AIR QUALITY MONITORING CONSIDERATIONS FOR THE SOUTHEAST COAST NETWORK

January 2003

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 Inventory for the parks. Air Quality Inventory products are available on the Internet at http://www2.nature.nps.gov/ard/gas/ (see section called *Air Atlas*). ARD used preliminary DU products to help develop a strategy for expanding ARD-funded ambient air quality monitoring with increased funding from the Natural Resources Challenge in FY 2002. At this time, ARD does not intend to fund additional monitoring at any NPS units in the Southeast Coast Network. The ARD air monitoring strategy will be revisited in FY 2004 if additional funding becomes available. Rough cost estimates for installation and annual operation of typical air quality monitoring stations are described in an attachment.

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 Southeast Coast Network: 1) the need for additional ambient air quality monitoring at any Network park, i.e., wet deposition, dry deposition, visibility, particulate matter 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 80 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.

None of the Southeast Coast Network parks have an NADP/NTN monitor on-site; all have a monitor within 85 miles. Distance, as well as terrain, intervening pollution sources, and differences in meteorology affect how well a monitoring site's data represent conditions at a park. Meteorology is an important consideration for coastal parks, since wind patterns on the coast can be very different from those inland. Nevertheless, based on a rough evaluation of these factors, it appears that all Network parks are well represented by existing NADP/NTN monitors.

There are currently nine MDN sites in the Southeast Coast Network area, including one at Congaree Swamp National Monument (NM) in South Carolina (site #SC19). Other stations are located at Centreville, Alabama (site #AL03); Chassahowitzka National Wildlife Refuge (NWR), Florida (site #FL05); Okefenokee NWR, Georgia (site #GA09); Fulton County, Georgia (site #GA22); Yorkville, Georgia (site #GA40); Lake Waccamaw State Park, North Carolina (site #NC08); Pettigrew State Park, North Carolina (site #NC42); and Barnwell County, South Carolina (site #SC03). MDN sites will be initiated in 2003 in Orlando, Florida (site #FL97) and Cape Romain NWR, South Carolina (site #SC05).

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 Air Inventory maps; also see 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 Southeast Coast Network parks are summarized below. Both the Clinton, North Carolina, and Santee NWR, South Carolina, sites show an increase in wet ammonium concentration that may be due to increased hog farming in the area.

Crossville, AL

The Crossville, Alabama, NADP/NTN site (site #AL99 (Sand Mountain Experiment Station)) was installed in 1984. Wet concentration and deposition of sulfate have decreased at the site, while wet concentration of ammonium, wet concentration of nitrate, and wet deposition of nitrate have increased. There has been no overall trend in wet ammonium deposition.

Dallas County, AL

An NADP/NTN site has been operating in Dallas County, Alabama (site #AL10 (Black Belt Substation)) since 1983. Site data show a decrease in concentration and deposition

of wet sulfate, but no overall trends in concentration and deposition of wet nitrate and wet ammonium.

Kennedy Space Center, FL

The NADP/NTN site at Kennedy Space Center, Florida (site #FL99) has been operating since 1983. Site data show an increase in concentration and deposition of wet nitrate and wet ammonium, but no overall trends in concentration and deposition of wet sulfate.

Sampson City, FL

An NADP/NTN site has been operating at Sampson City, Florida (site #FL03 (Bradford Forest)) since 1978. Site data show a decrease in concentration and deposition of wet sulfate, but no overall trends in concentration and deposition of wet nitrate and wet ammonium.

Okefenokee NWR, GA

An NADP/NTN site was installed at Okefenokee NWR, Georgia (site #GA09) in 1997. Trend data are not yet available from the site.

Pike County, GA

The Pike County, Georgia, NADP/NTN site (site #GA41 (Georgia Station)) has been operating since 1978. Site data show a decrease in concentration and deposition of wet sulfate, but no overall trends in concentration and deposition of wet nitrate and wet ammonium.

Sapelo Island, GA

An NADP/NTN site was installed at Sapelo Island, Georgia (site #GA33) in 2002. Data are not yet available from the site.

Skidaway, GA

An NADP/NTN site was installed at Skidaway, Georgia (site #GA98) in 2002. Data are not yet available from the site.

Beaufort, NC

An NADP/NTN site was installed at Beaufort, North Carolina (site #NC06) in 1999. Trend data are not yet available from the site.

Clinton, NC

An NADP/NTN site has been operating at Clinton, North Carolina (site #NC35) since 1978. Site data show a decrease in concentration and deposition of wet sulfate and no overall trend in concentration and deposition of wet nitrate. Concentration of wet ammonium has increased, with a substantial upward trend since 1993. Deposition of wet ammonium has increased since 1987.

Cape Romain NWR, SC

An NADP/NTN site was installed at Cape Romain NWR, South Carolina (site #SC05) in 2000. Data are not yet available from the site.

Fort Johnson, SC

An NADP/NTN site was installed at Fort Johnson, South Carolina (site #SC99) in 2002. Data are not yet available from the site.

Santee NWR, SC

An NADP/NTN site was installed at Santee NWR, South Carolina (site #SC06) in 1984. Site data show a decrease in wet sulfate concentration, but no trend in wet sulfate deposition. There has been no trend in wet nitrate concentration or deposition. There has been an increasing trend in wet ammonium concentration and deposition.

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 Southeast Coast Network parks have a CASTNet monitor on site. Nine of the parks have a monitor within 120 miles that can provide representative data. Eight parks (Castillo de San Marcos NM, Cumberland Island National Seashore (NS), Fort Caroline National Memorial (NMem), Fort Frederica NM, Fort Pulaski NM, Fort Matanzas NM, Fort Sumter NM and Timucuan Ecological and Historic Reserve) have no representative dry deposition data. However, given the expense of dry deposition monitoring, unless there is a need to better quantify dry deposition in a park, the ARD does not recommend the Network fund CASTNet monitoring.

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 at sites closest to Southeast Coast Network parks are summarized below.

Crossville, AL

The Crossville, Alabama, CASTNet site (site #SND152 (Sand Mountain Experiment Station)) has been in operation since 1988. There has been a decrease in dry sulfur deposition at the site, but no trend in dry nitrogen deposition. Total nitrogen deposition at the site is composed of 36 percent dry deposition and 64 percent wet deposition, while total sulfur deposition is 41 percent dry and 59 percent wet.

Indian River, FL

A CASTNet monitor was installed in Indian River County, Florida (site #IRL141) in 2001. Data are not yet available from the site.

Pike County, GA

The Pike County, Georgia, CASTNet site (site #GAS153 (Georgia Station)) has been operating since 1989. Site data indicate an increase in dry nitrogen deposition, and a decrease in dry sulfur deposition. Total nitrogen deposition at the site is estimated to be 58 percent wet and 42 percent dry; total sulfur deposition has the same percentages.

Beaufort, NC

A CASTNet site was installed at Beaufort, North Carolina (site #BFT142) in 1994. Data indicate no trends in dry nitrogen or sulfur deposition. Total nitrogen deposition at the site is estimated to be 68 percent wet and 32 percent dry, while total sulfur deposition is 64 percent wet and 36 percent dry.

Candor, NC

A CASTNet site has been operating at Candor, North Carolina (site #CND125) since 1990. Site data indicate no trends in dry nitrogen or sulfur deposition. CASTNet estimates total nitrogen deposition at the site is composed of 37 percent dry deposition and 63 percent wet deposition, while total sulfur deposition is 34 percent dry and 66 percent wet.

Air Toxics

Air toxics, e.g., mercury, dioxins, and benzene, may be a concern for Network parks, particularly those that are located near urban areas. Some states conduct air toxics monitoring. In most cases, the monitoring is focused primarily on urban areas and/or industrial sites. The air agencies in states with Southeast Coast Network parks were contacted regarding current and planned air toxics monitoring. The results are summarized below.

Alabama

Contact: Elvin Lang, 334-271-7905

Alabama currently monitors airborne mercury near Mobile. The state may expand their toxics monitoring program in the future.

Florida

Contact: Caroline Shire, Central District, 407-894-7555 and Air Program, Duvall County, 904-630-4900

According to Caroline Shire, no air toxics monitoring is conducted near Canaveral NS, and no toxics monitoring sites are planned at this time. There are two air toxics monitors currently located in Jacksonville, and three more will be installed in the near future. Site descriptions and some data from a 2001 study are available on the Duval County website (http://www.coj.net/Departments/Regulatory+and+Environmental+Services/Air+and+Water+Quality/Lab+Services.htm).

Georgia

Contact: Susan Zimmer-Dauphinee, 404-363-7079

Georgia has a long history of air toxics monitoring, and monitoring has taken place in a number of locations around the state. The state prepares annual reports on its toxics monitoring program. Copies of the reports are available from Susan Zimmer-Dauphinee. Current monitoring locations include Utoy Creek in Atlanta (Chattahoochee River National Recreation Area (NRA)), Brunswick (Cumberland Island NS and Fort Frederica NM), Dawsonville (Chattahoochee River NRA), Macon (Ocmulgee NM), Savannah (Fort Pulaski NM), Tucker (Chattahoochee River NRA), and Yorkville (Kennesaw Mountain National Battlefield Park (NBP)).

North Carolina

Contact: Julie Kinlaw, 919-733-3843

The state conducts air toxics monitoring in a number of locations, but none are near Southeast Coast Network parks. There are no plans to add additional sites to the state's toxics monitoring program in the near future.

South Carolina

Contact: Robert Schilling, 803-896-0907

The state monitors air toxics in a number of locations, including Charleston (Fort Sumter NM) and Columbia (Congaree Swamp NM). No additional toxics monitoring sites are planned at this time.

Surface Water Chemistry

The Water Resources Division's *Baseline Water Quality Data Inventory and Analysis* reports were reviewed for all Southeast Coast Network parks except Chattahoochee River NRA and Fort Sumter NM. Air pollution concerns relative to surface water chemistry include acidification due to sulfur and nitrogen deposition in fresh water, eutrophication from excess nitrogen deposition in fresh or saline water, and deposition of toxic air pollutants such as mercury, other metals, and organics. In general, acid-sensitive surface waters have a pH below 6.0 and an acid neutralizing capacity (ANC) below 100 microequivalents per liter (μeq/l). Results for the Network parks are summarized below.

Canaveral NS

The 1996 *Baseline Water Quality Data Inventory and Analysis report* for Canaveral NS suggests that all surface waters associated with the park are either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

Cape Hatteras NS

The 1994 *Baseline Water Quality Data Inventory and Analysis report* for Cape Hatteras NS suggests that all surface waters associated with the park are either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

Cape Lookout NS

The 1995 *Baseline Water Quality Data Inventory and Analysis report* for Cape Lookout NS suggests that all surface waters associated with the park are either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

Castillo de San Marcos NM

The 1998 *Baseline Water Quality Data Inventory and Analysis report* for Castillo de San Marcos NM suggests that all surface waters associated with the park are either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

Congaree Swamp NM

The 1998 *Baseline Water Quality Data Inventory and Analysis report* for Congaree Swamp NM contains data collected in the park from 1992 to 1997. Samples collected in Lower Tom's Creek, Cedar Creek, and the Congaree River had average pH values of 5.9 to 6.5, with a minimum pH of 5.1. The average ANC value on Cedar Creek was 38 μeq/l, and the minimum value was 16 μeq/l. The average ANC on the Congaree River was 160 μeq/l and the minimum value was 64 μeq/l. Weston and Wise Lakes also had low pH values, with an average pH of 5.9 and a minimum of 4.0. These data indicate surface waters in Congaree Swamp NM are extremely acid sensitive, and it's possible that they currently experience episodic acidification, i.e., precipitation events that cause the creeks and lakes to lose all buffering capacity for a short amount of time. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Cumberland Island NS

The 1997 *Baseline Water Quality Data Inventory and Analysis report* for Cumberland Island NS shows that no water chemistry data have been collected in the park. The report suggests that all surface waters associated with the park are either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. There is no indication that nitrogen-associated eutrophication is an issue.

Fort Caroline NMem

The 2002 *Baseline Water Quality Data Inventory and Analysis report* for Fort Caroline NMem shows Spanish Pond was sampled in 1997 and 1998. The pond had an average pH of 6.4 with a minimum value of 5.8. While it's not possible to accurately assess acid sensitivity without ANC data, the average pH values suggest the pond is not likely to be sensitive to acidification from atmospheric deposition. All other surface waters

associated with the park appear to be either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Fort Frederica NM

The 1998 Fort Frederica NM *Baseline Water Quality Data Inventory and Analysis report* indicates no water quality data have been collected in the park, and no pH or ANC data are available for the study area. Nevertheless, based on the description of the park on the Fort Frederica NM website, it doesn't appear this surface water acidification is a concern for the park. There is no indication that nitrogen-associated eutrophication is an issue.

Fort Matanzas NM

The 1999 *Baseline Water Quality Data Inventory and Analysis report* for Fort Matanzas NM suggests that all surface waters associated with the park are either saline or tidally influenced. If this is the case, then surface water acidification is not a concern for the park. The report did not indicate that nitrogen-associated eutrophication was an issue.

Fort Pulaski NM

The 2001 *Baseline Water Quality Data Inventory and Analysis report* for Fort Pulaski NM includes data collected in the park from 1971 to 1998. The feeder canal and Savannah River had average pH values of 7.3, and the Wilmington River had a pH of 6.5. The Savannah River had an average ANC of 504 μeq/l, and the Wilmington River had an ANC of 216 μeq/l. These data indicate surface waters in the park are not sensitive to acidification from atmospheric deposition. The report did not indicate that nitrogen-associated eutrophication was an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Horseshoe Bend NMP

The 1997 *Baseline Water Quality Data Inventory and Analysis report* for Horseshoe Bend National Military Park (NMP) includes data collected in the park from the Tallapoosa River and its tributaries between 1994 and 1997. The data show an average pH of 6.7 and an average ANC of about 300 μeq/l. The data indicate surface waters in the park are not sensitive to acidification from atmospheric deposition. The report did not indicate that nitrogen-associated eutrophication was an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Kennesaw Mountain NBP

The 1997 *Baseline Water Quality Data Inventory and Analysis report* for Kennesaw Mountain NBP includes data collected in the park from John Ward Creek and Noses Creek from 1993 to 1997. The creeks had an average pH of 6.6, with a minimum of 6.0. While it's not possible to accurately assess acid sensitivity without ANC data, the average pH values suggest the creeks are not likely to be sensitive to acidification from

atmospheric deposition. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Moores Creek NB

The 1997 *Baseline Water Quality Data Inventory and Analysis report* for Moores Creek National Battlefield (NB) says some surface waters in the study area have been affected by mining activities. This may be the case for Moores Creek, because samples collected from 1985 to 1996 had an average pH of 5.8 (4.9 minimum) and an average ANC of 40 μeq/l (range of 16-120 μeq/l). These data indicate Moores Creek is extremely acid sensitive, and it's possible that the creek currently experiences episodic acidification. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Ocmulgee NM

The 2002 *Baseline Water Quality Data Inventory and Analysis report* for Ocmulgee NM includes data collected in the park from Walnut Creek and an unnamed creek in 1994 and 1995. The creeks had an average pH of about 6.6, with a minimum of 6.2. While it's not possible to accurately assess acid sensitivity without ANC data, the average pH values suggest the creeks are not likely to be sensitive to acidification from atmospheric deposition. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Timucuan Ecological and Historic Reserve

The 2002 *Baseline Water Quality Data Inventory and Analysis report* for Timucuan Ecological and Historic Reserve appeared to contain data only for surface waters that are either saline or tidally influenced. If fresh water occurs in the park, its sensitivity to acidification is unknown. There is no indication that nitrogen-associated eutrophication is an issue. Surface waters in the study area contained elevated levels of a number of heavy metals, so deposition of airborne toxics may be of concern for the park.

Particulate Matter

Small or "fine" particles in the air, typically those less than 2.5 micrometers in diameter, $PM_{2.5}$, are a leading cause of human respiratory illness. Particles are present everywhere, but high concentrations and/or specific types have been found to present a serious danger to human health. Fine particles in the air are the main contributor to human-caused visibility impairment. The particles not only decrease the distance one can see; they also reduce the colors and clarity of scenic vistas. Moisture in the air enhances the impact, so areas in the Eastern U.S., with higher relative humidity, have worse visibility than areas in the arid West (see attached Air Inventory map). In 1997, EPA finalized new stricter, human-health based, National Ambient Air Quality Standards (NAAQS) for particulate matter. Original NAAQS for particulate matter were for those particles 10 microns or less (PM_{10}). The new national standards now regulate $PM_{2.5}$.

Fort Sumter NM has a PM_{10} monitor on-site, all other Southeast Coast Network parks have representative data collected within 35 miles. None of the states with Southeast Coast Network parks have areas currently designated nonattainment for PM_{10}. Nationwide $PM_{2.5}$ monitoring was initiated in 1999; nonattainment areas will not be designated until 2004. 1999-2001 data indicate coastal Southeast Coast Network parks will be in attainment for $PM_{2.5}$, but non-coastal parks will likely be nonattainment.

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). Some I&M Networks are considering monitoring visibility at scenic vistas with digital cameras. While this type of monitoring would not be adequate for regulatory purposes, it is useful for documenting visibility conditions and trends and provides an excellent means of sharing that information with the public.

None of the Southeast Coast Network parks have an IMPROVE monitor on site. Eleven parks have IMPROVE sites within 100 miles that can provide representative data. There are no nearby, Atlantic coast IMPROVE sites to provide data for Canaveral NS, Casa de San Marcos NM or Fort Matanzas NM, and there are no nearby inland sites for Horseshoe Bend NMP, Moores Creek NB or Ocmulgee NM. IMPROVE sites have been operating at Cape Romain NWR, South Carolina, since 1994 (site #ROMA); at Chassahowitzka NWR, Florida, since 1993 (site #CHAS); at Okefenokee NWR, Georgia, since 1991 (site #OKEF); and at Sipsey Wilderness Area (WA), Alabama, since 1992 (site #SIPS). Sites were installed at Cohutta WA, Georgia (site #COHU) and Swanquarter NWR, North Carolina (site #SWAN) in 2000.

Long-term visibility trends have not yet been determined for any IMPROVE sites in the Southeast Coast Network area. As for the sources of visibility impairment, 1996-1998 aerosol data from the four long-term sites 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 and chemical manufacturing), then soil (from windblown dust), then light absorbing carbon (sources include wood

burning), and then nitrates (sources include coal and natural gas combustion and automobiles). At all sites, visibility was best in the winter and worst in the summer.

Ozone

Congaree Swamp NM and Fort Sumter NM have ozone monitors on-site, the rest of the Southeast Coast Network parks have one or more ozone monitors within 35 miles. Chattahoochee River NRA, Congaree Swamp NM, Kennesaw Mountain NBP, and Ocmulgee NM are in areas that will likely be designated nonattainment under EPA's new human-health based 8-hour NAAQS (see attached state maps).

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 such as 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 NPSpecies database in January 2003 were compared to the lists of Ozone-Sensitive Plant Species compiled for the NPS ARD (see attached species lists). The Ozone-Sensitive Plant Species lists were developed by an expert in the field of ozone effects on vegetation. Note that the lists provide a general guide to ozone sensitivity. Differences in plant genetics, weather conditions, soil water availability, and ozone concentrations will affect whether or not a species exhibits injury in a park. In particular, studies have shown that plants will not take up ozone unless there is sufficient soil moisture. Ozone sensitive species of natural vegetation were identified for all of the parks in the Southeast Coast Network except Castillo de San Marcos NM (see attached lists of sensitive species for Southeast Coast Network parks).

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 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.

According to a SUM06 map generated for the Air Inventory (see attached map), all Southeast Coast Network parks have ozone concentrations, during some years, that are high enough to harm native vegetation. However, parks in Florida and coastal Georgia and South Carolina have interpolated ozone values (11-15 ppm-hrs) that are just barely within the range known to injure vegetation. Ozone injury symptoms are more likely to occur in Cape Hatteras NS, Cape Lookout NS, Chattahoochee River NRA, Congaree Swamp NM, Kennesaw Mountain NBP, Moores Creek NB and Ocmulgee NM, where interpolated values are 21-39 ppm-hrs. Note that there is greater uncertainty in interpolating data for coastal parks due to 1) a lack of offshore monitors and 2) the possibility that ocean breezes, with lower ozone concentrations, can blow into the parks. Network staff may want to conduct foliar injury surveys on sensitive plant species in those parks with high SUM06 ozone values. Good survey species are black cherry

(*Prunus serotina*) and milkweed (*Asclepias spp*) because ozone injury symptoms for these species are well described. The ARD has contracted with a plant physiologist to evaluate historic ozone concentration and precipitation data to assess the likelihood of finding ozone-induced foliar injury in I&M parks and to develop standardized protocols for ozone injury surveys. The risk assessment should be completed for the Southeast Coast Network by June 1, 2003, and the protocols should be available in early 2004.

Conclusions

None of the Southeast Coast Network parks have an NADP/NTN monitor on-site; all have a monitor within 85 miles. It is likely that all parks are well represented by existing monitors.

None of the Southeast Coast Network parks have a CASTNet monitor on site. Nine of the parks have a monitor within 120 miles that can provide representative data. Eight of the parks in Florida and coastal Georgia and South Carolina have no representative dry deposition data. However, given the expense of dry deposition monitoring, the existence of representative wet deposition data, and the fact that surface waters in these parks don't appear to be sensitive to atmospheric deposition, installation of a CASTNet monitor is not recommended.

Air toxics may be an issue for many Southeast Coast Network parks. States conduct air toxics monitoring near all parks except Canaveral NS, Cape Hatteras NS, Cape Lookout NS, Horseshoe Bend NMP, and Moores Creek NB. Network staff may want to consider monitoring contaminants in biota in those parks where air toxics are a concern.

Park water quality data were reviewed for fifteen Southeast Coast Network parks. The data indicated surface waters at Congaree Swamp NM and Moores Creek NB are extremely sensitive to acidification from atmospheric deposition. Network staff may want to consider long-term monitoring of acid deposition-related water chemistry parameters, such as pH and ANC, at these parks.

Fort Sumter NM has a PM_{10} monitor on-site, all other Southeast Coast Network parks have representative data collected within 35 miles.

None of the Southeast Coast Network parks have an IMPROVE monitor on site. Eleven parks have IMPROVE sites within 100 miles that can provide representative data. There are no nearby, Atlantic coast IMPROVE sites to provide data for Canaveral NS, Casa de San Marcos NM or Fort Matanzas NM, and there are no nearby inland sites for Horseshoe Bend NMP, Moores Creek NB or Ocmulgee NM. Installation of an IMPROVE monitor in a north Florida coastal park would fill a gap in the IMPROVE network, and would enhance data interpretation for a number of Southeast Coast Network parks. Parks with visibility concerns may want to consider using a less expensive, digital camera to document and interpret visibility degradation.

Congaree Swamp NM and Fort Sumter NM have ozone monitors on-site, the rest of the Southeast Coast Network parks have one or more ozone monitors within 35 miles.

Ozone sensitive vascular plant species have been identified for sixteen of the parks in the Southeast Coast Network. Ozone concentrations are high enough in all parks that foliar injury surveys may be warranted. Black cherry and milkweed are good candidates for such surveys.

Relevant Websites
NPS Air Inventory (*Air Atlas*) - http://www2.nature.nps.gov/ard/gas/
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