Monitoring Air Quality in Wilderness

Understanding air quality is a challenge. Air transports from one area to another and moves across wilderness area boundaries, bringing in particles and chemicals that may have originated many miles away. Knowing where air pollution comes from, what it is made of, and how it affects resources is key to protecting wilderness areas. A very small amount of air pollution may originate in wilderness (for example, wildland fires). Air pollution is almost exclusively a threat originating from outside wilderness boundaries. Power plants, oil and gas development, highway vehicles, and off-road equipment are some examples of sources of air pollution. Learn more about sources of air pollution.

Sources Impacting Wilderness Area

Visit EPA's State and County Emission Summaries webpage to view state and county emissions summaries for six common air pollutants. The EPA's National Emissions Inventory (NEI) is a detailed estimate of air emissions that include criteria pollutants and hazardous air pollutants. EPA's National Air Toxics Assessment (NATA) provides a snapshot of air toxic emissions and risks.

Regional or local air quality issues for a wilderness area can also be identified using air quality models. Based on meteorological data and air pollution source information, these models characterize primary pollutants that are emitted directly into the atmosphere and, in some cases, secondary pollutants that are formed as a result of complex chemical reactions within the atmosphere. Contact your regional or national air quality specialist for more information about air quality modeling.

Monitoring Resources

Air quality data from nationwide monitoring networks can provide information on trends and pollution levels for wilderness areas, including those that do not have on-site monitoring.

Monitoring data allow us to better understand air quality in or near wilderness areas, while gaining valuable nationwide perspective on air quality conditions and trends over time. The FLMs participate in several national, multiagency air quality monitoring networks. These networks focus on ozone, visibility, particulate matter, and atmospheric deposition of nitrogen, sulfur, and mercury.

Monitoring Information at-a-glance

- EPA interactive map of air quality monitoring locations
- NPS interactive map of in-park, representative of park air quality, and general air quality monitoring locations
- Visibility monitoring network (IMPROVE)
- Wet deposition monitoring network (NADP/NTN and NADP/MDN)
- Dry deposition monitoring network (CASTNET and NADP/AMoN)
- Ozone and particulate matter database (EPA AQS)

Visibility Monitoring

Visibility is monitored by measuring aerosol particles in the atmosphere. These particles can scatter and absorb light, creating haze that impairs visibility making it harder to see. Visibility monitoring sites are part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring network, an EPA funded nationwide network that tracks visibility conditions and trends at monitoring sites deemed representative of regional haze conditions for Class I Areas. IMPROVE samplers measure visibility indirectly by collecting particles from the air on filters. IMPROVE samples are automatically collected every three days. On sampling days, the system collects particles for a 24-hour period, from midnight to midnight local time. The filters are sent to laboratories to determine particle composition and concentration. These data can be used to determine visibility conditions and can provide information about particle sources. Watch a video to learn more about IMPROVE samplers and learn more about visibility monitoring.

Visibility may also be measured in real time (using a **nephelometer**) which provides continuous, direct, real-time light scattering measurements every 15 minutes. The measurements are averaged hourly. This short animation illustrates how a nephelometer works.

Effects of haze on visibility is evaluated using the haze index on most impaired days expressed in deciviews. Tracking visibility on the days with the most anthropogenic impairment captures overall trends in human-caused contributions to visibility. Most impaired days are the 20% of sampled days in a given year where measured visibility has the highest contribution from anthropogenic pollution relative to natural conditions. In context of air measures, “impairment” is identified in the Clean Air Act as impairment of visibility resulting from manmade pollution (42 U.S.C. § 7491). Note that this is different from the way impairment is defined in the NPS Organic Act and management policies. Also, note that this measure is different than the measure used for the visibility condition on the Air Conditions & Trends Page.

Annual haze index measures are averaged over a 5-year period for monitoring sites with at least 3-years of complete annual data. This measured 5-year average is used for Class I parks and additional parks with in-park visibility monitors. Estimated 5-year averages are used for parks in the contiguous US that do not have in-park visibility monitoring. To estimate 5-year average values, measured 5-year averages are interpolated across all monitoring locations in the contiguous US using an Inverse Distance Weighting (IDW) method. Note that estimated or measured values for individual parks represent wilderness areas.

A decrease of 1 deciview or more from the baseline data value over a 5-year period is considered an improving trend. An increase of 1 deciview or more from the baseline data value is considered a degrading trend. This threshold was developed by the NPS Air Resources Division. Using most impaired days to evaluate trends in visibility from human-caused haze is recommended by the NPS Air Resources Division and is commonly used by the NPS in wilderness character assessments.

Where to get visibility data:

1. Go to the NPS Explore Air Data Website
2. Select Visibility from the Parameter drop-down.
3. Scroll down to 5-year averages and open the selection pane.
4. Choose “Park” for scope and select a park where the wilderness is located from the “Park Name” drop down list.
5. Choose the latest available end-year and export the data set in a convenient format.

Ozone Monitoring

Monitoring ozone concentrations helps to determine air quality trends, provide public health alerts, and assess compliance with national standards. Across the United States ozone monitoring is conducted by the Environmental Protection Agency (EPA), states, and other agencies. These groups contribute to a nation-wide ozone monitoring network by observing common standards and reporting requirements. EPA's Clean Air Status and Trends Network (CASTNET) is largely responsible for site audits and data are reported to the EPA Air Quality System (AQS). Ozone data are collected continuously (1-minute averages) and reported in one-hour intervals. Because ozone is not stable, it must be measured onsite to accurately determine atmospheric concentrations. In this short video, an air quality expert explains measurements of ozone concentrations in the air and use the data to assess air quality. This animation shows how an ozone monitor uses ultraviolet (UV) light to measure ozone concentrations in the air.

Vegetation health risk from ground-level ozone

The W126 index is a biologically relevant measure that focuses on plant response to continuous ozone exposure. This measure is a better predictor of vegetation response to ozone exposure than the metric used for the human health standard (4th-highest daily maximum 8-hour average ozone concentration) because damage develops slowly under continuous exposure. The W126 index equation preferentially weights the higher ozone concentrations that are more likely to cause plant damage. It sums all of the weighted ozone concentrations during daylight hours because this is when the majority of gas exchange occurs between plants and the atmosphere. The highest 3-month period that occurs during the growing season (March–September) is reported as an annual value in parts per million-hours (ppm-hrs).

Annual W126 index values are averaged over a 5-year period at all monitoring sites with at least 3-years of complete annual data. This measured 5-year average is reported for parks with an in-park or nearby representative monitor in Alaska, Hawaii, Puerto Rico and Virgin Islands. Estimated 5-year averages are used for parks in the contiguous US. To estimate 5-year average values, measured 5-year averages are interpolated across all monitoring locations in the contiguous US using an IDW method. Note that estimated or measured values for individual parks represent wilderness areas.

A decrease of 2 ppm-hrs or more from the baseline data value over a 5-year period is considered an improving trend. An increase of 2 ppm-hrs or more from the baseline data value is considered a degrading trend. This threshold was developed by the NPS Air Resources Division. Using the W126 index to evaluate trends in vegetation health risk from ground-level ozone is recommended by the NPS Air Resources Division and is commonly used by the NPS in wilderness character assessments.

Where to get ozone data:

1. Go to the NPS Air Quality Park Condition & Trends Website.
2. Select the appropriate park where the wilderness is located from the Park drop-down.
3. Select Ozone from the Parameter drop-down.
4. In the Summary tab, scroll to the second section called "Ozone / Vegetation Health" and
5. click on Rationale +. Ozone exposure to vegetation is reported in the Condition text.
6. Report the numeric value for ppm-hrs in the second sentence from the Condition text.

Wet Deposition Monitoring

Wet deposition monitored measures nitrogen, sulfur, ammonium, and mercury in precipitation. The National Atmospheric Deposition Program (NADP)/National Trends Network (NTN) is a multi-agency cooperative network that monitors precipitation chemistry at more than 250 sites across the United States. The NADP/Mercury Deposition Network (MDN) measures total mercury (Hg) concentrations in precipitation. Precipitation is collected using an automated bucket system (watch animation). Watch a short video to learn more about wet deposition monitoring.

Dry Deposition Monitoring

Dry deposition monitoring measures gaseous and particulate nitrogen and sulfur. The Clean Air Status and Trends Network (CASTNET) and the National Atmospheric Deposition Program (NADP) Ammonia Monitoring Network (AMoN) collect dry deposition data in 95 sites across the U.S. At CASTNET monitoring sites, pollutant concentrations are measured by actively pulling air through a filter pack located in a shelter at the top of a tall tipping tower (watch animation). At the laboratory, the filters are analyzed for gaseous nitric acid (HNO_3), sulfur dioxide (SO_2), particulate ammonium (NH_4^+), nitrate (NO_3^-), and sulfate (SO_4^{2-}). Watch a short video to learn more about dry deposition monitoring.

Gaseous ammonia (NH_3) is measured with a passive sampler by the NADP/AMoN. This passive sampler does not require electricity to pump air through the filter pack, instead it uses a concentration gradient to move air through the sampler. Watch a short video to learn more about ammonia monitoring.

Nitrogen Deposition

While ecosystems respond to total (wet and dry) deposition, wet nitrogen deposition is used as a surrogate to track deposition trends because wet deposition is the most widely available source of measured nitrogen deposition data. Unless there are documented changes in natural sources of nitrogen deposition, trends can be attributed to changes in anthropogenic sources. Reporting units for wet deposition are kilograms per hectare per year (kg/ha/yr).

Annual wet nitrogen precipitation weighted mean concentrations are averaged over a 5-year period at monitoring sites with at least 3 years of annual data that meet completeness criteria. Estimated 5-year averages are used for parks in the contiguous US. To estimate 5-year average values, 5-year averages are interpolated across all monitoring locations in the contiguous US using an IDW method. Estimated nitrogen depositions are then calculated by multiplying estimated 5-year average concentrations (mg/L) by normalized precipitation (centimeters [cm]) and dividing by 10 to get deposition (kg/ha). For parks in Alaska, Hawaii, Puerto Rico and Virgin Islands with in-park or nearby representative monitors, measured 5-year averages are used to calculate wet deposition by multiplying average nitrogen concentrations (mg/L) by measured total annual precipitation (centimeters [cm]) and dividing by 10 to get deposition (kilograms per hectare [kg/ha]). Note that estimated or measured values for individual parks represent wilderness areas.

A decrease of 0.5 kg/ha/yr or more from the baseline data value over a 5-year period is considered an improving trend. An increase of 0.5 kg/ha/yr or more from the baseline data value is considered a degrading trend. This threshold was developed by the NPS Air Resources Division. Using wet nitrogen deposition to evaluate nitrogen deposition trends is recommended by the NPS Air Resources Division and is commonly used by the NPS in wilderness character assessments.

Where to get nitrogen deposition data:

1. Go to the NPS Air Quality Park Condition & Trends Website.
2. Select the appropriate park where the wilderness is located from the Park drop-down.
3. Select Nitrogen from the Parameter drop-down.

4. In the Summary tab, click on Rationale +. Nitrogen deposition is reported in the Condition text. Parks with a significant gradient in estimated nitrogen deposition have a range value for their estimated five-year average. For those parks, report the maximum value from the range. For parks without a range, use the numeric value in kg/ha/yr shown in the second sentence from the condition text.

Sulfur Deposition

While ecosystems respond to total (wet and dry) deposition, wet sulfur deposition is used as a surrogate for total deposition, because wet deposition is the most widely available source of measured sulfur deposition data. Unless there are documented changes in natural sources of sulfur deposition, trends can be attributed to changes in anthropogenic sources. Reporting units for wet deposition are kilograms per hectare per year (kg/ha/yr).

Annual wet sulfur precipitation weighted mean concentrations are averaged over a 5-year period at monitoring sites with at least 3 years of annual data that meet completeness criteria. Estimated 5-year averages are used for parks in the contiguous US. To estimate 5-year average values, 5-year averages are interpolated across all monitoring locations in the contiguous US using an IDW method. Estimated wet sulfur depositions are then calculated by multiplying estimated 5-year average concentrations (mg/L) by normalized precipitation (centimeters [cm]) and dividing by 10 to get deposition (kg/ha). For parks in Alaska, Hawaii, Puerto Rico and Virgin Islands with in-park or nearby representative monitors, measured 5-year averages are used to calculate wet deposition by multiplying average nitrogen concentrations (mg/L) by measured total annual precipitation (centimeters [cm]) and dividing by 10 to get deposition (kg/ha). Note that estimated or measured values for individual parks represent wilderness areas.

A decrease of 0.5 kg/ha/yr or more from the baseline data value over a 5-year period is considered an improving trend. An increase of 0.5 kg/ha/yr or more from the baseline data value is considered a degrading trend. This threshold was developed by the NPS Air Resources Division. Using wet sulfur deposition to evaluate sulfur deposition trends is recommended by the NPS Air Resources Division and is commonly used by the NPS in wilderness character assessments.

Where to get sulfur deposition data:

1. Go to the NPS Air Quality Park Condition & Trends Website.
2. Select the appropriate park where the wilderness is located from the Park drop-down.
3. Select Sulfur from the Parameter drop-down.
4. In the Summary tab, click on Rationale +. Sulfur deposition is reported in the Condition text. Parks with a significant gradient in estimated sulfur deposition have a range value for their estimated five-year average. For those parks, report the maximum value from the range. For parks without a range, use the numeric value in kg/ha/yr shown in the second sentence from the condition text.