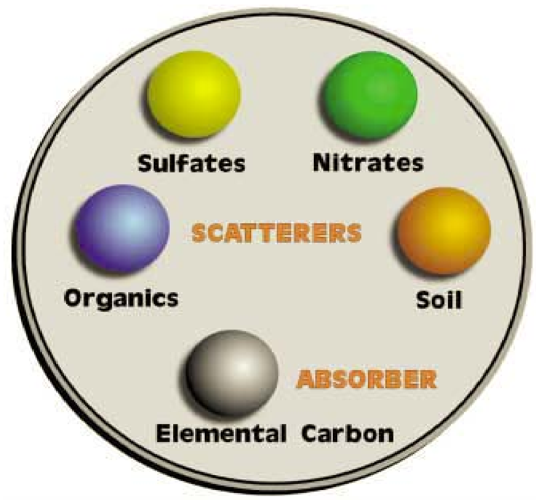
2015 Regional Haze & Visibility Summary

New Jersey Department of Environmental Protection

THE BASICS OF HAZE

Haze is a type of visibility impairment usually associated with air pollution, and to a lesser extent, moisture in the atmosphere. Small particles and certain gaseous molecules can cause poor visibility by scattering or absorbing light before it reaches an observer (Figure 1). When high concentrations of such pollutants are well-mixed in the atmosphere they form a uniform haze that can obscure distant objects.

Figure 1
Contributors to Visibility Impairment



Malm 1999

Air pollutants come from a variety of natural and man-made sources, and haze can occur at any time of year. Natural sources include small particles from windblown dust and soot from wildfires and volcanoes. Man-made sources, which are the primary cause of visibility impairment, include motor vehicle emissions, electric utility and industrial fuel burning emissions, and manufacturing operations.

Pollution from both natural and man-made sources can be transported over long distances and across state borders on prevailing winds, contributing to the problem of regional haze.

ANATOMY OF REGIONAL HAZE

The following categories of air pollutants are the major contributors to haze:

Sulfate particles form in the air from sulfur dioxide gas. Most of this gas is released from coal-burning power plants and other industrial sources, such as smelters, industrial boilers, and oil refineries. Sulfates are the largest contributors to haze in the eastern U.S. because of the large number of coal-fired power plants that affect the region. In humid environments, sulfate particles grow rapidly to a size that is very efficient at scattering light, thereby exacerbating the problem in the east.

Organic carbon particles can be emitted directly into the air or formed by the reaction of various gaseous hydrocarbons. Sources of direct and indirect organic carbon particles include vehicle exhaust, vehicle refueling, solvent evaporation (for example, from paints), cooking, and various commercial and industrial sources. Gaseous hydrocarbons are also emitted naturally from trees and from fires, but these sources usually have only a small or short-term effect on overall visibility.

Nitrate particles form in the air from nitrogen oxide gas. This gas is released from virtually all combustion activities, especially those involving cars, trucks, off-road engines (such as construction equipment, lawn mowers, and boats), power plants, and other industrial sources. Like sulfates, nitrates scatter more light in humid environments.

Elemental carbon particles are smaller than most other particles and tend to absorb rather than scatter light. The "brown clouds" often seen in winter over urban areas and in mountain valleys can be largely attributed to elemental carbon. These particles are emitted directly into the air from virtually all combustion activities, but are especially prevalent in diesel exhaust and smoke from the burning of wood and wastes.

Soil particles enter the air from dirt roads, fields, and other open spaces as a result of wind, traffic, and other surface activities. Whereas other types of particles form from the condensation and growth of microscopic particles and gases, crustal particles result from the crushing and grinding of larger, earth-borne material. Because it is difficult to reduce this material to microscopic sizes, crustal material tends to be larger than other particles and tends to fall from the air sooner, contributing less to the overall effect of haze.

PARTICLES AND VISIBILITY

Figure 2 below shows the composition of fine particles collected at the Interagency Monitoring of Protected Visual Environments (IMPROVE) site, located at the Brigantine air monitoring station. It is operated by the New Jersey Department of Environmental Protection (NJDEP), in the Edwin B. Forsythe National Wildlife Refuge, just north of Atlantic City. Note that a year of data is reported from July 1 to June 30 of the following year.

Most visibility impairment is due to sulfate, which can have a greater effect on light extinction (a measure of visibility impairment) because of its ability to accumulate water and grow in size in humid conditions. The data for 2014-2015 in Figure 2 show that sulfates accounted for approximately 48.8% of the total fine particle mass on days with good visibility, and approximately 35.6% on bad visibility days.

The graph below in Figure 3 represents the annual trend of sulfates, expressed in micrograms per cubic meter, measured at the Forsythe National Wildlife Refuge. The graph shows the annual average for each year as well as the average concentration on the days with the best visibility, and the average on the days with the worst visibility, using the upper and lower 20% of the data as a cut-off. Sulfate trends have improved over the last few years as a result of more stringent regulations and guidelines from both the United States Environmental Protection Agency (USEPA) and the state of New Jersey.

Figure 2
Composition of Fine Particles on Days with Good Visibility Compared to Days with Poor Visibility at Brigantine, NJ
July 2014 – June 2015

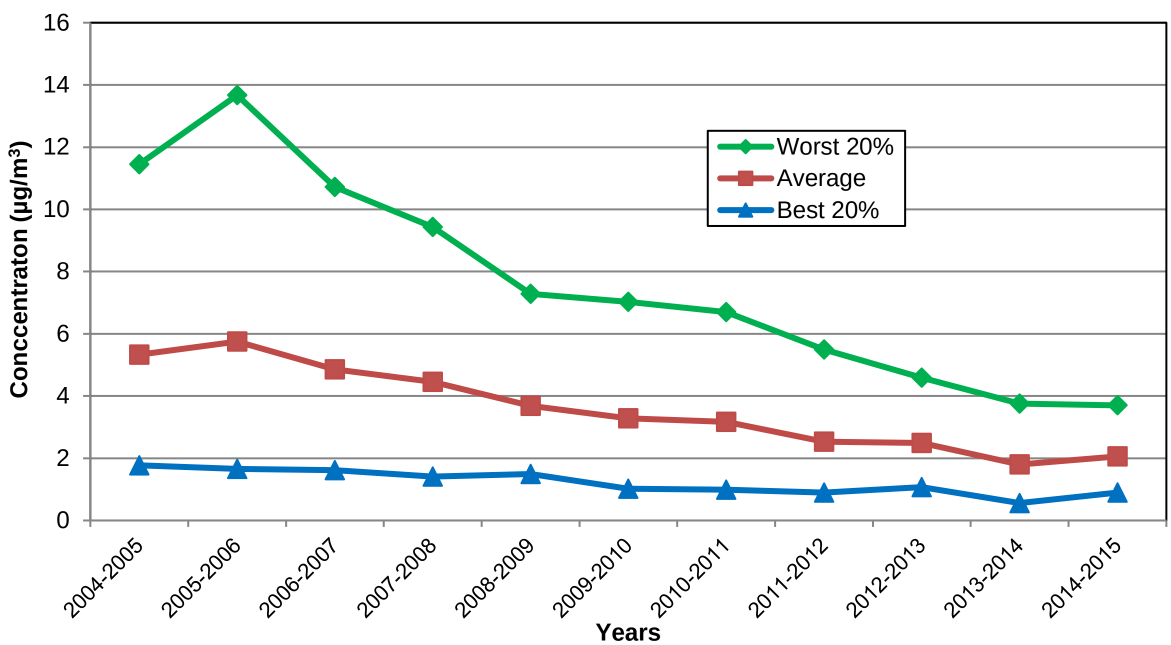
Average Fine Mass Composition on Days with Good Visibility

	Ammonium Nitrate	0.17 $\mu g/m^3$	9.2%
	Ammonium Sulfate	0.90 $\mu g/m^3$	48.8%
	Elemental Carbon	0.07 $\mu g/m^3$	3.8%
	Organic Carbon	0.62 $\mu g/m^3$	33.7%
	Soils	0.08 $\mu g/m^3$	4.6%
	Total 1.85 $\mu g/m^3$		

Average Fine Mass Composition on Days with Poor Visibility

	Ammonium Nitrate	3.03 $\mu g/m^3$	29.2%
	Ammonium Sulfate	3.70 $\mu g/m^3$	35.6%
	Elemental Carbon	0.46 $\mu g/m^3$	4.5%
	Organic Carbon	2.31 $\mu g/m^3$	22.2%
	Soils	0.89 $\mu g/m^3$	8.5%
	Total 10.39 $\mu g/m^3$		

Figure 3
Annual Average Sulfate Concentrations at Brigantine, NJ, 2004-2015
Micrograms per Cubic Meter ($\mu g/m^3$)

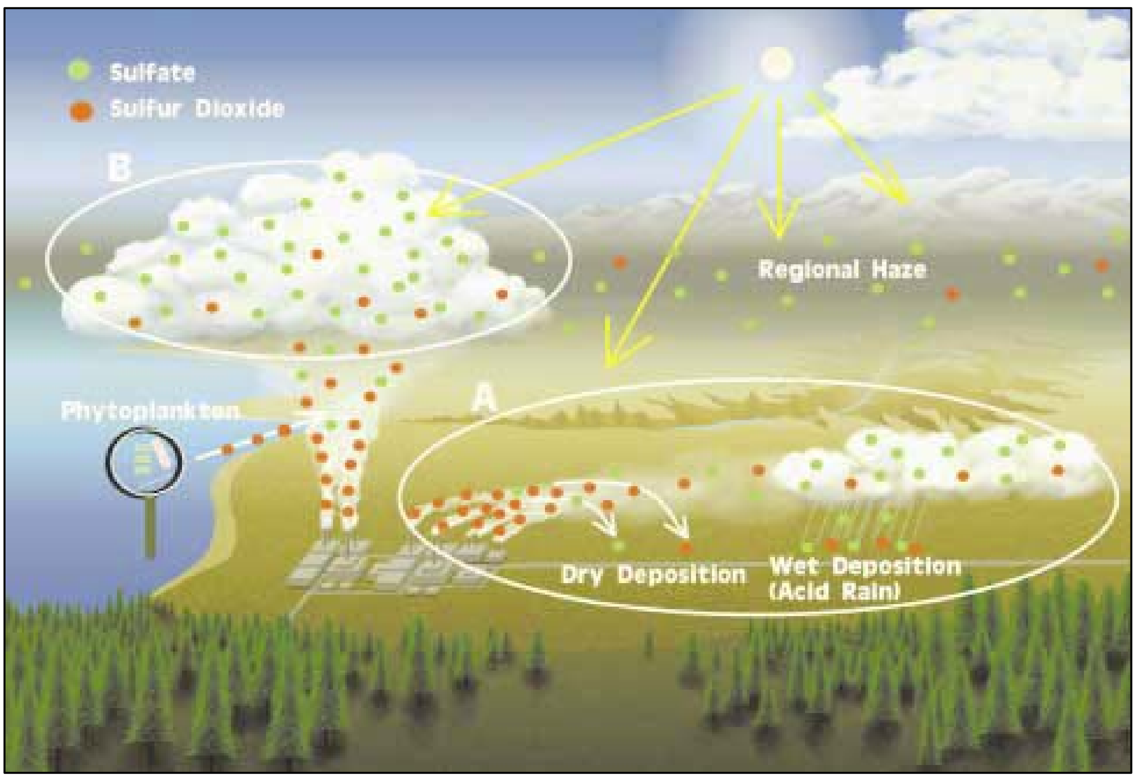


For this report annual data for a given year is defined as data from July 1 to June 30 of the following year.

ENVIRONMENTAL EFFECTS

Regional haze is most closely associated with its effects on prized vistas such as the Grand Canyon, Acadia National Park, and other Class I areas, such as the Edwin B. Forsythe National Wildlife. The impact of haze may be difficult to quantify but it certainly has a negative overall effect on aesthetics and the outdoors, and the enjoyment of natural areas throughout the nation. Haze also affects urban vistas, and can obscure or eclipse the view of an urban skyline, or important landmarks such as the Washington Monument. The pollution that causes regional haze has other detrimental effects on the environment because of the acidic makeup of fine particles such as sulfates. Sulfates eventually make their way into the ecosystem through atmospheric deposition, that is, they are transferred from the air into the water and soils (Figure 4). Too much atmospheric deposition can have adverse environmental effects by upsetting the delicate balance of the ecosystem, causing damage to waterways, plants, soils, and wildlife. For more information, see the summary on Atmospheric Deposition.

Figure 4
How Sulfates Enter the
Ecosystem by Way of Deposition



Malm 1999

How is Haze Regulated?

In 1999, USEPA announced a major effort to improve air quality in national parks and wilderness areas, aimed at achieving national visibility goals of no man-made impairment by 2064. The Regional Haze Rule calls for state and federal agencies to work together to improve visibility in national parks and wilderness areas such as the Grand Canyon and the Great Smokies. This rule addresses the combined visibility effects of numerous pollution sources over a wide geographic region and how they impact Class I areas. As defined by the Clean Air Act, Class I areas include national parks greater than 6,000 acres, wilderness areas and national memorial parks greater than 5,000 acres, and international parks that existed as of August 1977. The Edwin B. Forsythe National Wildlife Refuge–Brigantine Wilderness in Brigantine is the only Class I area in New Jersey. The haze rule requires states, in coordination with USEPA, the National Park Service, U.S. Fish and Wildlife Service, the U.S. Forest Service, and other interested parties, to develop and implement air quality protection plans to reduce the pollution that causes visibility impairment. New Jersey proposed its first regional haze plan for the Brigantine Class I area in September 2008, and it was finalized in July 2009. A five-year progress report, required as part of the approved plan, is available at http://www.state.nj.us/dep/baqp/5yearhaze.html. Figures 5 and 6 below from the progress report show the downward trend in all visibility-impairing pollutants on the 20% worst and best days of visibility impairment at the Brigantine Wilderness since 2000.

Figure 5
Visibility Improvements on the 20% Worst Days
at the Brigantine Wilderness

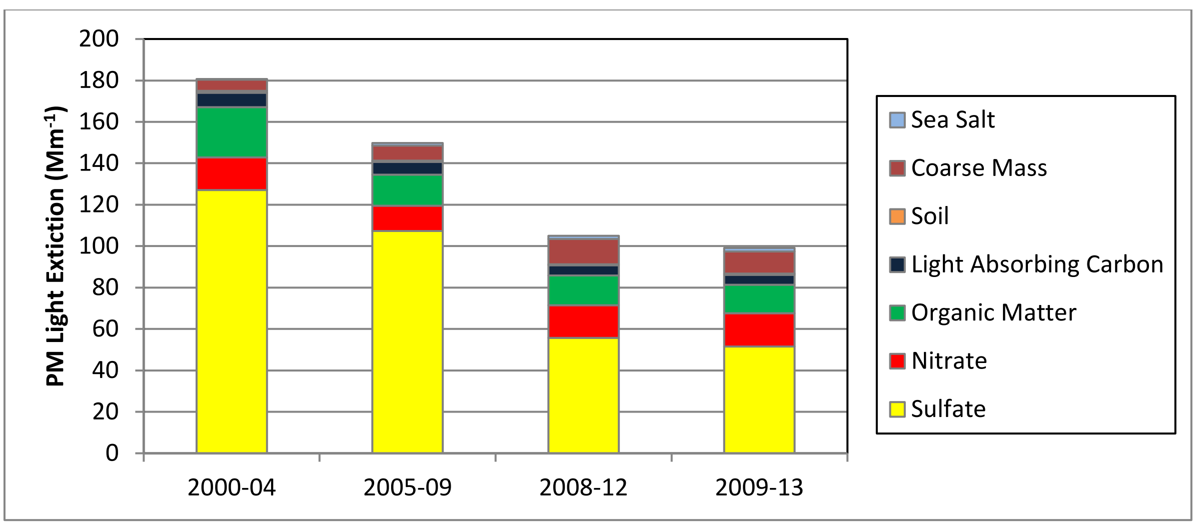
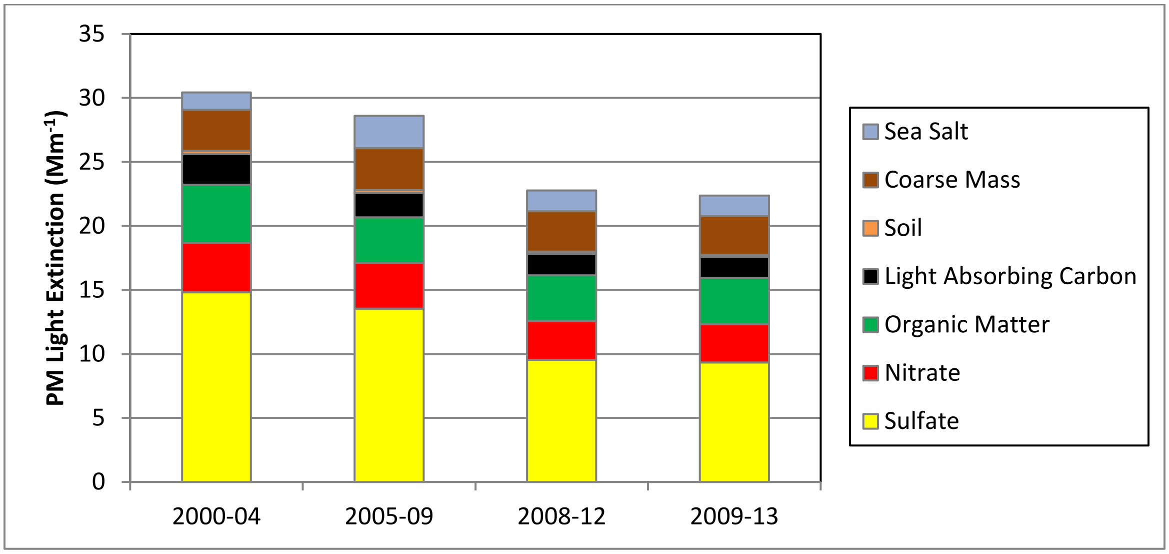


Figure 6
Visibility Improvements on 20% Best Days
at the Brigantine Wilderness



MONITORING HAZE IN NEW JERSEY

The typical visual range in the eastern U.S. is 15 to 30 miles, or about one-third of what it would be without man-made air pollution. In the western U.S. the typical visual range is 60 to 90 miles, or about one-half of the visual range under natural conditions. Haze diminishes this natural visual range (see www.hazecam.net).

Visibility and haze are monitored in two locations in New Jersey, Newark and Brigantine. The monitor in Newark measures the impact of haze on visibility by using a digital camera. The camera is located inside the New Jersey Transit building and is pointed at the New York City skyline. On clear days the entire skyline, as well as individual buildings, are easily distinguishable (Figure 7). The Manhattan skyline appears nonexistent when conditions are conducive to haze formation (Figure 8).

Visibility of New York City from the New Jersey Transit Building, Newark, NJ

Figure 7

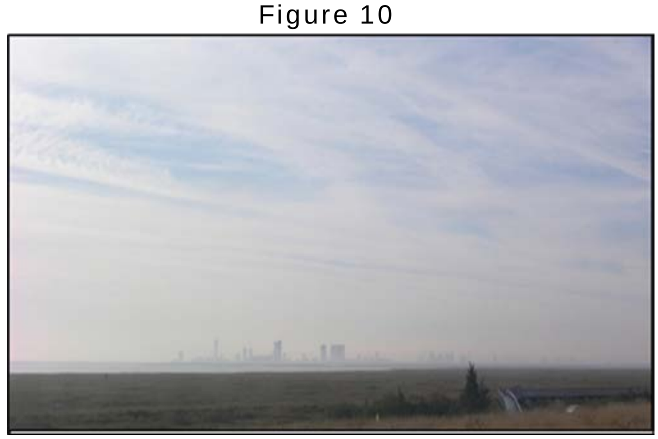
Figure 8

The IMPROVE site located within the Edwin B. Forsythe National Wildlife Refuge in Brigantine also monitors haze and visibility using a digital camera. Figure 9 below is an example of a clear day in Brigantine, when the Atlantic City skyline is easily distinguishable along the horizon. The example of a hazy day in Brigantine is illustrated in Figure 10, where the skyline is barely visible.

Visibility at the Edwin B. Forsythe National Wildlife Refuge, Brigantine, NJ

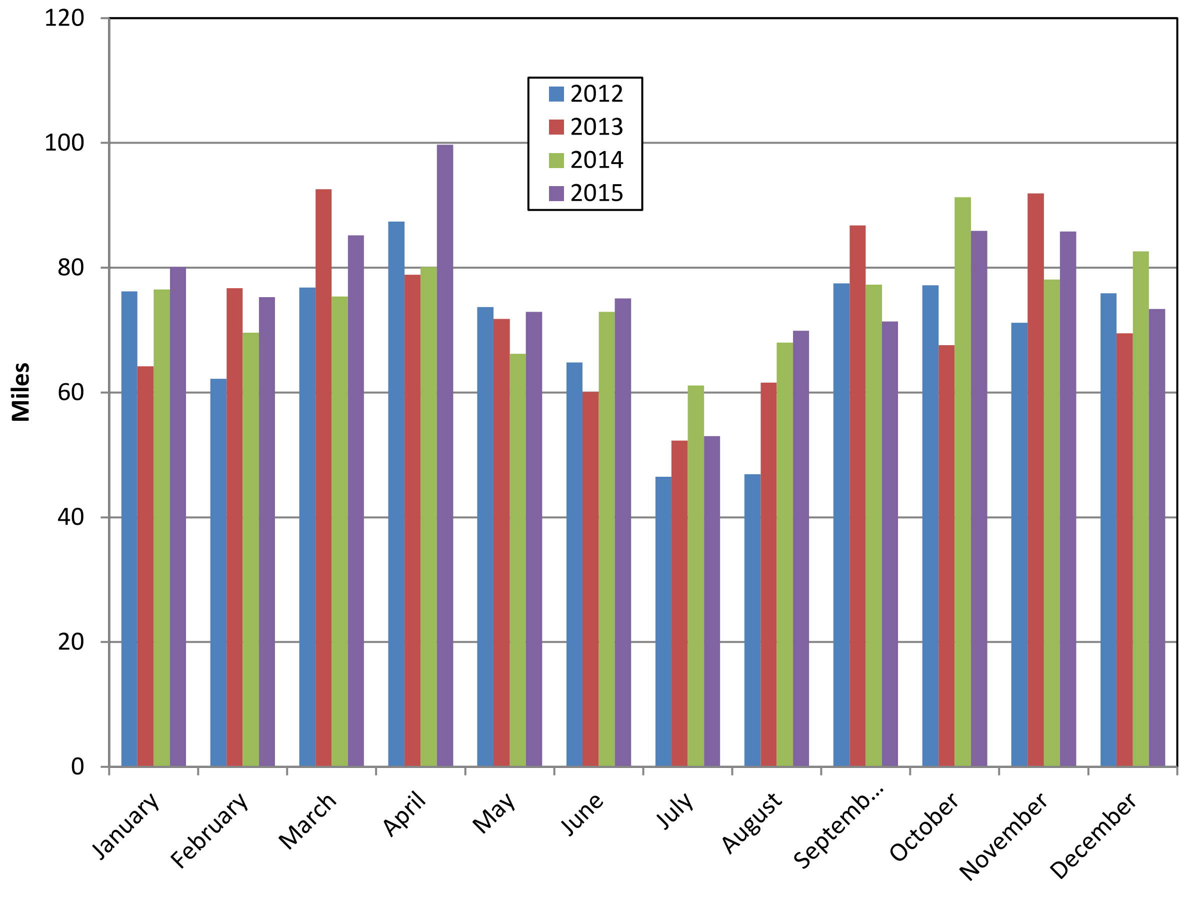
Figure 9

Figure 10



The Brigantine air monitoring station also provides a real-time estimate of visibility using a nephelometer, an instrument that measures the scattering of light by particles in the air. The nephelometer in Brigantine does not measure moisture in the air, and therefore the visual range values reported below in Figure 11 are higher than those normally reported for the eastern United States. Visual range is most impaired during the summer when warm, hazy, humid conditions are most frequent, as illustrated by the following graph.

Figure 11
Monthly Average Visual Range
Brigantine, NJ
2012-2015



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