Air

Introduction

Air quality has long been recognized as an important resource to protect on national forests. Not only does the public value the fresh air and sweeping views that national forests can provide, but the impacts from air pollution on forest health, water quality, and impacts to fisheries are also highly valued and are just a few that can be affected by poor air quality.

The 2012 Planning Rule requires National Forests and Grasslands to consider air quality when developing plan components. The purpose of the air quality assessment is to evaluate available information about air quality. This section assesses air quality on, and affecting, the Cibola. This assessment will describe the current conditions and trends regarding air quality in the plan area. This information will be used to anticipate future conditions, and to determine if trends in air quality pose risks to system integrity at the forest level. Additionally, this assessment will identify information gaps regarding air quality and any uncertainty with the data. The information contained in this assessment will be used to inform agency officials, whether current direction needs adjustment to protect air resources and the systems that rely on air quality on the forest.

Including in this assessment, the following components are identified, as specified by Forest Service Handbook, Chapter 10 Section 12.21 (FSH 1909.12 draft version 02/14/2013):

- Airsheds relevant to the plan area
- Location and extent of known sensitive air quality areas, such as Class I areas, non-attainment areas, and air quality maintenance areas
- Emission inventories, conditions, and trends relevant to the plan area
- Federal, State, and Tribal governmental agency implementation plans for regional haze, non-attainment, or maintenance areas (including assessing whether Forest Service emission estimates have been included in the appropriate agency implementation plans)
- Critical loads

Based on the above information the assessment characterizes and evaluates the status of airsheds and air quality relevant to the plan area assuming management consistent with current plan direction.

Identification of Airsheds

The Cibola is spread out across 10 counties in New Mexico and numerous airsheds. Figure 25 identifies the airsheds as classified by the New Mexico Environment Department. The Cibola is contained within the following counties: Bernalillo, Sandoval, McKinley, Cibola, Valencia, Torrance, and Socorro, with small portions within Catron, Sierra, and Lincoln. The Cibola lies primarily within the Middle and Lower Rio Grande and the Central Closed airsheds. Airsheds are similar to watersheds, in that they are defined geographic areas that because of topography, meteorology, or climate, they are frequently affected by the same air mass. The difference with airsheds is that air masses and air pollutants move between airsheds mostly based upon larger meteorological patterns, rather than primarily by topography, as with water flowing through a watershed. However, for the purpose of this assessment, the air quality and emissions will be limited to those counties and airsheds identified in Figure 25.

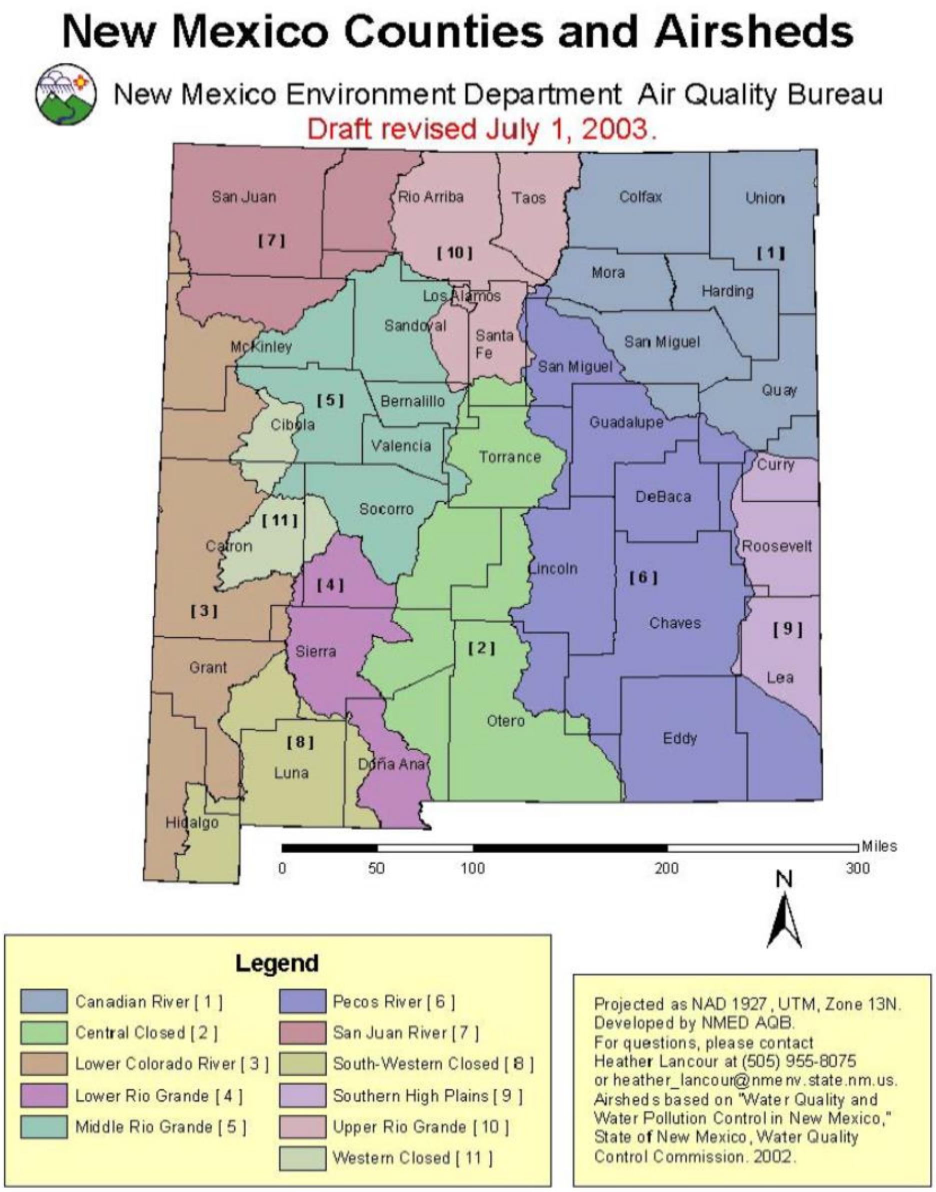


Figure 1. New Mexico Counties and Airsheds

Identification of sensitive air quality areas

The basic framework for controlling air pollutants in the United States is mandated by the Clean Air Act (CAA), originally adopted in 1963, and amended in 1970, 1977, and 1990. The CAA was designed to "protect and enhance" air quality. Section 160 of the CAA requires measures "to preserve, protect, and enhance the air quality in national parks, national wilderness areas, national monuments, national seashores, and other areas of special national or regional natural, recreation, scenic, or historic value."

Under the 1977 CAA, national wilderness areas existing as of August 7, 1977, and that exceeded 5,000 acres in size were designated as “Class I” areas. Class 1 areas have been designated within the Clean Air Act as deserving the highest level of air-quality protection. Congress designated (42 U.S.C. 7472) (CAA 162) 158 areas as Class 1 areas, including national parks larger than 6,000 acres and national wilderness areas larger than 5,000 acres, in existence on August 7, 1977. These “mandatory” Class 1 areas may not be re-designated to a less protective classification. The Cibola does not manage any Class 1 areas, however there are several nearby Class 1 areas that could be affected by projects and sources on or near the Cibola (Figure 26). They include the San Pedro Parks Wilderness, Bandelier National Monument, and the Pecos Wilderness to the North and East of the Mt. Taylor and Sandia Districts. The closest Class 1 areas to the south of the Magdalena and Mountainair Districts are the Gila Wilderness, the Bosque del Apache National Wildlife Refuge, and the White Mountain Wilderness.

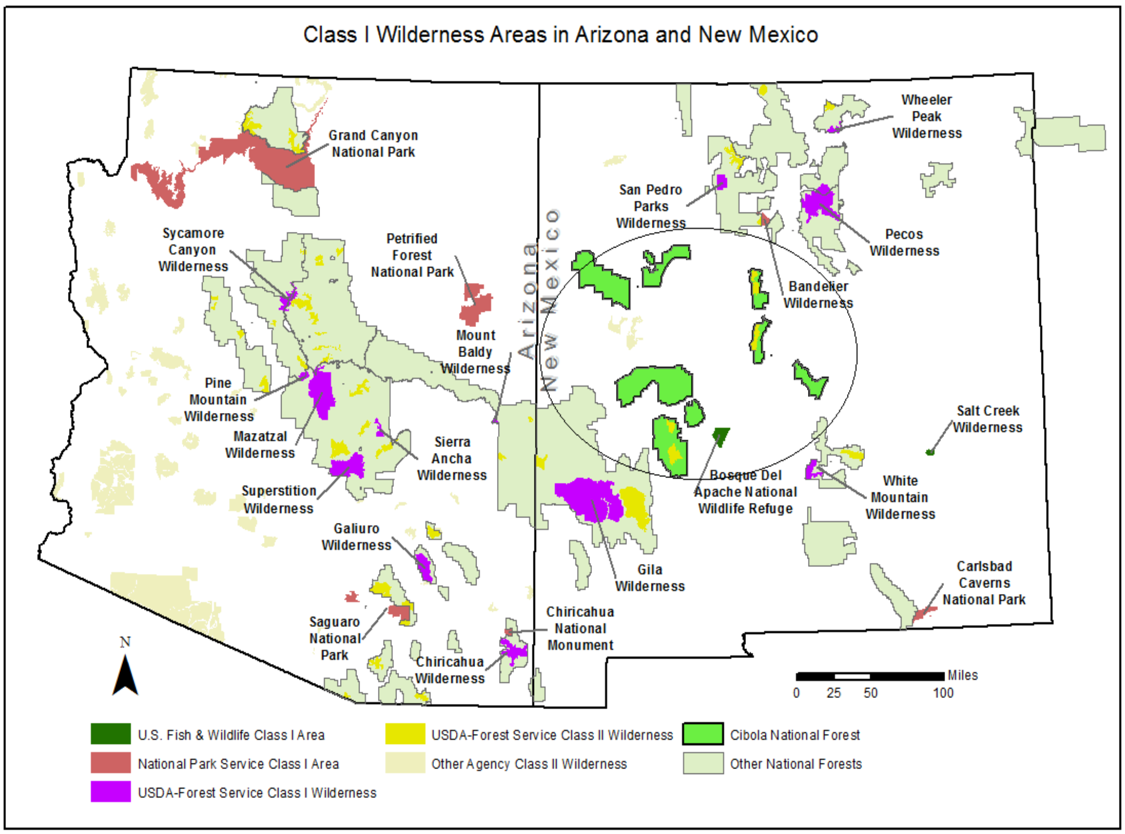


Figure 2. Class I Areas in Arizona and New Mexico. (Circled area represents the Cibola Plan Area for the 4 Mountain Districts.)

The purpose of the CAA is to protect and enhance air quality, while at the same time ensuring the protection of public health and welfare. The Act established National Ambient Air Quality Standards (NAAQS), which represent maximum air pollutant concentrations which would protect public health and welfare. The pollutants regulated by an NAAQS are called criteria air pollutants and include carbon monoxide (CO), nitrogen dioxide (NO2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), and particulate matter (PM_{10} and $PM_{2.5}$). The US Environmental Protection Agency (EPA) established NAAQS for specific pollutants considered harmful to public health and the environment. The Clean Air Act identifies two types of NAAQS, primary and secondary. The primary standards represent the maximum allowable atmospheric concentrations that may occur and still protect public health and welfare, and include a reasonable margin of safety to protect the more sensitive individuals in the population. Secondary standards provide public welfare protection, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. State agencies are given primary responsibility for air quality management as it relates to public health and welfare, and are further responsible for developing their State Implementation Plans to identify how NAAQS compliance will be achieved. If an area in a state has air quality worse than the NAAQS, that area becomes a non-attainment area. The state is then required to develop a SIP to improve air quality in that area. Once a non-attainment area meets the standards and that area can be designated as a maintenance area.

State standards, established by the New Mexico Environmental Improvement Board (EIB) and enforced by the New Mexico Environment Department, Air Quality Bureau (NMED-AQB), are termed the New Mexico Ambient Air Quality Standards (NMAAQS). The NMAAQS must be at least as restrictive as the National Ambient Air Quality Standards (NAAQS). NMAAQS also include standards for total suspended particulate matter (TSP), hydrogen sulfide, and total reduced sulfur for which there are no National standards. Table 1 presents the national and state ambient air quality standards.

Table 1. National and New Mexico ambient air quality standards.

Pollutant	Averaging Time	New Mexico Standards	National Standards (a)	
			Primary (b,c)	Secondary (b,d)
Ozone	8-hour	—	0.075 ppm	Same as primary
Carbon monoxide	8-hour	8.7 ppm	9 ppm	—
	1-hour	13.1 ppm	35 ppm	—
Nitrogen dioxide	Annual	0.05 ppm	0.053 ppm	Same as primary
	24-hour	0.10 ppm	—	—
	1-hour		0.1 ppm	—
Sulfur dioxide	Annual	0.02 ppm	0.03 ppm	—
	24-hour	0.10 ppm	0.14 ppm	—
	3-hour	—	—	0.5 ppm
	1-hour		0.75 ppm	—
Hydrogen sulfide	1-hour	0.010 ppm	—	—
Total Reduced Sulfur	½-hour	0.003 ppm	—	—

Pollutant	Averaging Time	New Mexico Standards	National Standards (a)	
			Primary (b,c)	Secondary (b,d)
PM_{10}	24-hour	Same as Federal	150 μg/m^3	Same as primary
$PM_{2.5}$	Annual (arithmetic mean)	Same as Federal	12 μg/m^3	Same as primary
	24-hour	Same as Federal	35 μg/m^3	Same as primary
Total Suspended Particulates (TSP)	Annual (geometric mean)	60 μg/m^3	—	—
	30-day Average	90 μg/m^3	—	—
	7-day	110 μg/m^3	—	—
	24-hour	150 μg/m^3	—	—
Lead	Quarterly Average	—	1.5 μg/m^3	Same as primary

Notes:

(a) Standards other than the 1-hour ozone, 24-hour PM_{10}, and those based on annual averages are not to be exceeded more than once a year.

(b) To attain the 8 hour ozone standard the 3 year average of the fourth-highest daily maximum 8-hour average ozone concentrations measured at each monitor within an area over each year must not exceed 0.075 ppm.

(c) Concentrations are expressed in units in which they were promulgated. μg/m^3 = micrograms per cubic meter and ppm = parts per million. Units shown as μg/m^3 are based upon a reference temperature of 25^{o}C and a reference pressure of 760 mm of mercury.

(d) Primary Standards: The levels of air quality necessary, with an adequate margin of safety to protect the public health.

(e) Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant.

μg/m^3 = micrograms per cubic meter; ppm = parts per million

The New Mexico Environment Department – Air Quality Bureau (NMED-AQB) enforces air pollution regulations and sets guidelines to attain and maintain the national and state ambient air quality standards within the State of New Mexico, except for tribal lands and Bernalillo County which maintain separate jurisdictions.

At the present time, the plan area attains all national and New Mexico ambient air quality standards. Dona Ana County is the only area in New Mexico that is currently in non-attainment for PM_{10}, which is approximately 45 miles south of the Magdalena Ranger District (Figure 30).

Emissions Inventories, including current conditions and trends
This section presents current and historical data related to air quality in or near the Cibola. Knowledge of the current data and any relevant trends provides an understanding of the air quality parameters that influence air quality on the forest that could affect resources on the forest impacted by air pollution. Included are a general description of baseline emissions inventories, ambient air quality measurements, visibility, and deposition measurements for sulfur, nitrogen, and mercury that define current air quality conditions of the plan area. Data are presented for the following parameters:

- Emission Inventory
- Ambient Air Quality
- Visibility
- Atmospheric Deposition (Acid Deposition and Mercury Deposition)

For emissions, the information presented in this section represents statewide totals for New Mexico. County level emissions inventories were analyzed and can be found Western Regional Air Partnership (WRAP) website, using the Technical Support System tool (WRAP TSS 2012). Emissions inventories are useful tools for understanding regional sources of pollution that could affect the forest. Emissions inventories are created by quantifying the amount of pollution that comes from point sources (power plants, factories) and area sources (emissions from automobiles in a city or oil and gas development). Emissions can also originate from natural events like a wildfire. WRAP is a voluntary partnership of states, tribes, federal land managers and the EPA. WRAP tracks emissions data from states, tribes, and local air agencies, as well as emissions from wildland fire, in coordination with the EPA's National Emission Inventory (NEI). In addition, WRAP supports states by analyzing this data and models what future emissions maybe based on future trends, as part of the Regional Haze Rule. The regional Haze Rule sets a 60–year timeline for states to improve visibility within mandatory federal Class I areas from baseline (2000-04) levels to natural conditions by 2064. States are required to show that reasonable progress is expected to be made toward this goal over the course of intermediary planning periods.

A summary of baseline emissions and projected emissions for 2018 for the state of New Mexico and the 10 counties that encompass the Cibola were analyzed (WRAP TSS 2012). The following pollutants were included in the summary: CO, nitrogen oxides, sulfur oxides, volatile organic compounds (VOCs), coarse particulate matter (surrogate for PM_{10}), and fine particulate matter (surrogate for $PM_{2.5}$). Nitrogen oxides and VOCs were included since they are precursors to the formation of ozone, which has both effects to human health but also has been shown to impact forested systems. Emissions information is important, as adverse air quality impacts on the Cibola can usually be traced to air emissions. Knowing the magnitude of emissions and recognizing trends in emissions over time is important because emissions are usually correlated to the type and severity of air quality impacts. Often, adverse air quality impacts to air quality related values can be mitigated through programs that reduce associated air emissions. However, the Forest Service typically lacks direct authority to control air emissions that impact a particular ranger district.

While emissions play an important role in determining overall air quality for a given area, air quality evaluations are also based, in part, on ambient concentrations of pollutants in the air. The EPA is primarily concerned with air pollutants that result in adverse health effects. The Forest Service also uses these ambient concentrations to determine how pollutants such as ozone (O_3), particulate matter (PM), and sulfur dioxide (SO_2) impact forest resources. Because ambient air quality measurements provide quantitative information, they can also be meaningfully incorporated into air quality models. Ambient air quality data are presented in this section for a number of state, county, and federal monitoring stations in and around the air quality monitoring plan area.

Visibility data are presented for stations operated as part of the IMPROVE monitoring program sponsored by the EPA and other government agencies. Visibility generally relates to the quality of visitors' visual experience on the forest and has been recognized as an important air quality related value in Class I wilderness areas dating back to the 1977 Clean Air Act Amendments. Generally, the presence of air pollution degrades the visual quality of a particular scene. In the Clean Air Act, a national visibility goal was established to return visibility to "natural background" conditions no later than 2064. IMPROVE monitoring data tracks the quality of visibility conditions and trends in visibility data and are specific to the wilderness areas of interest.

Deposition data are presented from the National Atmospheric Deposition Program (NADP). Deposition generally arises from the transformation in the atmosphere of air pollution to acidic chemical compounds (e.g., sulfuric acid, nitric acid), a portion of which are deposited into forested ecosystems. Excessive deposition may lead to adverse effects on ecosystems and on other (e.g., cultural) resources. Acid deposition can lead to changes in the pH of stream runoff and adverse effects on aquatic species. Also, acidic depositions can accumulate in the wintertime snowpack. Research has demonstrated that when portions of the snowpack with high acid concentrations melt during spring thaw, the acids are often released as an acute pulse. The sudden influx of acid can alter the pH of high altitude lakes and streams for short periods, with dramatic consequences for respective aquatic communities. Lastly, excessive nitrogen deposition can "over-fertilize" sensitive ecosystems, thereby promoting unnatural eruptions of native and non-native plant species, invasions by noxious species and altering long-term patterns of nutrient cycling. NADP monitoring data collected in the Plan area were chosen to best characterize these conditions in the wilderness areas of interest.

Where available, data on mercury deposition are also presented. Mercury is a neurotoxin which accumulates in plant and animal tissue, especially within the aquatic food chain. As birds, mammals, and humans consume fish and other aquatic organisms, the accumulated mercury is passed on to those species as well. Within human populations, mercury exposure is of particular concerns to pregnant women and mercury can pass through the placenta to developing fetuses. Low-level mercury exposure is also linked to learning disabilities in children and interferes with the reproductive cycle in mammals that consume fish.

Emissions Inventory

Air quality effects on national forests are generally traceable back to the original source of emissions; therefore, air emissions information provides an overview of the magnitude of air pollution and is important in understanding air quality on the forest. Also, trends in precursor emissions would be expected to track with trends on the forest, e.g. visibility, acid deposition, etc. For example, improving visibility conditions in Class 1 areas would generally be associated with corresponding decreases in emissions for visibility precursor pollutants.

Emissions information is generally tracked for pollutants that have health-based air quality standards such as carbon monoxide (CO), nitrogen oxides (NOX), sulfur dioxide (SO_2), volatile organic compounds (VOCs), and particulate matter (PM). VOC emissions do not have a health-based standard, but are involved in the atmospheric chemical reactions that lead to ozone (O_3), which does. Ozone pollution is of added concern because it can stress sensitive ecological systems. PM emissions are generally broken into two categories based on the size of the PM emissions. Fine PM (FPM) represents the particulate matter emissions sized at or below 2.5 microns in diameter. Coarse PM (CPM) represents the particulate matter emissions sized at or below 10 microns, but above 2.5 microns, in diameter. Smaller sized particles have greater health-related impacts because the smaller particles are more easily inhaled into the lungs.

Figure 27–Figure 29 show air emissions for the State of New Mexico for the criteria air pollutants of interest: CO, NOx, SO_2, VOC, CPM, and FPM. FPM is analogous to $PM_{2.5}$ and CPM represents the PM_{10} emissions that are not $PM_{2.5}$. Each figure also depicts the relative magnitude of emissions from various source categories, such as mobile sources (vehicle exhaust), point sources (industrial and commercial operations), fire, biogenic sources etc. These figures represent statewide emissions for the baseline period (2000-2004) along with projected emissions for the 2018 time frame, based on information at the end of 2005. Since that time, additional regulations have been passed which should continue to reduce emissions. All of the emissions information in these figures has been taken from the WRAP Technical Support System (WRAP TSS 2012).

For CO, NOx, and SO_2 emissions, the trend shows a projected decrease in statewide emissions through 2018. Most of the emissions reductions for CO and NOx emissions come from fewer mobile source emissions and are associated with the introduction of lower emitting vehicles over time, cleaner transportation fuels, and improvements in vehicle gas mileage. SO_2 emissions show improvement over time largely from reductions in stationary source emissions, such as coal-fired power plants, which are expected, in the near term, to install emission controls defined as Best

Available Retrofit Technology (BART) under the regional haze regulations. Some of the decrease in SO_2 emissions occurs from mobile sources and is associated with cleaner transportation fuels, such as the introduction of low sulfur diesel fuel.

The expected increase in oil and gas industry activity through 2018 increases emissions of NOx and SO_2, which offsets some of the emissions decreases described above.

The VOC emissions in New Mexico are dominated by biogenic emission sources, (i.e. trees, agricultural crops, and microbial activity in soils). These emissions are projected to increase slightly through 2018, again due to increased oil and gas industrial activity.

Particulate emissions, both CPM and FPM, are expected to increase across New Mexico through 2018, consistent with the projected population growth in the state. Higher population translates to more vehicular traffic and the projected particulate emission increases generally occur in the "fugitive dust" and "road dust" categories.

Data analyzed using the WRAP TSS Emissions Review Tool shows similar emissions information for the pollutants of interest on a county-by-county basis (WRAP TSS 2012). The seven counties of interest for this particular report are Bernalillo, Cibola, McKinley, Sandoval, Socorro, Torrance, and Valencia. County-by-county distribution of emissions mostly follows the distribution of population across the counties of interest. Higher emissions for nearly all of the pollutants occur in Bernalillo County (Albuquerque) and McKinley County, which have larger population densities.

The general trend both at the state and county level is for most of the emissions of CO, nitrogen oxides, and sulfur oxides to decrease through 2018. There are however, some notable exceptions. Nitrogen oxides and sulfur oxides are expected to increase in Bernalillo and Sandoval County from area sources primarily driven by area sources. Point source emissions of sulfur oxides are expected to increase in McKinley Country. Also of note is that wildfire emissions are a significant source of CO.

Particulate matter (PM) and VOCs are all expected to increase at both the state and county level through 2018. The primary source of PM, both coarse and fine, is from windblown dust across the land and from fugitive dust from anthropogenic sources. Higher temperatures and persistent drought could exacerbate this trend (Prospero 2003). At the state level VOCs are expected to increase primarily from oil and gas development in the Four Corners area and in the Permian Basin in eastern New Mexico. Biogenic sources of VOCs are a major source relative to the overall emissions in both New Mexico and in the counties where the Cibola is located.

The county-by-county emissions trends through 2018 generally share the patterns of decline described above.

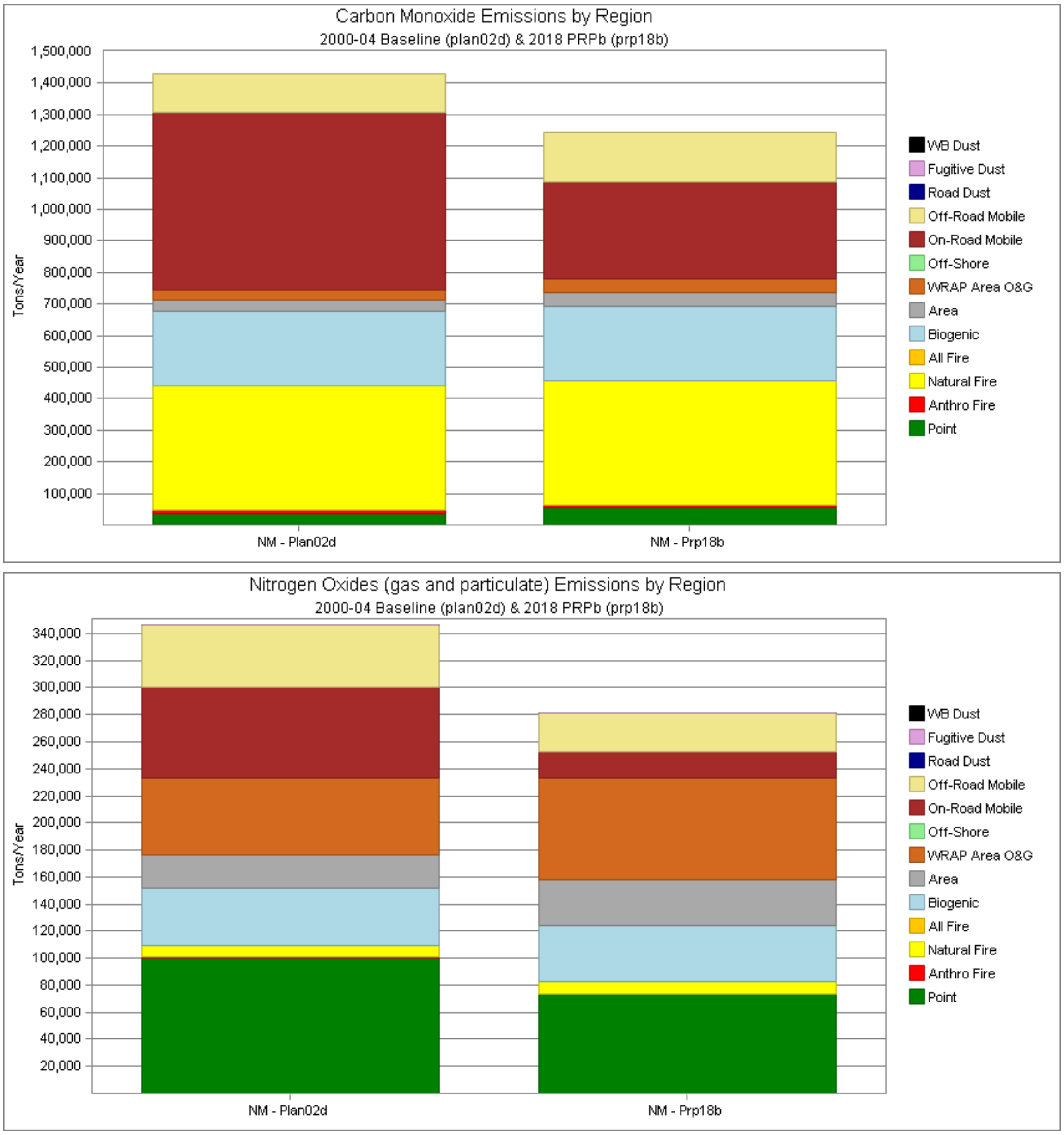
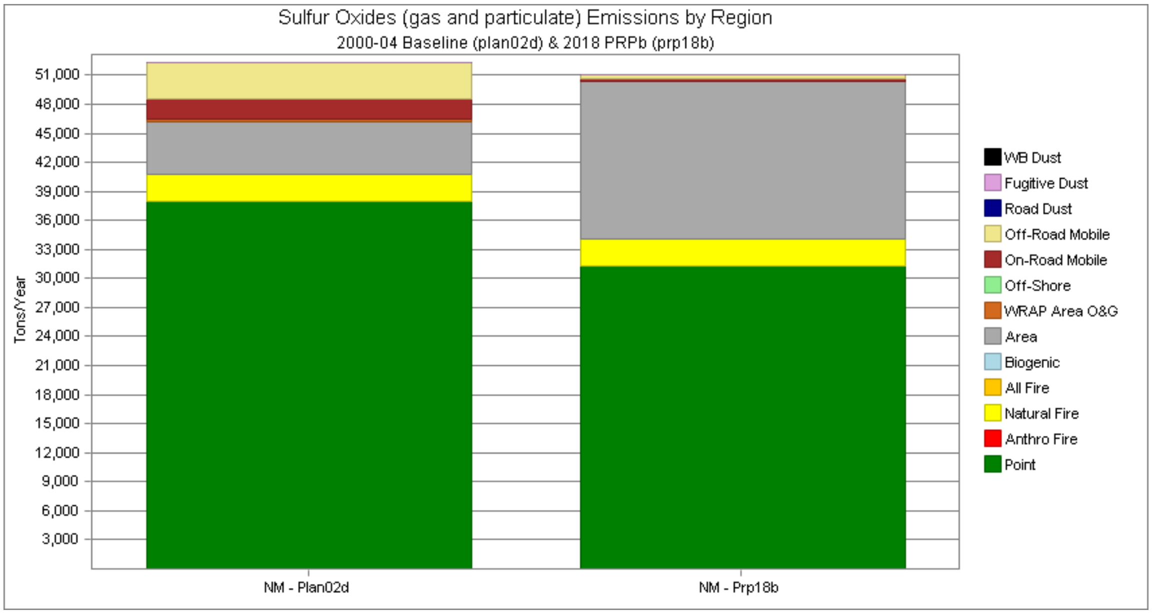


Figure 3. New Mexico 2002 Baseline and Projected 2018 Emission Summaries, Carbon Monoxide (Top) and Nitrogen Oxides (Bottom).

Products obtained from WRAP TSS Emissions Review Tool
http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx



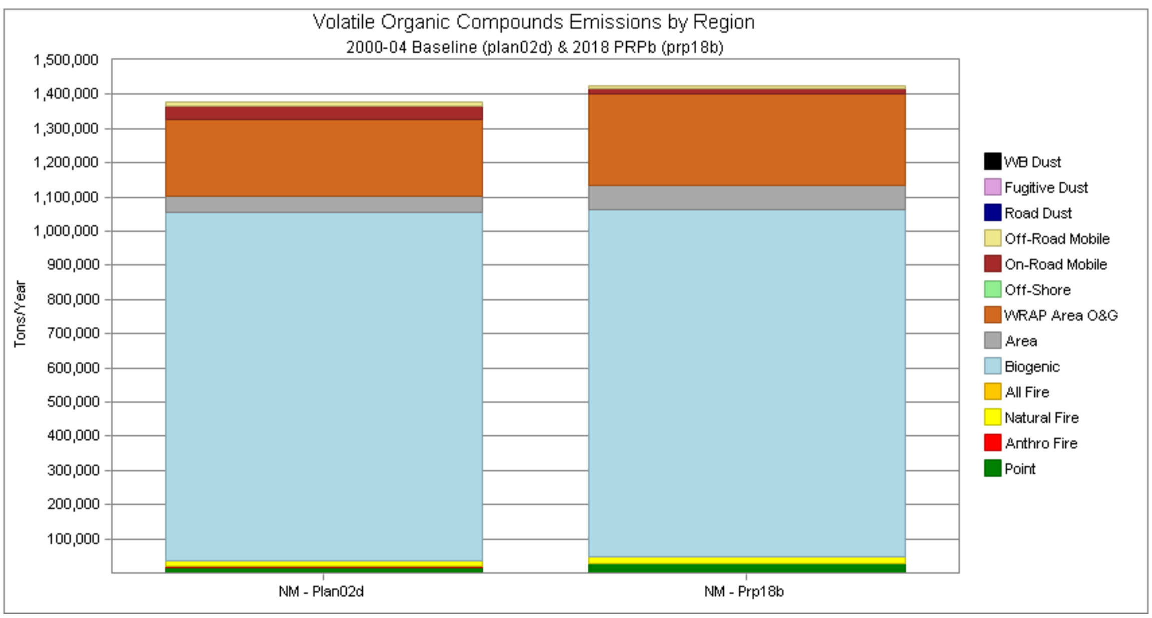


Figure 4. New Mexico 2002 Baseline and Projected 2018 Emission Summaries, Sulfur Oxides (Top) and Volatile Organic Compounds (Bottom).

Products obtained from WRAP TSS Emissions Review Tool

http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx

Plan02d data represent the 5-year baseline average period.

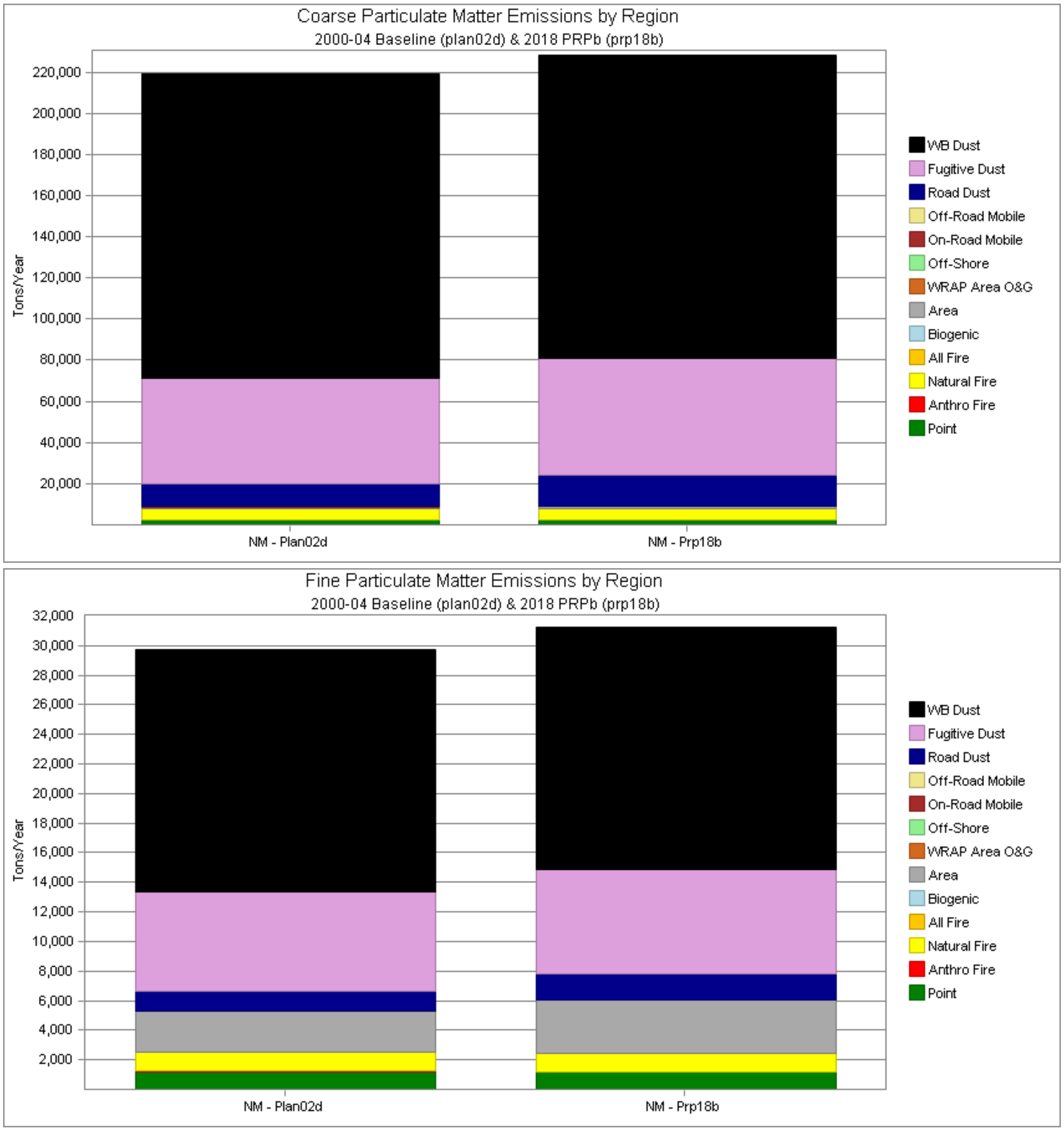


Figure 5. New Mexico 2002 Baseline and Projected 2018 Emission Summaries, Coarse Particulate Mass (Top) and Fine Particulate Mass (Bottom).

Products obtained from WRAP TSS Emissions Review Tool
http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx
Plan02d data represent the 5-year baseline average period.
PRP18b data represent WRAP's Preliminary Reasonable Progress Inventory

Ambient Air Quality Measurements

This section summarizes the ambient air quality measurements collected between the years 2000 and 2010 at New Mexico monitoring sites in and near the Cibola. These monitoring data depict concentrations of air pollutants which have the potential to cause adverse health effects in the general population and/or adverse ecological effects. Additional discussion about the health and ecological effects of individual pollutants is provided below.

Figure 30 shows the location of the air quality monitoring sites that are relevant to the plan area. There are a variety of air monitoring stations throughout New Mexico operated by the state, Bernalillo County, the Navajo Nation, and by federal land management agencies that can be used to gauge ambient air quality, visibility, and deposition of pollutants. A summary of the pollutants monitored and available period of record for each site is provided in Table 2. The visibility monitoring data are described in next section.

For the Cibola, most of the nearby ambient air quality monitoring stations are located in the greater Albuquerque metropolitan area. Although air quality levels in an urban area are not likely to be totally representative of the Cibola, these data do provide for a reasonable upper bound on air quality concentrations within the plan area. Lacking other data collected in more remote settings, the reported data are the best available information to characterize exiting air quality conditions for the wilderness areas of concern.

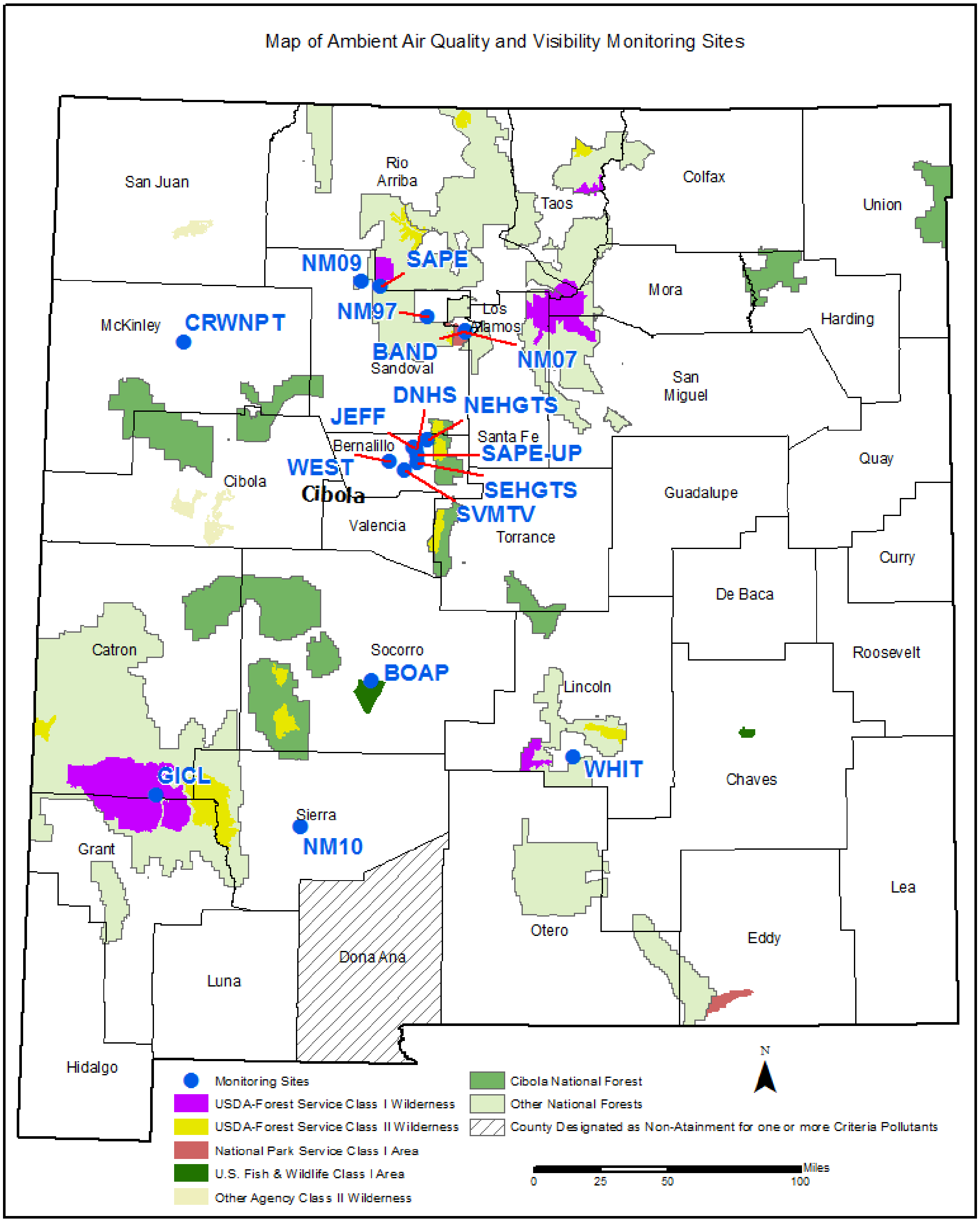


Figure 6. Map of Air Quality Monitoring Sites in the Plan Area.

Table 2. Air Quality Monitoring Sites for the Cibola.

Monitoring Site	Site Label	Pollutants Monitored and Period Reviewed*
Bandelier	NM07	NADP/NTN (2000-2010)
Bandelier National Monument	BAND	IMPROVE Aerosol, dv (2000-2010)
Bosque del Apache	BOAP	IMPROVE Aerosol, dv (2000-2010)
Caballo	NM10	MDN (2000-2005)
Crownpoint	CRWNPT	PM_{10} (2008-2010)
Cuba	NM09	NADP/NTN (2000)
Del Norte High School	DNHS	CO (2000-2010), O_3 (2000-2010), NO_2 (2000-2010), $PM_{2.5}$ (2000-10), PM_{10} (2000-2010)
Far North East Heights	NEHGTS	O_3 (2000-2010)
Gila	GICL	IMPROVE Aerosol, dv (2000-2010)
Jefferson Corridor	JEFF	PM_{10} (2000-2010)
San Pedro Parks	SAPE	IMPROVE Aerosol, dv (2001-2010)
South East Heights	SEHGTS	O_3 (2003-10), $PM_{2.5}$ (2000-2010)
South Valley Mountain View	SVMTV	CO (2002-2010), O_3 (2002-10), PM_{10} (2002-2010)
Uptown San Pedro	SAPE-UP	CO (2000-2010)
Valles Caldera National Preserve	NM97	MDN (2009-2010)
Westside	WEST	O_3 (2009-2010)
White Mountain	WHIT	IMPROVE Aerosol, dv (2002-2010)

*For the purposes of this assessment, only measurements collected between 2000 and forward were reviewed.

Table 1 lists the current primary NAAQS which represent ambient concentrations of air pollutants determined by the EPA to result in adverse health effects to the most sensitive population groups, such as children, the elderly, and persons with breathing difficulties. The health effects of air pollution are discussed further in the subsequent sections that describe specifics of monitoring data for each pollutant.

Carbon Monoxide (CO) Concentrations

CO data have been collected at three sites in and near the wilderness areas of interest. Generally, CO emissions are caused by exhaust from fuel combustion in mobile sources (cars, trucks, etc.) and as such are generally monitored only in urban settings. All of the CO monitoring sites are in the greater Albuquerque metropolitan area, and as such, measured concentrations may not represent conditions on the Cibola. However, these data are the only available monitoring for CO concentrations.

Excessive CO concentrations can have a detrimental impact on human health and the environment. CO can cause harmful health effects by reducing oxygen delivery to the body's organs (like the heart and brain) and tissues. Exposure to CO can also reduce the oxygen-carrying capacity of the blood. People with several types of heart disease may experience reduced capacity for pumping oxygenated blood to the heart, which can cause lead to myocardial ischemia (reduced oxygen to the heart), often accompanied by chest pain (angina). For these people, short-term CO exposure further affects their body's already compromised ability to respond to the increased oxygen demands of exercise or exertion (USEPA 2013).

Data representing the highest CO concentrations measured for the 1-hour and 8-hour average monitoring periods for calendar years 2000-2010 for the Del Norte, San Pedro, and South Valley monitoring stations were analyzed (WRAP 2012). These averaging periods correspond to the NAAQS. The data show a decrease in measured CO concentrations since 2000, generally attributable to improvements in the emissions profiles for passenger vehicles. Since after 2008, the peak 1-hour CO concentrations are generally less than 5 ppm and the peak 8-our CO levels are generally around 2 ppm.

Based on the available monitoring data, CO concentrations are well below the applicable NAAQS.

Ozone (O_3) Concentrations

O_3 data have been collected at five sites near the Cibola. All sites are located in the greater Albuquerque metropolitan area. Over 10 years of data are available for just two sites. The Westside monitoring station initiated monitoring in 2009 and has data available for only two years. The remaining sites having seven and eight years of data represented (USEPA 2012).

O_3 is one of the major constituents of photochemical smog. It is not emitted directly into the atmosphere, but instead is formed by the reaction between NOx emissions and VOC emissions in the presence of sunlight. The highest concentrations of O_3 typically occur in the summer months.

Excessive O_3 concentrations can have a detrimental impact on human health and the environment. Elevated O_3 levels can cause breathing problems, trigger asthma, reduce lung function, and lead to increased occurrence of lung disease. O_3 also has potentially harmful effects on vegetation, which is usually the principal threat to forested ecosystems. O_3 can enter plants through leaf stomata and oxidize tissue, causing the plant to expend energy to detoxify and repair itself at the expense of added growth. Damage to plant tissue can be more pronounced where the detoxification and repair does not keep up with the O_3 exposure. The mesophyll cells under the upper epidermis of leaves are particularly sensitive to O_3. O_3 damage can generate a visible lesion on the upper side of a leaf, termed "oxidant stipple". Other symptoms of elevated O_3 exposure may include chlorosis, premature senescence, and reduced growth, although these symptoms are not unique to ozone damage and may also occur from other stresses on plant communities such as disease and/or insect damage.

Data representing the 4th highest 8-hour average O_3 concentrations for calendar years 2000-2010 for the Del Norte, Southeast Heights, South Valley, Westside, and Far North East Heights monitoring stations were analyzed (WRAP 2012). The applicable 8-hour NAAQS is based on the annual fourth-highest daily maximum O_3 concentration averaged over three years. At some New Mexico monitoring sites, the annual 4th highest concentration is at or near the NAAQS level (75 ppb). However, in the last three years, the 75 ppb level has not been exceeded based on the 4th highest 8-hour average O_3 concentration. Note that given the form of the O_3 NAAQS, data analyzed does not allow for a strict comparison to the NAAQS as the data have not been averaged over three years as required for comparison to the NAAQS. However, it would appear that O_3 concentrations are below the applicable NAAQS although the margin of compliance is small.

Particulate Matter - $PM_{2.5}$/PM_{10}

$PM_{2.5}$ data are available from two monitoring sites over the period 2000-10. PM_{10} data have been collected at four sites in and near the forest areas of interest since 2008, with three sites having data prior to 2002, and only two sites prior to 2002 (USEPA 2012). Again, all monitoring sites except the Crownpoint PM_{10} site are located within the Albuquerque urban region. Crownpoint is located in McKinley County.

As shown by the emissions inventory data documented in the prior section, most PM emissions in New Mexico are associated with fugitive dust and other sources of dust (e.g., wind erosion and re-entrained dust from traffic on streets and roadways). Chronic exposure to elevated $PM_{2.5}$ and PM_{10} concentrations leads to an increased risk of developing cardiovascular and respiratory diseases (including lung cancer) where the PM emissions contain toxic constituents such as heavy metals (WHO, 2011).

The annual average $PM_{2.5}$ concentration was approximately 6 micrograms per cubic meter at the Del Norte and South East Heights monitoring sites, compared to the NAAQS of 12 micrograms per cubic meter (WRAP 2012). On December 14, 2012, the EPA reduced the primary $PM_{2.5}$ NAAQS from
15 micrograms per cubic meter to 12 micrograms per cubic meter (annual mean, averaged over three years). The 15 micrograms per cubic meter standard was retained as the annual mean secondary $PM_{2.5}$ NAAQS. In most years, Del Norte showed the highest $PM_{2.5}$ levels, but differences between $PM_{2.5}$ concentrations at the monitoring sites were small.

The 98th percentile 24-hour average $PM_{2.5}$ concentrations measured roughly 15-20 micrograms per cubic meter, with some minor year-to-year variability (WRAP 2012). The 24-hour NAAQS for $PM_{2.5}$ is 35 micrograms per cubic meter, based on the 98th percentile concentration averaged over three years.

The PM_{10} data for the annual mean and the maximum 24-hour average concentration for the Del Norte and Southeast Heights from 2000-2010 were analyzed (WRAP 2012). The PM_{10} NAAQS exists only for the 24-hour average (150 micrograms per cubic meter). The 24-hour average PM_{10} concentrations show considerable variability from site-to-site and from year-to-year. At the Jefferson and South Valley monitoring sites, occasional samples exceed the 150 microgram per cubic meter NAAQS. Maximum
24-hour average PM_{10} concentrations are below the NAAQS at the Del Norte and Crownpoint monitoring locations.

Over the period of record, the annual mean PM_{10} concentrations have been as high as 50 micrograms per cubic meter at the Jefferson monitoring site and 40 micrograms per cubic meter at the South Valley monitoring site. Elsewhere (Crownpoint and Del Notre), the measured PM_{10} concentrations are mostly 20 micrograms per cubic meter or less (annual average). An applicable annual mean NAAQS no longer exists for PM_{10} concentrations, although PM_{10} is still regulated by an NAAQS for the 24-hour average as noted above.

Available $PM_{2.5}$ monitoring data show that concentrations within the plan area comply with the applicable NAAQS. Available PM_{10} monitoring data show occasional excursions with measured concentrations above the 24-hour average NAAQS of 150 micrograms per cubic meter. However, the greater Albuquerque metropolitan area is current designated as "attainment" for PM_{10}.

Nitrogen Dioxide (NO_2) and Sulfur Dioxide (SO_2)

NOx and SO_2 emissions occur as a result of fuel combustion, either in industrial or commercial emission sources such as power generation facilities or in mobile sources (e.g., cars, trucks, busses, aircraft etc.). SO_2 emissions are linked to the quantity of sulfur in fuels that are combusted. SO_2 emissions may also result from smelting and refining of copper ores, due to the liberation of sulfur compounds contained in the ore body.

NOx and SO_2 emissions are also linked to the formation of nitrate and sulfate aerosols, which have potential adverse effects on visibility. Also, NOx and SO_2 emissions are linked to increases in acid precipitation and acid deposition.

NO_2 is the regulated form of NOx emissions. NO_2 monitoring data are available for only one site in the area of interest (USEPA 2012). NO_2 monitoring occurs at Del Norte High School, within the greater Albuquerque metropolitan area. No SO_2 monitoring data have been collected at New Mexico monitoring sites near the forests of interest.

Health effects from exposure to elevated concentrations of NO_2 include inflammation of the airways for acute exposures and increases in the occurrence of bronchitis for children and other sensitive individuals chronically exposed to elevated NO_2 levels (WHO 2011).

The Del Norte High School 98th percentile 1-hour NO_2 concentration was generally in the range of 50-65 ppb and the annual mean NO_2 concentration was generally 15 ppb or less (WRAP 2012). These levels are substantially below the applicable 1-hour and annual NAAQS (100 and 53 ppb respectively) and demonstrate that ambient NO_2 concentrations comply with the NAAQS in the area of interest.

Visibility

Visibility has been recognized as an important value going back to the 1977 CAA Amendments, which designated it as an important value for most wilderness areas that are designated as "Class I." Visibility refers to the conditions that allow the appreciation of the inherent beauty of landscape features. This perspective takes into account the form, contrast, detail, and color of near and distant landscapes. Air pollutants (particles and gasses) may interfere with the observer's ability to see and distinguish landscape features.

The IMPROVE program has been monitoring visibility conditions in Class I wilderness areas in New Mexico and nationwide since the late 1980s. The following five IMPROVE monitoring sites (mapped in Figure 30) are relevant to the Cibola:

- Bandelier National Monument (BAND1)
- Bosque del Apache (BOAP1)
- Gila (GICL1)
- San Pedro Parks (SAPE1)
- White Mountain (WHIT1)

IMPROVE monitors concentrations of atmospheric aerosols (sulfates, nitrates, etc.) and uses these data to assess light "extinction," or the degree to which light is absorbed and/or scattered by air pollution. Visibility is normally expressed in terms of "extinction" or by using the "deciview" index, which is calculated from the measured extinction value. The "deciview" index represents a measure of change in visibility conditions which is typically perceptible to the human eye. A deciview change in the range of 0.5 to 1.0 dv is generally accepted as being the limit of human perceptibility. Figure 31 illustrates the relationships among extinction, deciviews, and visual range.

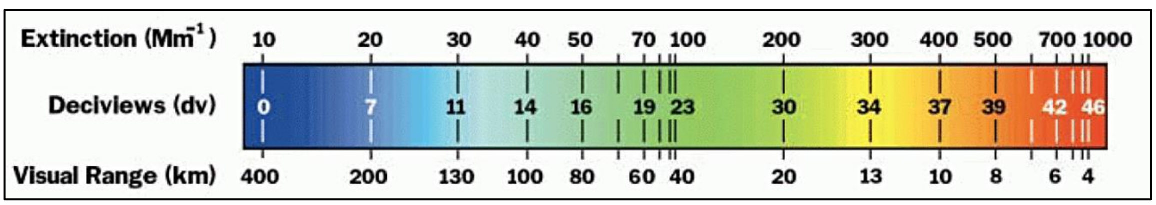


Figure 7. Relationship among Extinction, Deciview Index, and Visual Range.

Measurements of annual mean visibility (as extinction) across the United States are shown in Figure 32 as taken from IMPROVE (Hand et al. 2011). These data show lower values of extinction (better overall visibility) across the western United States and high value of extinction in the eastern United States. Western areas in and around urban centers (e.g., Phoenix, Denver, Las Vegas, etc.) also show more degraded visibility.

Under the CAA, the national visibility goal is to return visibility in Class I areas to the "natural background condition" no later than 2064. In order to meet this goal, the CAA has instituted measures for emissions control at large stationary sources that contribute to visibility impairment.

IMPROVE reconstructed extinction data for the Cibola were calculated from the IMPROVE aerosol measurements for the period 2000–2010 and are summarized in Table 3 for the 20% worst-case days (IMPROVE 2012). The IMPROVE measurements were sorted to provide the representative visibility conditions for the "worst 20%" visibility and the "average" visibility days, which are standard techniques for reviewing and assessing IMPROVE aerosol monitoring data. The visibility condition representing the 2064 goal for achieving "natural background" is also shown in Table 3. These data provide a measure of how much visibility improvement is required at each Class I area in order to achieve the 2064 National Visibility Goal (NMED 2011).

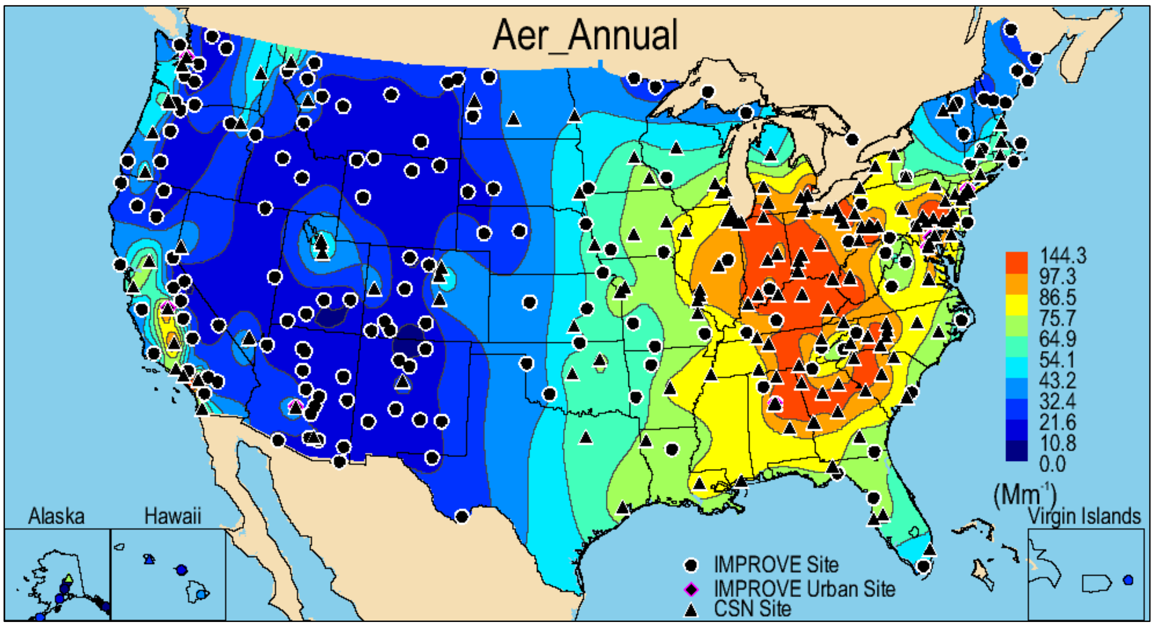


Figure 8. Reconstructed Annual Mean Aerosol Extinction from IMPROVE and Other Aerosol Data (Hand et al. 2011).

Table 3. Summary of IMPROVE Visibility Monitoring Data, 20% Worst-Case Days (dv).

Wilderness	IMPROVE Monitor	2000-04 Baseline Period		2005-09 Progress Period		2064 Goal
		Average	Range	Average	Range	Natural Background
Bandelier	BAND1	12.2	10.5-14.6	11.8	11.0-12.8	6.26
Bosque del Apache	BOAP1	13.8	12.9-14.6	13.4	11.9-14.3	6.73
Gila	GICL1	13.1	12.0-14.2	12.5	11.1-13.9	6.66
San Pedro Parks	SAPE1	10.2	9.3-11.6	9.9	8.2-10.8	5.72
White Mountain	WHIT1	13.7	12.4-14.8	13.2	12.4-14.3	6.8

The data in Table 3 are reported using the deciview metric described earlier. Higher values of deciview represent more degraded visibility conditions. Data are shown using the "baseline period" (2000-04) along with the "progress period" (2005-09) corresponding to the New Mexico regional haze SIP and the 2064 National Visibility Goal (natural background).

These data show that based on the 20% worst days during the 2005-09 "progress period," Bosque del Apache Wilderness and White Mountain have the most degraded visibility and San Pedro Parks has the least degraded visibility. Also, the general trend in visibility (based on the change in the worst 20% days between the baseline period and progress period) has been toward moderately improving visibility conditions. Table 3 also shows that the level of visibility improvement through the 2005-2009 "progress period" has been relatively modest compared to the visibility improvements needed by 2064 to achieve the goal of natural background conditions.

IMPROVE measurements at each of the nearby Class 1 areas of interest can be found at http://views.cira.colostate.edu/fed/ (IMPROVE 2012). Data from this site show the reconstructed extinction at each IMPROVE monitoring site for each year (2000-2010 where data are available for the entire period of record). This site also produces pie charts showing the percent contribution to the reconstructed extinction for the different aerosol species. The percent contribution charts represent the 2000-04 "baseline" and the 2005-09 "reasonable further progress" periods described above. For these particular charts, the visibility is reported using units of inverse megameters, which is a direct measure of atmospheric light extinction. Again, higher values of extinction represent more degraded visibility.

At Bandelier National Monument (BAND1), the reconstructed extinction for the most impaired 20% days showed levels generally in the 30-40 Mm-1 range, except during 2000, when the extinction measured around 70 Mm-1. The conditions in Year 2000 at BAND1 appear somewhat anomalous, with very high extinction budgets for organics, strongly suggesting the presence of nearby wildfires. These conditions are not apparent in any other data year. Excluding the potential bias introduced by the Year 2000 measurements, the extinction budgets at Bandelier are roughly 25% Rayleigh scattering, 25-30% sulfate and nitrate (indicative of industrial source emissions), 20-25% organics, and 10-15% coarse mass and soils. There has been a steady improvement in the visibility conditions represented by the 20% most impaired days since about 2007, which is mostly reflected by reductions in sulfate and may be a result of emissions control technology improvements at coal-fired electric generating stations.

At Bosque del Apache (BOAP1), the reconstructed extinction for the most impaired 20% days showed levels generally in the 30-45 Mm-1 range. The extinction budgets at Bosque del Apache are roughly the same as described above for Bandelier: about 25% Rayleigh scattering, 25-30% sulfate and nitrate (indicative of industrial source emissions), 20% organics, and 15-20% coarse mass and soils. At Bosque del Apache, there has been a steady improvement in the visibility conditions represented by the 20% most impaired days since about 2007, which is mostly reflected by reductions the contributions from sulfate and nitrate and may be a result of emissions control technology improvements at coal-fired electric generating stations.

At Gila (GICL1), the reconstructed extinction for the most impaired 20% days also showed levels generally in the 30-45 Mm-1 range. Generally, any variability in the year-to-year extinction budget at Gila corresponds to variability in the organic species concentrations. However, the Gila extinction budgets show significantly more contribution from organic species compared to the other IMPROVE sites. At Gila, the extinction budget shows about 20% Rayleigh scattering, 20% sulfate and nitrate (indicative of industrial source emissions), 30-40% organics, and about 10% coarse mass and soils. Like the other IMPROVE sites above, there has been a slight improvement in the visibility conditions represented by the 20% most impaired days since about 2007. However, unlike the other IMPROVE sites discussed above, the year-to-year changes appear to be affected by the variability in the organics budget and not changes to sulfate and nitrate concentrations.

As mentioned above, San Pedro Parks has the least degraded visibility, and this is also evident in the extinction data. For the 20% most impaired days, the reconstructed extinction ranges between 25-35 Mm-1. Because San Pedro Parks has the least impaired visibility, the Rayleigh contribution in the extinction budget is 30%, slightly larger than other IMPROVE sites. The sulfate and nitrate contribution is about 25-30%, the organics contribution is about 25%, and the coarse mass and soil contribution is about 15%. Similar to some of the other sites, the extinction data show some improvements in visibility conditions since 2007, generally reflecting less impact from sulfate, which might be indicative of regional SO_2 emission reductions.

At the White Mountain IMPROVE site, the extinction measurements for the most impaired 20% days range between 35-45 Mm-1. The extinction budgets at White Mountain are also different compared to the other IMPROVE monitoring sites discussed above. The White Mountain extinction budget shows greater visibility impacts from sulfate and nitrate (30-35%) and coarse mass and soil (20-25%) compared to the other IMPROVE monitoring sites discussed above. There is also no discernible trend in the IMPROVE data at White Mountain.

Atmospheric Deposition Information

Sulfur and Nitrogen Deposition

Air emissions of NOx and SO_2 can lead to atmospheric transformation of these pollutants to acidic compounds (e.g., nitric acid and sulfuric acid) and the resultant deposition onto land and water surfaces in forested ecosystems. Documented effects of nitrogen and sulfur deposition include acidification of lakes streams and soils, leaching of nutrients from soils, injury to high-elevation forests, changes in terrestrial and aquatic species composition and abundance, changes in nutrient cycling, unnatural fertilization of terrestrial ecosystems, and eutrophication of aquatic ecosystems.

Deposition impacts are generally described in terms of the “critical load,” defined as “the quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on specified sensitive elements of the environment are not expected to occur based on present knowledge” (NADP 2009). In other words, the “critical load” determines the tipping point at which harmful effects attributable to deposition in a particular ecosystem start to occur. Critical loads have been established at some, but not all wilderness areas. For the New Mexico wilderness areas of interest, critical loads for nitrogen and acid deposition have been established based on a national assessment, though they lack some site specific data for a more robust assessment (Pardo et al., 2011). This general approach has been applied to determine critical loads for nitrogen and sulfur deposition, for some sensitive receptors on the forest.

Figure 33 shows the sulfur and nitrogen deposition measurements collected at the Bandelier National Monument station operated for the National Trends Network (NTN) over the period 2000-2010 (CASTNET 2013). Totals are shown for wet deposition and dry deposition for both sulfur and nitrogen, along with other chemical species. Units of measurement are kilograms per hectare per year (kg/ha-yr).

Deposition has remained relatively constant over the period of record, although some year-to-year variability is noted. Generally, the observed deposition at Bandelier ranges between 6.0-8.5 kg/ha-yr. Nitrogen deposition makes up the bulk of the deposition and typically constitutes about 3 kg/ha-yr, while sulfur deposition is typically closer to 2 kg/ha-yr.

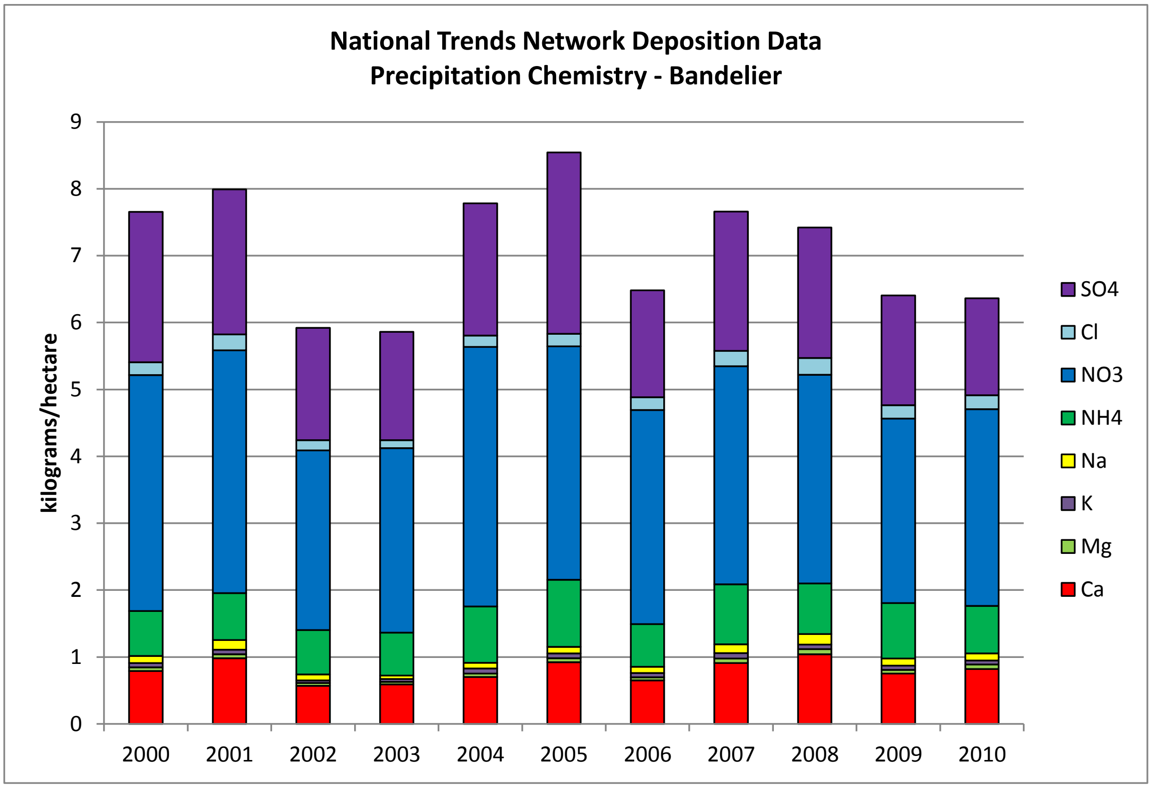


Figure 9. National Trends Network Deposition Data, Precipitation Chemistry, Bandelier Station, 2000-2010. (Data obtained from http://epa.gov/castnet/javaweb/index.html)

Mercury Deposition

Mercury is a persistent bioaccumulative toxin which can stay in the environment for long periods of time, cycling between air, water and soil. Mercury deposits on the earth's surface through wet or dry deposition, which can accumulate in the food chain and bodies of water. Toxic air contaminants like mercury, are emitted primarily by coal-fired utilities, and may be carried thousands of miles before entering lakes and streams as mercury deposition. Mercury can bioaccumulate and greatly biomagnify through the food chain in fish, humans, and other animals. Mercury is converted to methylmercury by sulfur reducing bacteria in aquatic sediments, and it is this form that is present in fish. Methylmercury is a potent neurotoxin, and has been shown to have detrimental health effects in human populations as well as behavioral and reproductive impacts to wildlife. Eating fish is the main way that people are exposed to methylmercury. However, each person's exposure depends on the amount of methylmercury in the fish they eat, how much they eat, and how often. Typically, larger fish that are higher up the food chain (eat lots of little fish rather than algae) will have a greater amount of methylmercury in them.

Almost every state (including New Mexico) has consumption advisories for certain lakes and streams warning of mercury-contaminated fish and shellfish. Bluewater Lake, which has its headwaters on the Mt. Taylor District, has a mercury advisory for Tiger Muskie; however, the fish consumption advisory is only for fish greater than 30 inches (NMED 2011). Often lakes have advisories for fish less than 10 inches, which is some indication of the level of impairment.

The Mercury Deposition Network collects and provides a long-term record of mercury concentrations and deposition in precipitation. As a result of coal-fired utilities in the Southwest, and the limited levels of mercury pollution controls at those sites, the total concentration of mercury in the air is fairly high relative to elsewhere in the United States (Figure 34) (MDN, 2011). However, due to the relatively low precipitation rates (except at higher elevations) the mercury from wet deposition is comparatively low (Figure 35) (MDN 2011).

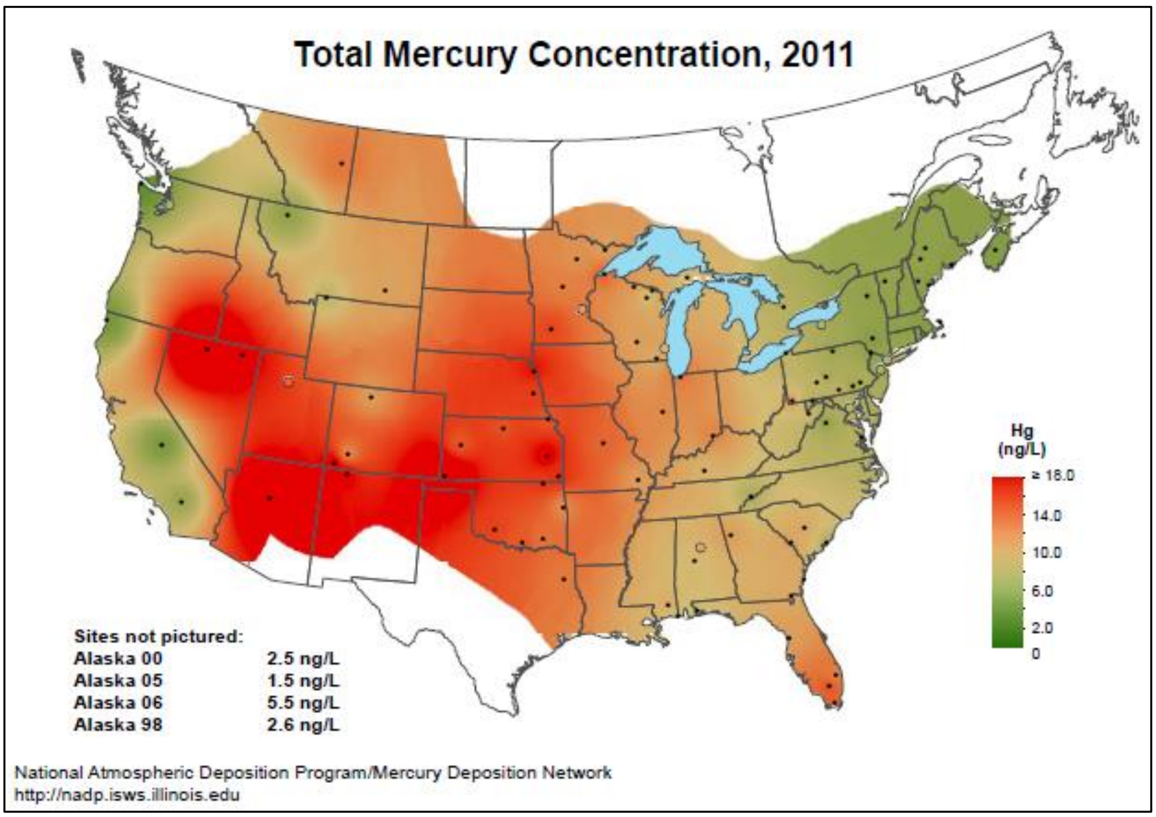


Figure 10. Total Mercury Concentration 2011.
http://nadp.sws.uiuc.edu/maplib/pdf/mdn/hg_Conc_2011.pdf

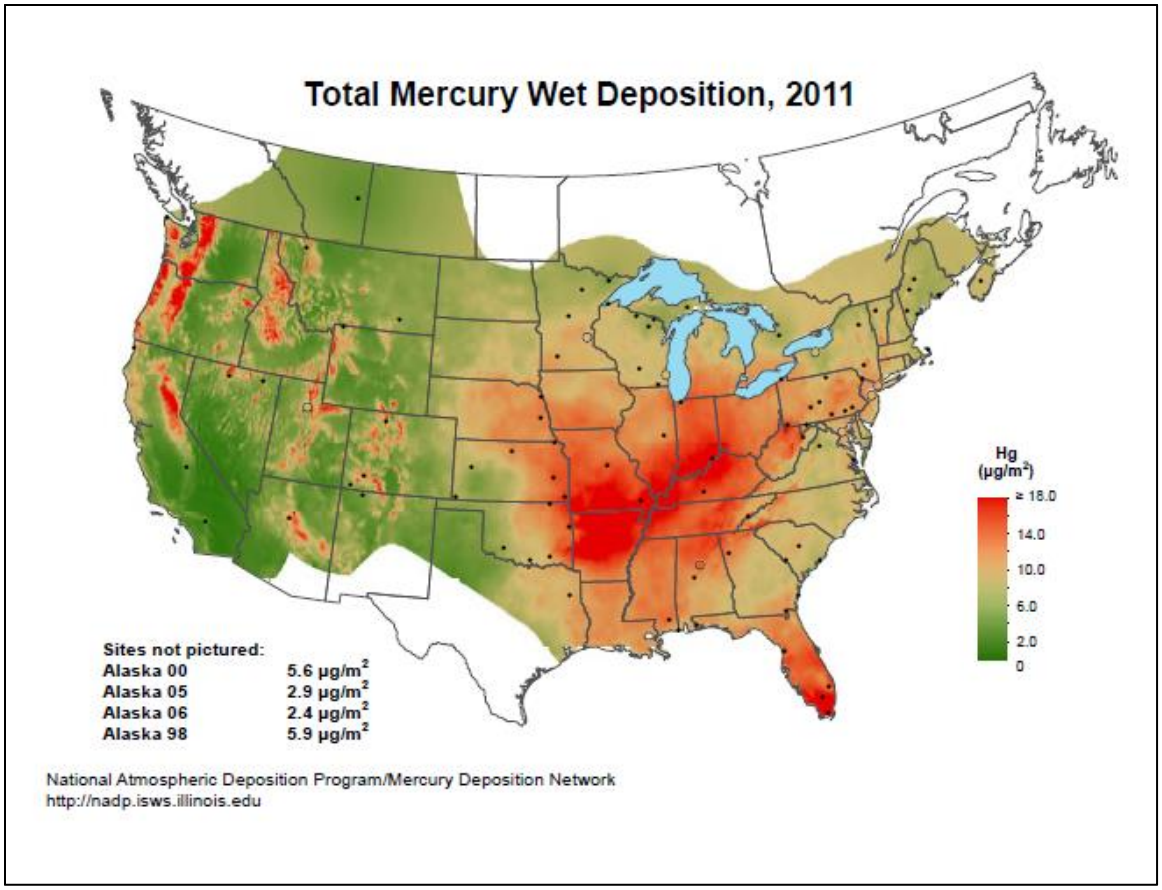


Figure 11. Total Wet Mercury Deposition, 2011.

Some sites also are now collecting total deposition, both wet and dry. One site is located on the Valles Caldera National Preserve. Although it is not on the Cibola, it can provide some indication of the conditions on the Cibola. While it has only been operating for two years, initial results suggest that dry deposition adds significantly to the total deposition (Sather 2013).

Figure 36 shows the mercury deposition measurements collected at the Mercury Deposition Network (MDN) Caballo site (Sierra County) over the period 2000–2005. No data are available for this site after 2005. Annual totals are shown for wet deposition in nanograms per square meter (ng/m^2) and concentration in nanograms per liter (ng/L) for the period of record. The mercury deposition at Caballo shows considerable year-to-year variability, with measurements ranging between 2,000 and 6,000 ng/m^2.

Figure 36 and additional mercury deposition data for the MDN monitoring site at Valles Caldera National Preserve (Sandoval County) can be accessed on the NADP/MDN network (NADP 2013). The Valles Caldera MDN site has data only for 2009 and 2010 and shows mercury deposition values greater than the Caballo site (about 7,000 ng/m^2).

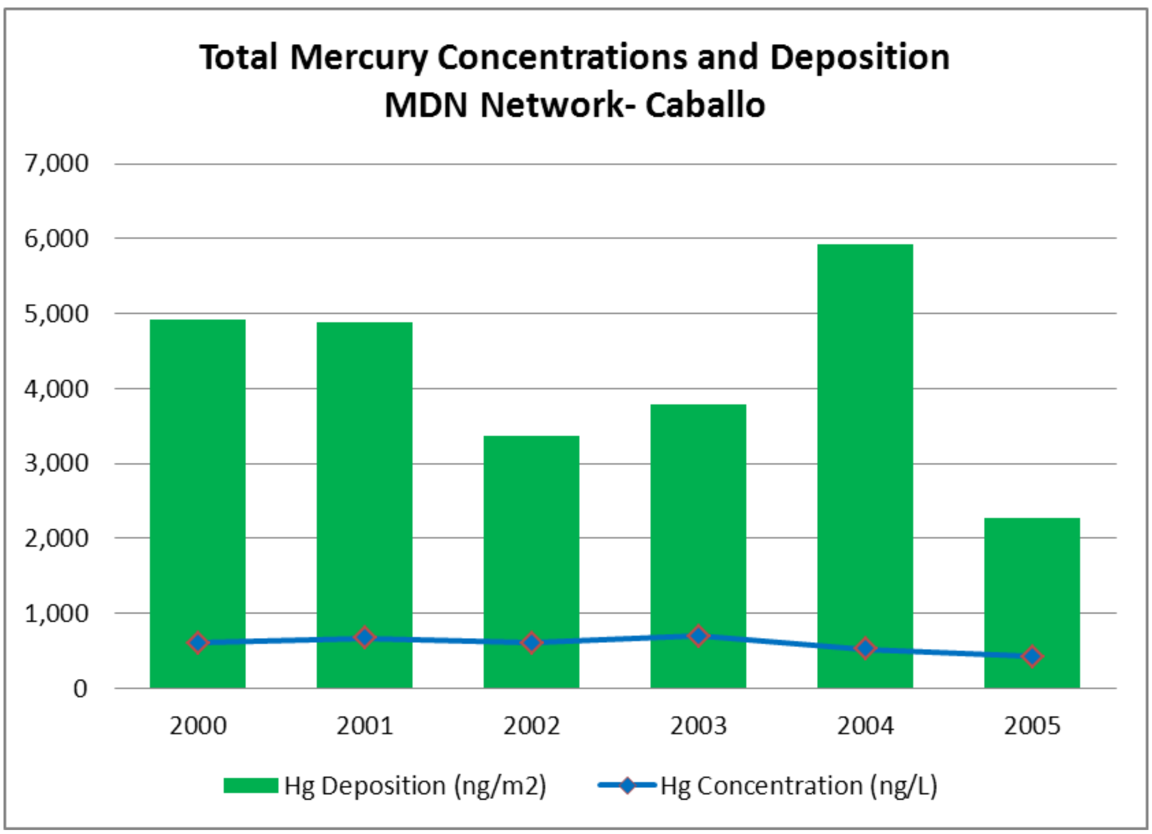


Figure 12. Total Mercury Concentrations and Deposition, MDN Network, Caballo Station, 2000-2005. (Data obtained from http://nadp.sws.uiuc.edu/MDN/).

While it is difficult to assess the current effects that mercury deposition is having on the Cibola, trends in two areas suggest that overall mercury effects will decline. First, new regulatory controls at a couple regional coal fired power plants should reduce the total mercury emissions over the next several years. In addition, sulfur emissions are also expected to decline, due to new sulfur fuel standards and pollution controls at the coal fired utilities. The link between sulfur-reducing bacteria and biotic mercury concentrations has led researchers to establish that reductions in sulfur dioxide emissions and a resulting reduction in sulfate deposition will abate mercury concentrations in wildlife. As a result, as sulfates are reduced in aquatic systems, sulfur reducing bacteria will reduce less sulfur, and this will lead to less inorganic mercury being methylated.

Federal, State & Tribal SIPs

As stated previously, the federal CAA provides the basic framework for controlling air pollution, but the states are primarily responsible for implementing and enforcing CAA requirements. Within this framework, there are a couple tools particularly relevant to protecting air quality related to national forests. Typically, air pollution that occurs off national forests is the primary concern for causing impacts on national forests. Pollution can result from either new or existing sources.

The primary tool for addressing new sources is the Prevention of Significant Deterioration (PSD) program. The 1977 CAA amendments established the PSD program to preserve the clean air usually found in pristine areas while allowing controlled economic growth. The PSD permitting program applies to new, major sources of air pollution or modifications to existing major sources which have the potential to emit certain amounts of air pollution regulated by the Environmental Protection Agency (EPA).

For existing sources of air pollution, the Federal Regional Haze Rule (RHR) requires states to develop programs to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas. The RHR addresses requirements for State Implementation Plans (SIPs), plan revisions, and periodic progress reviews to address regional haze and achieve natural haze conditions in each of the Class I areas by the year 2064.

Regional Haze Rule, 40 CFR 51.308 and 40 CFR 51.309

On July 1, 1999, the Environmental Protection Agency (EPA) issued regional haze rules to comply with requirements of the Clean Air Act. Under 40 CFR 51.308, the rule requires the State of New Mexico to develop State Implementation Plans (SIPs) which include visibility progress goals for each of the nine Class I areas in New Mexico, as well as provisions requiring continuing consultation between the state and Federal Land Managers (FLMs) to address and coordinate implementation of visibility protection programs. Under 40 CFR 51.309, the rule also provides an optional approach to New Mexico and eight other western states to incorporate emission reduction strategies issued by the Grand Canyon Visibility Transport Commission (GCVTC) designed primarily to improve visibility in 16 Class I areas on the Colorado Plateau, including San Pedro Parks Wilderness Area in New Mexico (NMED 2011).

New Mexico Environmental Department - State Implementation Plan (NMED SIP)

On December 31, 2003, the State of New Mexico submitted a visibility SIP to meet the requirements of 40 CFR 51.309 (309 SIP). The 2003 309 SIP and subsequent revisions to the 309

SIP address the first phase of requirements, with an emphasis on stationary source SO_2 emission reductions and a focus on improving visibility on the Colorado Plateau. In the 2003 submittal, New Mexico committed to addressing the next phase of visibility requirements and additional visibility improvement in New Mexico's remaining eight Class I areas by means of a State Implementation Plan meeting the requirements in 309(g). The regional haze SIP describes the Class I areas where visibility protections are in place, monitors existing visibility conditions and trends, defines the cause in terms of source emissions of visibility impairment at each Class I area, projects future trends in visibility conditions based on implementation of various emission control measures, and provides a long-term strategy to meet the stated national visibility goal of reducing all man-made visibility impairment by 2064.

Since the 2003 submittal of the 309 SIP, EPA has revised both 40 CFR 51.308 and 309 in response to numerous judicial challenges. The latest SIP petition was filed by NMED on February 28, 2011, revised March 31, 2011 (NMED 2011). The February 2011 revision was made to satisfy New Mexico's obligations under the "Good Neighbor" provision of the CAA at §110(a)(2)(D)(i). Included is a Best Available Retrofit Technology (BART) determination and proposed reductions for the San Juan Generating Station to achieve visibility reductions relied upon by other states in setting their visibility goals (NMED 2013). This SIP was challenged by San Juan Generating Station and the US EPA, which is currently still pending appeal. On February 15, 2013 a tentative settlement was announced between the State of New Mexico, the US EPA, and San Juan Generating Station. (EPA 2013). The agreement will shut down two of the plants two coal fired units and install selective non-catalytic reduction technology on the remaining two coal fired units. The two units being shut down will be replaced by less polluting natural gas-fueled units.

Grand Canyon Visibility Transport Commission – 1996 Findings and Recommendations

In 1990, amendments to the Clean Air Act under 40 CFR 51.309 established the Grand Canyon Visibility Transport Commission to advise the EPA on strategies for protecting visual air quality on the Colorado Plateau. The GCVTC released its final report in 1996 and initiated the WRAP, a partnership of state, tribal and federal land management agencies to help coordinate implementation of the Commission's recommendations (WRAP 1996).

Issues addressed by the GCVTC and WRAP are summarized below:

- Air pollution prevention
- Clean air corridors
- Stationary sources
- Areas in and near parks and wilderness areas
- Mobile sources
- Road dust
- Emissions from Mexico
- Fire

Forest Service Policy and Actions

Regional Forest Service Air Resource Management (ARM) staff act as the point of contact to receive and review permit applications filed with state and local regulatory agencies by new/modified emission sources and provide comments back to the state agency. Unless a specific issue arises, individual national forests are typically not responsible for conducting reviews of new/modified sources via the state level air quality applications process. The Forest Service regional office provides air quality analysis to determine if proposed actions are likely to cause, or significantly contribute to, an adverse impact to visibility or other air quality related values within the national forest system (USFS 2012).

Additionally, the Forest Service complies with the New Mexico State Smoke Management Programs (SMP). The New Mexico smoke management program is described in Section 12.7.14 of the February 2011 New Mexico Section 309(g) Regional haze SIP (NMED 2011). New Mexico's administrative code (20.2.65 NMAC-Smoke Management) stipulates that all burners must comply with requirements of the CAA and RHR, as well as all city and county ordinances relating to smoke management and vegetative burning practices. For prescribed fires and wildfires managed for resource benefit that exceed ten acres in area, additional requirements include registering the burn, notifying state and nearby population centers of burn date(s), visual tracking, and post fire activity reports (NMAC 2013).

Unique to the Sandia Ranger District is that Bernalillo County is the primary regulatory authority in terms of air quality, while the other districts fall under the jurisdiction of the New Mexico Environmental Department.

As indicated previously, Forest Service typically lacks direct authority to control air emissions that impact a particular ranger district of the Cibola. The primary role that ARM staff can provide to NMED staff as they prepare PSD permits or develop the RHR, is to provide information about potential impacts that could occur on national forest land, particularly in Class 1 areas. The primary tool FLMs use is the critical load concept described in the next section on atmospheric deposition. Currently the Cibola has critical loads based on a national assessment developing empirical critical loads for major ecoregions across the United States. However there are no forest specific critical loads developed for the Cibola, and therefore they have not been included in the New Mexico SIP.

Critical Loads

Air pollution emitted from a variety of sources is deposited from the air into ecosystems. These pollutants may cause ecological changes, such as long-term acidification of soils or surface waters, soil nutrient imbalances affecting plant growth, and loss of biodiversity. The term critical load is used to describe the threshold of air pollution deposition below which harmful effects to sensitive resources in an ecosystem begin to occur. Critical loads are based on scientific information about expected ecosystem responses to a given level of atmospheric deposition. For ecosystems that have already been damaged by air pollution, critical loads help determine how much improvement in air quality would be needed for ecosystem recovery to occur. In areas where critical loads have not been exceeded, critical loads can identify levels of air quality needed to maintain and protect ecosystems into the future.

U.S. scientists, air regulators, and natural resource managers have developed critical loads for areas across the United States through collaboration with scientists developing critical loads in Europe and Canada. Critical loads can be used to assess ecosystem health, inform the public about natural resources at risk, evaluate the effectiveness of emission reduction strategies, and guide a wide range of management decisions.

The Forest Service is incorporating critical loads into the air quality assessments performed for Forest Plan revision. There are no published critical loads in the southwest United States. For this assessment, national scale critical loads were used to determine if critical loads were exceeded for nutrient nitrogen (Pardo et al. 2011), acidity to forested ecosystems (McNulty 2007), and for acidity to surface water (Lynch 2012). In addition, mercury deposition was analyzed based on data from the mercury deposition network (MDN 2011). Ozone deposition was not assessed, due to lack of data availability and analysis in the southwest United States.

Nitrogen Saturation/Eutrophication

Nitrogen air pollution can have an acidifying effect on ecosystems as well as cause excess input of nitrogen in the ecosystem and nitrogen saturation. This excess nitrogen initially will accumulate in soil and subsequently be lost via leaching. While increased nitrogen may increase productivity in many terrestrial ecosystems (which are typically nitrogen limited) this is not necessarily desirable in protected ecosystems, where natural ecosystem function is desired. Excess nitrogen can lead to nutrient imbalances, changes in species composition (trees, understory species, nonvascular plants (lichens), or mycorrhizal fungi), and ultimately declines in forest health.

Based on research by Pardo and others (Pardo 2011, Pardo et al. 2011), national scale critical loads were developed for nitrogen deposition for lichen and herbaceous plants and shrubs. Pardo also developed critical loads for mycorrhizal fungi, forests, and nitrate leaching in soils, though they are not available for the Cibola. Summary results of this assessment are in Table 4.

Table 4. Critical Load Exceedance Summary for Nitrogen Deposition on the Cibola (109 grid cells).

	# grid cells	% of total	Minimum Exceedance (kg-N/ha)	Maximum Exceedance (kg-N/ha)	95% Exceedance level (kg-N/ha)
Lichens					
Exceedance	94	86%	1.953771	6.131773	4.868832
No Exceedance	7	6%			
Critical Loads Not Available	8	7%			

	# grid cells	% of total	Minimum Exceedance (kg-N/ha)	Maximum Exceedance (kg-N/ha)	95% Exceedance level (kg-N/ha)
Herbaceous Plants & Shrubs					
Exceedance	32	29%	0.002616	3.621773	2.254738
No Exceedance	35	32%			
Critical Loads Not Available	42	39%			
Mycorrhizal Fungi					
Exceedance		0%			
No Exceedance	8	7%			
Critical Loads Not Available	101	93%			
Forests					
Exceedance		0%			
No Exceedance		0%			
Critical Loads Not Available	109	100%			
Nitrate Leaching					
Exceedance		0%			
No Exceedance	8	7%			
Critical Loads Not Available	101	93%			

Lichens

Lichens, which add significantly to biodiversity of ecosystems, are some of the most sensitive species to nitrogen deposition (Pardo 2011). Unlike vascular plants, lichens have no specialized tissues to mediate the entry or loss of water or gases. They rapidly hydrate and absorb gases, water and nutrients during periods of high humidity and precipitation. They dehydrate and reach an inactive state quickly, making them slow growing and vulnerable to contaminate accumulation. As such, they are an important early indicator of impacts from air pollution.

Pardo used the major ecoregion types adapted from the Commission for Environmental Cooperation (CEC 1997), of which the Cibola is within the Temperate Sierras and North American Deserts ecoregions. The critical loads for lichens in these two ecoregions are based on research from Pardo and Geiser for North American Deserts and the Temperate Sierras, with minimum levels between 3-4 kg-N/ha-yr (Pardo 2011, Pardo et al 2011) (Geiser 2010). Based on these values, 86% of the Cibola exceeds critical loads to protect lichens, where 6% showed no exceedance and critical loads were not available for 7% or the area encompassing the Cibola. The minimum amount that the Cibola exceeded nitrogen deposition by was 1.95 kg-N/ha and the maximum was by 6.13 kg-N/ha. Almost all (95%) of the grid cells exceeded the critical loads for lichens by less than 4.87 kg-N/ha.

Herbaceous Plants and Shrubs

Herbaceous plants and shrubs comprise the majority of the vascular plants in North America (USDA, NRCS 2009). They are less sensitive to nitrogen deposition than lichens; however, they are more sensitive than trees due to rapid growth rates, shallow roots, and shorter life span (Pardo 2011). Herbaceous plants are the dominant primary producers, contributing significantly to forest litter biomass and biodiversity (Gilliam 2007). The shorter lifespan of some species can result in a rapid response to nitrogen deposition and can result to rapid shifts (1–10 years) in community composition sometimes resulting in an increase in invasive species compared to native species (Pardo 2011).

Based on the national scale empirical critical loads for nitrogen deposition for herbaceous plants and shrubs from Pardo (Pardo et al 2011), 29% of the Cibola is potentially exceeding critical loads, 32% does not exceed, and critical loads are not available for 39% of the Cibola. The areas exceeding critical loads for nitrogen deposition range from a slight exceedance of 0.002 kg-N/ha to 3.62 kg-N/ha, with 95% of the grid cells exceeding the critical loads by less than 2.25 kg-N/ha. The critical loads were based empirical data developed for the North American Desert ecoregion, which noted increased biomass of invasive grasses and a decrease of native forbs at 3 kg-N/ha-yr (Allen 2009)(Rao 2010). Critical loads for nitrogen deposition were not available for the Temperate Sierra ecoregion for herbaceous herds and shrubs.

Acid Deposition

The potential for impacts from acid deposition on forests has been recognized for more than 30 years in the United States. Research has shown that deposition of nitrogen and sulfur has resulted in acidifying effects, which has had negative impacts on ecosystem health, including impacts to aquatic resources, forest sustainability, and biodiversity (McNulty 2007). Acidifying effects can lead to mortality of tree species, reduced forest productivity, reduced biological diversity, and increased stream acidity (Driscoll 2001).

The following section presents critical acid load for soils and surface water on the Cibola. McNulty estimated critical loads and exceedances for forested soils across the United States (McNulty 2007). The surface water critical acid loads were based on research from Lynch (Lynch 2012).

Soils

Many factors contribute to an exceedance of critical acid loads in forested ecosytems. Key factors include the composition of the soil, including how weathered it is, the amount of organic matter present, and the amount of base cations (i.e. calcium, potassium, magnesium, and sodium), which all play a role in how well the soil is buffered against acid deposition (how well the soil can neutralize the acid). For example, sandy soils are typically low in base cations, which make them more vulnerable to acid deposition. Also important are the types of tree species present due to the various rates that they uptake nitrogen, and base cations, which can either counter act the effects of acid deposition or reduce soils buffering capacity. In conifer forests, as the needles break down, the soil is naturally acidified, which can also increase the systems vulnerability to acidification. Also important is the rate at which sulfur and nitrogen compounds fall to the ground through either wet or dry deposition, which is related to what sort of emissions are occurring that are adding these compounds to the airshed. Elevation also plays a role, since more precipitation tends to occur at higher elevations increasing the rate of acid deposition.

Estimates from McNulty, that factor all the parameters described above, show that there are no exceedances of acid critical loads on the Cibola (Figure 37). This is primarily a result of low amount of acid gases in the airsheds in New Mexico and the western United States.

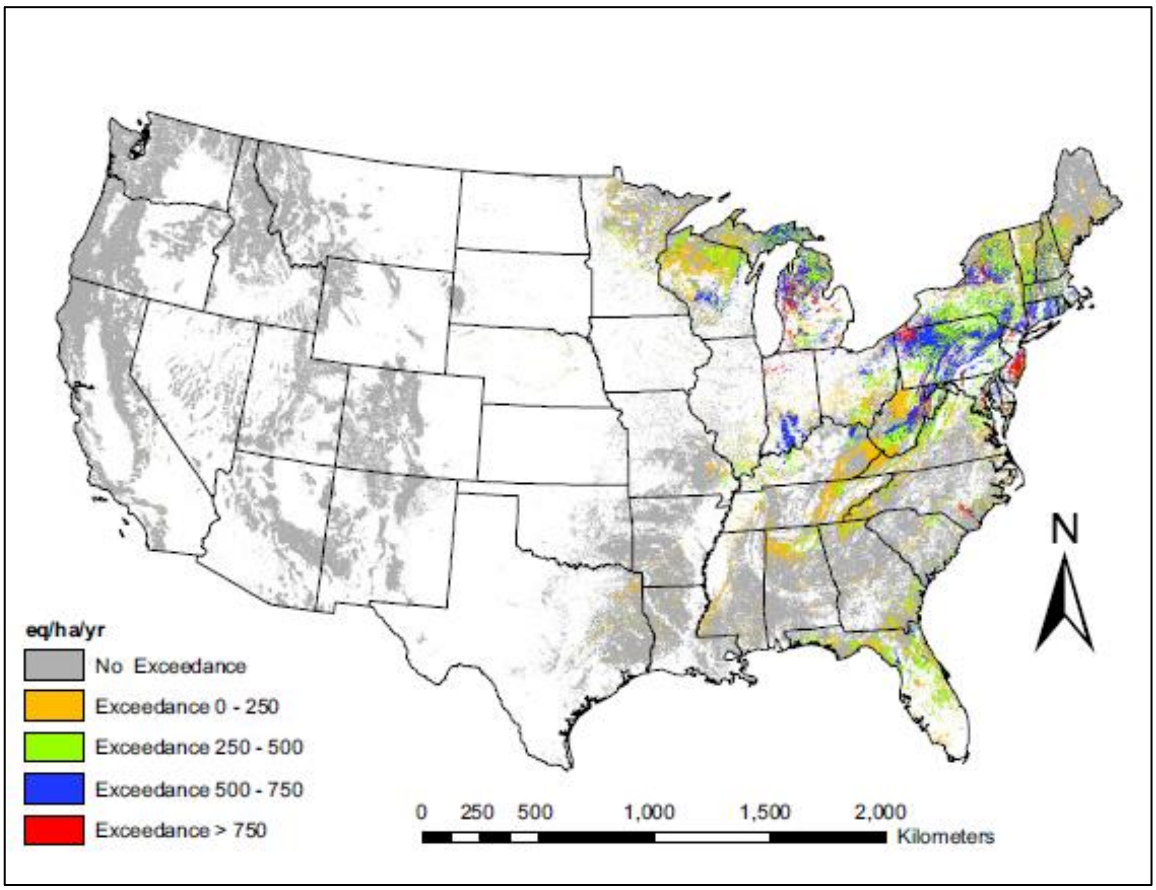


Figure 13. Average annual exceedance of the critical acid load for forest soils expressed in eq/ha-yr for the coterminous US for the years 1994–2000 at a 1-km^2 spatial resolution (McNulty 2007).

Surface Water Impacts

Stream and lake acidification can be a result of deposition of acid gases, which can reduce the pH of surface water resulting in reduced diversity and abundance of aquatic species. As described in the previous section, many of the same factors contribute to the susceptibility of aquatic ecosystems to the effects of acid deposition. Surface water acidification begins with acid deposition in adjacent terrestrial areas (Pidwirny 2006) and the system's ability to neutralize the acid before it leaches into the surface water.

There are no critical loads available for the Cibola to assess acid deposition to surface water, however acidification of surface water on the forest does not appear to be an issue. A national analysis, by Lynch was conducted using the Steady-State Water Chemistry model (SSWC) used a mass-balance approach to assess acid critical loads for surface water (Lynch 2012). This assessment did not include any surface water sites on the Cibola. However, every two years the New Mexico Environment Department is required by the Clean Water Act to submit and assessment of the surface waters in New Mexico to the USEPA. Based on the current list of impaired water in New Mexico, there are no impaired waters as a result of pH on the Cibola (NMED 2011b).

Ozone

Ground-level ozone interferes with the ability of plants to produce and store food, which makes them more susceptible to disease, insects, other pollutants, drought, and higher temperatures. Some plants have been identified as particularly sensitive to the effects of ozone and are reliable indicators of toxic levels of the pollutant on plant growth.

Ozone damages the appearance of leaves on trees and other plants. The most common visible symptom of ozone injury on broad-leaved bioindicator species is uniform interveinal leaf stippling. As a gaseous pollutant, ozone enters the stomata of plant leaves through the normal process of gas exchange, damaging the tissue. Elevated levels of ozone have not been directly measured on the Cibola, nor has an assessment of the forest's vegetation been conducted in terms of looking for impacts from ozone. The effects of ozone on tree growth on the Cibola are not well understood.

Uncertainty

There are many factors that contribute to the reliability and confidence of an assessment. Typically a sufficient amount of direct measurements taken over time, provide the greatest level of confidence regarding the current state and trends of forest health as it applies to air quality impacts. In the absence of direct measurements, modeled data can be used to assess relative risk of systems to the impacts for air pollution; however this creates a greater degree of uncertainty in the assessment. To understand the level of confidence in the modeled results it is important to understand the assumptions in the models as well as how they perform in a given environment. In this case, how do they perform assessing the potential impacts that air pollution has on various indicators, such as lichens, on the Cibola.

While there are direct measurements that have been taken over time, for ambient air quality and visibility, there have been no studies performed on the Cibola to directly measure the impacts from air pollution on forest health. The modeled results, that are available, indicate that lichens and to a lesser degree herbaceous plants and shrubs are at risk of being impacted by nitrogen deposition. There is a fair amount of uncertainty with these estimates, however. The critical loads were developed based on lichen studies in western Oregon and Washington for the Temperate Sierras and based on research in Hells Canyon for the North American Desert ecoregion (Pardo 2011, Pardo et al 2011). In addition, atmospheric nitrogen deposition estimates and critical loads are influenced by several other factors, including the difficulty of quantifying dry deposition on complex mountainous terrain in arid climates with sparse data (Pardo 2011, Pardo et al 2011), all of which are significant factors on the Cibola. At this time, there is a fair amount of uncertainty with the critical load estimates to have a high level of confidence in the assessment.

Risk Assessment

Air quality on the Cibola is within regulatory levels for NAAQS, and the trend based on projected emission inventories appears to be stable or is improving for most pollutants (Table 5). This is also true regarding visibility conditions. The main challenge could be with regards to both coarse and fine particulate matter, which can affect both the ambient air quality and visibility on the forest. Land-use both on and off the forest, as well as climate change and drought can contribute to windblown and fugitive dust. Wildfires can also be a significant source of particulate matter.

There is some indication that current levels of nitrogen deposition have exceeded critical loads and are significant enough to have resulted in impacts to lichen diversity and community structure and to a lesser degree impacts to herbaceous plants and shrubs. However, these results were based on modeled critical loads and have not been verified on the forest. The rate of deposition of nitrogen, which can lead to impacts affecting forest health, appear to be decreasing based on projected emissions at the state level.

Modeled results also indicate that the levels of acid gases are not at levels significant enough to result in impacts to either soils or surface water. There are no direct measurements on the forest that indicate otherwise.

There is some indication that mercury deposition at higher elevations on the forest may be significant, but there are not any studies to verify any impacts. Atmospheric mercury, based on regional emissions, is also expected to decrease.

Table 5. Summary of conditions, trends, and reliability of assessment.

Air Quality Measure	Current Conditions	Trend	Reliability of Assessment
NAAQS*			
CO	Good	Improving	High
NO_2	Good	Improving	High
SO_2	Good	Stable	High
Pb	Good	Stable	High
O_3	Good	Stable	High
$PM_{2.5}$	Good	Stable to Declining	High
PM_{10}	Good	Stable to Declining	High
Visibility**	Departed	Stable to Improving	High
Critical Loads- Deposition			
Nitrogen Eutrophication			
Lichens	Potentially at risk	Improving	Low
Herbaceous Plants & Shrubs	Potentially at risk	Improving	Low
Mycorrhizal Fungi	Unknown	Unknown	NA
Forests	Unknown	Unknown	NA
Nitrate Leaching	Unknown	Unknown	NA
Acid Deposition			
Soils	Good	Improving	Low
Surface Water	Good	Improving	Low
Mercury	Potentially at risk	Improving	Low
Ozone	Unknown	Unknown	NA

*Relative to NAAQS

**Relative to 2064 Regional Haze Goal

Best Available Science

For this assessment the Best Available Science was used, that is relevant, accurate, and reliable. Uncertainty in the assessment has been appropriately documented where relevant. Government data that has met strict protocols for data collection was used to assess the current conditions and trends with regards to ambient air quality, visibility, emissions inventories, and deposition. The critical load information was based on multi-agency government research, analysis, and following Forest Service protocols.

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