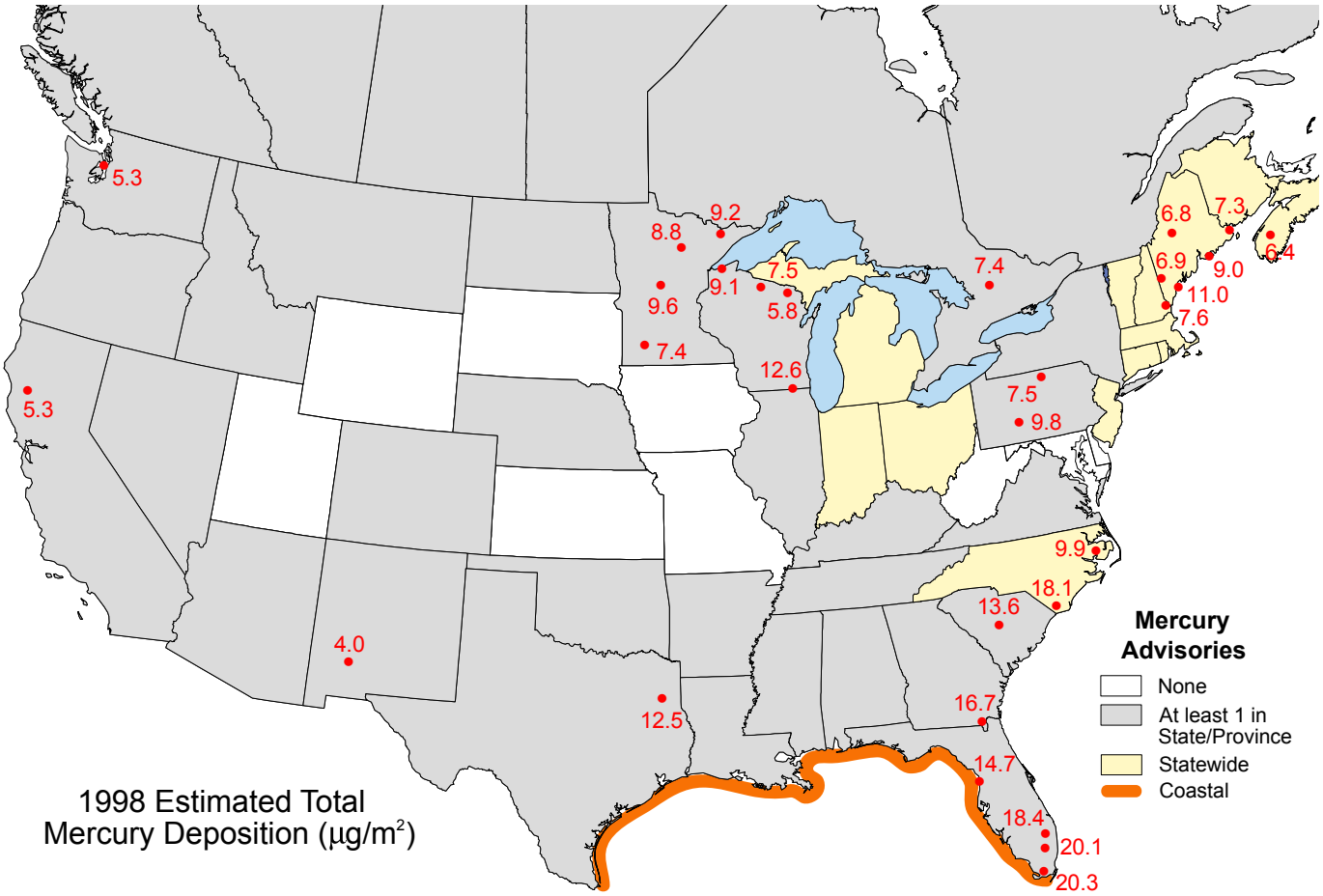
National Atmospheric Deposition Program
1998 Wet Deposition



National Atmospheric Deposition Program/Mercury Deposition Network

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

A Cooperative Research Support Program of the
State Agricultural Experiment Stations (NRSP-3)
Federal and State Agencies
and Private Research Organizations

What is NADP?

Every year the National Atmospheric Deposition Program (NADP) fulfills thousands of requests for data, maps, and other information through its Internet site (see the back cover for the address). Requests come from scientists, students, policymakers, and other people who use NADP data to address important questions about the chemicals in precipitation and their effect on the environment.

NADP is now in its third decade of recording high quality precipitation chemistry data. This cooperative effort is supported by government agencies at the national, state, and local levels, State Agricultural Experiment Stations, universities, and private organizations. Peer review scientists have said that NADP "is perhaps the most significant, long-term, continuous, and comprehensive sampling and analysis program to be undertaken in the environmental sciences." Certainly the length and quality of the data record are due to the continued commitment of NADP sponsors and participating scientists.

Why does NADP keep such diligent vigil over our precipitation? The answer lies in our need to monitor how human activities and the forces of nature affect air and precipitation quality, i.e., the health of the atmosphere. The information we gain will equip us to make more responsible decisions about how to preserve and improve our air quality and how to manage our agricultural, forest, aquatic, cultural, and energy resources.

NADP Past and Present

In 1977, U.S. State Agricultural Experiment Stations (SAES) organized a project, later titled NADP, to measure atmospheric deposition and study its effects on the environment. Sites in the NADP precipitation chemistry network first began collecting weekly samples for chemical analysis in 1978. The goal was to provide data on the amounts, temporal trends, and geographic distributions of acids, nutrients, and base cations in precipitation. Initially organized as a regional project, the network grew and expanded its coverage to the entire country and today is SAES National Research Support Project - 3. The U.S. National Acid Precipitation Assessment Program, established in 1981 to improve understanding of the causes and effects of acidic precipitation, provided support for much of the network growth. Today there are more than 200 sites in NADP's nationwide precipitation chemistry network, now called the National Trends Network (NTN).

In the 1990s, NADP expanded to include two additional networks. The Atmospheric Integrated Research Monitoring Network (AIRMoN) joined NADP in October 1992. By 1998, there were ten AIRMoN sites collecting samples within 24 hours of the start of precipitation. AIRMoN measures the same chemicals as NTN, but sampling is daily rather than weekly. These higher resolution samples enhance researchers' ability to evaluate how emissions affect precipitation chemistry using computer models that simulate atmospheric transport and removal of pollutants on a storm-by-storm basis. AIRMoN also evaluates new sample collection and preservation methods.

Another network, the Mercury Deposition Network (MDN), joined NADP in 1996. All samples from the 37 sites collecting weekly samples are analyzed for total mercury, and some are analyzed for the more toxic methyl mercury. Nearly 40 states have advisories warning people to limit their consumption of fish and wildlife from certain water bodies because of mercury contamination. These MDN data enable researchers to determine seasonal and annual fluxes of mercury in precipitation falling on lakes, wetlands, streams forested watersheds, and other sensitive ecosystems.

[**Front cover:** 1998 Estimated Total Mercury Deposition map showing areas with fish and wildlife consumption advisories for mercury. For more information about mercury advisories, see the U.S. Environmental Protection Agency Internet site (http://www.epa.gov/ost/fish).]

This Report

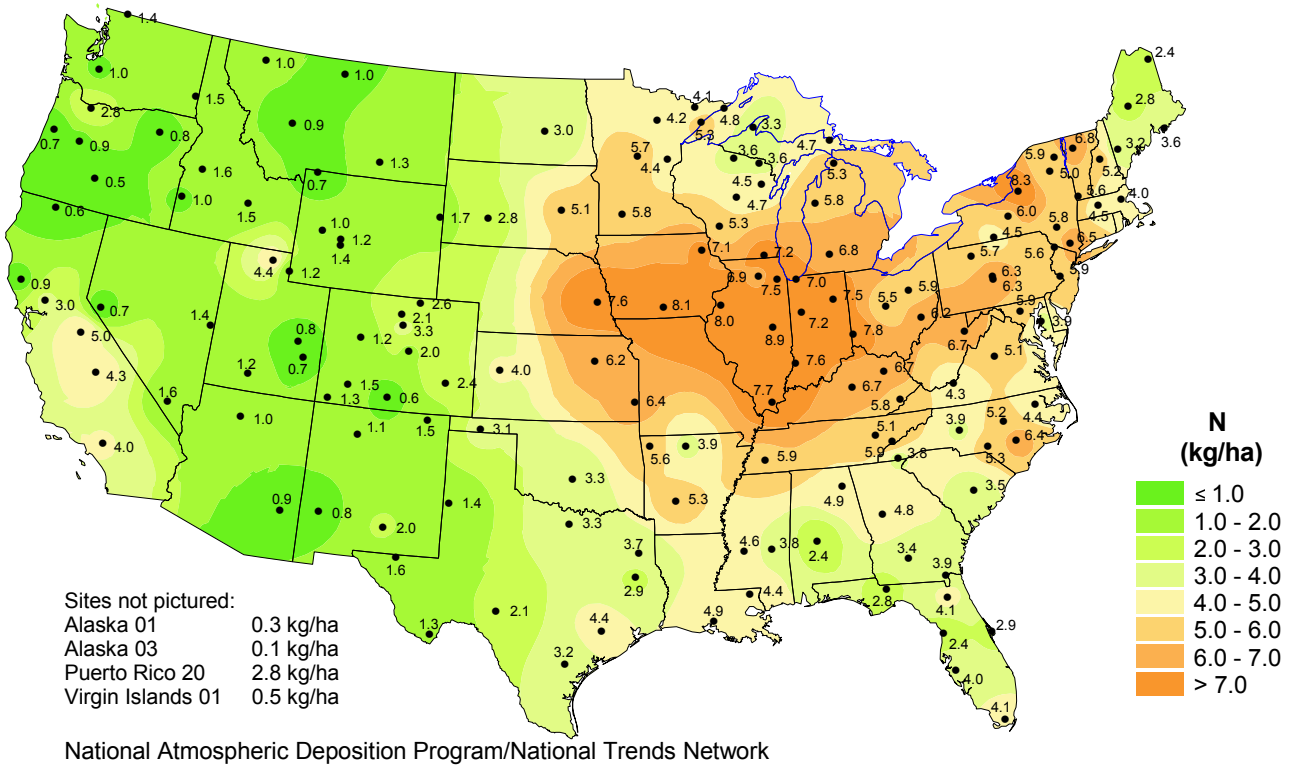
NTN Data

The NTN maps portray spatial variability in the concentration and deposition of selected acids, nutrients, and base cations on regional and national scales. Only sites that meet prescribed data completeness criteria are included. In 1998, 161 sites met these criteria. Black dots mark site locations. Annual concentration or deposition values are printed next to each site. The concentrations are volume-weighted averages. (For an explanation of the data completeness criteria or how the volume-weighted averages or deposition fluxes were calculated, see the NADP Internet site.)

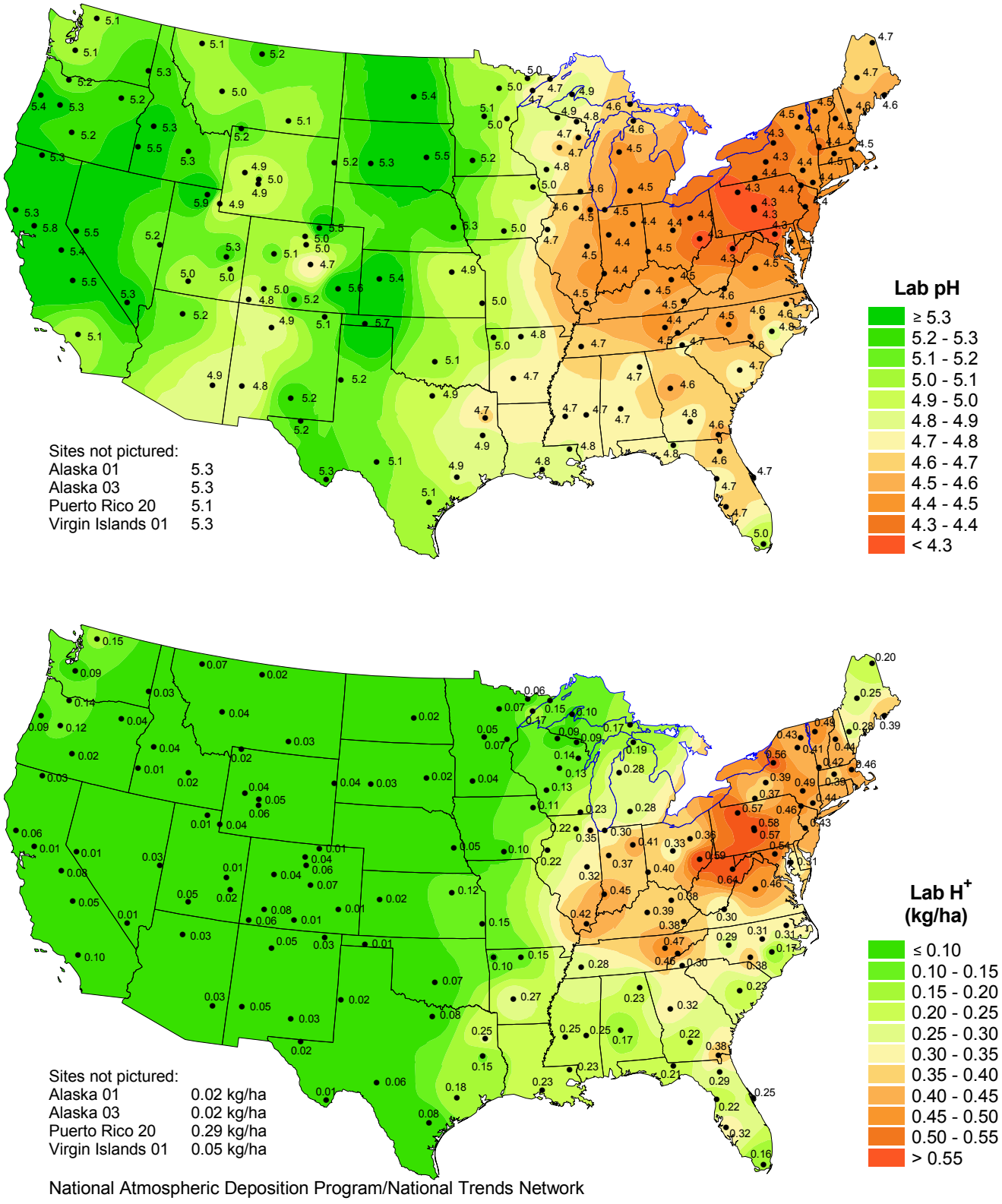
To make the color contours on the NTN maps, site values were used to compute an array of regularly spaced grid-point values covering the country. Sites within 500 kilometers of each grid point were used in computations. Color contours were drawn on this array of grid-point values. Each contour represents the class of concentrations or depositions indicated in the legend. (For a more complete description of the algorithm used to compute grid-point values, see the NADP Internet site.)

In addition to the map of inorganic nitrogen deposition, below, are concentration and deposition maps of laboratory pH (H^+), sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), calcium (Ca^{2+}), magnesium (Mg^{2+}), sodium (Na^+), and chloride (Cl^-). Also shown are maps of total precipitation and field pH. Maps for potassium (K^+) and field H^+ deposition are not included in this report but are available from the NADP Internet site.

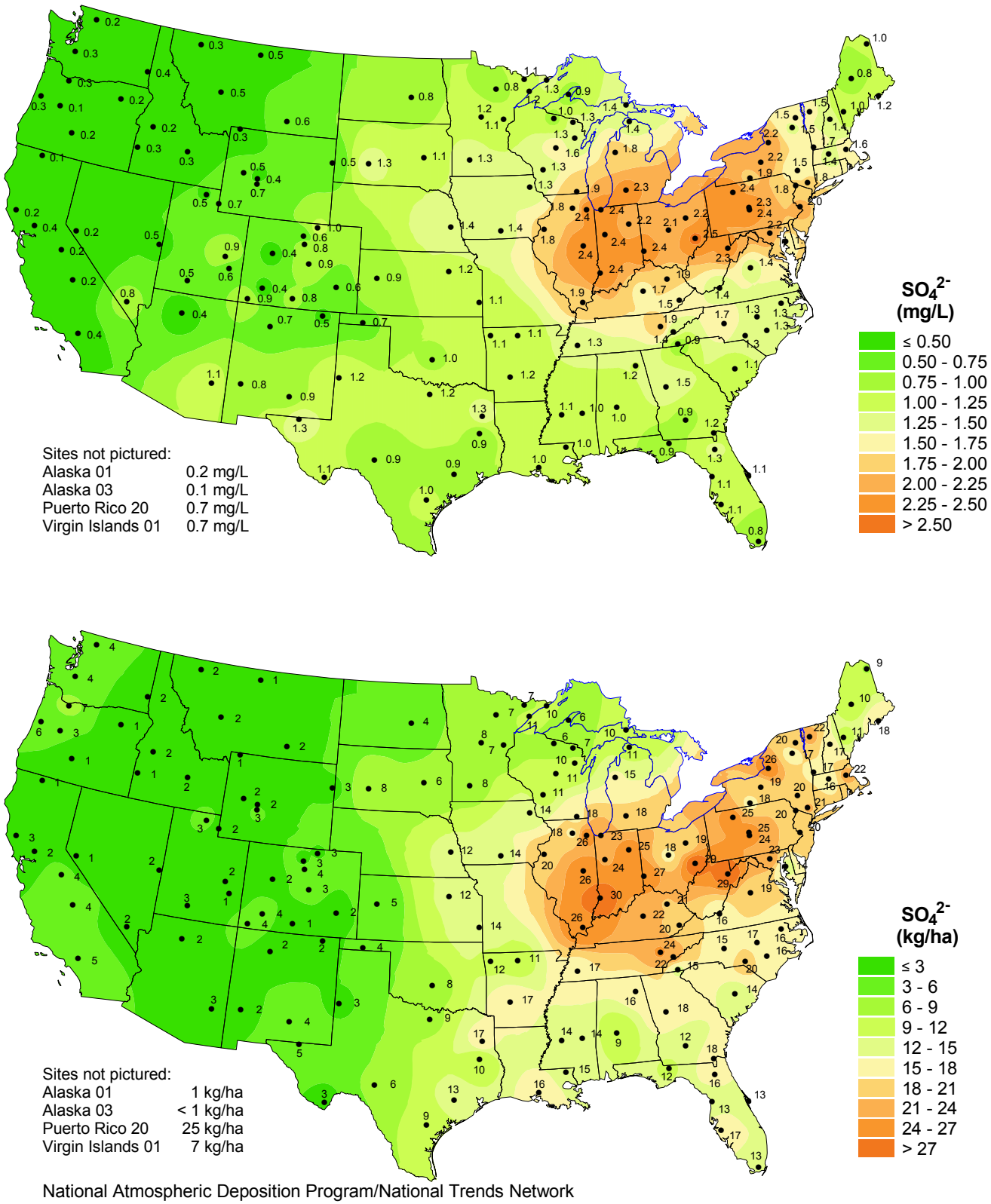
Explanation of NTN Color Contours: Refer to the figure below, which has eight inorganic nitrogen deposition classes or contours. The light green contour in the middle represents 3.0 - 4.0 kilograms per hectare (kg/ha). Nitrogen deposition values in the area covered by this contour are greater than 3.0 kg/ha and less than or equal to 4.0 kg/ha.



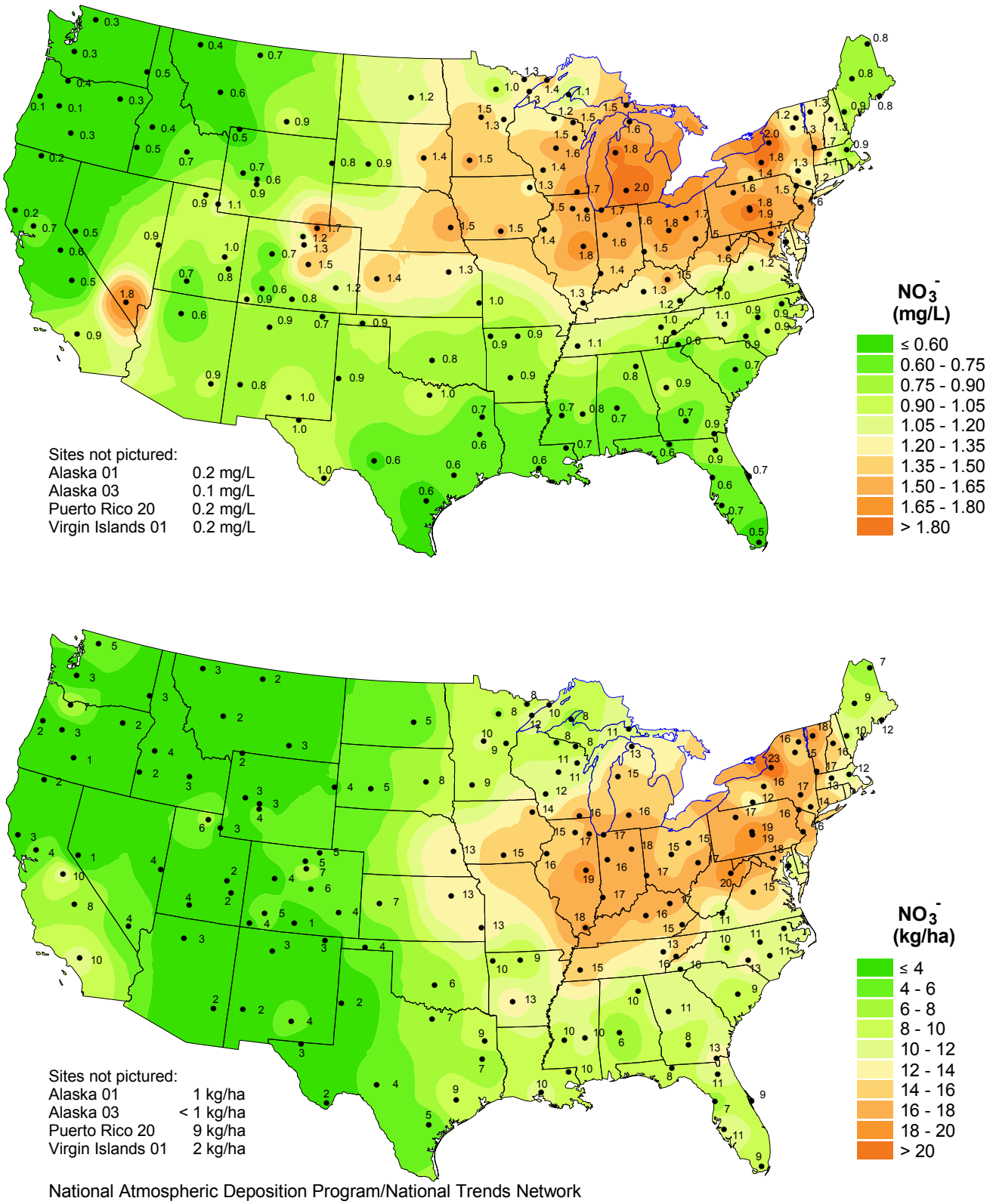
Estimated inorganic nitrogen deposition from nitrate and ammonium, 1998.



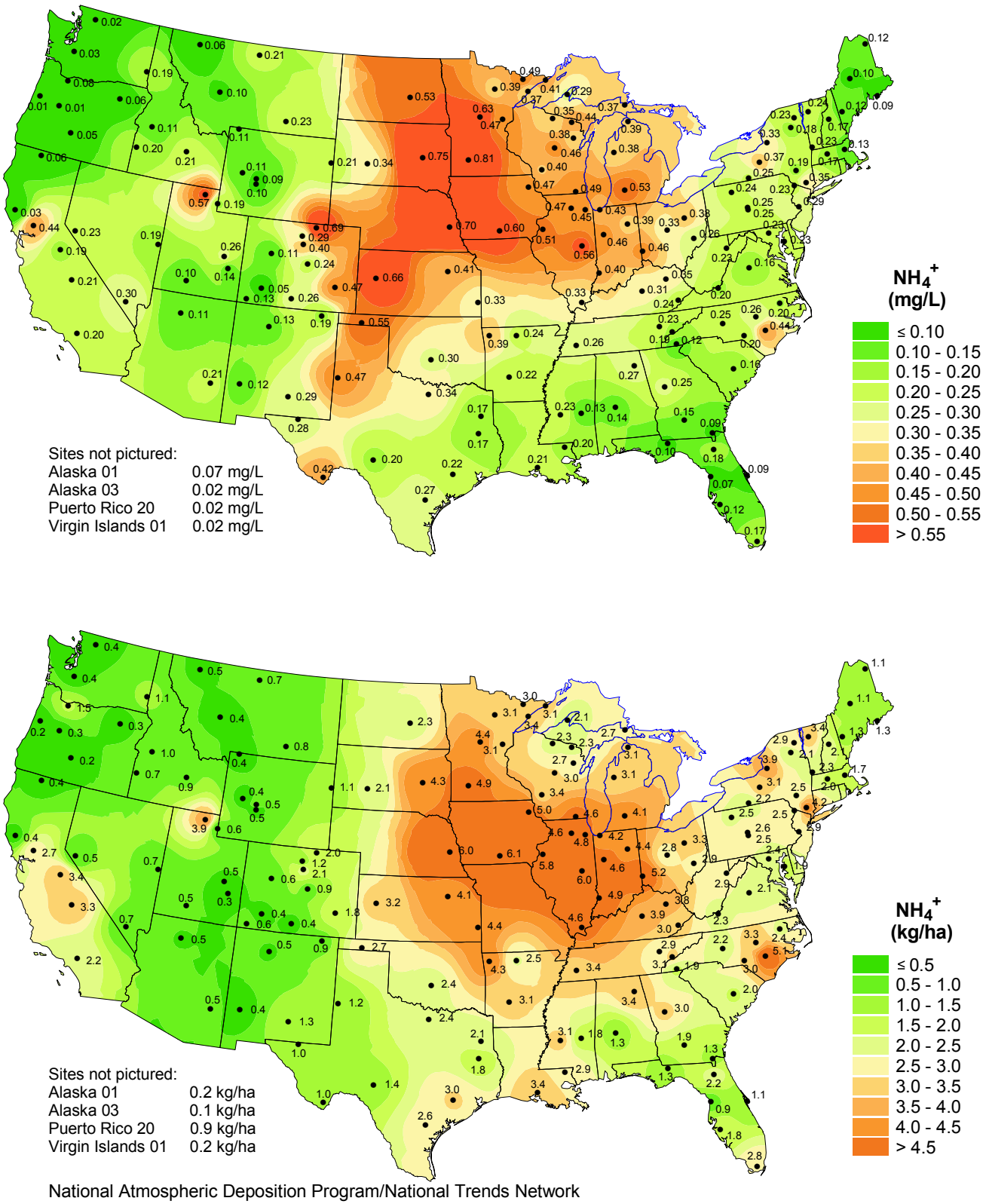
Hydrogen ion concentration as pH (top) and estimated deposition (bottom) from measurements made at the Central Analytical Laboratory, 1998.



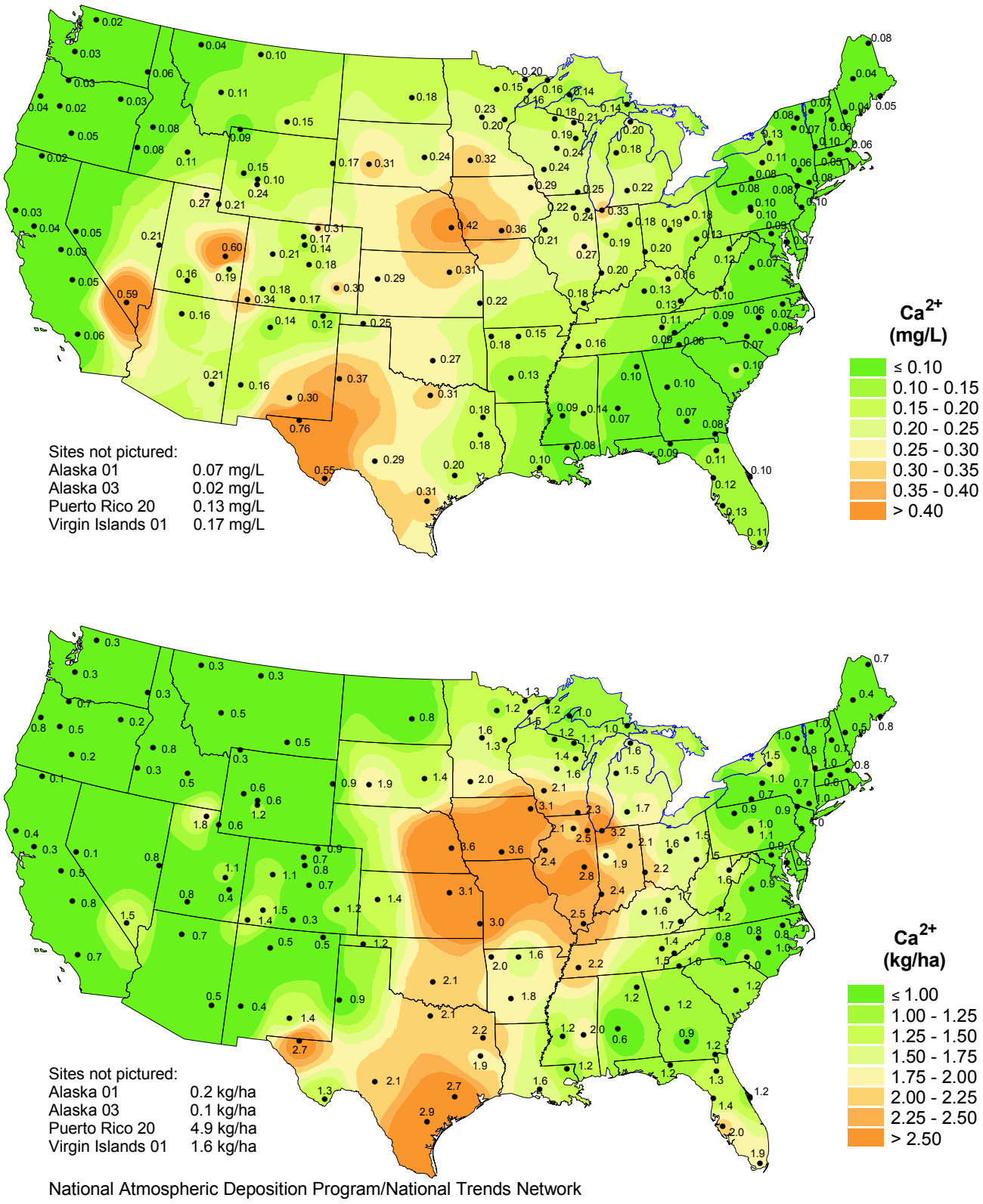
Sulfate ion concentration (top) and estimated deposition (bottom), 1998.



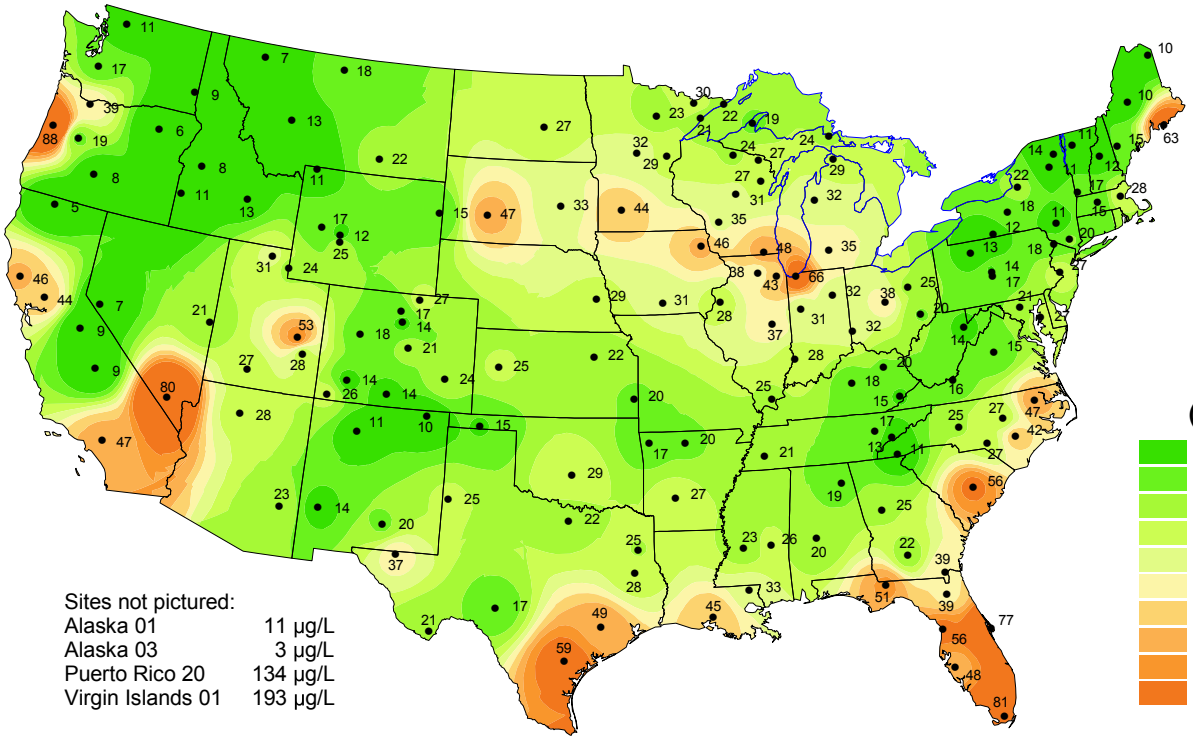
Nitrate ion concentration (top) and estimated deposition (bottom), 1998.

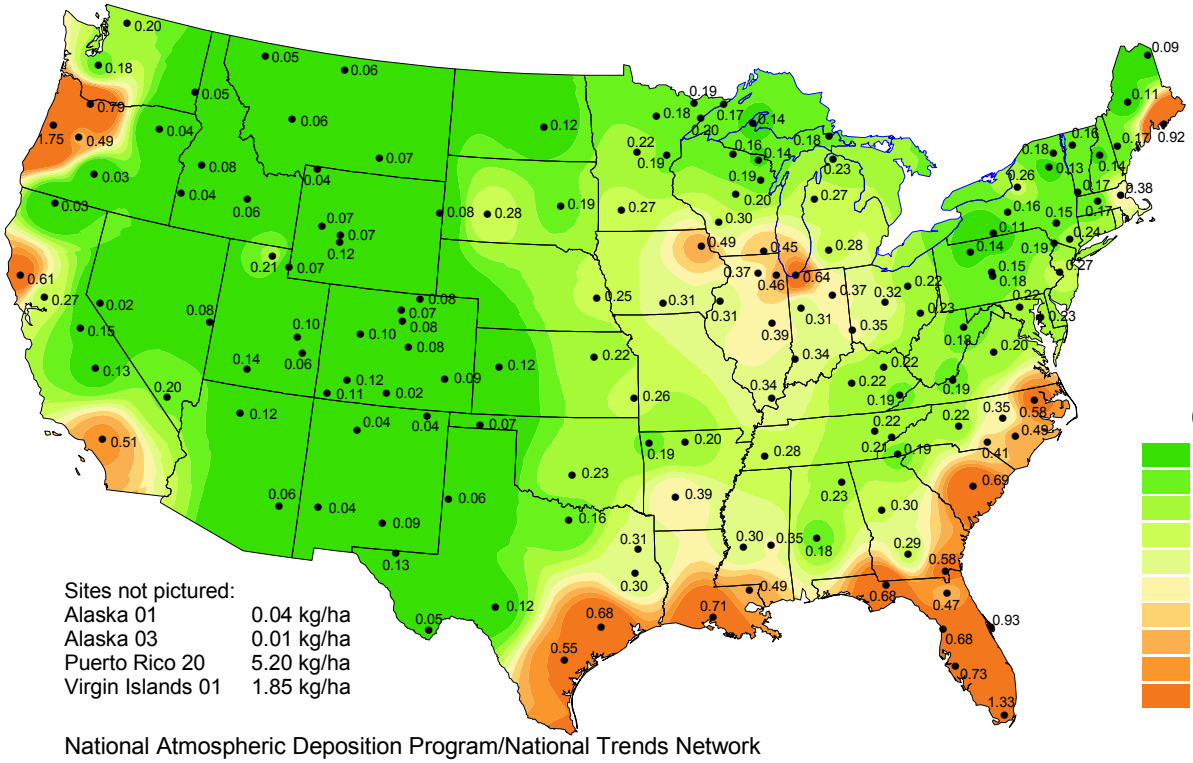


Ammonium ion concentration (top) and estimated deposition (bottom), 1998.

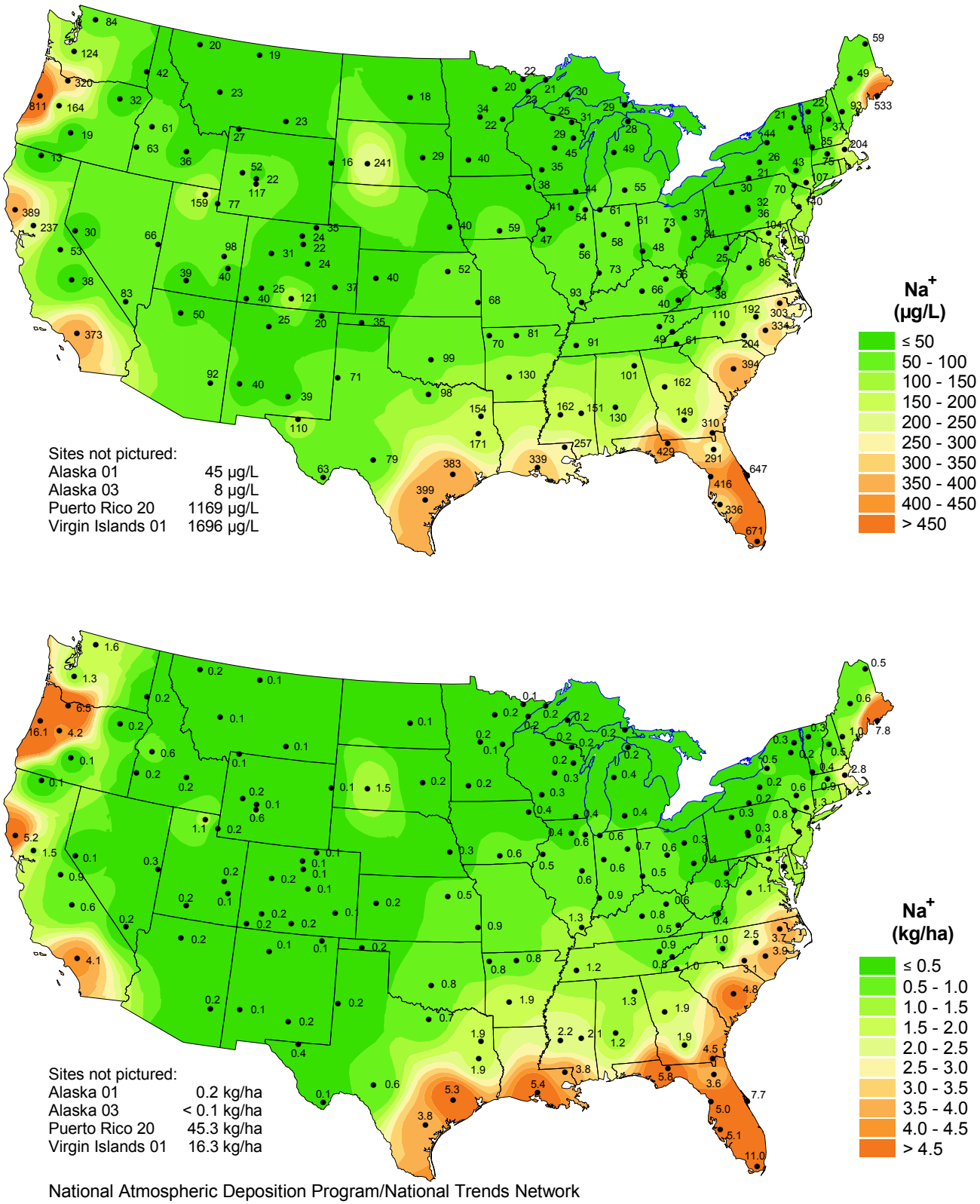


Calcium ion concentration (top) and estimated deposition (bottom), 1998.

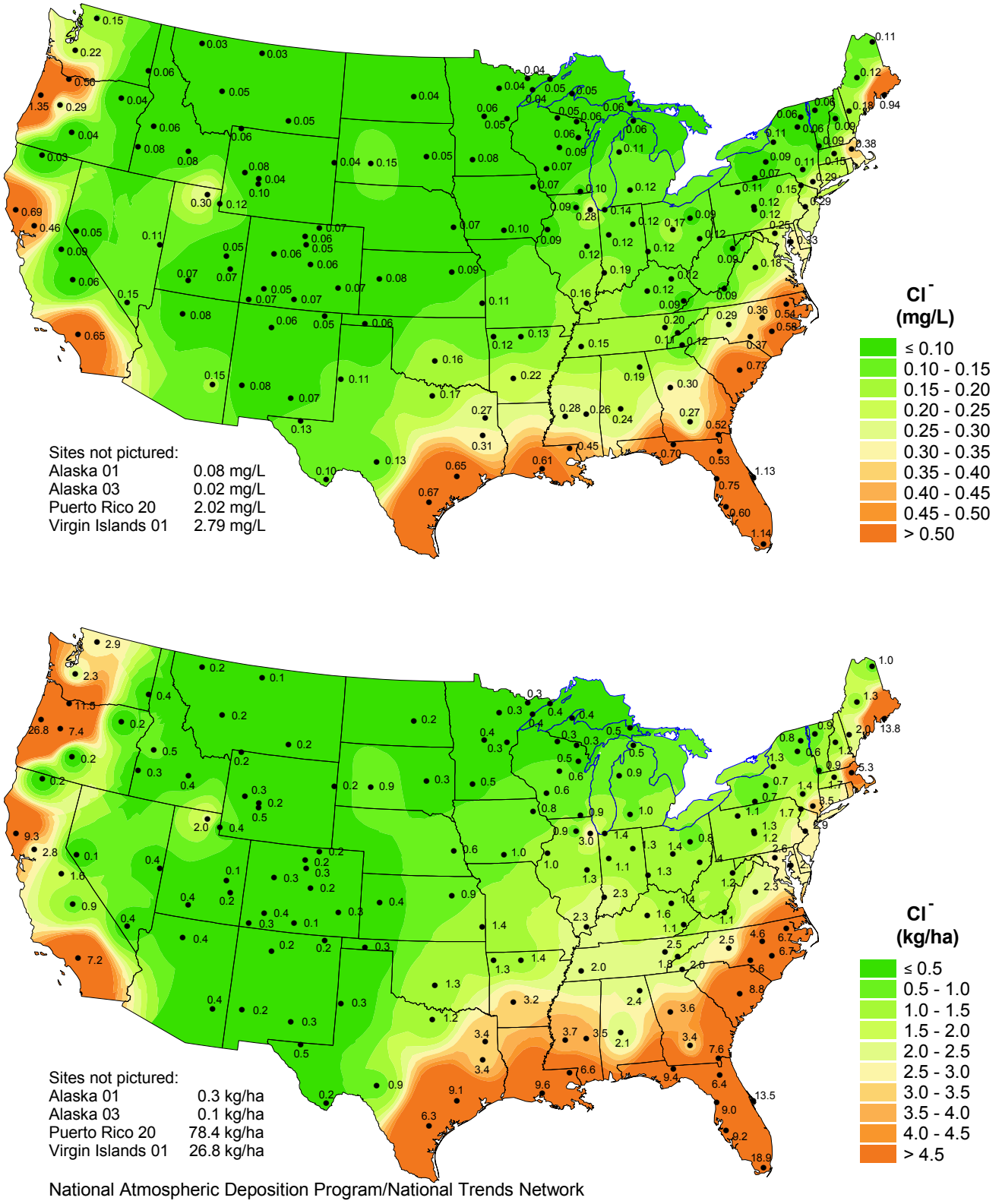




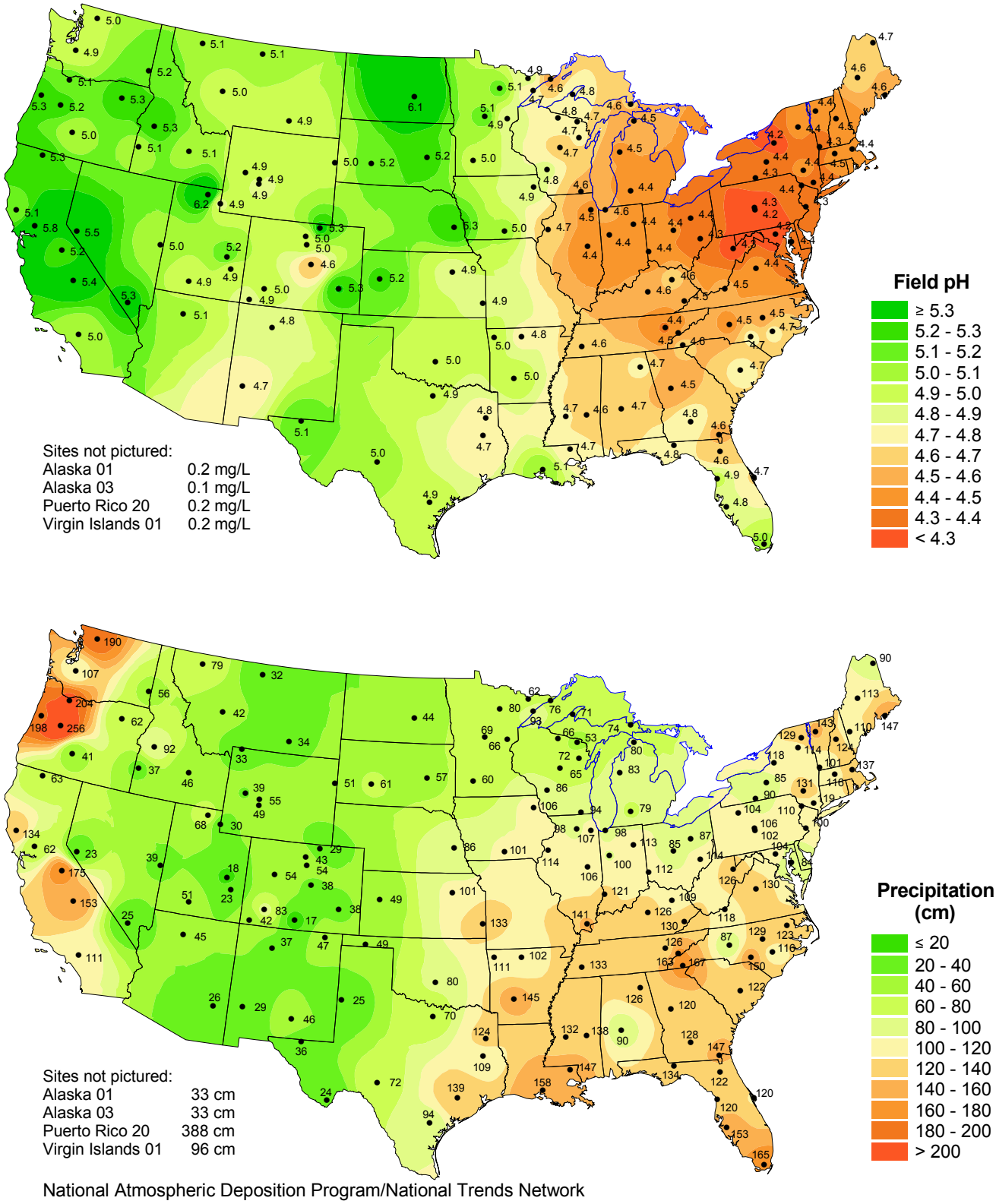
Magnesium ion concentration (top) and estimated deposition (bottom), 1998.



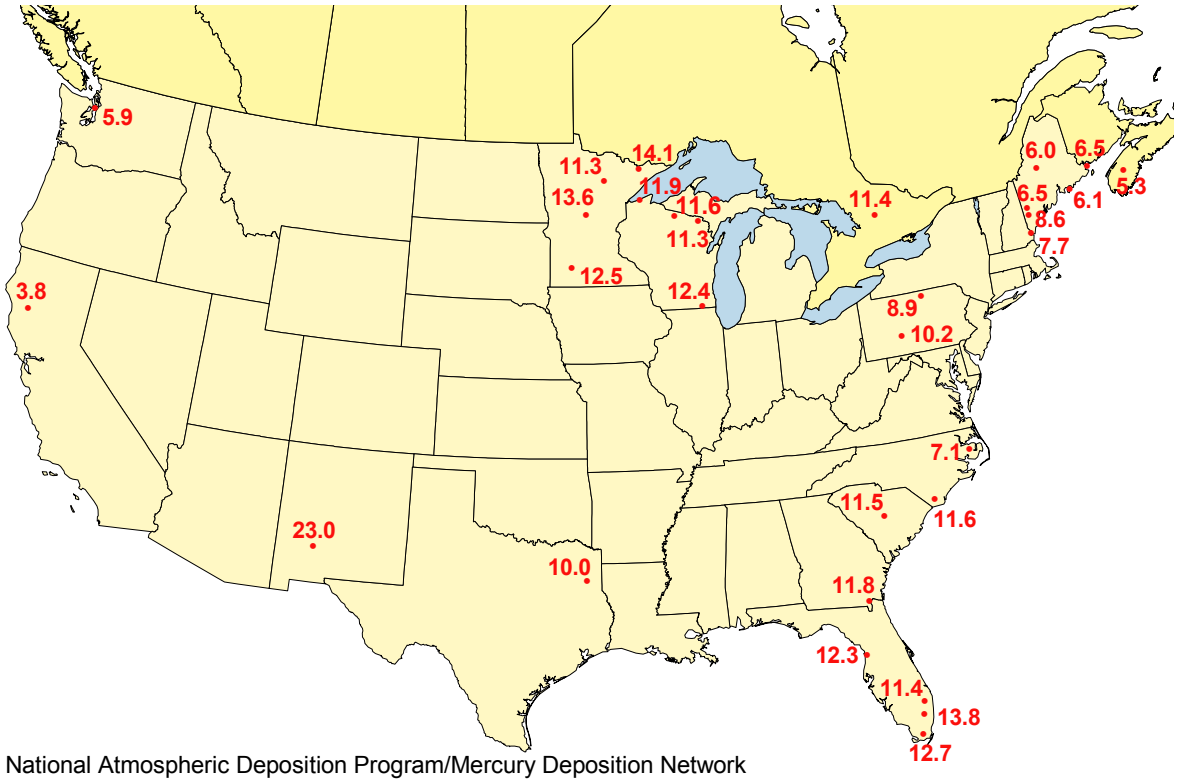
Sodium ion concentration (top) and estimated deposition (bottom), 1998.



Chloride ion concentration (top) and estimated deposition (bottom), 1998.



Hydrogen ion concentration as pH from measurements made in field laboratories (top) and total precipitation (bottom), 1998.



Mercury concentration in ng/L, 1998

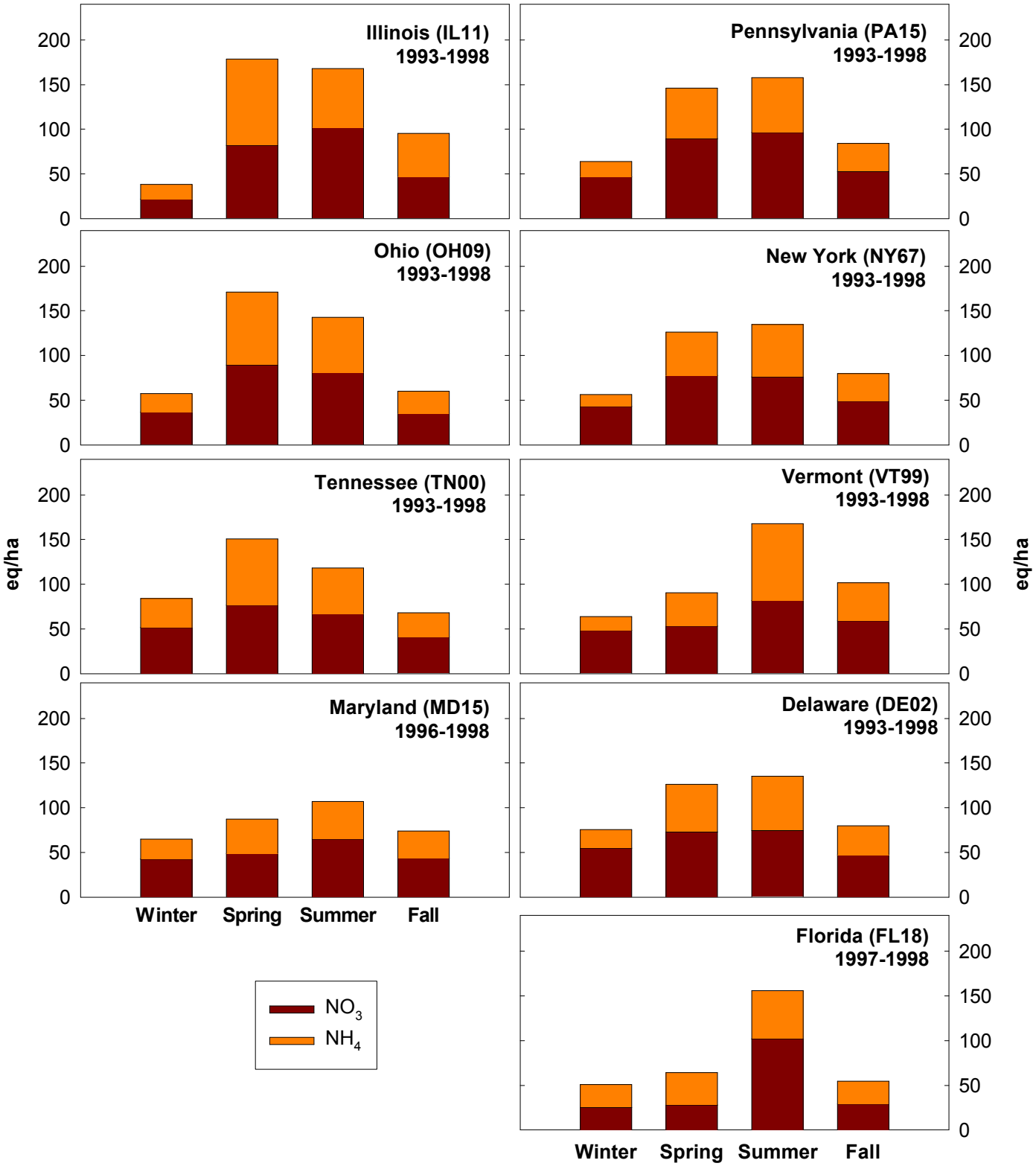
MDN Data

The MDN maps show the concentration (above) and deposition (front cover) of total mercury in precipitation. Only sites meeting prescribed data completeness criteria are included. In 1998, 30 sites met these criteria. Red dots mark the site locations. Annual concentration or deposition is printed next to each site. The concentrations are volume-weighted averages. (For an explanation of the data completeness criteria and how volume-weighted averages or deposition were calculated, see the NADP Internet site.)

AIRMoN Data

Bar graphs (next page) show average seasonal nitrate (NO_3^-) and ammonium (NH_4^+) deposition for the nine AIRMoN sites active at the end of 1998. These are 1993-1998 averages at all sites except Maryland (MD15) and Florida (FL18), which joined AIRMoN in late 1995 and 1996, respectively. The averaging period for these two sites is 1996-1998 (MD15) and 1997-1998 (FL18). Seasons are winter, (December-February), spring (March-May), summer (June-August), and fall (September-November). Not shown is the AIRMoN site at South Lido Key, near Sarasota, Florida, which began its operations in September 1998.

Average seasonal depositions were calculated by computing the seasonal weighted-average concentrations of nitrate and ammonium then multiplying these concentrations by the average seasonal precipitation amounts. Depositions in the bar graphs are in units of equivalents per hectare. The bar graphs show how nitrogen from nitrate and ammonium and the sum of these forms of inorganic nitrogen vary by season and among sites.



National Atmospheric Deposition Program/Atmospheric Integrated Research Monitoring Network

Average seasonal ion deposition of nitrate and ammonium.

NTN Operations

NTN is the only network providing a long-term record of precipitation chemistry across the United States. NTN sites are predominantly located away from urban areas and point sources of pollution. Each site has an Aerochem Metrics precipitation chemistry collector and a Belfort recording precipitation gage. The precipitation collection bucket on the Aerochem is open only when precipitation is occurring. This is wet-only sampling. Rigorous siting criteria and standard operational procedures ensure the comparability and representativeness of NTN data.

Samples are collected on a weekly basis. The site operator then transfers the precipitation sample from the collection bucket to a shipping bottle. All collection buckets and sample bottles are cleaned at the Central Analytical Laboratory (CAL) at the Illinois State Water Survey. If there is sufficient sample, the site operator pours off a portion and measures pH and conductivity. The sample is then shipped to the CAL for analysis, data entry, and validation. The CAL has served as the sole analytical laboratory since the program began. The following measurements are made in samples of sufficient volume: Ca^{2+}, Mg^{2+}, K^{+}, Na^{+}, NH_4^{+}, NO_3^{-}, Cl^{-}, SO_4^{2-}, H^{+} (pH), conductivity, and orthophosphate (PO_4^{3-}).

Field and laboratory data are reviewed at the CAL for completeness and accuracy. Data are also screened to identify or flag samples for which the quality is compromised: samples that are not wet-only deposition, samples that are compromised by mishandling, and samples that are grossly contaminated by debris not normally removed by precipitation. A leaf, insect, or cotton thread is an example of a contaminant not normally removed by raindrops. Once the CAL finishes the data review and validation, data are delivered to the NADP Program Office. One final set of checks is applied, and any discrepancies that arise are resolved on a case-by-case basis. At that point the data are made available on the Internet.

AIRMoN Operations

AIRMoN sites have the same siting criteria and equipment as NTN sites, with one exception: AIRMoN sites are equipped with a National Weather Service standard precipitation gage. AIRMoN operators collect samples daily within 24 hours of the start of precipitation. Samples are refrigerated after collection and until analysis at the CAL. The CAL performs the same analyses and similar data validation procedures as for NTN. The NADP Program Office makes the data available on the Internet.

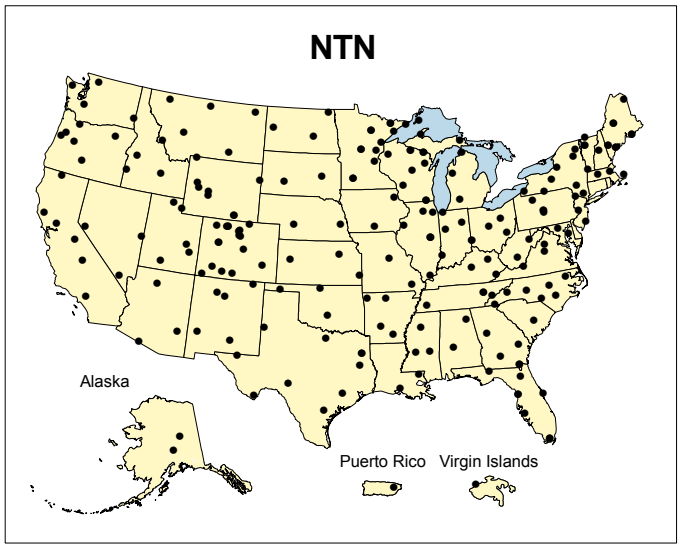
MDN Operations

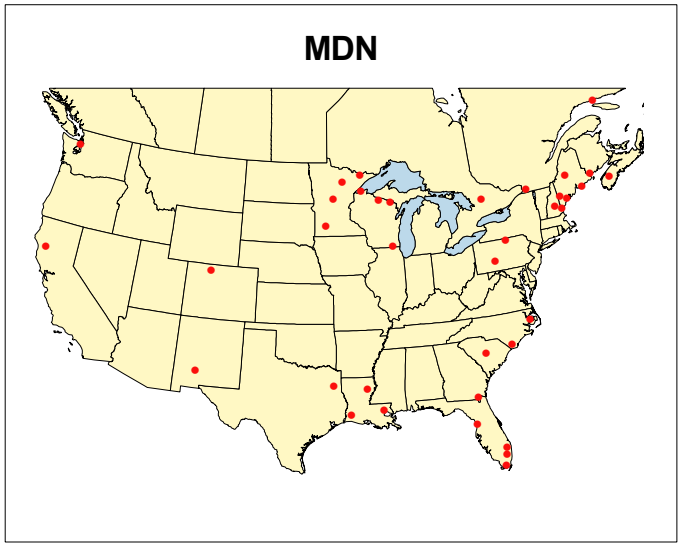
MDN sites collect samples weekly using a modified Aerochem Metrics collector equipped with ultraclean glassware. Rigorous sample handling procedures are followed. Samples are analyzed for total mercury (Hg) at the Hg Analytical Laboratory (HAL) at Frontier Geosciences, Inc., in Seattle, Washington. Data are reviewed and validated by the NADP Program Office before being made available on the Internet.

Recent NADP Accomplishments

NADP has:

- Provided data to evaluate the effectiveness of the 1990 Clean Air Act Amendments.
- Provided data for estimating nitrogen loading to the Chesapeake Bay and Mississippi River drainages.
- Contributed mercury deposition data to the Northeast States/Eastern Canadian Provinces mercury study.
- Contributed data for the National Acid Precipitation Assessment Program (NAPAP) report to Congress.





Note:

When referencing maps or information in this report, please use the citation: National Atmospheric Deposition Program. 2000. *National Atmospheric Deposition Program 1998 Wet Deposition*. NADP Data Report 2000-01. Illinois State Water Survey, Champaign, IL.

Support for NADP comes from a diverse group of sponsors and participants, ranging from landowners that provide a site location to federal agencies that fund dozens of sites. These include a high school, the U.S. Military Academy, the Kennedy Space Center, Native American tribal organizations, private companies, city governments, state agencies, universities, Forest Experiment Stations, State Agricultural Experiment Stations, national laboratories, agencies of the Canadian government, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the Environmental Protection Agency, the National Park Service, the U.S. Forest Service, the Bureau of Land Management, the U.S. Fish & Wildlife Service, the Tennessee Valley Authority, and the Cooperative State Research, Education, and Extension Service.

The NADP Program Office is located at the Illinois State Water Survey, an Affiliated Agency of the University of Illinois and a Division of the Illinois Department of Natural Resources.
NADP data and information, including color contour maps in this publication, are available from the NADP Internet site:

http://nadp.sws.uiuc.edu

For further information, special data requests, or to obtain copies of this publication, contact the NADP Program Office, Illinois State Water Survey, 2204 Griffith Drive, Champaign, IL 61820.
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