Air Pollutants of Concern

The primary air pollutants of concern to wilderness include:

- Particulates
- Ozone
- Nitrogen and Sulfur Deposition
- Mercury and Toxics
- Greenhouse Gasses

The principle impact of these air pollutants is to the natural quality of wilderness character. Presence of these pollutants effect wilderness ecological systems, and are generally present only because of the activities of modern civilization. Particulates may further impact the outstanding opportunities quality of wilderness character by diminishing a visitor's feeling of separation from civilization, and the other features of value quality where, for a given wilderness, ecological or geological features have been identified as a scenic value, and they cannot be realized due to impaired visibility.

Particulates

Visibility, or the clarity of the air and how well a visitor can see scenery, is impacted by particles in the atmosphere that scatter and absorb light, creating haze. Haze mutes colors and contrast detail, reducing the definition of land forms and detracting from the visitor's experience of scenic views.

Air pollution almost always results from sources outside the wilderness boundaries. Despite the relative remoteness of many wilderness areas, scenic views may be obscured by particulates emitted hundreds of miles away. The amount and type of haze depends on what particles are in the air (composition), their size, and how many there are (concentration). Common particles that scatter and absorb light and cause haze are:

- sulfates
- nitrates
- chloride
- organics
- elemental carbon (soot)
- fine soil
- coarse mass

Sulfates and nitrates originate mainly from fossil fuel combustion sources (e.g. power plants, motor vehicles, and industrial boilers and smelters). Organics originate from wildland fires and formation of particles from biogenic (trees) and human-caused (vehicles, fuel evaporation, industrial sources) emissions. Natural sources generally limit visibility to a minor degree. What is often considered as natural impairment, for example from smoke and dust, may actually originate from unnatural sources. Wildfires producing significant amounts of smoke are often the result of human ignition as well as fires burning at greater intensity due to human caused changes in fuel loading. A significant amount of the dust in the atmosphere is the result of human land management practices reducing soil cover and exposing soil to be taken up in the wind. During the night, air-borne particulates reflect and scatter artificial light, increasing the effect of light pollution. Learn more about air pollution effects on visibility.

Ozone

Ground-level ozone is not emitted directly into the air but is formed by photochemical reactions between oxides of nitrogen (NOx), volatile organic compounds (VOCs), and sunlight. Anthropogenic NOx and VOCs include pollutants emitted by motor vehicles, industrial facilities, oil and natural gas development activities, and other sources. Although there are also natural sources of VOCs, NOx is mainly an anthropogenic pollutant. Long-term exposures to elevated levels of ground-level ozone can cause respiratory problems in humans and animals, and injury to ozone-sensitive plants.

Ozone damages plants by entering leaf openings (stomata) and oxidizing plant tissue as it respirates. Plant leaves are damaged causes reduced growth, and at the worst can lead to mortality of the plant. When other environmental stresses such as drought, other air pollutants, and insects or diseases are present, ozone injury is exacerbated. Ozone effects on natural vegetation have been documented throughout the country, especially in many areas of the eastern U.S. and in California. Learn more about ozone effects on plants and human health.

Nitrogen & Sulfur Deposition

Excess nitrogen can be deposited from the air and have harmful effects on plants, animals and natural processes. Airborne nitrogen, in the form of nitrate and ammonium, is deposited to the earth's surface through wet or dry atmospheric deposition. Wet deposition occurs through rain or snow, while dry deposition through gravitational settling, impaction, or absorption.

Deposited nitrogen can originate from wildfires or human sources (power plants, vehicles, industrial facilities, oil and gas development, and agriculture). Emissions from cars, power plants, and other industries are generally nitrogen oxides (NO_x) while emissions from agriculture are mainly ammonia (NH_3) and ammonium (NH_4^+). The largest sources of sulfur dioxide emissions are from coal and oil combustion at power plants and other industrial facilities.

Nitrogen is an essential plant nutrient, but excess nitrogen acts as a fertilizer that favors some plants and leaves others at a competitive disadvantage. Ecosystem effects are most often detected in naturally nutrient-poor environments. Plants in arid shrublands and grasslands are most vulnerable to nitrogen deposition. An increase in nitrogen has been found to promote invasions of fast-growing non-native grasses (e.g., cheatgrass) and forbs (e.g., Russian thistle), which then compete with native species. High elevation lakes and forests are especially susceptible to wet nitrogen deposition because they receive greater precipitation. Short growing seasons and shallow soils in alpine areas limit the capacity of soils and plants to absorb excess nitrogen. Learn more about nitrogen effects.

When sulfur, in the form of sulfate, is deposited to the earth's surface by rain, snow, or other precipitation it is called wet sulfur deposition. Dry deposition occurs when sulfur is removed by gravitational settling, impaction, or absorption. Sulfur can acidify surface waters and soils, which can lead to a loss of biodiversity of microorganisms, fish, amphibians, and plants.

The biggest threat to water bodies in the Eastern U.S. is acidification from nitrogen and sulfur deposition. Some streams and soils are heavily impacted, and much of the impact occurred before emission regulation under the Clean Air Act. Affected streams may continue to be uninhabitable for native brook trout and their food sources. Learn more about sulfur effects.

Mercury and toxics

Air toxics include heavy metals like mercury, as well as persistent organic pollutants like pesticides and DDT. Regulated airborne toxins are of concern because they are long-lasting. They do not readily break down in the environment, and can bioaccumulate in the tissues of organisms. Often fish and fish-eating birds and other wildlife are the most affected by toxic contaminants. Effects can include reduced reproductive success, impaired growth and development, disease, and decreased survival.

Volcanoes are a natural source of airborne mercury, however, elevated levels of mercury in the environment are mostly the result of human activities. These include burning coal for electricity, burning mercury-contaminated waste, and making chlorine. Once released into the air, mercury can travel long distances before it is deposited on land or water. In nature, especially in certain types of wetlands, deposited mercury can chemically change into a toxic form called methylmercury.

Toxic air pollutants such as pesticides, PCBs, flame retardants (PBDEs), and other industrial or combustion by-products are generally released into the atmosphere through manufacturing activities. Once they are in the air, toxic contaminants are often carried towards polar or high elevation environments where, in cold conditions, they deposit as solids. Learn more about toxic effects.

Greenhouse Gases

There are six regulated greenhouse gases:

- carbon dioxide (CO2)
- methane (CH4)
- nitrous oxide (N2O)
- hydrofluorocarbons (HFC)
- perfluorocarbons (PFC)
- sulfur hexafluoride (SF6)

These are compounds that in most cases have no direct adverse impact on public health. However, they have indirect effects to public health because they impact how much energy from the sun is trapped in the atmosphere versus radiated back to space. Although most greenhouse gases occur naturally in our atmosphere, human activities such as fossil fuel combustion, agriculture, and waste generation have increased concentrations above natural amounts. Increased amounts of greenhouse gases trap more of the sun's energy and result in warming at a global scale. The general warming of the climate can result in or amplify rising ocean levels and weather irregularities including unusually severe heat or cold events, severe flooding, wind events, and severe fire events. Climate change can make conditions unfavorable for plants and animals in their natural range due to reduced water availability, growing seasons out of sync, increased competition from species that benefit from the change, and other alterations of available habitat. The impact of climate change often exacerbates other human caused environmental stressors. In some wilderness areas, the melting of glaciers and permafrost are readily visible impacts. Along the coast, wilderness areas are threatened by sea level rise induced by climate change, causing the influx of saline water into ground water. In many western wilderness areas, tree mortality and wildfire activity are increasing due to climate change. Learn more about climate change effects in BLM areas, FWS areas, FS areas, and NPS areas.

Scientific research regarding air quality impacts is ongoing and expanding as new analyses are completed.

National Ambient Air Quality Standards (NAAQS)

The NAAQS limit ambient concentrations of six pollutants, called criteria air pollutants, to protect the public health and welfare from air pollution:

1. particulates (regulated in 2 size categories: PM10 and PM2.5)
2. ground level ozone (O3)
3. carbon monoxide (CO)
4. sulfur dioxide (SO2)
5. nitrogen dioxide (NO2)
6. lead (Pb)

The CAA requires EPA to establish primary threshold concentrations for these pollutants, which are designed to protect human health rather than natural resources. These are called "primary standards" or "primary NAAQS." The CAA also requires EPA to establish "secondary" NAAQS to protect public welfare, including ecosystems. However, in most cases the secondary NAAQS are identical to the primary NAAQS and generally are not protective of sensitive ecosystems. The EPA is currently reviewing the secondary NAAQS to identify ambient concentration thresholds protective of natural resources.