

AIR QUALITY MONITORING CONSIDERATIONS FOR THE NORTHEAST COASTAL AND BARRIER NETWORK

April 2002

Introduction

The NPS Air Resources Division (ARD) contracted with the University of Denver (DU) to produce GIS-based maps and an associated look-up table that provide baseline values for a set of air quality parameters for all Inventory and Monitoring parks in the U.S. These maps and table will serve as the Air Quality Inventory for the parks. ARD used preliminary DU products to help develop a strategy for expanding NPS ambient air quality monitoring with increased funding from the Natural Resources Challenge. At this time, ARD does not intend to fund additional monitoring at any NPS units in the Northeast Coastal and Barrier Network. The air monitoring strategy will be revisited in FY 2004 if additional funding becomes available. Draft Air Quality Inventory products are available on the NPS Intranet (at <http://www2.nrintra.nps.gov/ard/> under "Air Atlas") and are provided in an attachment to this report. Final products will be available on the NPS Internet in a few months.

Data from the Air Quality Inventory, national air monitoring programs described below, and other air quality sources, were used in conjunction with park-specific resource information to evaluate the following needs relative to the Northeast Coastal and Barrier Network: 1) the need for additional ambient air quality monitoring at any Network park, i.e., wet deposition, dry deposition, visibility, and/or ozone monitoring, and 2) the need for air quality effects-related monitoring at any Network park. The results of this evaluation, as well as a brief summary of results of past air quality monitoring at relevant sites, are discussed below.

Wet Deposition

The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) is a nationwide network of precipitation monitoring sites. The network is a cooperative effort between many different groups, including the U.S. Environmental Protection Agency (EPA), U.S. Geological Survey, U.S. Department of Agriculture, and private entities. The NPS is a major participant in NADP/NTN, and the ARD recommends that any new wet deposition site installed in a park meet NADP/NTN siting criteria and follow NADP/NTN protocols. There are currently more than 200 NADP/NTN sites spanning the continental U.S., Alaska, Puerto Rico, and the Virgin Islands.

The purpose of the network is to collect data on the chemistry of precipitation to monitor geographical and temporal long-term trends. The precipitation at each station is collected weekly according to strict clean-handling procedures. It is then sent to the Central Analytical Laboratory in Illinois where it is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium and sodium). NADP/NTN's excellent quality assurance programs ensure that the data remain accurate and precise. The National Atmospheric Deposition Program has also expanded its sampling to include the Mercury Deposition Network (MDN), which currently has over 35 sites. The MDN was formed in 1995 to collect weekly samples of

precipitation, which are analyzed for total mercury. The objective of the MDN is to monitor the amount of mercury in precipitation on a regional basis.

Two of the eight Northeast Coastal and Barrier Network units currently have a NADP/NTN monitor on-site (Assateague Island National Seashore (NS) and Cape Cod NS); the rest of the parks have a monitor within 85 miles. Many of the closest NADP/NTN monitors are inland of the parks. The distance to, and location of, these NADP/NTN sites is problematic, because in coastal areas, there can be substantial differences in wind patterns, and localized meteorology may significantly affect pollutant deposition. The Wye, Maryland, site is probably representative of George Washington Birthplace National Monument (NM) and Thomas Stone National Historic Site (NHS). However, existing wet deposition monitoring may not be adequate for Colonial National Historical Park (NHP), or for the three units in New York City--Gateway National Recreation Area (NRA), Fire Island NS, and Sagamore Hill NHS. A NADP/NTN wet deposition site costs \$5,000 to \$8,000 for equipment purchase and installation, and operating costs (including site operation, chemical analysis, and reporting) are about \$7,000 per year. The Network may want to consider conducting wet deposition monitoring in Colonial NHP or in a New York City park if eutrophication is a concern.

There are no MDN sites located near parks in the Northeast Coastal and Barrier Network. The closest sites are in Freeport, Maine (site #ME96); Milford, Pennsylvania (site #PA72); and Pettigrew State Park, North Carolina (site #NC42). The NPS will be installing a MDN site in Shenandoah NP in FY2003. Adding mercury sampling to a NADP/NTN site increases annual costs by about \$3,000.

Deposition varies with the amount of annual on-site precipitation, and is useful because it gives an indication of the total annual pollutant loading at the site. Concentration is independent of precipitation amount, therefore, it provides a better indication of whether ambient pollutant levels are increasing or decreasing over the years. In general, annual average wet deposition and concentration of sulfate, nitrate, and ammonium are higher in the eastern than in the western U.S. (see attached Draft Air Inventory maps and NADP/NTN maps at <http://nadp.sws.uiuc.edu>). At many NADP/NTN sites across the U.S., concentration and deposition of sulfate have declined in recent years as sulfur dioxide emissions have decreased. Trends have been variable for nitrate and ammonium, with concentration and deposition at various sites increasing, decreasing, or showing no overall change. Results from NADP/NTN sites in and near Northeast Coastal and Barrier Network parks are summarized below.

Cape Cod, MA

The Cape Cod, Massachusetts, NADP/NTN site (site #MA01 (North Atlantic Coastal Laboratory)) was installed in 1981. To date, site data have not met the completeness criteria required for NADP/NTN to perform trend analyses. However, a review of site data suggests a decrease in concentration and deposition of wet sulfate.

Wye, MD

The Wye, Maryland, NADP/NTN site (site #MD13) has been operating since 1983. Site data show a decrease in concentration and deposition of wet sulfate; a slight decrease in concentration of wet nitrate; and no overall trend in wet nitrate deposition, wet ammonium concentration, or wet ammonium deposition.

Assateague Island NS, MD

The Assateague Island NS, Maryland, NADP/NTN site (site #MD 18) was installed in September 2000. Trend data are not yet available for the site.

Edwin B. Forsythe NWR, NJ

The Edwin B. Forsythe National Wildlife Refuge, New Jersey, NADP/NTN site (site #NJ00 (Brigantine)) was installed in 1998. Trend data are not yet available for the site.

Pennington, NJ

Pennington, New Jersey, has had an NADP/NTN site (site #NJ99 (Washington Crossing)) since 1981. Site data show a decrease in concentration and deposition of wet sulfate; no overall trend in concentration and deposition of wet nitrate; and no overall trend in concentration and deposition of wet ammonium.

West Point, NY

The West Point, New York, NADP/NTN site (site #NY99) was installed in 1983. Site data show a decrease in concentration and deposition of wet sulfate; a decrease in concentration and deposition of wet nitrate; and an increase in concentration and deposition of wet ammonium.

Prince Edward County, VA

An NADP/NTN site was installed in Prince Edward County, Virginia (site #VA24) in 1999. Trend data are not yet available for the site.

Dry Deposition

The Clean Air Status and Trends Network (CASTNet) is considered the nation's primary source for atmospheric data to estimate dry acidic deposition. Established in 1987, CASTNet now comprises over 70 monitoring stations across the U.S. The majority of the monitoring stations are operated by EPA; however, approximately 20 stations are operated by the NPS in cooperation with EPA. Each CASTNet dry deposition station measures: weekly average atmospheric concentrations of sulfate, nitrate, ammonium, sulfur dioxide, and nitric acid; hourly concentrations of ambient ozone; and meteorological conditions required for calculating dry deposition rates. Dry deposition rates are calculated using atmospheric concentrations, meteorological data, and information on land use, vegetation, and surface conditions. CASTNet complements the database compiled by NADP/NTN. Because of the interdependence of wet and dry deposition, NADP/NTN wet deposition data are collected at or near all CASTNet sites. Together, these two long-term databases provide the necessary data to estimate trends and spatial patterns in total atmospheric deposition. The ARD recommends that all new dry deposition sites installed in parks use CASTNet siting criteria and follow CASTNet protocols.

None of the Northeast Coastal and Barrier Network parks have a CASTNet monitor on-site; all have a monitor within 100 miles. As with the NADP/NTN sites, distance to, and direction from, parks may limit the usefulness of the CASTNet data. The Blackwater NWR, Maryland, data are probably adequate for Assateague Island NS, George Washington Birthplace NM, and Thomas Stone NHS. The other parks likely do not have representative CASTNet data. Nevertheless, given the expense of dry deposition monitoring, unless there is a particular need to quantify dry deposition in a park, the ARD does not recommend the Network fund CASTNet monitoring. Installation and annual operating costs for a CASTNet site are about \$50,000 and \$15,000, respectively.

Because CASTNet uses different monitoring and reporting techniques than NADP/NTN, the dry deposition amounts are reported here as nitrogen and sulfur, rather than nitrate, ammonium, and sulfate. In addition, because CASTNet calculates dry deposition based on measured ambient concentrations and estimated deposition velocities, there is greater uncertainty in the reported values. Due to the small number of CASTNet sites nationwide, use of dry deposition isopleth maps is not advised at this time. CASTNet data collected near Northeast Coastal and Barrier Network parks is summarized below.

Abington, CT

The Abington, Connecticut, CASTNet site (site #ABT147) has been in operation since 1993. There have been decreasing trends in both dry nitrogen and dry sulfur deposition at the site. Total nitrogen deposition at Abington is composed of 24 percent dry deposition and 76 percent wet deposition, while total sulfur deposition is 21 percent dry and 79 percent wet.

Blackwater NWR, MD

A CASTNet site has been operating at Blackwater NWR, Maryland, (site #BWR139) since 1997. Site data indicate a decrease in dry sulfur deposition, but no trend in dry nitrogen deposition. CASTNet estimates total nitrogen deposition at the site is composed of 39 percent dry deposition and 61 percent wet deposition, while total sulfur deposition is 42 percent dry and 58 percent wet.

Pennington, NJ

A CASTNet site has been operating at Pennington, New Jersey, (site #WSP144 (Washington Crossing)) since 1988. Site data indicate a decrease in dry sulfur deposition, but no trend in dry nitrogen deposition. CASTNet estimates total nitrogen deposition at the site is composed of 38 percent dry deposition and 62 percent wet deposition, while total sulfur deposition is 49 percent dry and 51 percent wet.

Prince Edward County, VA

A CASTNet site has been operating at Prince Edward County, Virginia, (site #PED108) since 1987. Site data show a decrease in dry sulfur deposition, but no trend in dry nitrogen deposition. CASTNet estimates total nitrogen deposition at the site consists of 35 percent dry deposition and 65 percent wet deposition, while total sulfur deposition is 33 percent dry and 67 percent wet.

Surface Water Chemistry

For most inland parks, the greatest concern relative to atmospheric deposition and surface water chemistry is acidification. For the parks in the Northeast Coastal and Barrier Network, the bigger concern is eutrophication from nitrogen (nitrate and ammonium) deposition. Because the Network already has a very knowledgeable team investigating the need to monitor eutrophication in various parks, the issue will not be addressed in this report.

Visibility

In 1985, in response to the mandates of the Clean Air Act, Federal and regional/state organizations established the Interagency Monitoring of Protected Visual Environments (IMPROVE) program to protect visibility in Class I air quality areas. Class I areas are national parks greater than 5,000 acres and wilderness areas greater than 6,000 acres, that were established prior to August 7, 1977. All other NPS areas are designated Class II. The objectives of the IMPROVE program are: to establish current visibility conditions in all Class I areas; to identify pollutants (particles and gases) and emission sources responsible for existing man-made visibility impairment; and to document long-term trends in visibility. In 1999, there were 30 official IMPROVE sites and 40 protocol sites. Because of recently enacted regulations that require improving visibility in Class I areas, the number of visibility monitors is increasing. Protocol sites are being upgraded to full IMPROVE sites and 80 new sites are being added to the IMPROVE network.

While the IMPROVE program has focused on Class I air quality areas, a great deal of visibility monitoring has been conducted in Class II areas. The ARD recommends that new visibility monitoring in NPS areas be conducted in coordination with the IMPROVE program (the IMPROVE program is managed out of the NPS ARD office in Fort Collins, Colorado). Installation and annual operating costs for a full IMPROVE site are about \$15,000 and \$30,000, respectively; however, partial monitoring, such as a camera-only site, is much less expensive.

There are, or soon will be, five IMPROVE sites in or near parks in the Northeast Coastal and Barrier Network. Massachusetts has been funding a protocol site at Cape Cod NS (site #CACO1). Other sites include a protocol site operated by Connecticut at Mohawk Mountain (site #MOMO1); Edwin B. Forsythe NWR, New Jersey (site #BRIG1), operating since 1991; the National Mall in Washington, D.C. (site #WASH1), operating since 1988; and a new site at Swanquarter NWR, North Carolina (site #SWAN1). Therefore, all parks in the Northeast Coastal and Barrier Network will have an IMPROVE monitor within 115 miles. This will be sufficient to provide a Network-wide assessment of visibility. If parks are interested in more site-specific monitoring, e.g., monitoring the plume from a nearby source, ARD can advise Network staff on how best to conduct this type of monitoring.

Not enough data have been collected and analyzed at these sites to detect long-term visibility trends (i.e., ten or more years). 1996-1998 data show that, as with previous years, standard visual range is substantially less in the eastern, than in the western, U.S. (see attached map). As for the sources of visibility impairment, 1996-1998 aerosol data

from Edwin B. Forsythe NWR and the National Mall are consistent with data from other eastern U.S. IMPROVE sites. These data show that, on an annual basis, visibility impairment is primarily due to sulfates (sources include coal combustion and oil refineries), then organics (sources include automobiles), then nitrates (sources include coal and natural gas combustion and automobiles), then light absorbing carbon (sources include wood burning), then soil (from windblown dust).

Ozone

Cape Cod NS has an ozone monitor on-site (site #250010002); the other parks in the Northeast Coastal and Barrier Network have one or more monitors within 30 miles. All parks except Assateague Island NS and George Washington Birthplace NM are in ozone nonattainment areas (see attached maps), meaning that the ozone levels in those areas exceed EPA's human health-based 8-hour National Ambient Air Quality Standard (NAAQS). Assateague Island NS and George Washington Birthplace NM are not in designated nonattainment areas because ozone is not monitored in those counties; however, based on high ozone concentrations in nearby counties, the NAAQS would be likely be exceeded at those parks, as well. In areas with high ozone concentrations, an ozone nonattainment designation can actually benefit the parks, because the designation requires the local or state air pollution control agency to take measures to reduce ozone levels. In case the Network is interested, installation and annual operating costs for an ozone monitoring site are about \$90,000 and \$14,000, respectively.

Vegetation

For vegetation, the focus is on ozone sensitivity because 1) ozone is a regional pollutant and is, therefore, more likely to affect park resources than other gaseous pollutants like sulfur dioxide and nitrogen oxide which quickly convert to other compounds, and 2) the literature on ozone sensitivity is more recent and more reliable than that for other pollutants. Park vascular plant lists contained in the April 2002 NPSpecies database were compared to the list of Very Ozone-Sensitive Plant Species contained in the NPS Synthesis information management system (see attached Synthesis species lists). The Synthesis lists were developed by an expert in the field of ozone effects on vegetation. Note that the Synthesis lists provide a general guide to ozone sensitivity. Differences in plant genetics, weather conditions, water availability, and ozone concentrations will affect whether or not a species exhibits injury in a particular park. Ozone sensitive species of natural vegetation were identified for seven of the eight parks in the Northeast Coastal and Barrier Network (see attached tables of sensitive species for Network parks). A vascular plant list for Thomas Stone NHS was not available in the NPSpecies database.

It is generally agreed that plant foliar injury occurs after a cumulative exposure to ozone. One ozone statistic that is used to evaluate the risk of plant injury is the SUM06. SUM06 is the sum of all hourly average ozone concentrations greater than or equal to 60 parts per million (ppm). In 1997, a group of ozone effects experts recommended 3-month, 8:00 a.m. to 8:00 p.m., SUM06 effects endpoints for natural vegetation, i.e., 8 to 12 ppm-hrs for foliar injury to natural ecosystems and 10 to 15 ppm-hrs for growth effects on tree seedlings in natural forest stands. According to a SUM06 map generated by DU, all eight Northeast Coastal and Barrier Network parks have ozone concentrations, during some

years, that are high enough to harm native vegetation. Given this, Network staff may want to conduct foliar injury surveys on sensitive species. Good survey species are black cherry (*Prunus serotina*) and common milkweed (*Asclepias syriaca*) because 1) ozone injury symptoms for these species are well described and 2) standardized survey protocols and training manuals have been developed.

Conclusions

Two of the eight Northeast Coastal and Barrier Network units currently have a NADP/NTN monitor on-site. Existing monitoring may not be adequate for Colonial NHP, Gateway NRA, Fire Island NS, or Sagamore Hill NHS. Wet deposition monitoring may be desirable in parks where eutrophication is a concern.

None of the Northeast Coastal and Barrier Network parks have a CASTNet monitor on-site. Current monitoring is probably not adequate for Cape Cod NS, Colonial NHP, Gateway NRA, Fire Island NHP, or Sagamore Hill NHS. However, given the expense of CASTNet monitoring, installation of a dry deposition monitor is not recommended.

Cape Cod NS has an IMPROVE monitor on-site; the other seven parks in the Northeast Coastal and Barrier Network will soon have an IMPROVE monitor within 115 miles. This will be sufficient to provide a Network-wide assessment of visibility.

Cape Cod NS has an ozone monitor on-site; the other seven parks in the Northeast Coastal and Barrier Network have one or more monitors within 30 miles. Ozone monitoring is adequate for the parks. Six of the eight parks are in designated ozone nonattainment areas; the other two parks likely have exceedances of the NAAQS, as well.

Ozone sensitive vascular plant species have been identified for seven of the eight parks in the Northeast Coastal and Barrier Network. Ozone concentrations are high enough in all eight units to warrant foliar injury surveys. Black cherry and common milkweed are good candidates for foliar injury surveys.

Relevant Websites

NADP - <http://nadp.sws.uiuc.edu/>

CASTNet - <http://www.epa.gov/castnet/>

IMPROVE - <http://vista.cira.colostate.edu/improve/>

Ozone - <http://www.epa.gov/air/data/index.html>

Pollution sources and air quality data - <http://www.epa.gov/air/data/index.html>

Pollution sources and monitors (maps and data) - <http://www.epa.gov/ttnotag1/areas/>