AIR QUALITY MONITORING CONSIDERATIONS FOR THE NATIONAL CAPITAL NETWORK

November 2001

Introduction

The NPS Air Resources Division (ARD) has contracted with the University of Denver (DU) to produce GIS-based maps that estimate baseline values (with confidence limits) for a set of air quality parameters for all Inventory and Monitoring parks in the U.S. This information will be available in early FY 2002. ARD used preliminary DU products to help develop an implementation strategy for expanding NPS air quality monitoring under the Natural Resources Challenge. Based on the implementation strategy, ARD may fund installation of a wet deposition monitor at Catoctin Mountain Park in FY 2003. The air monitoring implementation strategy will be revisited in FY 2004 if additional funding becomes available. The National Capital Network can use the final DU products (which will be sent to you when available), along with on-site and/or nearby off-site ambient monitoring and natural resource data discussed in this report, to help assess air quality-related conditions and monitoring needs in Network parks.

Wet Deposition

None of the NPS units in the National Capital Network have a National Atmospheric Deposition Program/National Trends Network (NADP/NTN) wet deposition monitor on-site, but all units have a monitor within 100 km (60 miles). NADP/NTN collects data on both pollutant deposition (in kilograms per hectare per year) and pollutant concentration (in microequivalents per liter). 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 2000, wet deposition and concentration of sulfate, and wet deposition of nitrate were high in the northeast U.S., including the National Capital Network, relative to the rest of the United States. Wet concentration of nitrate was high in the northeast U.S. Wet ammonium concentration was relatively low in the northeast U.S., while wet ammonium deposition was moderate in the northeast (see U.S. wet deposition isopleth maps at http://nadp.sws.uiuc.edu). Data from the NADP/NTN sites in the National Capital region are summarized below.

Finksburg, MD

The Finksburg, Maryland, NADP/NTN site (site #MD03 (White Rock)) has been in operation since 1984. The site data show a decrease in concentration and deposition of wet sulfate since 1984, a decrease in concentration of wet nitrate, and no apparent trend in deposition of wet nitrate, deposition of wet ammonium, or concentration of wet ammonium.

Wye, MD

The NADP/NTN site was installed at Wye, Maryland, (site #MD13) in 1983. The trends are the same as at the Finksburg site.

Arendtsville, PA

An NADP/NTN site was installed at Arendtsville, Pennsylvania, (site #PA00) in 1999. Sufficient data are not yet available to characterize pollutant trends at the site.

Shenandoah NP

The NADP/NTN site at Shenandoah NP (site #VA28) has been operating since 1981. A review of site data shows concentration and deposition of wet sulfate have decreased, as has deposition of wet nitrate. There has been no apparent trend in concentration of wet nitrate, concentration of wet ammonium, or deposition of wet ammonium.

Parsons, WV

The Parsons, West Virginia, NADP/NTN site (site #WV18) has been in operation since 1978. There has been a decrease in wet sulfate concentration, wet sulfate deposition, wet nitrate deposition, and wet ammonium concentration. There has been no apparent trend in wet nitrate concentration or wet ammonium deposition.

Data from all National Capital Network region NADP/NTN sites show a decrease in wet sulfate concentration and deposition, which is consistent with a nationwide reduction in sulfur dioxide emissions. While trends in wet deposition and concentration of nitrate and ammonium are not consistent among sites, in all cases they are either stable or decreasing.

Based solely on spatial distribution, it appears existing NADP/NTN sites provide adequate coverage for the National Capital Network. ARD will evaluate the adequacy of existing data before making a final decision about installing a wet deposition monitor at Catoctin Mountain Park. Cost information is provided in case the Network is interested in installing a site. 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.

Dry Deposition

None of the units in the National Capital Network have a Clean Air Status and Trends Network (CASTNet) dry deposition monitor on-site, but all units have a monitor within 100 km. CASTNet uses different monitoring and reporting techniques than NADP/NTN, so 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 at the sites in the National Capital Network region are summarized below.

Beltsville, MD

The Beltsville, Maryland, CASTNet site (site #BEL116) has been operating since 1989. A review of the site data shows a decrease in dry sulfur deposition, but no apparent trend in dry nitrogen deposition since 1989. Based on a comparison of CASTNet and Finksburg, Maryland, NADP/NTN data, CASTNet estimates total sulfur deposition at Beltsville

consists of 61 percent wet deposition and 39 percent dry deposition, while total nitrogen deposition is 63 percent wet and 37 percent dry.

Arendtsville, PA

Arendtsville, Pennsylvania, has had a CASTNet site (site #ARE128) since 1988. A review of site data shows a decrease in dry sulfur deposition but no apparent trend in dry nitrogen deposition. According to CASTNet, total sulfur deposition at the site consists of 54 percent wet and 46 percent dry deposition, while total nitrogen deposition is 64 percent wet and 36 percent dry.

Shenandoah NP

The CASTNet site at Shenandoah NP (site #SHN418) has been operating since 1988. The site data show a decrease in dry sulfur deposition but no apparent trend in dry nitrogen deposition. Based on a comparison of CASTNet and on-site NADP/NTN data, CASTNet estimates total sulfur deposition at Shenandoah NP is 60 percent wet and 40 percent dry, while total nitrogen deposition is 56 percent wet and 44 percent dry.

Parsons, WV

The Parsons, West Virginia, CASTNet site (site #PAR107) has been operating since 1988. The site data show a decrease in dry sulfur deposition but no apparent trend in dry nitrogen deposition. Based on a comparison of CASTNet and on-site NADP/NTN data, CASTNet estimates total sulfur deposition is 61 percent wet deposition and 36 percent dry deposition, while total nitrogen deposition is 74 percent wet and 26 percent dry.

Again, the decreasing trend in dry sulfur deposition at the CASTNet sites in the National Capital Network region reflects a decrease in sulfur dioxide emissions. Based solely on spatial distribution, it appears existing CASTNet sites provide adequate coverage for the Network. For future reference, installation and annual operating costs for a CASTNet site are about $50,000 and $15,000, respectively.

Surface Water Chemistry

The Water Resources Division's (WRD) *Baseline Water Quality Data Inventory and Analysis* reports were reviewed for all of the NPS units in the National Capital Network. Acid-sensitive surface waters typically have a pH below 6.0 and an acid neutralizing capacity (ANC) below 100 microequivalents per liter (μeq/l). Data from the *Baseline Water Quality Data Inventory and Analysis* reports for National Capital Network parks are summarized below.

Antietam NB

A review of the 1995 *Baseline Water Quality Data Inventory and Analysis* report for Antietam National Battlefield (NB) indicated many water chemistry data have been collected in the park. Samples collected at various locations along Antietam and Sharpsburg Creeks between 1963 and 1994 had a mean pH of 7.9 and average ANC values of 90-1544 μeq/l. These data indicate surface waters in Antietam NB are not sensitive to acid deposition.

Cactoctin Mountain Park

A review of the 1995 *Baseline Water Quality Data Inventory and Analysis* report for Catoctin Mountain Park indicated few water quality data have been collected in the park and none have been collected since 1985. Many pH values were 7.0 or higher, but some were in the range of 5.4 to 5.7. No ANC data were available. It is possible that the underlying bedrock of certain streams causes those streams to be more acidic. Regardless, the limited data indicate streams and springs in the park are susceptible to acidification from atmospheric deposition. A systematic monitoring program that includes pH, ANC, and other water chemistry parameters would provide better information on the current condition, and sensitivity, of surface waters in the park.

Chesapeake and Ohio Canal NHP

A review of the *Baseline Water Quality Data Inventory and Analysis* report for the Chesapeake and Ohio Canal National Historic Park (NHP) indicated park surface waters consist of the canal, the Potomac, Shenandoah and Monocacy Rivers, and some small tributaries. Typically, large rivers are not sensitive to acidification from atmospheric deposition. Samples collected in the Potomac River had an average pH of about 7.6 and an average ANC of about 500 μeq/l. Samples collected in the canal in 1973 had an average pH of about 7.2. Samples collected from Conococheague Creek between 1980 and 1994 had an average pH of 8.3 and an average ANC of 1160 μeq/l. These data indicate surface waters in the Chesapeake and Ohio Canal NHP are not sensitive to acidification from atmospheric deposition.

George Washington Memorial Parkway

A review of the 1996 *Baseline Water Quality Data Inventory and Analysis* report for the George Washington Memorial Parkway indicated water quality data were collected in the Potomac River and its tributaries between 1972 and 1994. Average pH values were 7.2 to 8.0 and average ANC values were 280-672 μeq/l. A low pH value of 1.0 was reported in 1978, but this was most likely a monitoring or reporting error. In general, the data indicate the river is not susceptible to acidification from atmospheric deposition. Eutrophication, however, is of concern, and many of the samples did have high nitrate and nitrite levels. Given the parkway's metropolitan location, and the Potomac River's exposure to industrial and sewage effluents and runoff, it may be difficult to separate the influence of atmospherically deposited nitrogen from other sources. If eutrophication is a concern, the Network may want to consult with ARD and WRD staff, as well as with other subject matter experts, to determine the best way to monitor water quality and potential nitrogen sources.

Harpers Ferry NHP

A review of the 1997 *Baseline Water Quality Data Inventory and Analysis* report for Harpers Ferry National Historic Park (NHP) indicated all water quality data collected in the park were obtained from the Shenandoah River. These data, collected between 1946 and 1995, had an average pH of about 8.1 and an average ANC of about 936 μeq/l. If streams and springs are an important resource at Harpers Ferry NHP, Network staff may want to perform a synoptic water quality survey to assess the sensitivity of these water resources to acidification from atmospheric deposition.

Manassas NBP

A review of the 1997 *Baseline Water Quality Data Inventory and Analysis* report for Manassas National Battlefield Park (NBP) indicated many water quality data are available for the park. Data collected between 1973 and 1994 had an average pH of about 7.2 and an average ANC that ranged from 352-1680 μeq/l. These data indicate surface waters in the park are not sensitive to acidification from atmospheric deposition.

Monocacy NB

A review of the 2000 *Baseline Water Quality Data Inventory and Analysis* report for Monocacy National Battlefield (NB) indicated few pH and ANC data are available for the park. Data collected on Bush Creek and the Monocacy River in 1972-73 and 1996 had an average pH of 7.5, and an average ANC of 1152 μeq/l. If creeks, lakes, ponds, and springs are important resources at Monocacy NB, Network staff may want to perform a synoptic water quality survey to assess the sensitivity of these water resources to acidification from atmospheric deposition.

National Capital Parks-East

A review of the 1999 *Baseline Water Quality Data Inventory and Analysis* report for National Capital Parks-East indicated the parks contain a diverse array of water resources including rivers, marshes, wetlands, creeks, and lakes. Data collected on the Potomac River show the river is not sensitive to acidification from atmospheric deposition. Water samples collected on Upland Creek between 1979 and 1984 had an average pH of 6.6 and an average ANC of 160 μeq/l, indicating the creek is not sensitive to acidification. Extremely low pH and ANC events were reported at various locations, e.g., a pH of 1.2 was reported at Watts Branch. It is difficult to determine if this was a sampling or reporting error or a true reading. Given the urban setting, park surface waters are likely exposed to a variety of air- and waterborne pollutants. If the Network has a particular concern about the impacts of atmospheric deposition on National Capital Parks-East surface waters, we recommend Network staff meet with ARD to discuss how best to address those concerns.

Prince William Forest Park

A review of the 1994 *Baseline Water Quality Data Inventory and Analysis* report for Prince William Forest Park indicated limited pH and ANC data are available for creeks, no creek data are available since 1985, and no water quality data are available for ponds. Data collected on Quantico Creek between 1951 and 1985 had an average pH of about 6.7 and an average ANC of about 100 μeq/l. Network staff may want to consider collecting some new creek and pond water chemistry data to assess surface water sensitivity to atmospheric deposition.

Rock Creek Park

A review of the 1994 *Baseline Water Quality Data Inventory and Analysis* report for Rock Creek Park indicated water quality data were collected between 1973 and 1989. The average pH was about 7.3 and the average ANC ranged from 144 to 592 μeq/l. These data indicate the creek is not sensitive to acidification from atmospheric deposition. Some samples had high concentrations of nitrates and nitrites, so

eutrophication may be a concern. However, it may be difficult to distinguish atmospherically deposited nitrogen from other sources, i.e., industrial and sewage effluents and runoff. If eutrophication is a concern, the Network may want to consult with ARD and WRD staff, as well as with other subject matter experts, to determine the best way to monitor water quality and potential nitrogen sources.

Wolf Trap Farm Park for the Performing Arts

A review of the 1996 *Baseline Water Quality Data Inventory and Analysis* report for the Wolf Trap Farm Park for the Performing Arts indicated no water quality data have been collected in the park. Limited data have been collected outside the park. Data collected at the Route 193 Bridge between 1979 and 1996 had an average pH of 6.9 and an average ANC of 208 μeq/l. Data collected at the Route 674 Bridge between 1980 and 1996 had an average pH of 7.4 and an average ANC of 176 μeq/l. These data indicate nearby streams are not susceptible to acidification from atmospheric deposition. However, it is not clear if these data are representative of surface water conditions within the park.

Visibility

Visibility-impairing particles and certain gases are monitored in natural areas through the Interagency Monitoring of Protected Visual Environments (IMPROVE) program. Because of the mandates of the Clean Air Act, the IMPROVE program has focused monitoring efforts in Class I air quality areas. Regardless, IMPROVE monitoring provides a regional analysis of visibility; therefore, the data indicate conditions in nearby Class II air quality areas. IMPROVE program staff recently identified an error in past data calculations, and are in the process of re-calculating the data. Therefore, trend data are not currently available for IMPROVE sites. None of the units in the National Capital Network have an IMPROVE monitor on-site, but all units have a monitor within 100 km. The four monitors in the National Capital region are located on the National Mall in Washington, D.C. (site #WASH1), in Arendtsville, Pennsylvania (site #AREN1), in Shenandoah NP (site #SHEN1), and in Davis, West Virginia, near the Dolly Sods and Otter Creek Wilderness Areas (site #DOSO1). Based solely on spatial distribution, it appears existing IMPROVE sites provide adequate coverage for the National Capital Network. Installation and annual operating costs of an IMPROVE site are about $15,000 and $30,000, respectively.

Ozone

None of the units in the National Capital Network have an ozone monitor on-site, but all units have a monitor within 25 km (15 miles) of some portion of the park. Based solely on spatial distribution of ozone monitors, it appears the portion of the Chesapeake and Ohio Canal NHP between Hagerstown and Cumberland, Maryland, may not be well-represented by existing monitors. In addition, it is not clear if monitors in Frederick and Hagerstown, Maryland, adequately represent ozone conditions in Catoctin Mountain Park. Final products from the DU analysis will help clarify these issues. 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 either sulfur dioxide or 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 a May 2001 version of NPSpecies were compared to the general ozone-sensitive plant species lists 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 are 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 ten of the 11 units in the National Capital Network; NPSpecies did not contain a list for Wolf Trap Farm Park for the Performing Arts (see attached tables of sensitive species for Network parks). Note that some crops and other cultivated plants are also sensitive to ozone. In order to determine if any cultivated species grown in National Capital Network parks would be good indicators of ozone injury, it would be necessary for the Network to identify specific cultivars at each site.

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 0.06 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 to12 ppm-hrs for foliar injury to natural ecosystems and 10 to 15 ppm-hrs for growth effects on tree seedlings in natural forest stands. The DU products will give some indication of the ozone risk to sensitive vegetation in National Capital Network parks. If ozone concentrations indicate potential foliar injury of vegetation, Network staff may want to conduct foliar injury surveys on a handful of sensitive species.

Conclusions

All of the NPS units in the National Capital Network have a NADP/NTN wet deposition monitor within 100 km.

All of the NPS units in the National Capital Network have a CASTNet dry deposition monitor within 100 km.

Data indicate surface waters in three Network parks—Antietam NB, Chesapeake and Ohio Canal NHP, and Manassas NB are not susceptible to acidification from atmospheric deposition. Eutrophication from atmospherically deposited nitrogen, along with industrial and sewage effluent, and runoff, is a potential concern at George Washington Memorial Parkway and Rock Creek Park. Additional water chemistry data collection may be desirable at other Network parks to clarify surface water sensitivity to atmospheric deposition.

All of the NPS units in the National Capital Network have an IMPROVE visibility monitor within 100 km.

All of the NPS units in the National Capital Network have an ozone monitor within 25 km. It may be desirable to install an ozone monitor in the western portion of the Chesapeake and Ohio Canal NHP or in Catoctin Mountain Park.

Ozone sensitive species have been identified for ten of the 11 NPS units in the National Capital Network. Ozone concentrations may be high enough to warrant foliar injury surveys in some parks.

Relevant Websites
NADP - http://nadp.sws.uiuc.edu/
CASTNet - http://www.epa.gov/castnet/
Ozone - http://www.epa.gov/airsdata/sources.htm
IMPROVE - http://vista.cira.colostate.edu/improve/
Pollution sources and air quality data - http://www.epa.gov/air/data/index.html
Ozone-specific sources and data - http://www.epa.gov/ttn/rto/areas/
Pollution source and air quality graphics - http://www.epa.gov/agweb/