds significantly more moisture than a cool one. Depending on weather conditions, much of this moisture eventually makes its way to the earth in the form of rain or snow. Heavy downpours have increased in frequency and intensity in the Northeast, where a 67% increase in the amount of water falling during very heavy precipitation events has been documented over the period spanning 1958 to 2007 [2].

In order to continue to fulfill its mission of leaving parks "unimpaired for the enjoyment of future generations" the National Park Service is looking at new ways to think about, and plan for, the effects of climate change. Monitoring natural resources in our national parks is an important aspect of this planning and helps park managers understand how ecological systems react and respond to a changing climate. With this relevant and long-term information at hand, better informed managers can make better informed decisions about how to direct their natural resource programs. The Northeast Temperate Network (NETN) of the Inventory & Monitoring (I&M) Program has many ongoing and expanding monitoring, data management, and other well-established projects important for tracking the current and future effects of climate change.

NETN Climate-related Programs

Historic & Current Weather Data

NETN is currently compiling decades of climatic data for network parks. Data for all units show that as temperatures have increased in the Northeast, so has the amount of precipitation.

Freshwater Monitoring

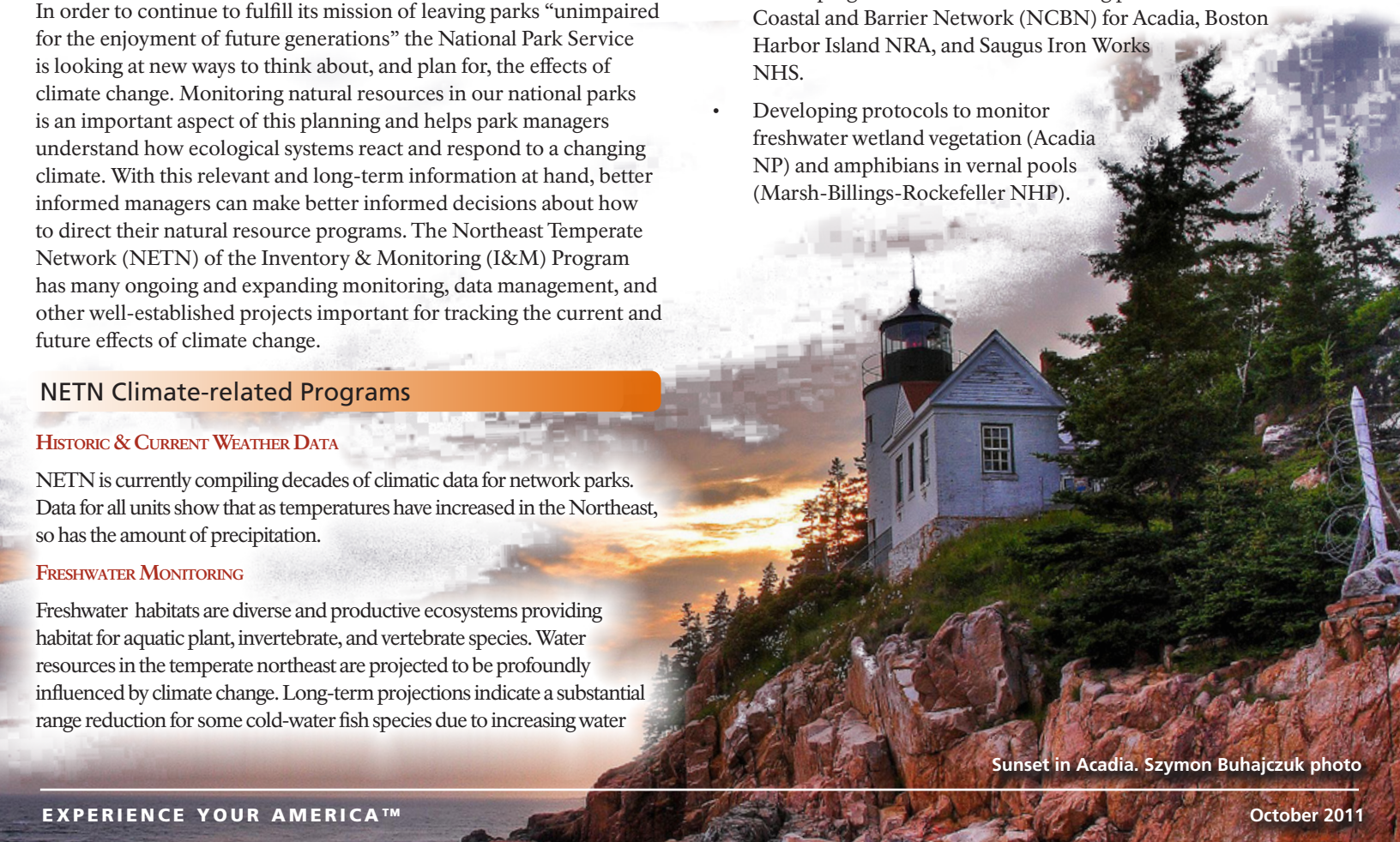
Freshwater habitats are diverse and productive ecosystems providing habitat for aquatic plant, invertebrate, and vertebrate species. Water resources in the temperate northeast are projected to be profoundly influenced by climate change. Long-term projections indicate a substantial range reduction for some cold-water fish species due to increasing water temperatures. The network's ongoing water quality and quantity monitoring will continue to provide valuable data on hydrological changes in network parks. Current and developing projects include:

- Timing and quantity of flows at continuous stream / river gauging stations in Acadia NP and Saugus Ironworks NHS.
- Installation of continuous temperature and water sensors at many ponds and stream sites.
- Vernal pool (parks TBD) and freshwater wetland monitoring program under development that includes temperature and water-level loggers (Acadia NP).

Fauna & Flora Monitoring

As changes in climate continue to affect distribution and quality of plant and wildlife habitat in both the interior and coastal regions of the Northeast, careful and accurate monitoring of key species will provide vital data on the ways ecosystems are being affected by climate change. Monitoring projects include:

- Since 2006, tracking presence and relative abundance of forest (most parks), grassland (Saratoga NHP), coastal (Boston Harbor Islands NRA), and mountain (Appalachian NST) breeding bird species.
- Developing tidal marsh bird monitoring protocol with Northeast Coastal and Barrier Network (NCBN) for Acadia, Boston Harbor Island NRA, and Saugus Iron Works NHS.
- Developing protocols to monitor freshwater wetland vegetation (Acadia NP) and amphibians in vernal pools (Marsh-Billings-Rockefeller NHP).



Sunset in Acadia. Szymon Buhajczuk photo

- Since 2006, monitoring forest health in network parks. Data gathered includes tree growth, mortality, regeneration, and understory species presence/abundance. In addition, rare plant species and community monitoring along the Appalachian Trail will detect changes in known occurrences.
- Since the late 1990's, the U.S. Forest Service (USFS) Forest Inventory and Analysis program has installed nearly 4,100 sampling plots near the Appalachian Trail. This collection of plots is part of a national network that the USFS uses to report on things such as tree health, growth, and mortality. NETN has developed a process to use the data to characterize the condition of forest resources around the Appalachian Trail. These data establish a meaningful baseline that should help detect and interpret climate-driven change that may affect the region in the future.

Phenology Monitoring

Phenology is the study of periodic plant and animal life-cycle events and how they are influenced by seasonal and inter-annual variations in climate, and is a key indicator of the pace of climate change. NETN has partnered with the USA National Phenology Network, Appalachian Mountain Club, University of Vermont, Harvard University, and others to develop methods for monitoring phenology that could be used in areas beyond NETN parks. Phenology-related projects and events in the network include:

- Pilot phenology monitoring began in 2009 and continues in Acadia, Appalachian NST, Boston Harbor Islands NRA, Saugus Iron Works NHS, and Marsh-Billings-Rockefeller NHP. Trained volunteers observed phenophases of target species of plants and animals with automatic PlantCam® photography of selected plants used as quality control.
- NETN and partners are on target to complete a multi-method phenology monitoring protocol by the end of 2012. The protocol will feature observational, acoustic, and photographic data, often collected by citizen scientists with appropriate levels of quality control. The protocol should be suitable for implementation nation-wide.
- In 2010, NETN and Marsh-Billings-Rockefeller NHP collaborated with local teachers to produce a middle school and high school curriculum about phenology.

Coastal & Saltwater Resources

With a warming climate comes sea level rise, creating the potential for the submergence of salt marshes and the loss of coastal habitat. There is increasing evidence in the northeastern U.S. that some marsh sites may already be at the early stages of wetland submergence and projected sea-level rise will greatly alter intertidal and estuarine habitat.

At the intersection of terrestrial, freshwater, and marine systems, estuaries and marine wetlands serve a number of important functional roles and are important areas of ecological productivity and exchange. These areas provide nursery habitat for a variety of important fisheries, serve as a resource for migrating birds, and act as natural hydrologic, nutrient, sediment, storm, and wave energy buffers. Coastal monitoring strategies being developed by NETN include:

- In collaboration with NCBN, USGS, NOAA, and the Southeast Coast I&M Network, Surface Elevation Table (SET) and Marker Horizon Method monitoring programs were initiated at Boston Harbor Islands and Acadia NP in 2009 and 2010. The monitoring method measures accretion and erosion by repeated sampling of the height of the marsh relative to a fixed point and depth to artificial marker horizon plots.
- Rocky intertidal monitoring program continues to progress at Boston Harbor Islands and Acadia with sea-temperature loggers and additional permanent bolts placed along surveyed vertical transects in 2010 to document sea-level rise with more detail.
- Implementing the NCBN protocols for estuarine monitoring in Acadia NP. Salt marsh vegetation monitoring using NCBN's protocol began in brackish marshes at Acadia and Boston Harbor Islands in 2010. Estuarine water quality monitoring began in Acadia in 2011.

SET monitoring site being set up on Acadia NP's Schoodic peninsula. NPS photo.

More Information

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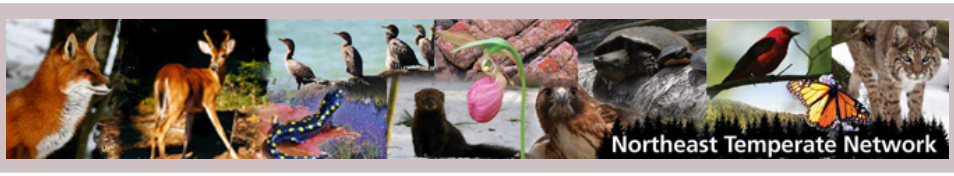
Links & Resources

NETN website: *www.science.nature.nps.gov/im/units/netn/*

[1] Climate Change in the U.S. Northeast, Union of Concerned Scientists, UCS Publications. 2006.

[2] Global Climate Change Impacts in the United States, Thomas R. Karl, Jerry M. Melillo, and Thomas C. Peterson, (eds.). Cambridge University Press, 2009.

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