# Air Quality-Related Monitoring Considerations for the Greater Yellowstone Network

May 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 ambient air quality parameters for all Inventory and Monitoring parks in the U.S. This information will be available in late FY 2001. ARD will use the DU products to help determine where to expand the existing NPS ambient air quality monitoring network. In the meantime, the Greater Yellowstone Network can use the information provided below to help identify network air quality-related monitoring needs. Maps of the Clean Air Status and Trends (CASTNet) dry deposition monitoring network, the National Atmospheric Deposition Program/National Trends Network (NADP) wet deposition monitoring network, the NADP Mercury Deposition Network (MDN), and the Interagency Monitoring of Protected Visual Environments (IMPROVE) visibility monitoring network are attached.

We focus on ozone sensitivity for vegetation 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. 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 an indication of the ozone risk to sensitive vegetation in Greater Yellowstone Network parks based on this statistic.

Note that the MDN monitor closest to the Greater Yellowstone Network is in northern Colorado. If mercury is a potential concern for Great Yellowstone Network parks, the Network may want to consider installing a mercury monitor at one of the parks. The first year cost for a MDN site is about $16,000, and subsequent monitoring costs about $14,000 a year. Equipment costs are about $3,500 lower if the mercury monitor is co-located with an existing NADP site.

## Bighorn Canyon NRA

At present, no ambient air quality monitoring is conducted in the park. The closest ozone and CASTNet dry deposition monitors are located in Yellowstone NP. The closest IMPROVE visibility monitor is located near the U.S.D.A. Forest Service (FS) North Absoraka Wilderness Area in northcentral Wyoming (site NOAB). The FS site has been in operation since January 2000. The closest long-term visibility data are available from the Yellowstone NP IMPROVE site (site YELL; in operation since September 1988). The closest NADP wet deposition monitor is located at Little Bighorn Battlefield NM (site MT00). The Little Bighorn Battlefield NM NADP site has been in operation since 1984. We recommend waiting for the results of the DU analysis before determining the need to institute ambient air quality monitoring in Bighorn Canyon NRA.

Current ozone levels at the Yellowstone NP monitor suggest ozone concentrations in Bighorn Canyon NRA are not high enough that we would expect ozone-sensitive vegetation to be injured. However, because the Yellowstone NP data show an increasing trend in ozone concentrations, it may be advisable, in the future, to survey vegetation in Bighorn Canyon NRA for ozone injury. The park vascular plant list (provided by Lane Cameron) was compared to the general ozone-sensitive plant species lists contained in the NPS Synthesis information management system (lists attached) to identify potentially ozone-sensitive species in Bighorn Canyon NRA (see table below). Good choices for ozone injury surveys in the park are ponderosa pine (*Pinus ponderosa*), quaking aspen (*Populus tremuloides*), and skunkbush (*Rhus trilobata*) because the symptoms of ozone injury are well documented on those species.

| **PLANT SPECIES VERY SENSITIVE TO OZONE** | |
|---|---|
| **Latin Name** | **Common Name** |
| *Amelanchier alnifolia* | Saskatoon serviceberry |
| *Apocynum androsaemifolium* | Spreading dogbane |
| *Pinus ponderosa* | Ponderosa pine |
| *Populus tremuloides* | Quaking aspen |
| *Rudbeckia hirta* | Black-eyed susan |
| *Rudbeckia laciniata* | Cut-leaf coneflower |
| *Sambucus canadensis* | American elder |
| *Sambucus racemosa* | Red elderberry |
| *Senecio serra* | Tall butterweed |
| **PLANT SPECIES SLIGHTLY SENSITIVE TO OZONE** | |
| **Latin Name** | **Common Name** |
| *Acer negundo* | Boxelder |
| *Bromus tectorum* | Cheatgrass |
| *Rhus glabra* | Smooth sumac |
| *Rhus trilobata* | Skunkbush |
| *Rubus idaeus* | Red raspberry |
| *Symphoricarpos albus* | Common snowberry |
| *Vitis riparia* | Riverbank grape |

Nitrogen and sulfur deposition can acidify surface waters. Acid-sensitive surface waters typically have a pH below 6.0 and an acid neutralizing capacity (ANC) below 100 microequivalents per liter (μeq/l). A review of the 1998 NPS Water Resources Division report for Bighorn Canyon NRA indicated many water chemistry data have been collected in the park. However, most of these data were collected prior to 1985. Not surprisingly, the data showed large rivers such as the Bighorn and the Shoshone, as well as Yellowtail Reservoir and Bighorn Lake, are not sensitive to acidification from acid deposition. The pH values were in the range of 8.0 and ANC values were over 1,000 μeq/l. A number of unnamed streams were sampled in the park in 1978 and 1979, and all the pH data indicated streams in the park are not sensitive to acidification (pH values ranged from 7.0 to 8.4). Unless there is reason to believe that previous samples do not characterize conditions in the park, there is no need to conduct air quality-related stream chemistry sampling.

**Grand Teton NP**

The 1998 Peterson *et. al*. report summarized ambient air quality and effects information for Grand Teton NP and provided air quality-related monitoring and research needs. At present, no ambient air quality monitoring is conducted in the park. The report recommended installation of ozone, wet deposition, visibility, and sulfur dioxide monitors in Grand Teton NP. Because sulfur dioxide emissions quickly convert to sulfate and sulfuric acid, we do not believe sulfur dioxide monitoring is warranted in this situation. The closest monitoring for the other parameters occurs in Yellowstone NP. We recommend deferring the decision to install ambient monitors in Grand Teton NP until the DU products are available. These products will help us determine how well Yellowstone NP monitoring represents conditions at Grand Teton NP.

Current ozone levels at the Yellowstone NP monitor suggest ozone concentrations in Grand Teton NP are not high enough that we would expect ozone-sensitive vegetation to be injured. However, because the Yellowstone NP data show an increasing trend in ozone concentrations, it may be advisable, in the future, to survey vegetation in Grand Teton NP for ozone injury. Based on the Peterson *et. al*. report, candidate species for the survey include lodgepole pine (*Pinus contorta*), quaking aspen (*Populus tremuloides*), strawberry (*Fragaria virginiana*), skunkbush (*Rhus trilobata*) and red clover (*Trifolium repens*).

Data from the Yellowstone NP NADP and CASTNet monitors show nitrogen and sulfur deposition in northwestern Wyoming is relatively low. However, limited data indicate some high-elevation lakes in Grand Teton NP are sensitive to acidification from acid deposition. Therefore, Peterson *et. al*. recommended a synoptic survey be conducted to identify acid-sensitive lakes in Grand Teton NP, followed by long-term chemical and biological monitoring of a handful of the sensitive lakes. We agree with this recommendation, and encourage the Network to consider such monitoring when designing its Vital Signs monitoring program.

**Yellowstone NP**

At present, ozone (site #560391010611011; in operation since 1986), wet deposition (NADP site WY08; in operation since 1980), dry deposition (CASTNet site YEL408; in operation since 1996), and visibility (IMPROVE site YELL; in operation since 1988) are monitored in Yellowstone NP. The Peterson *et. al*. report recommended passive ozone sampling be conducted throughout the park to assess the spatial distribution of ozone concentrations. We recommend a decision about passive sampling be delayed until the DU products are available.

Current ozone levels in the park are not high enough that we would expect ozone-sensitive vegetation to be injured. However, because the Yellowstone NP data show an increasing trend in ozone concentrations, it may be advisable, in the future, to survey vegetation in the park for ozone injury. Based on the Peterson *et. al*. report, candidate species for the survey include lodgepole pine (*Pinus contorta*), quaking aspen (*Populus tremuloides*), strawberry (*Fragaria virginiana*), skunkbush (*Rhus trilobata*) and red clover (*Trifolium repens*).

Peterson *et. al*. concluded that because surface waters in Yellowstone NP do not appear to be sensitive to atmospheric deposition, deposition-related water quality monitoring is not necessary. We agree with their assessment.

**References**

Peterson, D.L., T.J. Sullivan, J.M. Eilers, S. Brace, K. Savig and D. Morse. 1998. *Assessment of Air Quality and Air Pollutant Impacts in National Parks of the Rocky Mountains and Northern Great Plains*. National Park Service, Air Resources Division. Denver, CO.

Water Resources Division. 1998. *Baseline Water Quality Data Inventory and Analysis: Bighorn Canyon National Recreation Area.* National Park Service, Water Resources Division. Fort Collins, CO.

**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/airsdata/
**Pollution sources and air quality data** - http://www.epa.gov/ttn/rto/areas/
**Pollution sources and air quality data** - http://www.epa.gov/agweb/

# PLANT SPECIES VERY SENSITIVE TO OZONE

These species would be expected to produce distinctive foliar injury when exposed to “normal” levels of ambient ozone. This list was developed for the AQUIMS Project and is considered a work in progress. Future updates and changes to this list will be posted to AQUIMS. This version is dated September 20, 1999.

| Code | Scientific Name | Common Name | Family |
|---|---|---|---|
| AIAL | Ailanthus altissima | Tree-of-heaven | Simaroubaceae |
| AMAL2 | Amelanchier alnifolia | Saskatoon serviceberry | Rosaceae |
| APAN2 | Apocynum androsaemifolium | Spreading dogbane | Apocynaceae |
| ARDO3 | Artemisia douglasiana | Mugwort | Asteraceae |
| ASAC6 | Aster acuminatus | Whorled aster | Asteraceae |
| ASEN2 | Aster engelmannii | Engelmann's aster | Asteraceae |
| ASEX | Asclepias exaltata | Tall milkweed | Asclepiadaceae |
| ASMA2 | Aster macrophyllus | Big-leaf aster | Asteraceae |
| ASPU5 | Aster puniceus | Purple-stemmed aster | Asteraceae |
| ASQU | Asclepias quadrifolia | Four-leaved milkweed | Asclepiadaceae |
| ASSY | Asclepias syriaca | Common milkweed | Asclepiadaceae |
| ASUM | Aster umbellatus | Flat-toppped aster | Asteraceae |
| FRAM2 | Fraxinus americana | White ash | Oleaceae |
| FRPE | Fraxinus pennsylvanica | Green ash | Oleaceae |
| GEAM4 | Gentiana amarella | Northern gentian | Gentianaceae |
| LIST2 | Liquidambar styraciflua | Sweetgum | Hamamelidaceae |
| LITU | Liriodendron tulipifera | Yellow-poplar | Magnoliaceae |
| OEEL | Oenothera elata | Evening primrose | Onagraceae |
| PAQU2 | Parthenocissus quinquefolia | Virginia creeper | Vitaceae |
| PHCA11 | Physocarpus capitatus | Ninebark | Rosaceae |
| PHCO7 | Philadelphus coronarius | Sweet mock-orange | Hydrangeaceae |
| PIJE | Pinus jeffreyi | Jeffrey pine | Pinaceae |
| PIPO | Pinus ponderosa | Ponderosa pine | Pinaceae |
| PIPU5 | Pinus pungens | Table mountain pine | Pinaceae |
| PITA | Pinus taeda | Loblolly pine | Pinaceae |
| PLOC | Platanus occidentalis | American sycamore | Platanaceae |
| POTR5 | Populus tremuloides | Quaking aspen | Salicaceae |
| PRPE2 | Prunus pensylvanica | Pin cherry | Rosaceae |

| | | | |
|---|---|---|---|
| PRSE2 | Prunus serotina | Black cherry | Rosaceae |
| RHCO13 | Rhus copallina | Flameleaf sumac | Anacardiaceae |
| RUAL | Rubus allegheniensis | Allegheny blackberry | Rosaceae |
| RUHI2 | Rudbeckia hirta | Black-eyed susan | Asteraceae |
| RULA3 | Rudbeckia laciniata | Cut-leaf coneflower | Asteraceae |
| SAAL5 | Sassafras albidum | Sassafras | Lauraceae |
| SACA12 | Sambucus canadensis | American elder | Caprifoliaceae |
| SAME5 | Sambucus mexicana | Blue elderberry | Caprifoliaceae |
| SARA2 | Sambucus racemosa | Red elderberry | Caprifoliaceae |
| SESE2 | Senecio serra | Tall butterweed | Asteraceae |
| VAME | Vaccinium membranaceum | Thin-leaved blueberry | Ericaceae |
| VILA8 | Vitis labrusca | Northern fox grape | Vitaceae |

SOURCE: National Park Service, Air Resources Division and Penn State University, Department of Plant Pathology, June 1999

Entered: June 1999

# PLANT SPECIES SLIGHTLY SENSITIVE TO OZONE

These species would show distinctive foliar injury only when exposed to “extremely high” levels of ambient ozone. This list was developed for the AQUIMS Project and is considered a work in progress. Future updates and changes to this list will be posted to AQUIMS. This version is dated September 20, 1999.

| Code | Scientific Name | Common Name | Family |
|---|---|---|---|
| ACMA3 | Acer macrophyllum | Bigleaf maple | Aceraceae |
| ACNE2 | Acer negundo | Boxelder | Aceraceae |
| ACRU | Acer rubrum | Red maple | Aceraceae |
| AEGL | Aesculus glabra | Ohio buckeye | Hippocastanaceae |
| AEOC2 | Aesculus octandra | Yellow buckeye | Hippocastanaceae |
| BEAL2 | Betula alleghaniensis | Yellow birch | Betulaceae |
| BEPO | Betula populifolia | Gray birch | Betulaceae |
| BRTE | Bromus tectorum | Cheatgrass | Poaceae |
| CECA4 | Cercis canadensis | Redbud | Fabaceae |
| CLLU | Cladrastis lutea | Yellowwood | Fabaceae |
| COFL2 | Cornus florida | Flowering dogwood | Cornaceae |
| GLNU | Glyceria nubigena | Manna grass | Poaceae |
| KRMO | Krigia montana | Mountain dandelion | Asteraceae |
| LADE2 | Larix decidua | European larch | Pinaceae |
| _LALE0 | Larix leptolepis | Japanese larch | Pinaceae |
| PINI | Pinus nigra | Austrian pine | Pinaceae |
| PIRA2 | Pinus radiata | Monterey pine | Pinaceae |
| PIRI | Pinus rigida | Pitch pine | Pinaceae |
| PIVI2 | Pinus virginiana | Virginia pine | Pinaceae |
| RHGL | Rhus glabra | Smooth sumac | Anacardiaceae |
| RHTR | Rhus trilobata | Skunkbush | Anacardiaceae |
| RHTY | Rhus typhina | Staghorn sumac | Anacardiaceae |
| ROPS | Robinia pseudoacacia | Black locust | Fabaceae |
| RUID | Rubus idaeus | Red raspberry | Rosaceae |
| RUNU2 | Rugelia nudicaulis | Rugel's ragwort | Asteraceae |
| SAAR13 | Saxifraga arguta | Saxifrage | Saxifragaceae |
| SAGO | Salix gooddingii | Gooding's willow | Salicaceae |

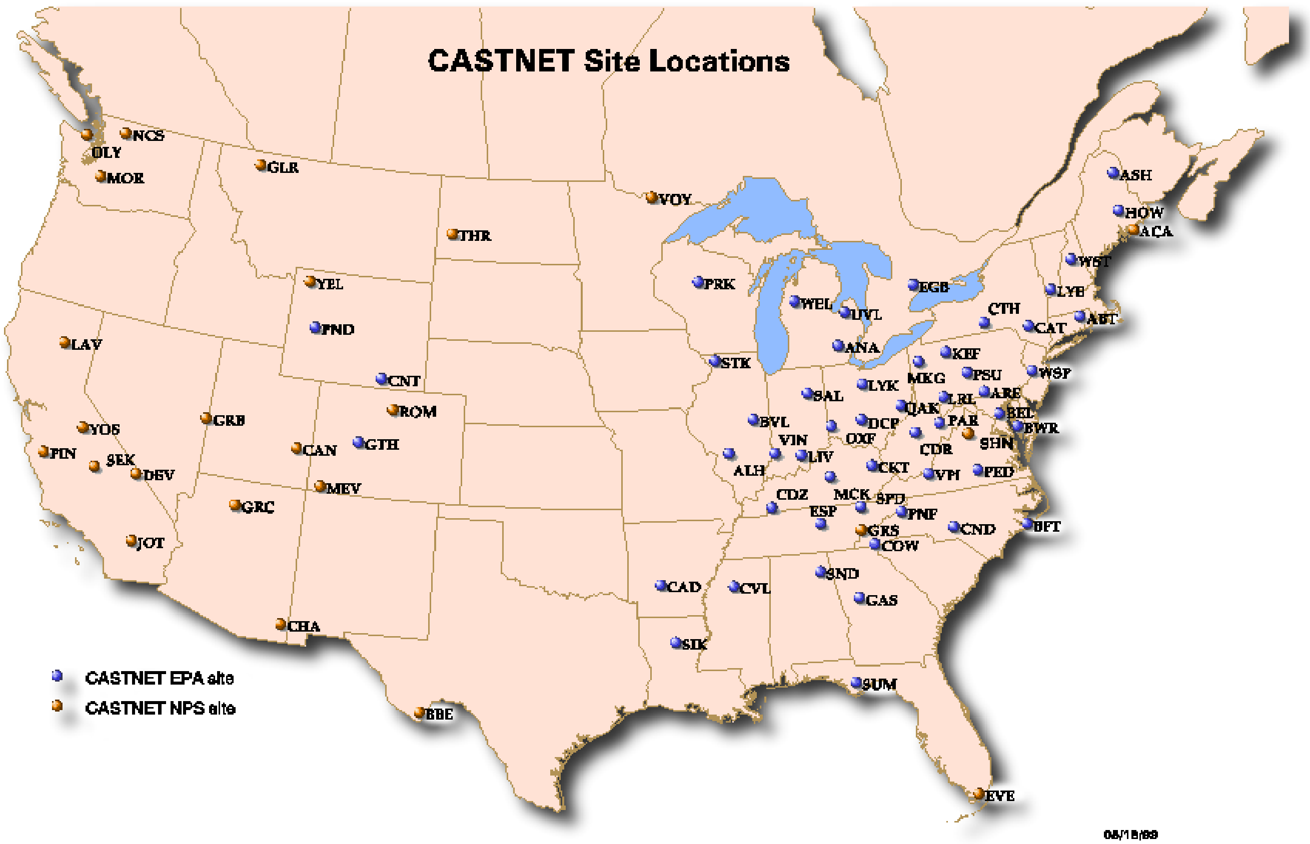
| | | | |
|---|---|---|---|
| SASC | Salix scouleriana | Scouler's willow | Saliaceae |
| SPVA2 | Spiraea x vanhouttei | Vanhoutte spirea | Rosaceae |
| SYAL | Symphoricarpos albus | Common snowberry | Caprifoliaceae |
| _SYCHX | Syringa x chinensis | Chinese lilac | Oleaceae |
| SYVU | Syringa vulgaris | Common lilac | Oleaceae |
| TIAM | Tilia americana | American basswood | Tiliaceae |
| _TIEU0 | Tilia euchlora | Crimean linden | Tiliaceae |
| TIPL | Tilia platyphyllos | Bigleaf linden | Tiliaceae |
| TORA2 | Toxicodendron radicans | Poison-ivy | Anacardiaceae |
| VEOC | Verbesina occidentalis | Crownbeard | Asteraceae |
| VICA5 | Vitis californica | California grape | Vitaceae |
| VIGI2 | Vitis girdiana | Wild grape | Vitaceae |
| VIRI | Vitis riparia | Riverbank grape | Vitaceae |
| VIVI5 | Vitis vinifera | European wine grape | Vitaceae |

Note: A code, such as _LALE0, which is preceded by an underscore indicates that the code is tentative and was created for the purpose of referencing the species. An NRCS PLANTS database code does not yet exist for the given species.

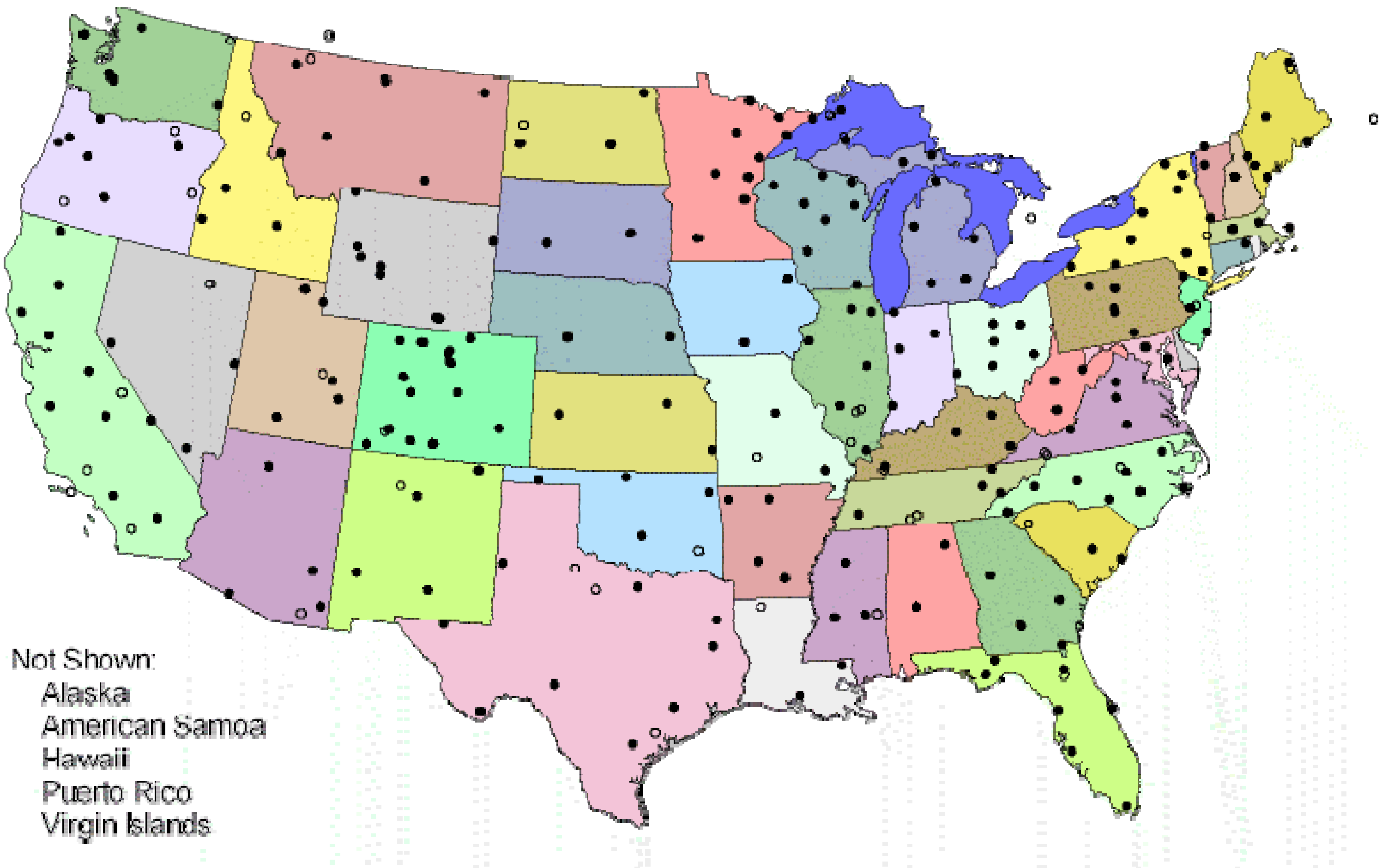
SOURCE: National Park Service, Air Resources Division and Penn State University, Department of Plant Pathology, December 1998

Entered: 1999

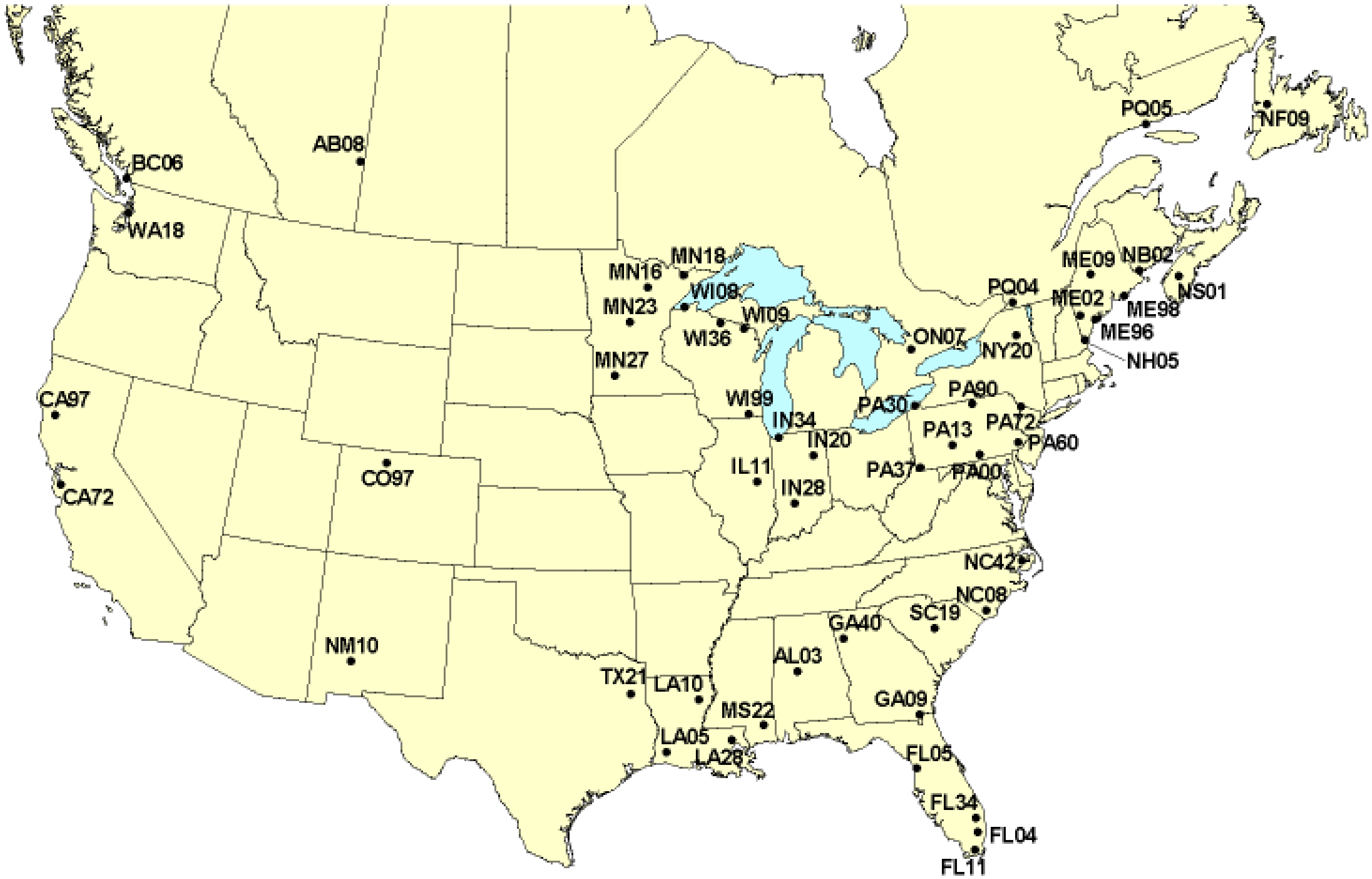
## MAP OF CASTNet DRY DEPOSITION MONITORING NETWORK



## MAP OF NADP WET DEPOSITION MONITORING NETWORK



# National Atmospheric Deposition Program
# Mercury Deposition Network



# MAP OF IMPROVE VISIBILITY MONITORING NETWORK