

INTRODUCTION

Acadia National Park is the only National Park in the northeastern United States. With more than 40,000 acres it is one of the largest publicly owned and protected natural areas in the region. Northern coniferous and temperate deciduous forest meet and overlap at Acadia, resulting in a rich and diverse flora of approximately 1200 species, and more than 330 bird and 50 mammal species. Acadia NP has more 52 miles of spectacular rocky shoreline with steep cliffs, sand and boulder beaches, and tidal pools containing abundant marine life.

Located along the mid-coast of Maine, Acadia National Park (ANP) contains at least 22 named lakes and ponds, more than 25 perennial and intermittent streams, and numerous wetlands located partially or entirely within it's boundaries. Six lakes within or adjacent to the park are designated public drinking water sources for several surrounding communities. All these water bodies are exposed to impacts resulting from development within and adjacent to park lands, including sewage disposal, and non-point source pollution. Other impacts to ANP water resources may come from oil or hazardous waste spills, landfill activity, high visitor use, and atmospheric deposition. Lake monitoring by park staff began in the late 1970's, in cooperation with the Maine Department of Environmental Protection (DEP). These efforts consisted primarily of monitoring secchi disk transparency and surface temperature in several selected lakes on Mount Desert Island. This program continues today, with monitoring expanded to include measurement of a larger variety of chemical and physical parameters. Additional studies and monitoring include benthic stream macroinvertebrate sampling (1997-present), bacterial monitoring of ANP swim beaches (1993-1996), water resource baseline data and analysis of acid deposition impacts (1985, '87, '94), and mercury contamination in freshwater aquatic habitats (1995-1997). A major research initiative at the watershed scale was started in 1999 to comprehensively assess the impacts of atmospheric deposition and mercury cycling on park resources.

The water resource program at Acadia NP is a collaborative effort involving the National Park Service's Water Resource Division, the Maine Department of Environmental Protection, the US Geological Survey the University of Maine at Orono, and park natural resource staff. A Water Resource Management Plan has recently been completed and a Freshwater Monitoring Plan is being developed to provide program direction and management guidance on major water-related issues, which are complicated by overlapping jurisdiction and management objectives between state, town, and park interests.

ATMOSPHERIC DEPOSITION AND CONTAMINANT RESEARCH

Atmospheric Deposition (Heath, Kahl, Norton. *University of Maine*)- Over the past 15 years, several studies have been conducted to document the effects of atmospheric and marine aerosol deposition on ANP water bodies. Baseline lake chemistry measurements have been periodically replicated and data trends have been compared with those of precipitation chemistry. Researchers have also utilized stream samples and calibrated watersheds to analyze deposition effects. Despite significant reductions in sulfur dioxide emissions and sulfate deposition during the past decade as a result of the Clean Air Act Amendments of 1990,, the pH and acid neutralizing capacity of park waters remains relatively unchanged.

Evaluate Mercury Contamination in Aquatic Environments (Haines. *University of Maine*)- This study evaluated mercury concentrations in fish from lakes in ANP and Cape Cod National Seashore, along with broader ecosystem implications. In some warm water species (bass, perch, pickerel) from selected lakes, mercury concentrations were above US EPA human health standard of 1 part per million. Concentrations in cold water species (trout, salmon) are generally within acceptable limits. Additional research is investigating atmospheric deposition of mercury in sediment cores and cycling through watersheds, and mercury concentrations in other fauna including loons, mergansers, tree swallows, and turtles.

NUTRIENT LOADING AND HABITAT RESEARCH

Nutrients (Doering, Farris, Kinney, Roman. *University of Rhode Island*)- Nutrient cycling, salinity levels, dissolved oxygen patterns, and primary production have been studied at both Bass Harbor Marsh and Somes Sound, two of the park's estuarine/marine resources. A similar study of the Northeast Creek estuary, conducted by researchers from the University of Rhode Island and the US Geological Survey, began in the Spring of 1998. Another study by the USGS starting in 2000, will utilize data from Northeast Creek, Bass Harbor marsh, and other park wetlands to develop key indicators of wetland function that can be used to develop a model to predict future change to park wetland systems.

Wetlands (Calhoun, et al. *University of Maine*)- A comprehensive study to describe the wetlands of ANP was conducted by the University of Maine, Maine Agricultural and Forest Experiment Station, US Fish & Wildlife Service, and the National Park Service, culminating in a 1994 technical report. The report discussed the soils, hydrology, vegetation, utilization by fauna, and the ecological and cultural values of wetlands, as well as information on their size and distribution.

Inventory of Fish Resources of Acadia National Park with Emphasis on Wild Brook Trout. (Moring, Le, Stone, *University of Maine*)- This recently completed study, was conducted in three phases: Phase I assessed the current state of knowledge concerning fish resources and fish management practices at the park. Phase II involved inventory work in park streams and lakes to survey fish species and assess fish habitats. Phase III focused on wild brook biology and ecology in the park.

PRIMENet PROGRAM

The **P**ark **R**esearch and **I**ntensive **M**onitoring of **E**cosystems **N**etwork (PRIMENet) is a cooperative USEPA/NPS long-term research and monitoring program designed to assess the effects of environmental stressors on ecological resources. Acadia is one of 14 National Parks nationwide that have been established as regional index sites to monitor environmental stressors and related ecosystem response. In addition to the core air and water monitoring programs, ultraviolet radiation (UV-B) monitoring using a Brewer Spectrophotometer was initiated in 1998. Initial research is planned to assess the potential impacts of UV-B to amphibian populations. Other research is being conducted to better assess the ecological effects of atmospheric deposition of nitrogen and mercury at both the watershed and landscape scales. Two hydrologically gauged-watersheds with differing ecological characteristics (one burned by a major fire, and another unburned) will be studied to compare

patterns and processes in nitrogen and mercury retention and mobility. Input measurements of direct deposition and canopy throughfall will be compared to output concentrations (stream discharge) to determine nitrogen retention levels in soils, locations and processes of mercury speciation, and estimate nitrogen loading to adjacent estuaries. Current and historical vegetative histories, soil characterizations, and forest health assessments are being made for both watersheds.

Another study is evaluating the spatial (landscape and topography) patterns of atmospheric deposition to determine potential 'hotspots' of deposition. This study is designed to provide data necessary to develop a modeling capability that will allow point measurements of atmospheric deposition to be scaled to whole landscapes. Three hundred deposition collectors will be arrayed over varied terrain throughout the park, and a GIS-based approach will be used to develop the model.

Forested Watershed Nitrogen Cycling and Estuarine Loading

This USGS study, started in 1998, is designed to document the spatial variability of nitrogen loading to major estuaries on Mount Desert Island by measuring nitrogen concentrations and other chemical parameters in 10 park streams. This study will utilize data from the two PRIMENet calibrated watersheds, fire history, hydrogeology and landuse to expand the spatial understanding of stream water quality at Acadia.

ACADIA NATIONAL PARK WATER MONITORING

ANP Water Monitoring Program objectives are to: 1) provide baseline data on park water resources, 2) serve as an early warning system for anthropogenic impacts and threats such as non-point source pollution (cultural eutrophication), acid deposition, and climate change, 3) assist in identifying potential sources of pollution. and 4) track trends.

Lake Monitoring

- * 1980- present.
- * Documents change due to eutrophication and atmospheric deposition.
- * Monitoring parameters: Temperature, dissolved oxygen, transparency, pH, specific conductance, alkalinity, color, total phosphorus, total nitrogen, chlorophyll *a*, lake stage, and light penetration.

Bacteriological Monitoring of Swim Beaches

- * 1993- 1996.
- * Monitored guarded freshwater and marine beaches and unguarded lake beach for indicator bacteria of swimming-related illness.
- * Monitoring parameters: *E. coli*, *Enterococci*.

Benthic Stream Macroinvertebrate Monitoring

- * 1997- present.
- * Provides baseline information on numbers and diversity of macroinvertebrates in ANP streams and brooks.
- * Monitoring parameters: Benthic macroinvertebrates, habitat characterization, stream temperature, pH, dissolved oxygen, specific conductance, color, and flow rate.

Atmospheric Deposition

- * National Atmospheric Deposition Program (NADP): 1980 - present
- * Mercury Deposition Network (MDN): 1995 - present

Geographic Information System (GIS) Applications

- * ArcView databases include shoreline, lakes, streams, watersheds, soils, vegetation, land use/ownership, wetlands, topography, roads, trails, etc. for park lands and surrounding environs.
- * A watershed atlas is being developed to link water quality and spatial data and allow analysis of the effects of watershed characteristics on water quality.

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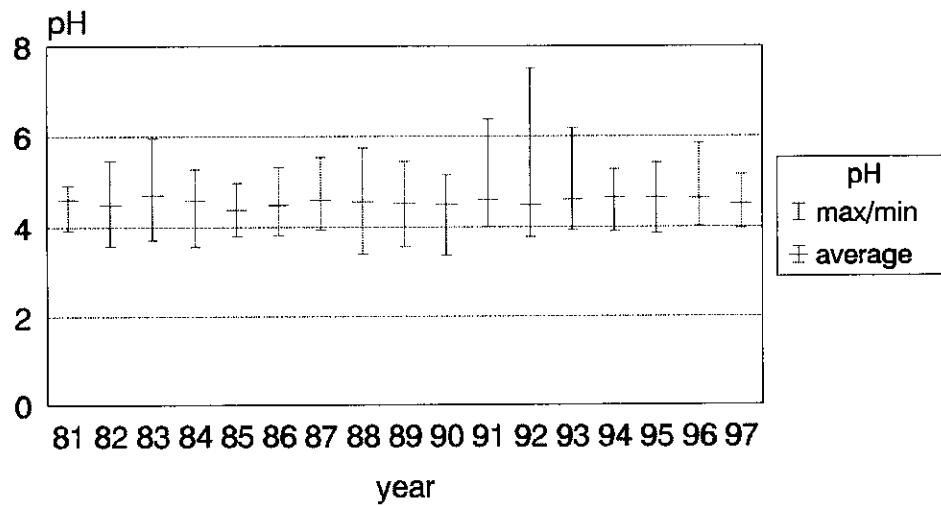
Table 2. Acadia NP Atmospheric Deposition Data Summary 1982-1997

DEPOSITION					
<u>YEAR</u>	<u>MAX. PH</u>	<u>MIN. PH</u>	<u>MEAN PH</u>	<u>SULFATE (KG/HA)</u>	<u>NITRATE (KG/HA)</u>
<u>1982</u>	<u>6.14</u>	<u>3.58</u>	<u>4.49</u>	<u>22.7</u>	<u>11.1</u>
<u>1983</u>	<u>5.90</u>	<u>3.70</u>	<u>4.71</u>	<u>23.0</u>	<u>10.4</u>
<u>1984</u>	<u>5.40</u>	<u>3.20</u>	<u>4.59</u>	<u>22.0</u>	<u>11.0</u>
<u>1985</u>	<u>5.60</u>	<u>3.80</u>	<u>4.39</u>	<u>20.2</u>	<u>11.5</u>
<u>1986</u>	<u>5.30</u>	<u>3.80</u>	<u>4.49</u>	<u>23.7</u>	<u>12.2</u>
<u>1987</u>	<u>5.50</u>	<u>3.50</u>	<u>4.60</u>	<u>16.8</u>	<u>8.7</u>
<u>1988</u>	<u>5.80</u>	<u>3.40</u>	<u>4.56</u>	<u>19.5</u>	<u>10.0</u>
<u>1989</u>	<u>5.50</u>	<u>3.60</u>	<u>4.54</u>	<u>21.1</u>	<u>12.5</u>
<u>1990</u>	<u>5.20</u>	<u>3.70</u>	<u>4.51</u>	<u>22.7</u>	<u>14.6</u>
<u>1991</u>	<u>5.50</u>	<u>4.00</u>	<u>4.62</u>	<u>16.5</u>	<u>9.8</u>
<u>1992</u>	<u>7.50</u>	<u>3.78</u>	<u>4.50</u>	<u>18.1</u>	<u>12.4</u>
<u>1993</u>	<u>6.19</u>	<u>3.95</u>	<u>4.62</u>	<u>16.9</u>	<u>11.3</u>
<u>1994</u>	<u>5.28</u>	<u>3.90</u>	<u>4.66</u>	<u>15.9</u>	<u>9.1</u>
<u>1995</u>	<u>5.42</u>	<u>3.86</u>	<u>4.66</u>	<u>16.5</u>	<u>10.6</u>
<u>1996</u>	<u>5.83</u>	<u>4.03</u>	<u>4.64</u>	<u>15.0</u>	<u>10.7</u>
<u>1997</u>	<u>5.16</u>	<u>3.98</u>	<u>4.52</u>	<u>16.2</u>	<u>11.3</u>

Source: National Atmospheric Deposition Program

Acidity of Wet Deposition, pH

Acadia National Park, 1981-1997



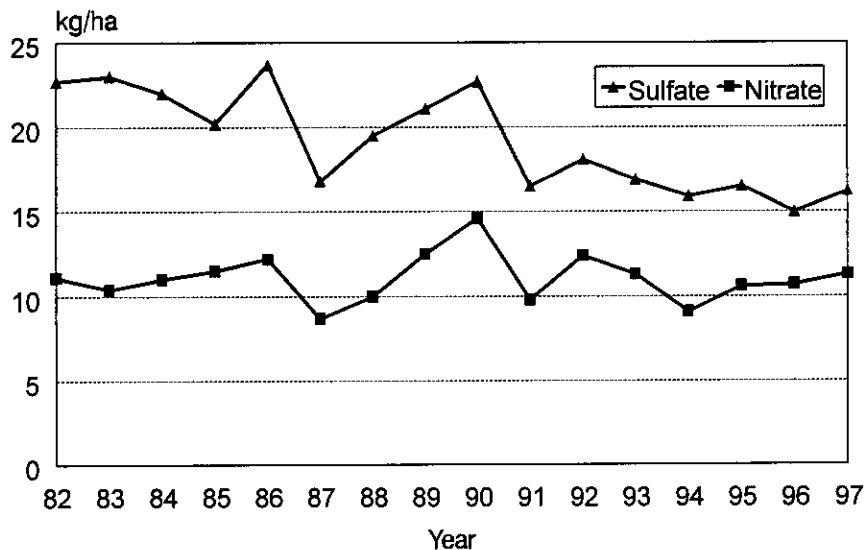
source: National Atmospheric Deposition Program

Figure 3.

Figure 4.

Sulfate/Nitrate Deposition (kg/ha)

Acadia National Park, 1982-1997



source: National Atmospheric Deposition Program

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