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State of Washington

# Washington State Regional Haze 5-Year Progress Report

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# Washington State Regional Haze 5-Year Progress Report

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# Acknowledgements

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# Executive Summary

This report is an interim progress report as required by the federal Regional Haze Rule, which protects visibility (visual air quality) in 156 national parks and wilderness areas (Class I areas). The Regional Haze Rule requires each state:

- Every 10 years, to evaluate and develop a new State Implementation Plan (SIP) to continue to improve visibility.
- Every five years after submitting each plan to EPA, to evaluate progress on improving visibility in the state as well as its impact to neighboring states.

Washington has eight Class I areas:

- Alpine Lakes Wilderness Area
- Glacier Peak Wilderness Area
- Goat Rocks Wilderness Area
- Mount Adams Wilderness Area
- Mount Rainier National Park
- North Cascades National Park
- Olympic National Park
- Pasayten Wilderness Area

Washington's 2010 Regional Haze Plan established visibility goals for 2018 and described the strategy to control air pollution from human sources. The plan depended on numerous federal requirements to establish the 2018 goals. For example, one of the requirements was for vehicle emission control.

Haze-forming pollution comes from both natural and human sources. Natural sources include:

- windblown dust
- ocean spray
- wildfire soot

Human sources include:

- vehicles
- electricity-generating facilities
- industrial fuel burning
- manufacturing operations

While some haze-causing particles are emitted directly to the air, secondary particles can form when emitted gases form particles downwind of the emission sources. Nitrates and sulfates are examples of secondary particles that contribute to haze. Some of the pollutants that form haze can cause health problems and environmental damage.

Washington continues to reduce air pollution that produces regional haze. Because of this, visibility is improving in these areas. Overall, the Class I area visibility record shows improvement since the 2000–2004 baseline period. Levels measured in the 2010–2014 period met or exceeded the 2018 visibility goals.

Visibility data also shows that reductions of precursor emissions (pollutants which react in the air to form other air pollutants) are on track to meet our 2018 visibility goals. Strategies to reduce oxides of nitrogen and oxides of sulfur have lowered these haze-producing precursor emissions throughout the state. Average visibility on the worst and best haze days is improving. Wildfire smoke remains the biggest cause of reduced visibility on worst days.

Ecology held a public comment period on the report from June 20, 2017, through August 1, 2017. Ecology notified the public about the comment period via:

- Ecology's website
- social media (blog, facebook, and twitter)
- The Daily Journal of Commerce newspaper
- email distribution lists

No one requested that Ecology held a hearing, so we did not have one. A copy of the public notices is in Appendix F.

We received three comments during the public comment period: one from a citizen, one from an environmental organization, and one from the National Park Service. The public comments and our response are in Appendix G. We did not change the report as the result of the comments received.

# 1. Background and Overview of Progress Report Requirements

Congress recognized the importance of visibility in our national parks and wilderness areas by amending the Clean Air Act (CAA) in 1977 to include a goal for "prevention of any future, and the remedying of any existing, impairment of visibility."[1] In order to implement this provision of the Act, the U.S. Environmental Protection Agency (EPA) established the Regional Haze Rule (RHR)[2] in 1999, specifying how states must work toward this visibility improvement goal. Final amendments to this rule and revised implementation guidance were completed in 2005 allowing states to complete their plans. The RHR requires that states identify and implement pollution control strategies to make continuous progress toward a goal of "natural conditions"[3] state of visibility by 2064.

Progress toward natural conditions visibility is expected by reducing or eliminating man-made impairment of visibility at the 156 Class I areas in the U.S. These public areas are national parks, forests, monuments, seashores, and wilderness areas managed by federal land management agencies. The RHR requires that continuous progress toward visibility improvement goals be evaluated at periodic checkpoints, with State Implementation Plans (SIPs) required every 10 years, and interim progress reports five years after each plan is submitted to EPA.

The Washington State Department of Ecology (Ecology) adopted the Washington Regional Haze Plan (RH Plan) in December 2010 and transmitted it to EPA in December 2010. EPA approved the RH Plan in June 2014. The RH Plan described visibility conditions for the baseline years 2000–2004 and included the state strategy for reaching the first Reasonable Progress Goals (RPGs) in 2018.[4] The 2018 RPGs are interim visibility improvement benchmarks on a path to the ultimate, long-term goal of natural background conditions. The 2018 RPGs were developed by Ecology for each Class 1 area in Washington, in consultation with other affected states and the federal land managers. This first Progress Report (Report) evaluates progress made toward the 2018 RPGs and addresses the following:

- Status of RH Plan state strategy
- Emissions reductions from RH Plan control strategies
- Visibility progress
- Emission inventory trends
- Assessment of changes impeding visibility progress
- Assessment of current strategy

[1] Section 169A of the CAA.
[2] CFR 40 Part 51 Regional Haze Regulations; Final Rule, July 1, 1999.
[3] Note that "default" natural conditions as defined by the U.S. EPA are subject to revisions. States can extend the period of time needed to achieve natural conditions, beyond the nominal 2064 in the RHR, defining and defending new interim reasonable progress rates and adjusting the 2064 end year as needed (see CFR Section 51.308).
[4] See Chapter 9 of the December 2010 Regional Haze State Implementation Plan for information on the development of the RPGs.

- Review of visibility monitoring strategy
- RH Plan adequacy determination
- Federal land manager (FLM) comments

## 1.1. Washington Class I areas

Washington has eight Class I areas. Visibility and progress toward better visibility is calculated from data collected by the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. There are six IMPROVE monitors representing one or more of the Class I areas in Washington. Class I areas in Washington with their respective IMPROVE monitor names and locations are shown in Figure 1.

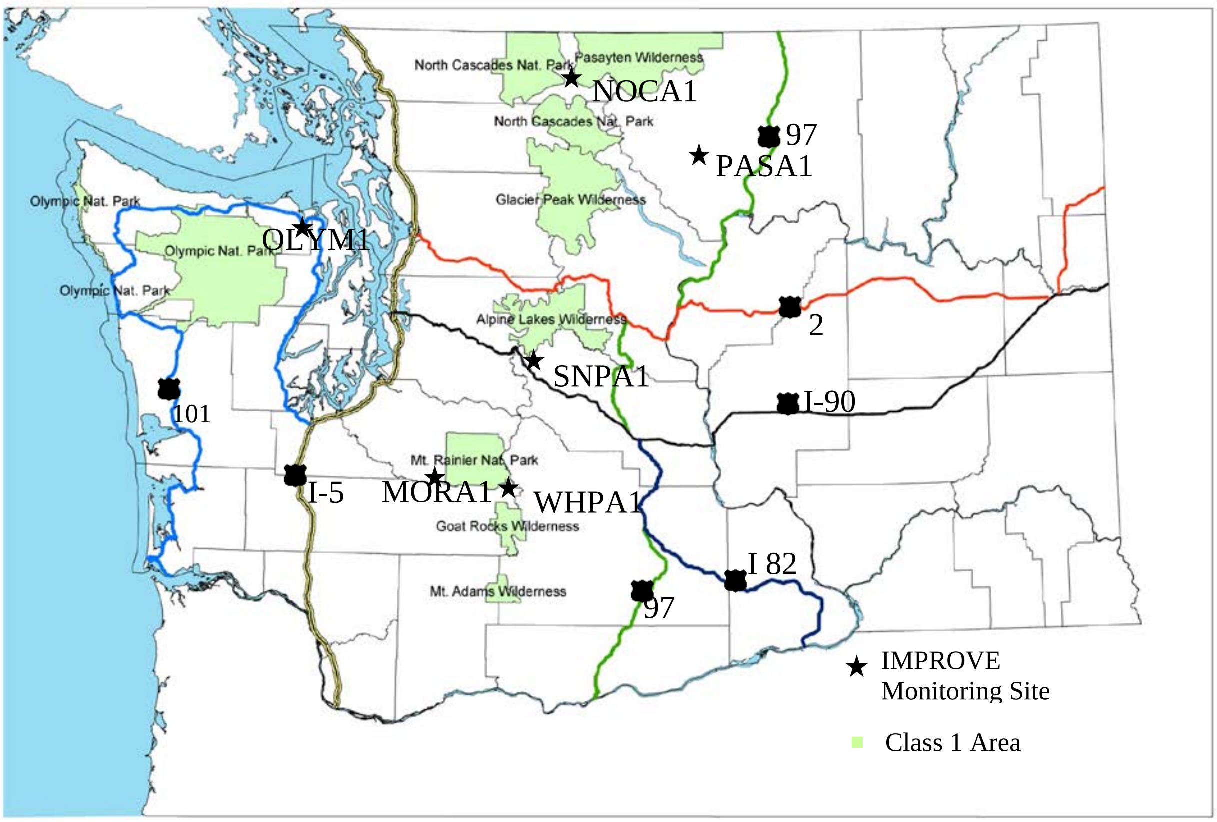



**Figure 1. Map of Class I areas and IMPROVE monitors**

## 1.2. Measuring visibility

Measuring visibility is complex. Visibility impairment as perceived by a person is a combination of the relative humidity of the atmosphere, the quantity and size of particulates in the air, elevation, and which direction they are looking relative to the sun. To minimize the vagaries of what an individual person would see, atmospheric scientists have devised a method to estimate the visibility impairment. The estimates are based on the quantities of haze-causing particles and aerosols in the air. The principle haze-causing pollutant species included in the analyses are ammonium nitrates (nitrates), ammonium sulfates (sulfates), organic carbon matter aerosols (OMC), elemental carbon (EC), fine soil (FS), coarse mass (CM), and sea salt (SS). There is also natural light scattering by gases, known as Rayleigh scattering, which produces a constant light extinction value based on elevation. Reducing the concentrations of the pollutant species contributing to visibility impairment means their contribution to light extinction lessens, and visibility improves.

There are six IMPROVE monitors in Washington that are designated as monitoring specific mandatory federal Class I areas. There are two IMPROVE monitors that monitor visibility in Class II areas. This report only evaluates visibility at the six IMPROVE monitors associated with Class I areas. The eight monitors that are currently operating and the areas they are designated to represent are:

**Table 1. IMPROVE Monitor Sites in Washington**

| Monitor Name | Area Represented | Class I or II? |
|---|---|---|
| OLYM1 | Olympic National Park | I |
| NOCA1 | North Cascades National Park and Glacier Peak Wilderness | I |
| PASA1 | Pasayten Wilderness | I |
| SNPA1 | Alpine lakes Wilderness | I |
| MORA1 | Mt. Rainier National Park | I |
| WHPA1 | Goat Rocks and Mt. Adams Wildernesses | I |
| CORI1 | Columbia River Gorge National Scenic Area | II |
| PUSO1 | Central Puget Sound Basin (Seattle) | II |

The IMPROVE monitors measure the concentration of each haze-causing pollutant species every three days. Since each pollutant species has a different capacity to extinguish light, a mathematical formula was created to add up the light extinction caused by the concentrations of each pollutant species (plus the natural Rayleigh scattering) on each measurement day. This formula, called the Haze Algorithm, converts the total light extinction calculated for each day into units of visibility impairment called "deciviews" (dv).[5] One dv unit corresponds with the minimum visibility change detectable to the human eye. As dv levels decrease, visibility improves.

The RHR requires that assessments of visibility progress must be based on 5-year averages of the dv values for the annual haziest (Worst) and clearest (Best) days at each IMPROVE monitor. The Worst Days measurement is the average of the dv levels for the 20 percent of the sampling days with the highest visibility impairment each year. The Best Days measurement is the average of the dv values for the 20 percent of the sampling days with the lowest visibility impairment.

[5] Chapter 3 of the December 2010 RH Plan explains further how deciviews are calculated from measurements of mass concentrations of haze species at each IMPROVE monitor.

The 2018 RPGs are the projected dv levels for the Worst Days' averages at each Class I area monitor in 2018, after implementing the strategies contained in the state's RH Plan. EPA approved the 2018 RPGs when they approved the RH Plan. Worst Days dv levels should be decreasing as they progress toward the 2018 RPGs. The RHR and RH Plan also specifies that Best Days' averages should not degrade from the baseline period (2000–2004).

## 1.3. Source impacts on visibility

A better understanding of visibility improvement emerges from relating reductions in precursor air pollutant emissions in and near the Class I areas to changes in concentrations of haze-causing pollutant species measured at the monitors. Also important is the change in each haze species' contribution to light extinction, as the mix of precursor emissions changes. Emissions from both natural sources (vegetation, volcanos, ocean, etc.` `) and from man-made activities (anthropogenic sources) affect visibility. These sources can be located within Washington or adjacent states and Canadian Provinces, but long-range transport also brings visibility-impairing pollutants from out-of-state and international sources into Washington's atmosphere. Washington's emissions control strategy focuses on sources within the state's regulatory jurisdiction that it has the ability to control.[6]

The fact that "uncontrollable" natural and anthropogenic sources affect visibility is not neglected in this analysis. For example, visibility progress in western states is slowed by the increased frequency and intensity of wildfires during the summer. Smoke originating from wildfires within and outside Washington generates enormous concentrations of organic carbon aerosols that form far-reaching plumes impacting many visibility monitors before dissipating. Depending on the wildfire location, smoke impacts different monitoring locations from year-to-year. On occasion, trans-Pacific movement of air pollution from eastern Asia can result in detectable but minor haze consequences in Washington.

Uncontrollable emissions sources add to the atmospheric mix of visibility-impairing pollutants produced by anthropogenic sources in Washington. While the IMPROVE monitors are able to differentiate the chemical makeup of the particulates measured, the monitor systems results only provide a rudimentary ability to differentiate the types of sources producing these pollutants. Seasonal inversions, sea breezes, wildfires, forest health prescribed fires, and humidity enhance the impact of these variable emissions. Washington's coastal location, topography, and complex meteorology, may result in somewhat uneven year-to-year visibility improvement progress at some sites, despite steady reductions of stationary, area, and mobile source emissions and long term visibility improvement. The Progress Report appendices describe localized and regional situations where uncontrollable emissions adversely impact visibility progress.

For all of the Class I area IMPROVE monitors in Washington, visibility impairment is caused by sulfates, organic carbon, and nitrates. As the emissions of sulfate and nitrate have gone down since the baseline period, the relative impacts of light absorbing (black) carbon coarse mass and sea salt have increased. Overall the total visibility impact of these components is essentially

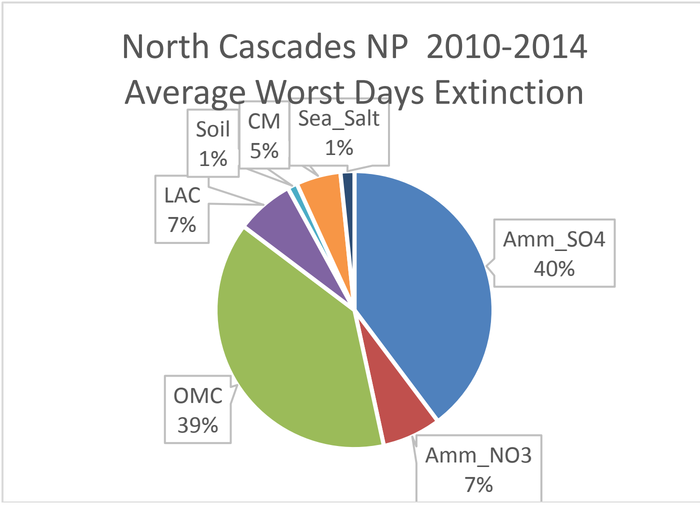
[6] Sources that Washington is unable to control include wildfires, on- and off-road motor vehicles, marine vessels, and sources in other states and Canada.

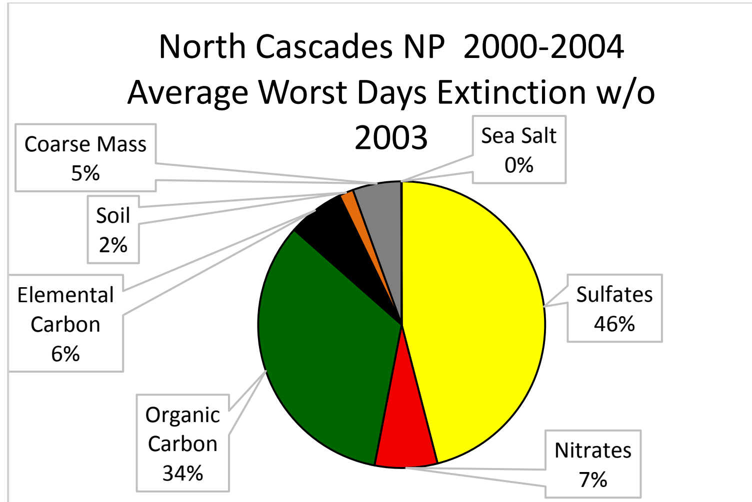
unchanged between the baseline and the current review period. The analysis of the IMPROVE filters assumes that all collected sulfate and nitrate are combined with ammonia. While ammonia is not monitored by the IMPROVE network, it is an important, though unregulated component of regional haze visibility impairment.

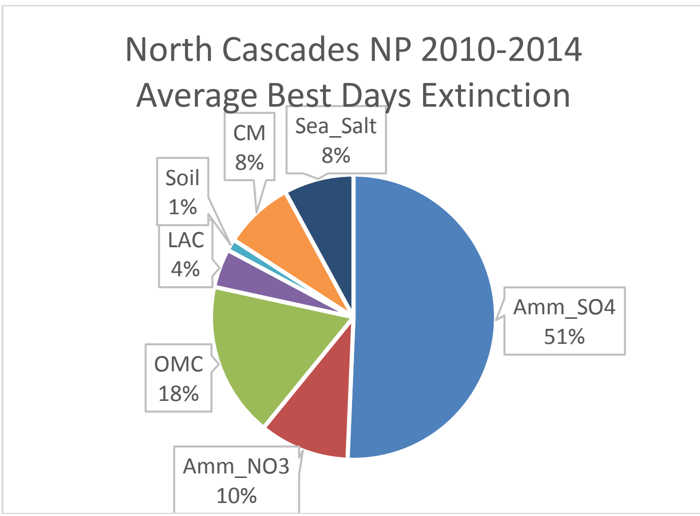
Ammonia concentrations in the atmosphere are not routinely monitored and ammonia or ammonium are not part of the parameters measured by or analyzed for by the IMPROVE monitoring program or the state operated ambient air quality monitoring networks. In Washington, the National Park Service operates one Ambient Ammonia Monitoring Network site at Tahoma Woods. This monitoring started in March 2011 and uses passive ammonia monitors put out and retrieved every two weeks. The reported 2012 ammonia concentration for this monitor is reported to be 0.28 micrograms/cubic meter.

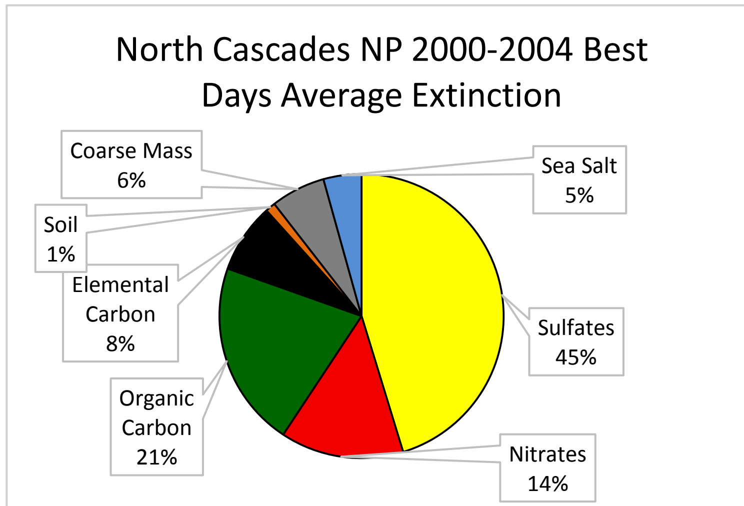
The following table illustrates the 5-year average percentage contribution of each particulate species on the best (least impaired) and worst (most impaired) days. For comparison graphs of conditions during the baseline period and the current period are presented. With the exception of the Pasayten and Alpine Lakes Wildernesses, sulfates and organic carbon continue to be the primary pollutants that contribute to visibility impairment. At the Pasayten Wilderness, organic carbon (OMC), primarily from forest fires, is the significant source of impairment on the worst days. At the Alpine Lakes Wilderness and Olympic National Park, nitrates are also a significant contributor to visibility impairment on the worst days. All Class I area monitors exhibit a similar distribution of components contributing to visibility impairment on the best days.

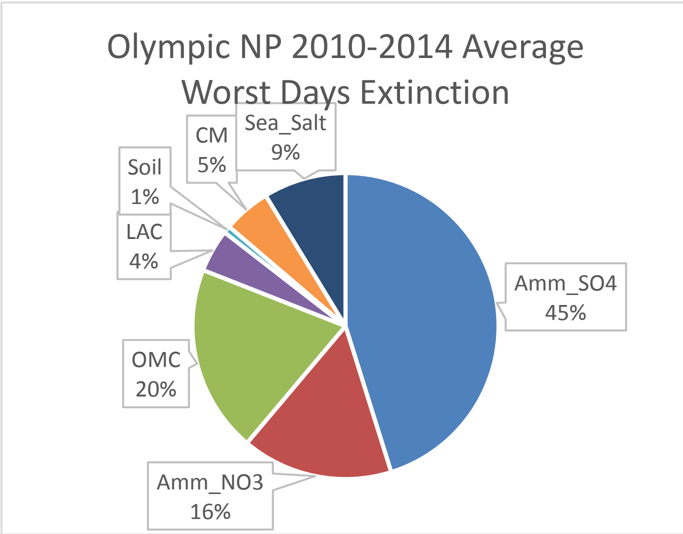
While the graphs in Figure 2 show that the relative contributions to impairment on the best and worst days is relatively unchanged, as shown on Table 4, visibility at all Class I areas has improved and by 2014 either exceeded the state goal for 2018 or the uniform rate of progress value for 2018.

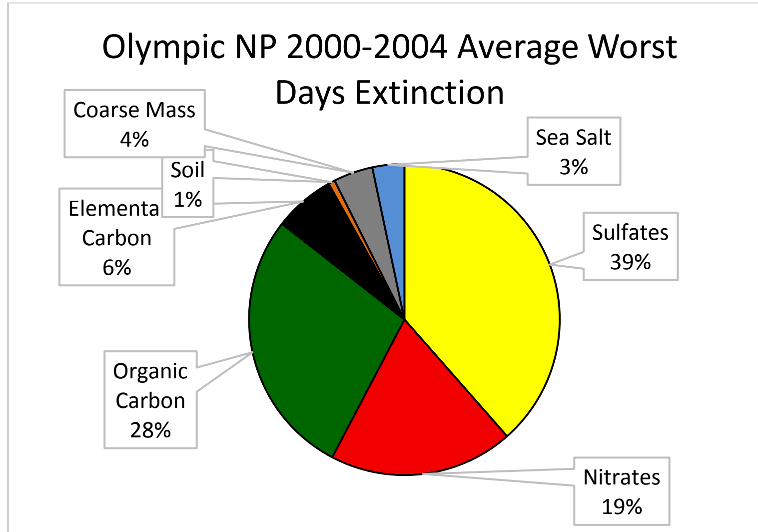

North Cascades NP 2010-2014
Average Worst Days Extinction
Soil 1%
CM 5%
Sea_Salt 1%
LAC 7%
Amm_SO4 40%
OMC 39%
Amm_NO3 7%

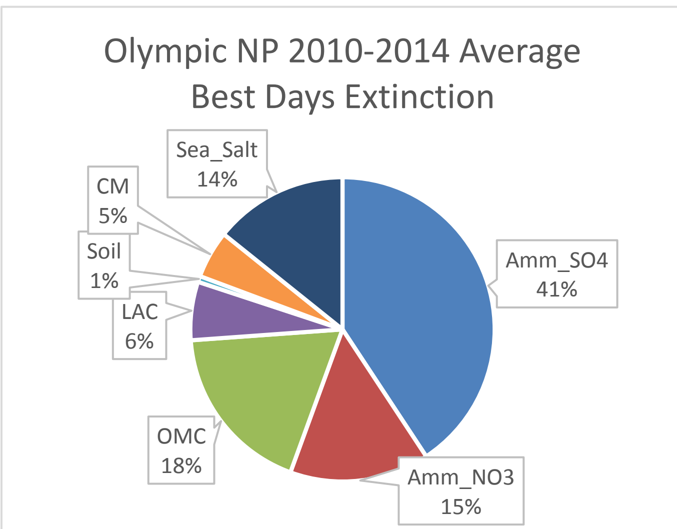

North Cascades NP 2000-2004
Average Worst Days Extinction w/o 2003
Coarse Mass 5%
Sea Salt 0%
Soil 2%
Elemental Carbon 6%
Sulfates 46%
Organic Carbon 34%
Nitrates 7%

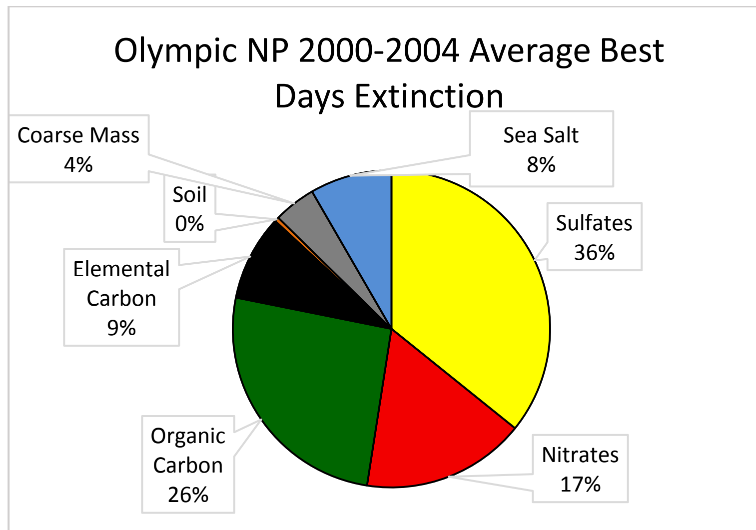

North Cascades NP 2010-2014
Average Best Days Extinction
CM 8%
Sea_Salt 8%
Soil 1%
LAC 4%
Amm_SO4 51%
OMC 18%
Amm_NO3 10%

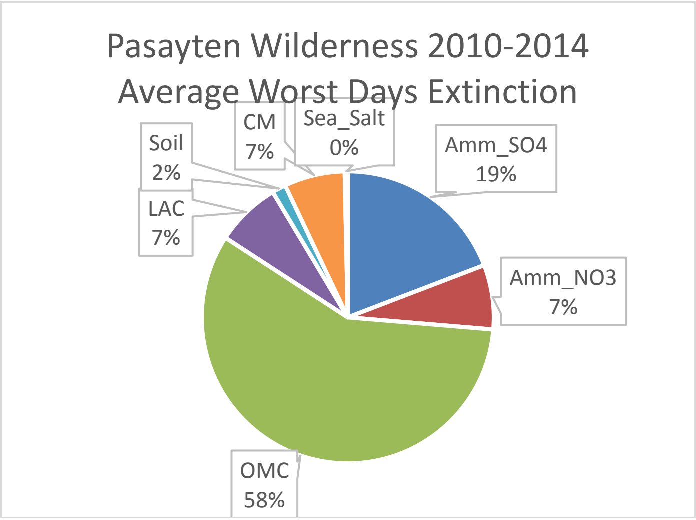

North Cascades NP 2000-2004 Best Days Average Extinction
Coarse Mass 6%
Sea Salt 5%
Soil 1%
Elemental Carbon 8%
Sulfates 45%
Organic Carbon 21%
Nitrates 14%

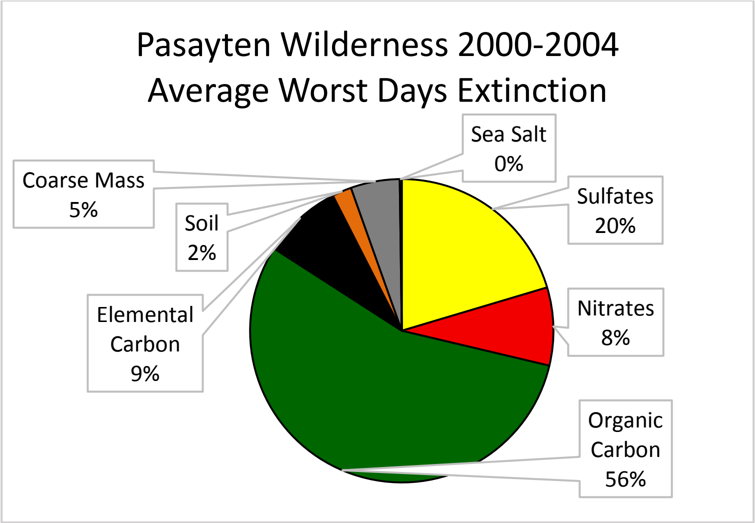

Olympic NP 2010-2014 Average Worst Days Extinction
Sea_Salt 9%
CM 5%
Soil 1%
LAC 4%
OMC 20%
Amm_NO3 16%
Amm_SO4 45%

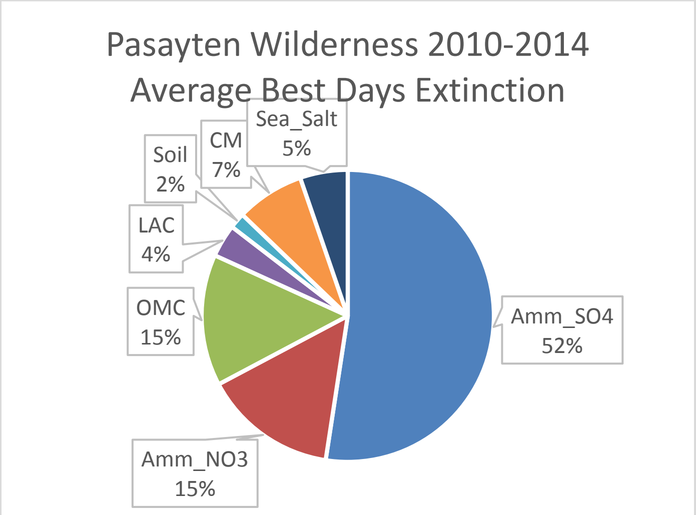

Olympic NP 2000-2004 Average Worst Days Extinction
Coarse Mass 4%
Soil 1%
Elementa Carbon 6%
Organic Carbon 28%
Sea Salt 3%
Sulfates 39%
Nitrates 19%

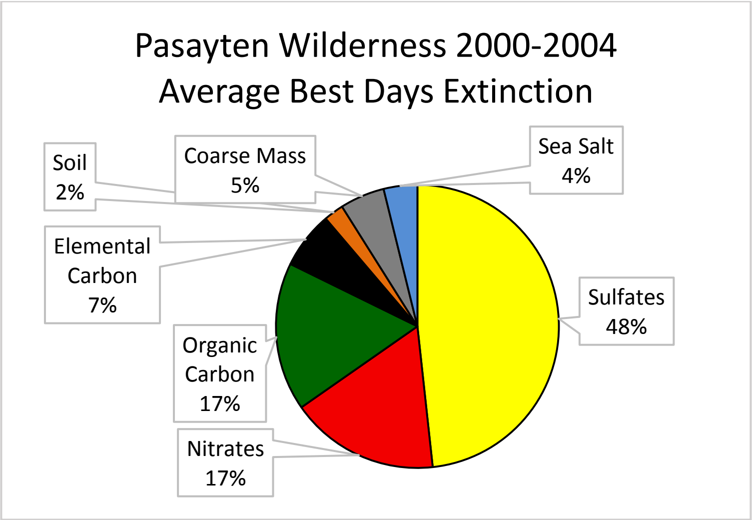

Olympic NP 2010-2014 Average Best Days Extinction
Sea_Salt 14%
CM 5%
Soil 1%
LAC 6%
OMC 18%
Amm_NO3 15%
Amm_SO4 41%

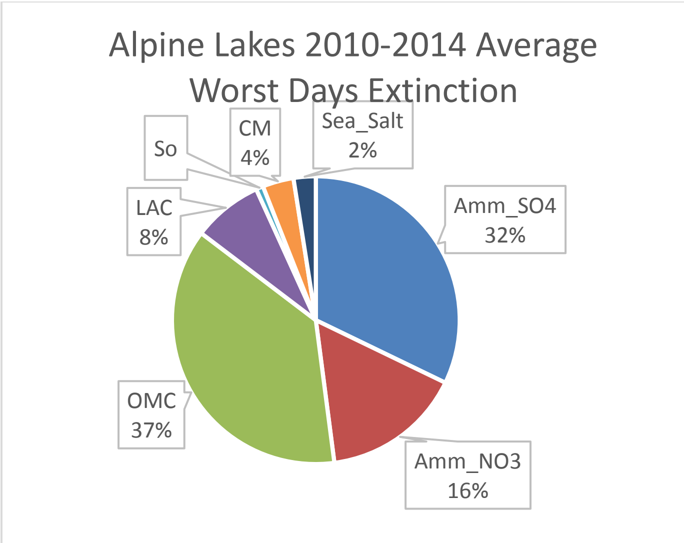

Olympic NP 2000-2004 Average Best Days Extinction
Coarse Mass 4%
Soil 0%
Elemental Carbon 9%
Organic Carbon 26%
Sea Salt 8%
Sulfates 36%
Nitrates 17%


Pasayten Wilderness 2010-2014
Average Worst Days Extinction
Soil
2%
CM
7%
Sea_Salt
0%
Amm_SO4
19%
LAC
7%
Amm_NO3
7%
OMC
58%

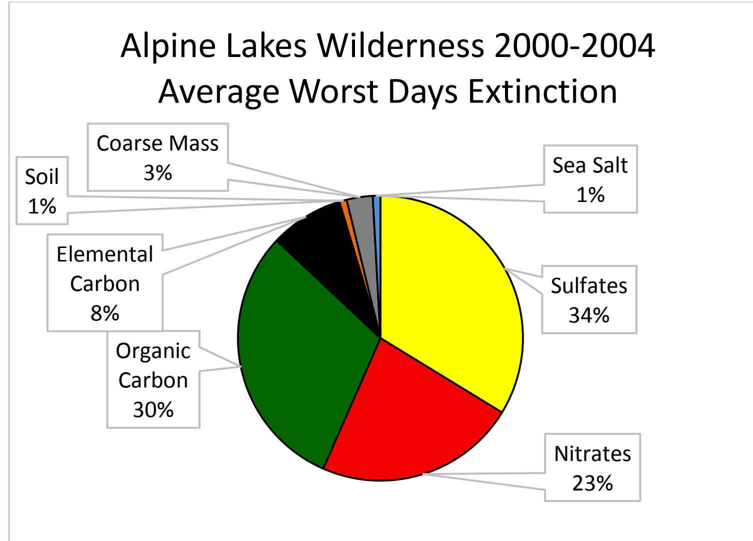

Pasayten Wilderness 2000-2004
Average Worst Days Extinction
Sea Salt
0%
Coarse Mass
5%
Sulfates
20%
Soil
2%
Nitrates
8%
Elemental
Carbon
9%
Organic
Carbon
56%


Pasayten Wilderness 2010-2014
Average Best Days Extinction
Sea_Salt
5%
Soil
2%
CM
7%
LAC
4%
OMC
15%
Amm_SO4
52%
Amm_NO3
15%

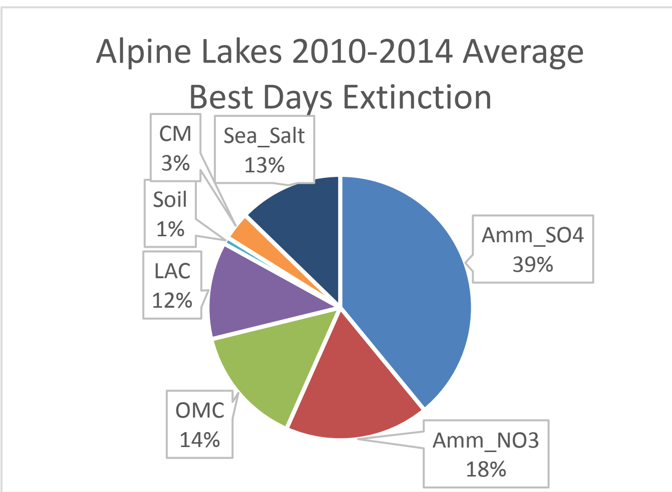

Pasayten Wilderness 2000-2004
Average Best Days Extinction
Soil
2%
Coarse Mass
5%
Sea Salt
4%
Elemental
Carbon
7%
Sulfates
48%
Organic
Carbon
17%
Nitrates
17%



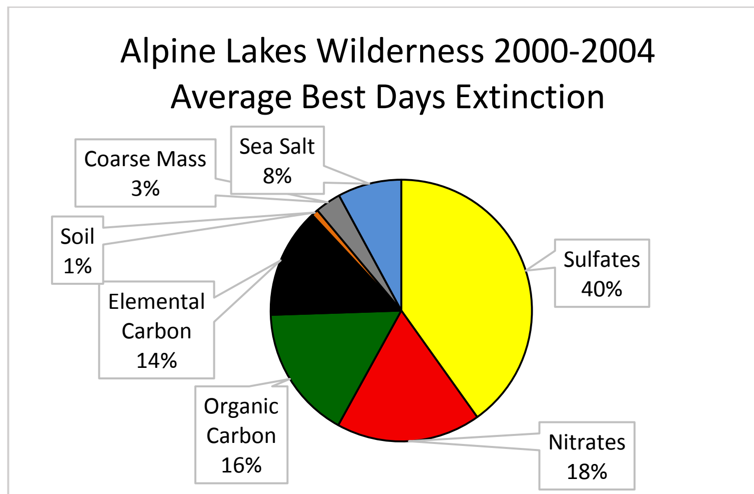
Alpine Lakes 2010-2014 Average Worst Days Extinction
So
CM 4%
Sea_Salt 2%
LAC 8%
Amm_SO4 32%
OMC 37%
Amm_NO3 16%

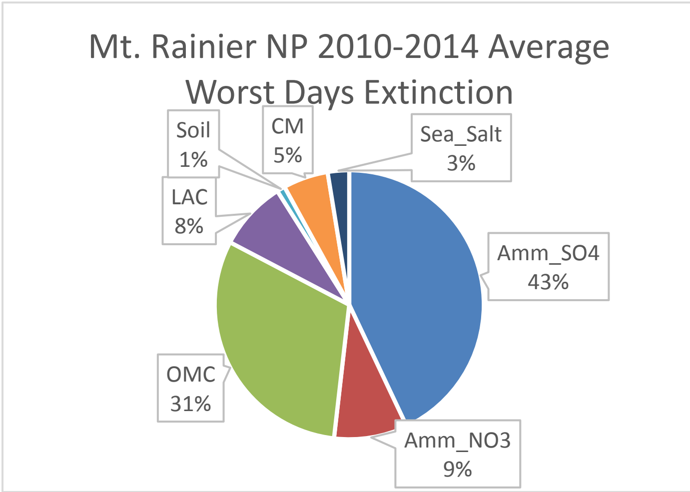
Alpine Lakes Wilderness 2000-2004 Average Worst Days Extinction
Coarse Mass 3%
Soil 1%
Sea Salt 1%
Elemental Carbon 8%
Sulfates 34%
Organic Carbon 30%
Nitrates 23%

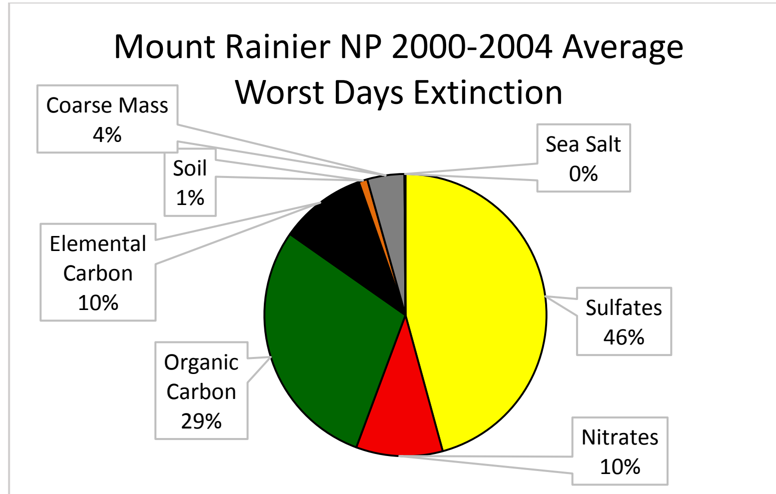
Alpine Lakes 2010-2014 Average Best Days Extinction
CM 3%
Sea_Salt 13%
Soil 1%
Amm_SO4 39%
LAC 12%
OMC 14%
Amm_NO3 18%

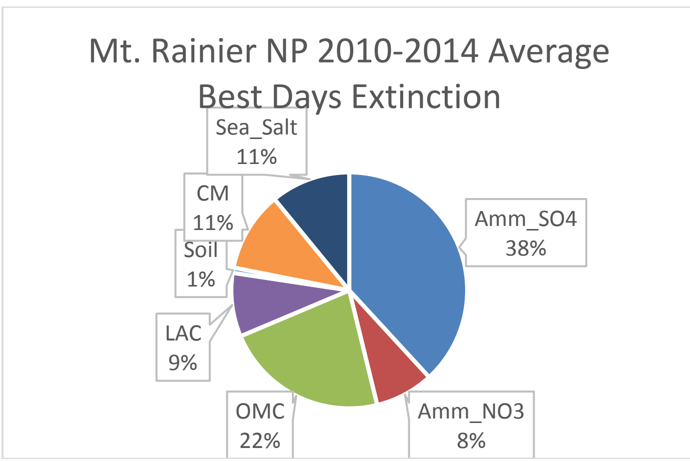
Alpine Lakes Wilderness 2000-2004 Average Best Days Extinction
Coarse Mass 3%
Sea Salt 8%
Soil 1%
Sulfates 40%
Elemental Carbon 14%
Organic Carbon 16%
Nitrates 18%



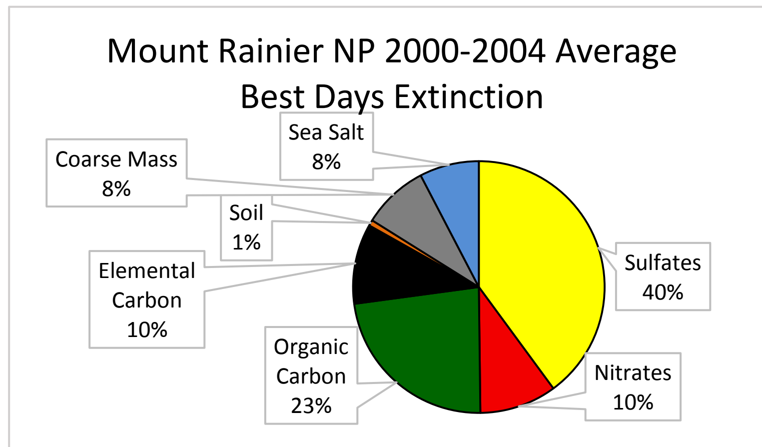
Mt. Rainier NP 2010-2014 Average
Worst Days Extinction
Soil 1%
CM 5%
Sea_Salt 3%
LAC 8%
Amm_SO4 43%
OMC 31%
Amm_NO3 9%

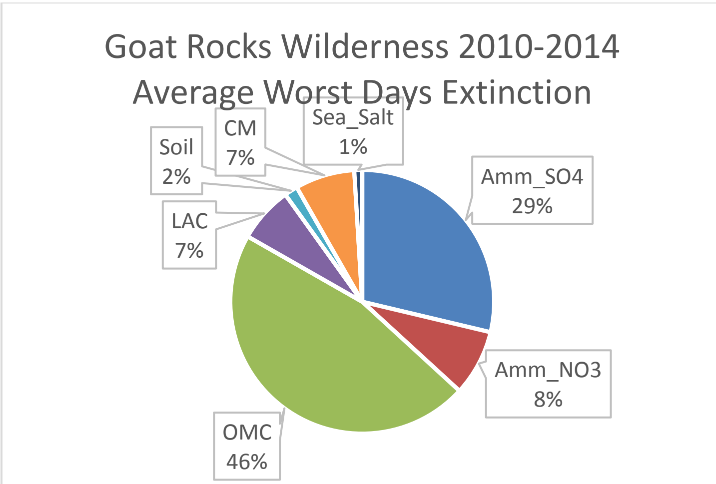
Mount Rainier NP 2000-2004 Average
Worst Days Extinction
Coarse Mass 4%
Sea Salt 0%
Soil 1%
Elemental Carbon 10%
Sulfates 46%
Organic Carbon 29%
Nitrates 10%

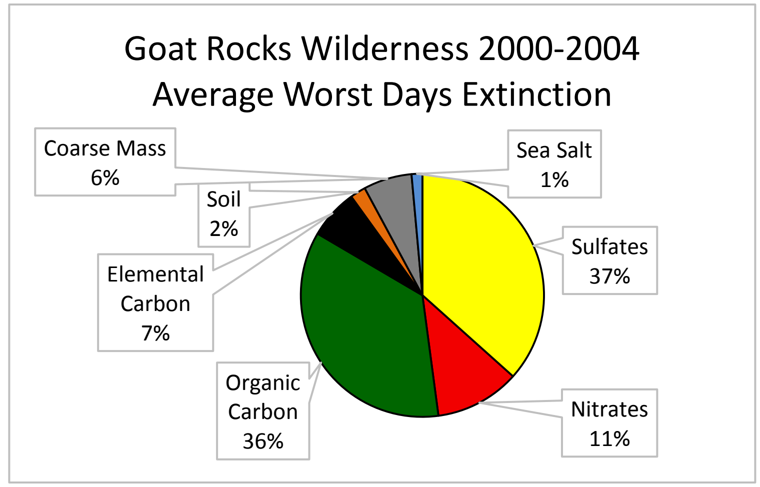



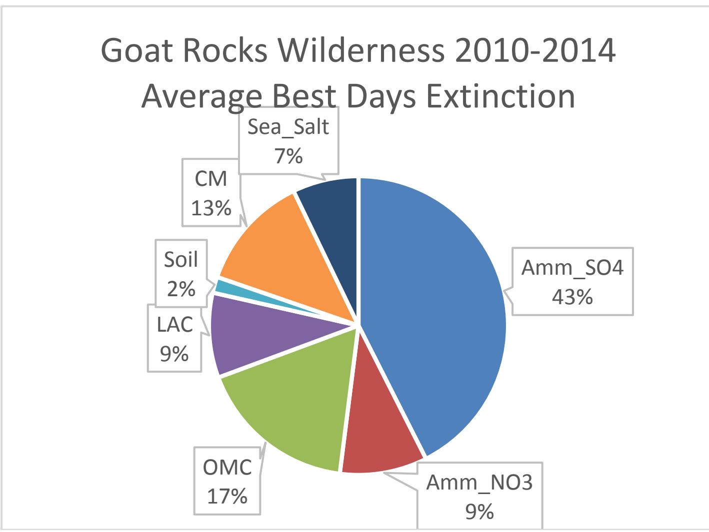
Mt. Rainier NP 2010-2014 Average
Best Days Extinction
Sea_Salt 11%
CM 11%
Amm_SO4 38%
Soil 1%
LAC 9%
OMC 22%
Amm_NO3 8%

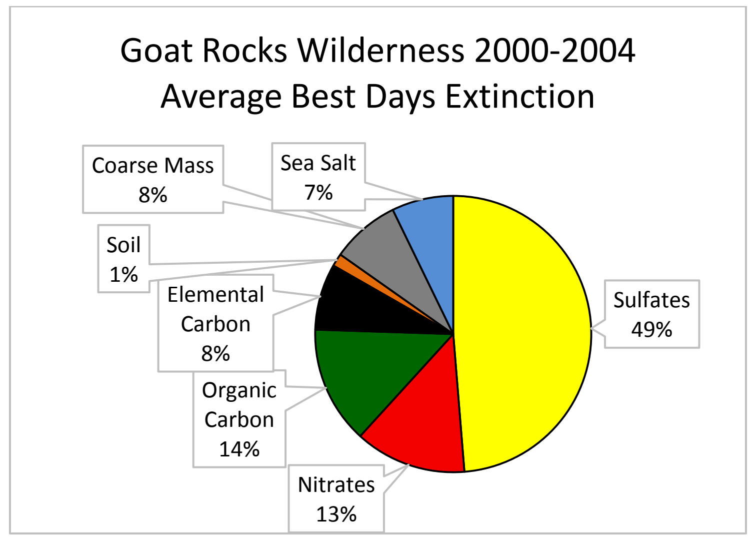



Mount Rainier NP 2000-2004 Average
Best Days Extinction
Sea Salt 8%
Coarse Mass 8%
Soil 1%
Elemental Carbon 10%
Sulfates 40%
Organic Carbon 23%
Nitrates 10%




Amm_SO4 = Sulfates    Amm_NO3 = Nitrates    OMC = Organic Carbon    EMC = Elemental Carbon
Soil = Soil    CM = Coarse Mass    Sea_Salt = Sea Salt

**Figure 2. Comparison of 5-year average contribution to extinction on worst (most impaired) and best (least impaired) days for all Class I Area IMPROVE monitors in Washington**

## 1.4. Initial reporting requirements

In this Progress Report, the RHR requires all states to report on the implementation status for emission control measures implemented within the state for achieving reasonable progress toward the 2018 goals for Class I areas within and outside the state. Washington's Progress Report was due to EPA in December 2015. In April 2013, EPA issued guidance[7] that states evaluate visibility improvement using the most recent monitoring data available for the initial Progress Reports. At the time of preparation of this Progress Report for the required review by the FLMs, the most recent monitoring data available was through 2014 at all of the IMPROVE monitors used to characterize Class I area visibility.

In this Progress Report, "current" conditions are the 5-year averages of 2010–2014 visibility data. The "current" conditions are compared with "baseline" conditions, 2000–2004, from the initial Washington RH Plan to evaluate trends. While some years may not have enough dv days statistically to calculate the annual Worst and Best Days' values for all Class I areas, good information is still available for extensive parts of the year. Analyzing all the data gives a better understanding of seasonal patterns and long-term trends in visibility improvement.

For further analysis on a regional scale, Washington joined with 14 other states to prepare the Western Regional Air Partnership (WRAP) Regional Summary Report included in Appendix A. The WRAP Summary Report was released in June 2013 and includes a comprehensive analysis of both measured visibility changes at the IMPROVE monitors and changes in emissions inventories between the baseline period (2000–2004) and the five following years (2005–2009) to meet some of the RHR reporting requirements. Washington's Progress Report goes further to update the Regional Summary Report with Washington-specific data through 2014.

# 2. Control Strategy Status and Emissions

In Washington, sulfate, nitrate, and organic carbon aerosols are the primary drivers of poor visibility on Worst Days. Therefore, reductions in the precursors for these pollutants, sulfur oxides ($SO_X$), oxides of nitrogen ($NO_X$) and volatile organic compounds (VOCs), along with directly-emitted fine particulate matter ($PM_{2.5}$) support improvements in visibility throughout the state. In the RH Plan Control Strategy, Washington addressed all of these air pollutants.

Mobile sources of all types are the primary contributor to $NO_X$ emissions, a precursor to nitrate. They also contribute $SO_X$ emissions, a precursor to sulfates; VOC emissions, a precursor to organic carbon aerosols; and $PM_{2.5}$, which includes directly emitted organic aerosols. Statewide control measures implemented to comply with federal fuel sulfur requirements for mobile source and marine vessels combined with the federal on and off-road engine requirements have been effective in driving all three of these emission sources downward. Light-duty passenger vehicles, heavy-duty diesel powered trucks, and off-road equipment were the three largest sub-

[7] "General Principles for the 5-Year Regional Haze Progress Reports for the Initial Regional Haze State Implementation Plans (Intended to Assist States and EPA Regional Offices in Development and Review of the Progress Reports)," EPA, Office of Air Quality Planning Standards, April 2013.

category sources of all $NO_X$ emissions in 2005. While still the most important source of $NO_X$, the various engine requirements instituted between 2005 and 2013 have reduced $NO_X$ from all on-road engines by 46 percent. Between 2005 and 2011, the non-road mobile sources (including locomotives) have reduced their $NO_X$ emissions by 23 percent.

Stationary sources are the primary source of $SO_X$ emissions. 3 individual sources contribute half of the total stationary source $SO_X$ emitted in the state. These sources have all been subject to BART either under the Reasonably Attributable Visibility Impairment or Regional Haze BART requirements (discussed below). Other stationary sources that emitted large quantities of $SO_X$ during the baseline period (2000–2004) have installed controls for various business and regulatory reasons.

## 2.1. Status of control strategies in the RH Plan

The RH Plan Control Strategy relies upon already adopted federal and state control measures for emissions from mobile sources and a variety of stationary sources. The visibility impairing pollutants regulated under these regulations include: $NO_X$, $SO_X$, VOC, and $PM_{2.5}$. Washington's adoption of California low emission vehicle requirements have further reduced mobile source emissions beyond the federal levels.

Specific federal and state control measures were identified in the Washington RH SIP as programs used in making projections of the emission inventory from the 2002 base year to 2018. These control measures were relied on in determining reasonable progress goals for Washington's Class I areas. The following control measures were included:

- Centralia Power Plant $SO_2$ and PM controls
- Mobile source controls
    - Heavy Duty Diesel (2007) Engine Standard
    - Tier 2 Tailpipe Standards
    - Large Spark Ignition and Recreational Vehicle Rule
    - Non-road Diesel Rule
    - Low sulfur fuel requirements for gasoline engines, on-road diesel engines, off-road diesel engines, and locomotives
- Combustion Turbine and Industrial Boiler/Process Heater/Reciprocating Internal Combustion Engine (RICE) Maximum Achievable Control Technology (MACT)
- 2002–2007 permits and state /EPA Consent Agreements
- Reductions in 2000–2004 average fire emissions due to Emissions Reduction Techniques in Smoke Management Programs
- Ozone and Coarse Particulate Matter (PM10) SIP requirements

All of these control programs are fully implemented with minor exceptions (i.e., standards for rebuilt locomotive engines). Additional federal programs that were issued at the time the inventory completion were not included in the projections and as a result were not included as a state control strategy.

In conjunction with its New Source Review (NSR) program requirements, Washington has adopted and implements the requirements of new and revised New Source Performance Standards and Maximum Available Control Technology programs. These programs work to reduce the emissions of air pollutants, including precursors to visibility impairing aerosols, from existing and new stationary sources.

Washington's Smoke Management Plan, approved by EPA in June 2003, continues to manage and minimize the occurrence of and impacts of prescribed silvicultural fires. The Smoke Management Plan requires that Class I areas be included as sensitive receptors that receive extra protection from smoke impacts. Washington State continues to supplement smoke management regulatory programs with financial and other incentives to promote new technologies providing for additional beneficial use of forest and agricultural wastes.

Agricultural burning is regulated through a comprehensive permitting program that limits both the timing and total acreage of agricultural land allowed to be burnt every day. This agricultural burning program primarily operates in Eastern Washington, normally down-wind of the state's Class I areas, but possibly impacting downwind Class I areas located in Idaho and Montana. In addition to limiting the opportunity of smoke plumes from agricultural fires to travel to urban areas, the agricultural burning permit program does consider impacts to the Class I areas of Oregon, Idaho, and Washington in making decisions on whether to allow burning.

## 2.2. BART requirement

In Washington, there were eight industrial facilities that have emission units that were subject to the Best Available Retrofit Technology (BART) program. Of these eight facilities, six were required to implement additional emission controls. Five of the facilities have installed and are operating the emission controls required under BART. The emission controls have resulted in reductions of $SO_2$, $PM_{2.5}$, and $NO_X$ from these five facilities. The sixth facility has ceased operation of its BART-eligible emission units. A seventh facility is required to cease operation by 2025. The current status of implementing BART at each of the eight BART-eligible facilities in Washington are briefly discussed below.

<u>BP Cherry Point Refinery</u>

BART was required by Ecology Order 7836 to be implemented at specific emission units in the facility, principally process heaters. BART was determined to be controls and emission limitations for $NO_X$ and $SO_X$ from process heaters and total sulfur content of the refinery fuel gas used in all process heaters and boilers. At this time, all emission reductions required by the BART Order have been implemented. The Ecology regulatory order has been modified three times since it was issued and the SIP incorporation of this Order has been updated two times and now incorporates the current version of the Ecology Order. The changes were to coordinate emission limitations with final limits in local authority minor source NSR approvals and to accommodate future equipment replacement projects. The company continues to demonstrate compliance with the requirements of the BART Order, a federal Consent Decree, and all other regulatory requirements contained in the plant's Air Operating Permit (AOP).

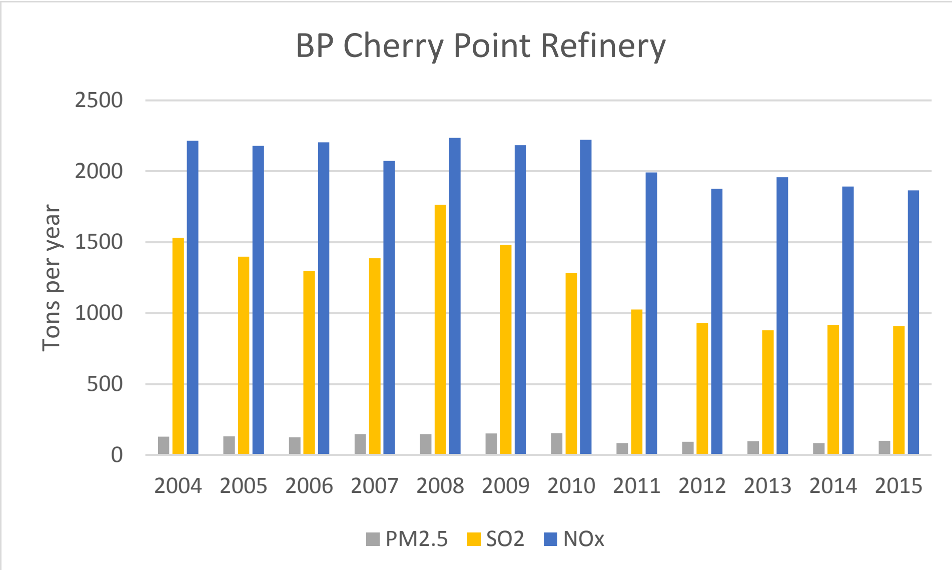



**Figure 3. BP Cherry Point emissions**

<u>Intalco</u>

BART was required by Ecology Order 7837. Ecology determined that no additional emission controls for $SO_2$ were cost-effective and required no additional emission limitations on the plant. This Order was revised once to incorporate updated emission limits, monitoring and reporting requirements, and a $NO_X$ limit for the potlines. EPA subsequently issued a partial Federal Implementation Plan (FIP) (40 CFR 52.2500) limiting the sulfur dioxide emissions from the plant and establishing monitoring and reporting requirements that were incorporated in the Ecology's BART Order. The company has complied with the requirements of the BART Order, the partial FIP and continues to operate in accordance with the FIP and all other regulatory requirements contained in the plant's Air Operating Permit (AOP).

Emissions have increased over the past 11 years due to fluctuations in the market price of aluminum and the corporate decision in 2007 to ramp up production to nearly full capacity.

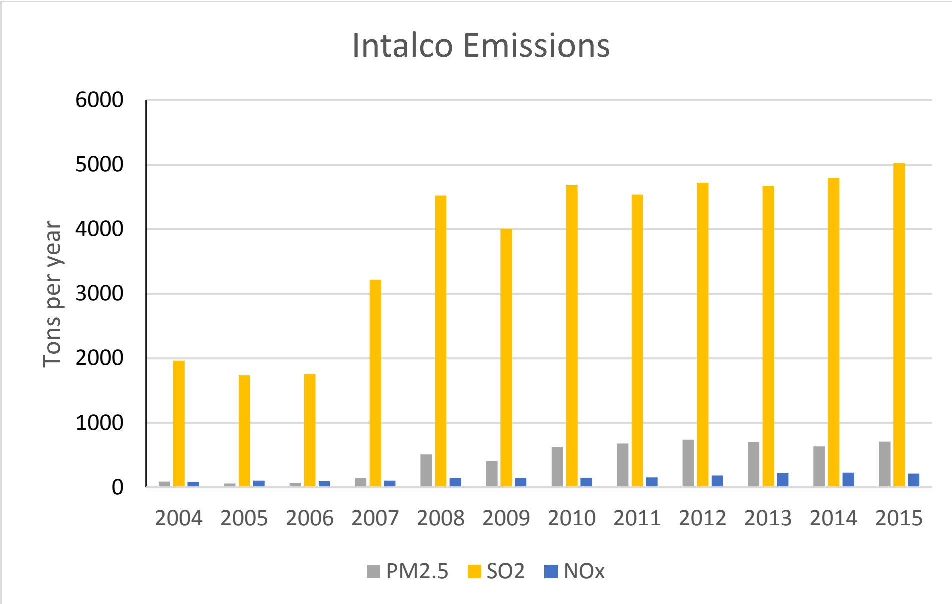



**Figure 4. Intalco Ferndale Emissions**

<u>Tesoro</u>

BART was required by Ecology Order 7838 as requirements to be implemented at specific process heaters in the plant. The Order required meeting specific fuel gas sulfur content limits, a wet scrubber system on the catalyst regeneration/carbon monoxide boiler exhaust, and $NO_X$ limits on two process heaters. EPA incorporated this Order into the SIP and subsequently has negotiated a "Better-than-BART" alternative that has replaced part of the Ecology Order in the SIP (40 CFR 52.2501). The company continues to demonstrate compliance with the requirements of the BART Order, the "Better than BART" partial FIP and all other regulatory requirements contained in the plant's Air Operating Permit (AOP).

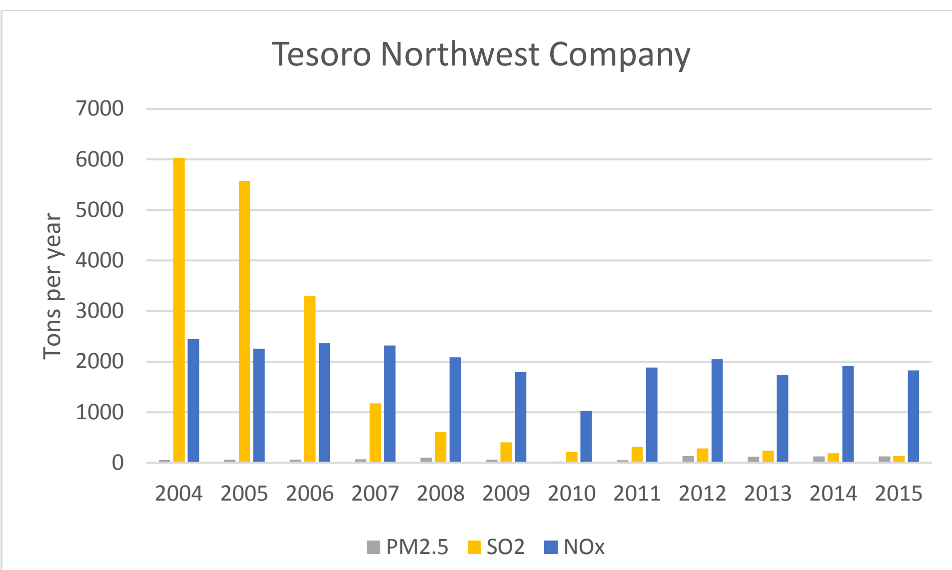



**Figure 5. Tesoro Refinery emissions**

Alcoa Wenatchee Works

This facility was not determined to be BART-eligible by Ecology based on Ecology's evaluation of the visibility modeling performed by the company. EPA received adverse comments during the public comment period on EPA's proposed approval of the Washington RH Plan and decided to develop a FIP for $SO_2$ and PM emissions from the facility. The FIP requires new emission limitations on a number of emission points within the facility along with a plant-wide limit on sulfur content of petroleum coke used to make anodes. The new emission standards reflected what the facility actually emits from these units and did not result in actual emission reductions. The carbon anodes are used in the electrolytic reduction cells (aka pots) used to refine aluminum. Prior to a temporary production stoppage which started in December 2015, the plant met the BART emission standards established in the FIP and all other emission requirements contained in its AOP.

As with Alcoa's Intalco facility, emissions at this plant have varied over time as the corporation has determined operation rate for the plant. Alcoa decided to curtail operations of this plant at the end of 2015 lasting until market prices of aluminum recover sufficiently to restart the plant.

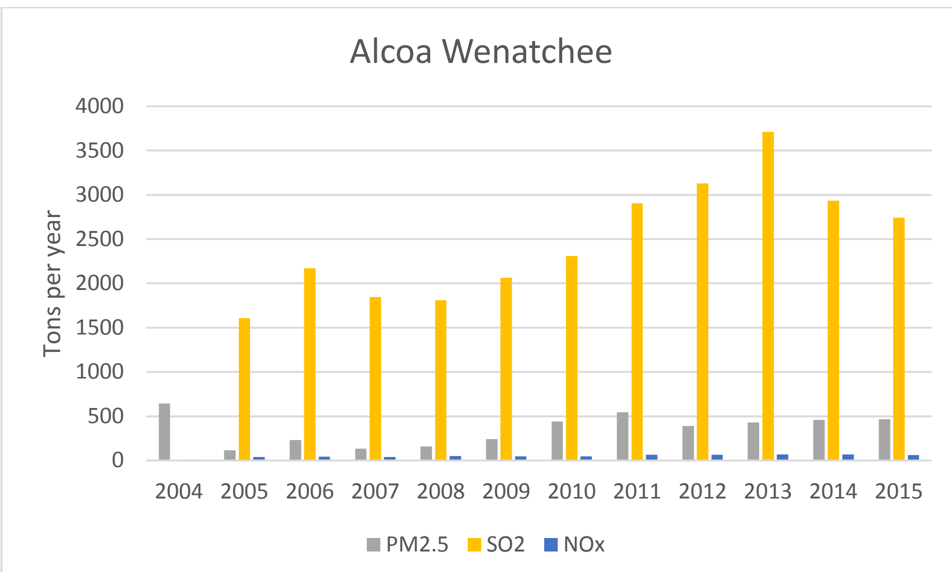



**Figure 6. Alcoa Wenatchee Works emissions**

Lafarge Cement

BART was required by Ecology Order 7841 to implement BART emission controls identical to the $NO_X$ and $SO_X$ emission requirements contained in an EPA national Consent Order which contained requirements for the plant. Prior to the compliance date in the BART and Consent Orders, the company ceased cement production at this facility. According to the terms of the Consent Order, the plant must meet all requirements of the Consent Order, which includes the $NO_X$ and $SO_2$ emission control identified in the BART Order, prior to restarting the plant. Current emissions are zero and the plant is not operating. No emissions history graph is included.

TransAlta Centralia Power Plant

BART was required by Ecology Order 6426 to require $NO_X$ reductions from the coal-fired boilers at the plant. The Order was revised once require use of selective non-catalytic reduction to reduce $NO_X$ and a schedule for retirement of the power plant (required by state law). The company has installed the required controls and demonstrated compliance with the initial emission limitation in the Order.

However, the Order also required the plant to determine if it could reliably comply with a lower emission limitation. This work has not been completed according to the schedule in the Order due to a number of factors, primarily inconsistent plant operation and difficulties with the in situ ammonia slip monitors. The local agency which oversees compliance for the plant has issued a Notice of Violation on this element of the BART Order. The plant operates inconsistently due to the dramatic changes in the cost of power produced by other fossil fueled power plants in the Northwest. Over the course of the past five years, plant operation has reduced to 50%-60% of full annual capacity compared to 80+ percent when the BART Order was issued.

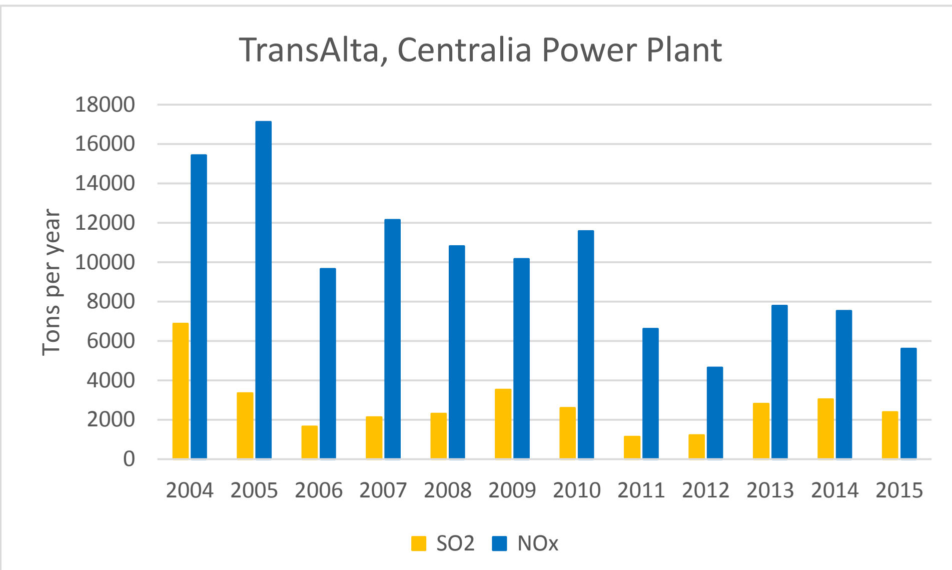



**Figure 7. TransAlta $SO_2$ and $NO_X$ emissions**

Weyerhaeuser Corporation, Longview

BART was required by Ecology Order 7840 to be implemented at specific process units in the plant. The three units subject to BART at this facility were determined to utilize a BART level of control at the time the Order was issued. They were in compliance when the Order was issued and continue to be in compliance.

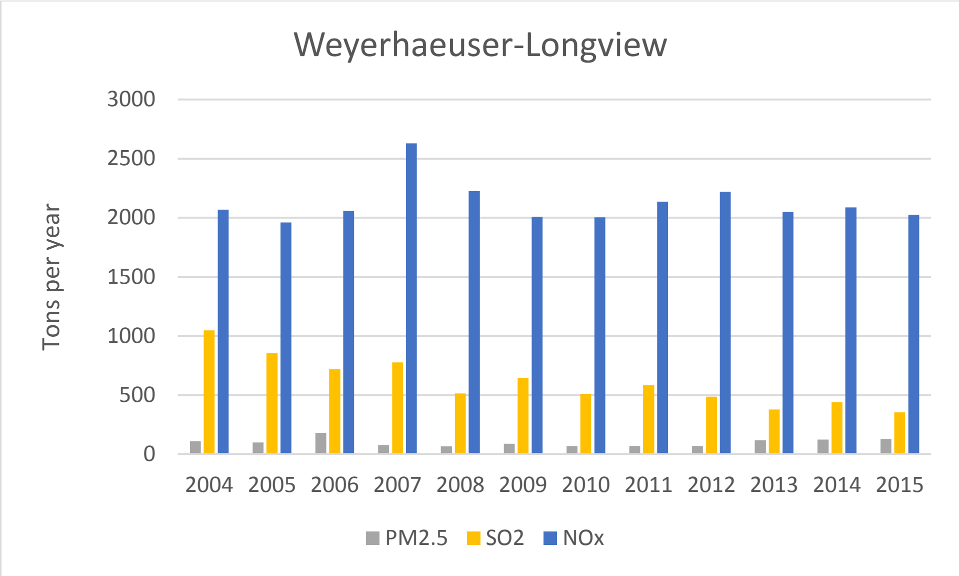



**Figure 8. Weyerhaeuser Longview Mill Complex emissions**

Port Townsend Paper

BART was required by Ecology Order 7839 to be implemented at specific emitting in the plant. There are four units subject to BART at this facility. All units were determined to be at a BART level PM and $SO_X$ control at the time the Order was issued. They were in compliance when the Order was issued and continue to be in compliance.

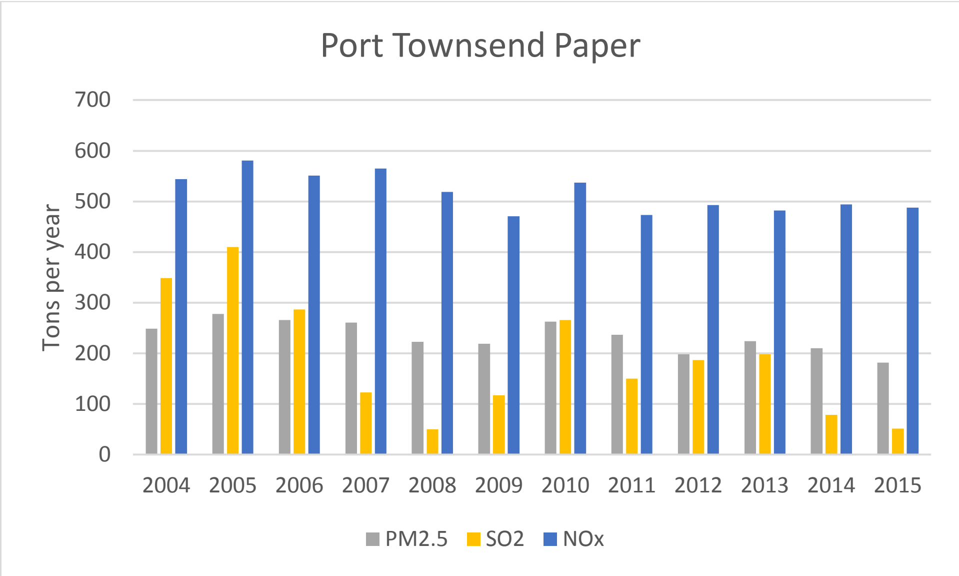



**Figure 9. Port Townsend Paper emissions**

## 2.3. New control strategies

In the RH Plan, Washington committed to evaluate the need to require additional emission controls on two industrial categories not included in the RH Plan. The evaluation of one source category, chemical combustion units at kraft and sulfite pulp mills, has been completed following the process required by state law rather than the EPA 4-factor process in 40 CFR 51.308. While review indicated there are small emission reductions possible at the units evaluated, the reductions are not cost-effective for installation. The potential visibility improvements that might result from implementing the most effective control technically achievable results in visibility improvements on the 8th most impaired days are less than 0.05 dv at the Class I area showing the most potential benefit for each plant evaluated. Ecology has determined that the small reduction in emissions possible, the cost to implement the evaluated controls, and the small visibility improvement do not justify requiring the sources to install those controls. We will be selecting a second source category to evaluate after submittal of this review report.

Since the closure of the process to determine what "on-the-books" regulations and emission control strategies was completed by WRAP for modeling the initial existing conditions and 2018 projections, Ecology, EPA, and the federal government have adopted or implemented the following programs to reduce emissions from stationary and mobile sources.

**Table 2. Control Strategies not Included in 2018 Emission Projections**

| Regulatory Program | Affected Sources | Affected Visibility Impairing Air Pollutants |
|---|---|---|
| North American Maritime Emission Control Area (ECA) and MARPOL VI | Marine vessels operating within 200 nautical miles of United States and Canada's Pacific and Atlantic Ocean coast lines | $SO_X$, $NO_X$, $PM_{2.5}$ |
| 40 CFR Part 94 Marine Engine Requirements | Marine vessels operating in US Waters. | $NO_X$, $SO_X$, $PM_{2.5}$ |
| Motor Vehicle CAFÉ/GHG standards | Light and medium duty on-road vehicles | $NO_X$, $PM_{2.5}$ |
| On-road Tier 3 diesel standards | Diesel fueled engines, especially on road vehicles | $SO_X$, $PM_{2.5}$ |
| Utility Boiler MACT | Coal fired boilers at electric generating stations | $PM_{2.5}$, $SO_X$ |
| Large and Area Source Boiler MACTs | All commercial/industrial boilers | $NO_X$, $PM_{2.5}$, $SO_X$ |
| CISWI NSPS | Industrial/commercial boilers burning designated solid wastes | $NO_X$, $PM_{2.5}$, $SO_X$ |
| SSI NSPS | Sewage sludge incinerators | $NO_X$, $PM_{2.5}$ |
| Revised Petroleum Refinery NSPS and MACT requirements | Petroleum refineries, very large petroleum storage tanks | VOC, $PM_{2.5}$ |
| 2010 $NO_X$ NAAQS | Combustion sources | $NO_X$ |
| 2010 $SO_X$ NAAQS | Combustion sources | $SO_X$ |
| 2013 $PM_{2.5}$ NAAQS | Combustion, area, and industrial sources | PM, $PM_{10}$, $PM_{2.5}$ |
| 2015 Ozone NAAQS | All sources | VOC (organic carbon), $NO_X$ |

The effects of many of these rules are reflected in the most current emission inventory available. Specific programs not included in the inventory are MARPOL V, the North American ECA, the marine vessel fuel sulfur standard, and the NAAQS that have been revised since 2007. Starting in August 2012, the ECA required marine vessels within 200 nautical miles of the North American coast to use fuels with no more than 1% sulfur content which lowered to 0.1% in 2015. EPA and the U.S. Coast Guard share implementation responsibilities for these requirements and have allowed some shipping companies delayed compliance dates with these requirements. Together, these programs require marine vessels to reduce $SO_2$ emissions the equivalent of changing from 3.5%-5% sulfur by weight fuel[8] to 0.1% sulfur by weight fuel. The expected reductions in $SO_X$ emissions resulting from full implementation of this program will be about a 70%-90% reduction in $SO_X$ emissions from marine vessels in the ECA area. An emissions inventory for these marine vessels is being developed and will be included in the modeling for the next RH SIP. The MARPOL V required reductions in $NO_X$ emissions starting in 2011. The EPA Part 90 marine engine requirements phase in $NO_X$ reductions as vessels are newly built or install new replacement engines. Part 90 requires new engines meet Tier 2 requirements in 2011 (equal to the MARPOL requirement) and Tier 3 requirements starting in 2016. EPA estimates that the $NO_X$ requirements will reduce national marine vessel NOx by 80% from 2009 levels. The effects of the marine vessel fuel sulfur requirements are reflected in the IMPROVE data, though the effects of the ECA are not fully reflected in the data due to the long lead time for the MARPOL requirements and the relatively recent date (2013) for vessels to meet the first stage requirements.

Washington State does not have any nonattainment areas. In January 2017, we anticipate submitting our proposal to designate all of the state except two areas as attainment/unclassifiable for the $SO_2$ standard. We have embarked on an ambient monitoring program for the two areas that will not be included in the proposal. To date, the revised NAAQS have not resulted in additional emission controls emission reductions beyond what is normally required as a result of our new source permitting procedures.

In Washington, seven local clean air agencies implement stationary source and area source control programs. The seven local clean air agencies, the Energy Facility Site Evaluation Council (EFSEC), and Ecology implement the minor and nonattainment NSR permit programs for stationary sources in their jurisdictions. Ecology implements the Prevention of Significant Deterioration (PSD) for the whole state and EFSEC implements the PSD permit program for sources under their jurisdiction.

Ecology and the local clean air agencies utilize local and pass-through funds to incentivize reductions of emissions, especially for the change-out of old, uncertified wood stoves with new certified stoves or other heating options, and grants to incentivize the installation of emission controls on old diesel engines, the replacement of older diesel engines, vehicles or equipment, and the installation of technologies to reduce engine idling. Some local clean air agencies and cities encourage actions by residents that reduce emissions and reduce the chance for future nonattainment, such as swap-outs of gas powered lawnmowers to electric or battery-powered

[8] Exact emission reductions are difficult to estimate due to the variation in fuel sulfur in marine diesel fuels prior to the start of the ECA. Prior to 2011, marine vessels operating outside of the European ECA were allowed to use fuels with a sulfur content above 4.5 percent.

lawnmowers or from uncertified wood stoves to Washington certified wood and pellet stoves. These programs have localized benefits for meeting the federal and state criteria pollutant standards. They also decrease emissions transported from populated areas to the more remote Class I areas.

## 2.4. Emission inventory trends

The control measures discussed above are reflected in the statewide emission inventories shown in Table 3. The inventories shown are the WRAP inventory used for baseline condition modeling and Ecology's periodic comprehensive inventory submitted to EPA for the national emission inventories. The data presented is based on information supplied by the companies and reviewed by emission inventory specialists with Ecology and the local air agencies plus estimates of emissions from area sources based on the best available information. The table includes data for 2002, 2005, 2011, and WRAP's projected emissions inventory for 2018. The Washington inventory is different from that of the WRAP Summary Report in Appendix A.[9] This is based on several factors, most notable being a difference in emission factors for some area source categories and fires, (Washington has more recently updated its inventory to reflect revised emission factors compared to what was used in the WRAP inventory) and the area source and mobile source information is based on some different assumptions. Appendix B includes additional information on the emission inventory.

Mobile source emission estimates done by WRAP and those done by Ecology are based on different models. The Mobile 6.2 emissions model was used for the 2002 inventory (and 2018 projections). Starting in 2007, EPA has required the use of the MOVES model for mobile source emissions modeling. The change in models represented a significant change in methodology and resulting mobile source emissions estimates. In practice, this means that emissions reported for 2007 and later are not comparable to those reported before that year. The model change resulted in significant changes, especially for $NO_X$ emissions, when compared to the prior estimates and projections based on those estimates.

**Table 3. WA State Emission Inventory Summary (all emissions are in tons per year)**

| Pollutant | Category | WRAP 2002d* | 2005 | 2011 | WRAP 2018a |
|---|---|---|---|---|---|
| $NO_X$ | Stationary sources | 43,355 | 43,386 | 26,565 | 49,456 |
| | Area sources | 17,587 | 8,581 | 8,599 | 22,746 |
| | Wildfires | 5,997 | 5,714 | 679 | 5,997 |
| | Anthropogenic fires | 6,821 | --- | --- | 4,971 |
| | Mobile sources | 286,701 | 198,168 | 202,436 | 102,440 |
| | Locomotives | --- | 18,973 | 15,026 | --- |
| | Marine vessels | --- | 29,142 | 20,486 | --- |
| | Biogenic | 17,923 | --- | --- | 17,923 |

[9] Assumptions are included in WRAP's emissions inventory are found in documents on this web page <http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx>.

| Table 3. WA State Emission Inventory Summary (all emissions are in tons per year) | | | | | |
|---|---|---|---|---|---|
| **Pollutant** | **Category** | **WRAP 2002d*** | **2005** | **2011** | **WRAP 2018a** |
| | **Total** | **378,384** | **303,964** | **273,791** | **203,533** |
| | Stationary sources | 52,885 | 23,367 | 13,832 | 37,444 |
| | Area sources | 7,311 | 1,562 | 1,472 | 8,667 |
| | Wildfires | 1,641 | 1,563 | 348 | 1,641 |
| | Anthropogenic fires | 1,411 | --- | --- | 1,043 |
| $SO_X$ | Mobile sources | 19,436 | 7,505 | 1,059 | 941 |
| | Locomotives | --- | 1,546 | 95 | --- |
| | Marine vessels | --- | 15,774 | 11,529 | --- |
| | **Total** | **82,684** | **51,317** | **28,335** | **49,736** |
| | Stationary sources | 2,257 | 5,773 | 3,958 | 2,625 |
| | Area sources | 12,708 | 39,822 | 55,060 | 17,234 |
| | Wildfires | 1,139 | 22,196 | 3,706 | 1,139 |
| | Anthropogenic fires | 3,869 | --- | --- | 2,691 |
| $PM_{2.5}$ | Mobile sources | 2,819* | 6,944 | 8,757 | 2,910 |
| | Locomotives | --- | 583 | 428 | --- |
| | Marine vessels | --- | 1,440 | 1,021 | --- |
| | Fugitive and windblown dust | 18,358 | --- | --- | 22,767 |
| | **Total** | **41,150** | **76,758** | **72,930** | **49,366** |
| | Stationary sources | 18,651 | 18,247 | 10,523 | 26,212 |
| | Area sources | 151,680 | 88,247 | 111,214 | 253,703 |
| | Wildfires | 13,160 | 12,538 | 9,954 | 13,161 |
| | Anthropogenic fires | 14,858 | --- | --- | 10,532 |
| VOC | Mobile sources | 201,782 | 168,726 | 124,339 | 89,243 |
| | Locomotives | --- | 984 | 810 | --- |
| | Marine vessels | --- | 833 | 782 | --- |
| | Biogenic | 642,736 | --- | --- | 642,736 |
| | **Total** | **1,042,867** | **289,575** | **257,622** | **1,035,587** |
| | Stationary sources | 3,863 | 498 | 499 | 5,466 |
| | Area sources | 45,218 | 54,115 | 51,288 | 47,769 |
| | Wildfires | 1,265 | 1,206 | 692 | 1,265 |
| $NH_3$ | Anthropogenic fires | 3,439 | --- | --- | 2,398 |
| | Mobile sources | 5,268 | 5,554 | 2,638 | 7,159 |
| | Locomotives | --- | --- | --- | --- |
| | Marine vessels | --- | --- | 1 | --- |
| | **Total** | **59,053** | **61,373** | **55,118** | **64,057** |

* As presented in Chapter 6 of the 2010 RH Plan. The 2002d emissions inventory was used for the baseline visibility impact modeling performed by WRAP. This inventory is also the basis for the inventory projections used in the 2018a inventory used for visibility impact modeling. This is the inventory and modeling used by Washington in developing the RPGs contained in the 2010 RH Plan.

| Table 3. WA State Emission Inventory Summary (all emissions are in tons per year) | | | | | |
|---|---|---|---|---|---|
| Pollutant | Category | WRAP 2002d* | 2005 | 2011 | WRAP 2018a |

Notes:

- The 2002d and 2018a emission inventories did not separately report emissions from locomotives or marine vessels. These emissions are included in the mobile source segment.
- Area sources includes residential open burning, structure fires, silvicultural, agricultural burning, and minor sources not included in the stationary source inventory.
- Stationary sources include majors and many minor sources.
- Wildfires are only forest and range fires.
- Mobile sources includes cars, trucks, recreational vehicles, watercraft, non-road mobile sources, and aviation.
- Locomotives is only locomotives. WRAP's inventory includes these emissions in mobile sources.
- Marine vessels includes only emissions from vessels in Washington territorial waters, including Columbia River towboats. WRAP includes these emissions in mobile sources.
- 2005 mobile source fine particulate is road dust only, not direct emissions. WRAP did not estimate direct PM2.5 from mobile sources, only dust from road surfaces.

## 2.5. Control measure emission reductions

Washington's emissions have declined for all visibility impairing precursor pollutants since 2002 as shown in Figure 3.

Mobile source $NO_X$, VOC, and $PM_{2.5}$ emissions declined since 2005. The comparison between the WRAP 2002d on-road mobile source emissions and the state 2005 and 2011 emission estimates cannot be made due to differences in the mobile source emission estimating methodologies. WRAP used the older MOBILE6 emission estimating approach for the 2002d (and projecting the 2018a) emissions. Ecology utilized the newer MOVES model for estimating the 2005 and 2011 mobile source emissions. The emissions from non-road mobile sources (locomotives, construction equipment, marine vessels) is also different between the WRAP inventory and the Ecology inventory. The model used for non-road mobile source emissions estimating was updated after the 2005 inventory was completed, adding additional changes to the mobile source emissions estimates. However, mobile source emissions are expected to have gone down as older vehicles and equipment has been replaced by new vehicles and equipment that meet current emission standards. Ecology has spent considerable funds to replace and install new engines in short-haul diesel vehicles that serve the marine ports in the state.

Stationary source emissions have also declined for precursors to all visibility impairing pollutants. Area sources also decline for the precursor pollutants for most visibility impairing pollutants between 2005 and 2011. Overall, between 2005 and 2011, total $NO_X$, VOC, $SO_X$, $NH_3$, and $PM_{2.5}$ emissions have declined. These emission reductions reflect the maturity of

Washington's emission control program and the preexisting level of control on the stationary sources.

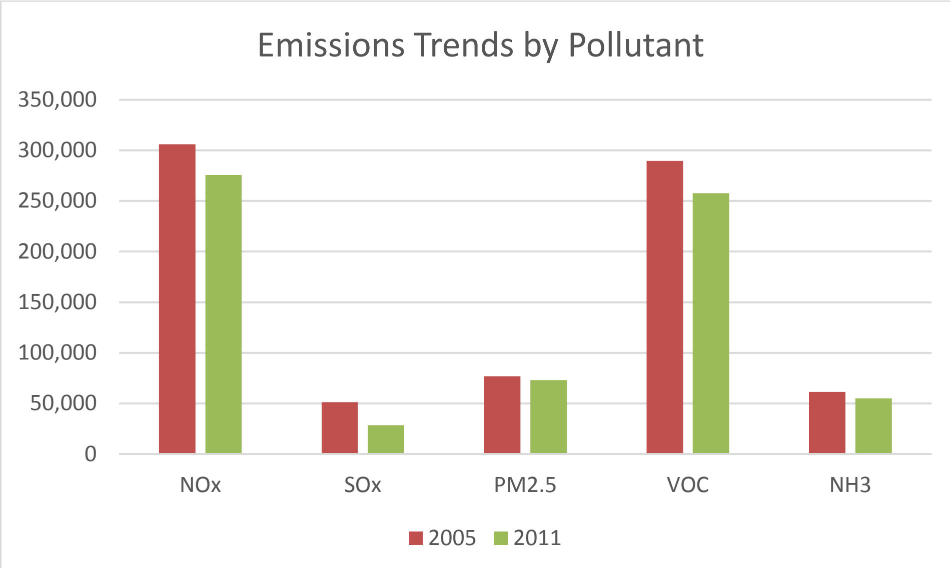



**Figure 10. Washington's statewide inventory trends**

# 3. Visibility Progress

The RHR requires each state to assess visibility conditions and changes, using the Worst Days and Best Days metrics. The RHR requires states to assess current visibility, the change compared to baseline, and change over the past five years for both Worst Days and Best Days. For this initial Progress Report, the current conditions are the 2010-2014 period; the baseline period is 2000-2004.

Appendix C evaluates the IMPROVE monitoring data for Washington's Class I areas to determine the current rate of progress and help identify any impediments to progress to meet both the 2018 and ultimate visibility program goals. This appendix shows the trends in visibility impairment since the baseline period through the end of 2014 and is the basis for the brief overview given in this section. The trend analyses are supported by annual graphs of visibility impairment followed by pie charts showing the contribution of each visibility impairing particulate to visibility impairment on the average best and worst days for recent selected years and the 2010–2014 progress evaluation period of this report.

Table 4 compares current, 2018 RPG, and Baseline Worst Days and Table 5 shows the same information for the Best Days for each Class I area. The comparison shows the visibility improvement required by the RHR, in spite of the adverse impacts caused by wildfires. Using the 2010–2014 five-year averages, visibility is improving on the Best Days at all monitoring sites meeting the RHR requirement that Best Days should not degrade.

The current conditions already meet the 2018 RPGs for the Worst Days, four years ahead of schedule. However, this trend can be affected by just one or two years with significant wildfires that impact the monitors. This can be seen in the year-to-year changes in visibility shown in Appendix C. When looking at the annual graphs, focus on the impacts of organic carbon peaks, which are caused by organic carbon originating in wild fires.

Several monitoring sites have been adversely impacted by the effects of wildfires over the most recent 5-year period, reducing visibility on the Worst Days. Some of the sites were also impacted by wildfire smoke during the baseline period. The monitors representing the Alpine Lakes, North Cascades, Goat Rocks, and Mt. Rainier Class I areas have had the most impact by wildfire smoke. Analysis of trends in haze-causing pollutant concentrations and contributions to light extinction at these monitors reveals wildfire smoke is the cause of the limited improvement. In the western U.S., wildfire smoke can elevate or produce all Worst Day values at particular monitors in a single year, as well as skew subsequent 5-year averages. For example, in 2012, smoke from a wildfire located near Cle Elum, WA, caused unusually high Worst Day values with the first and second highest single day dv values since 1999 at the Alpine Lakes monitoring site.

The Goat Rocks monitor was affected by multiple days of impairment due to relatively small wildfires in the nearby William O. Douglas Wilderness and a small fire just west of the monitor in 2012. In conjunction with significant impact from wildfires in 2010, the effects of wildfire produced organic carbon measured at this monitor combined to mask the progress made in reducing the visibility impairment from $NO_X$ and $SO_X$ which Washington can affect.

Offshore emissions from ocean-going vessels (OGV) contribute to sulfate formation, impacting visibility at monitoring sites closest to the coast. Washington has no specific emission controls on these vessels, however the implementation of the Pacific Coast portion of the North America Emission Control Area and the MARPOL VI emission controls on OGV has begun to reduce measured sulfate concentrations at the IMPROVE monitors. Section 2.3 discusses anticipated effects and timing of the effects of the MARPOL and ECA requirements on OGV emissions. The Class I area monitor showing the greatest benefit from these controls is the one representing Olympic National Park since this monitor sits adjacent to the primary route for these vessels entering and leaving ports on Puget Sound and southern British Columbia (Strait of Georgia). The monitors for the North Cascades National Park and Alpine Lakes Wilderness also show some benefits from these reductions due to their locations near the heavier travelled portions of Puget Sound and the Strait of Georgia. This can be seen in the reductions in measured sulfates at these IMPROVE monitors shown in Appendix C.

| Table 4. Statewide 2018 Worst Days Reasonable Progress Goal Summary Compared to Current Conditions* | | | | | | |
|---|---|---|---|---|---|---|
| Class I Area | Monitoring Site Designation | Most Impaired Days | | | | |
| | | 2000-2004 Baseline (dv) | 2018 Reasonable Progress Goal (dv) | 2018 Uniform Rate of Progress Target (dv) | 2010-2014 Actual Visibility (dv) | Meeting 2018 RPG? |
| Olympic Nat'l Park | OLYM1 | 16.74 | 16.38 | 14.81 | 13.82 | Yes |
| North Cascades Nat'l Park and Glacier Park Wilderness | NOCA1 | 16.01 | 15.62 | 14.23 | 13.03 | Yes |
| Alpine Lakes Wilderness | SNPA1 | 17.84 | 16.32 | 15.34 | 15.61 | Yes |
| Mount Rainier Nat'l Park | MORA1 | 18.24 | 16.66 | 15.98 | 15.16 | Yes |
| Goat Rocks Wilderness and Mount Adams Wilderness | WHPA1 | 12.76 | 11.79 | 11.73 | 11.77 | Yes |
| Pasayten Wilderness | PASA1 | 15.23 | 15.09 | 13.60 | 13.14 | Yes |

| Table 5. Statewide 2018 Best Days Reasonable Progress Goal Summary Compared to Current Conditions | | | | |
|---|---|---|---|---|
| Class I Area | Least Impaired Days | | | |
| | 2000-2004 Baseline (dv) | 2018 Progress Goal (dv) | 2010-2014 Actual Visibility (dv) | Meeting 2018 Goal? |
| Olympic Nat'l Park | 6.02 | 6.02 | 3.65 | Yes |
| North Cascades Nat'l Park and Glacier Park Wilderness | 3.37 | 3.37 | 2.65 | Yes |
| Alpine Lakes Wilderness | 5.5 | 5.5 | 3.35 | Yes |
| Mount Rainer Nat'l Park | 5.47 | 5.47 | 3.90 | Yes |
| Goat Rocks Wilderness and Mount Adams Wilderness | 1.66 | 1.66 | 0.92 | Yes |
| Pasayten Wilderness | 2.73 | 2.73 | 1.82 | Yes |

* The 2000–2004 baseline and 2018 projected visibility come from the December 2010 RH SIP, Section 10.

# 4. Assessment of Changes Impeding Visibility Progress

As discussed in the RH Plan, in Washington there are four factors, largely beyond state control, that can interfere with progress toward improved visibility in Class I areas: wildfire smoke, offshore and ocean-going vessel emissions, mobile source emissions (on-road and non-road sources under federal emission control), and international emissions. None of these emission sources is subject to control by the state of Washington.

Each of these emission source types can produce high concentrations of haze-causing pollutant species in the sampling record.

Wildfire smoke originating in Washington or transported from outside the state, is measured as elevated organic carbon concentrations that can last from a single high value day, last for several consecutive sampling days or intermittently over a period of a few weeks. The effects on a particular IMPROVE monitor vary depending on the size of the fire, its proximity to the monitor, the wind directions, and ability of the wildfire to be controlled.

Pacific offshore shipping emissions from ocean going vessels have increased dramatically in the last decade due to shifts in the global economy. These ships burn sulfur-containing fuels; with higher sulfur content fuels used outside of the North America Emission Control Area. As these vessels enter the Emission Control Area they are required to switch to lower sulfur fuel or use emission controls that result in an $SO_X$ emissions equivalent to what using low sulfur fuel would have produced. These $SO_X$ emissions form sulfates, with higher levels found near the Washington coast and in the Cascade Mountains near the main shipping lanes of the Strait of Juan de Fuca and the Georgia Strait. The higher humidity along the shoreline enhances sulfate formation and the proximity of the vessels to some of the Class I area monitors (most notably the Olympic National Park monitor) can result in marine vessel emissions that affect the haze-causing pollutant concentrations measured at the IMPROVE monitor. Sulfates are normally elevated during the summer at all Washington monitors. They can be the secondary driver of haze at some monitors on Worst Days when elevated organic carbon is the primary driver.

While not under state control, it is expected that the impact of $SO_X$ and $NO_X$ emissions from marine vessels in the open ocean and within the North America ECA will continue to go down as the effects of the ECA enters full implementation. An evaluation done by Kotchenruther in 2014[10] on the effects of the early phases of these marine vessel emission requirements during the pre-control and early requirements period (June 2006–August 2013) indicates beneficial effects from controls on $SO_X$ and $NO_X$ emissions by marine vessels.

Emissions from Canada and transpacific pollutants from Asia have been identified through WRAP modeling and analyses by researchers as contributing to background concentrations (Best Day visibility) and can contribute to impairment on the Worst Days. As shown in Appendix D, wildfires in British Columbia can adversely impact Washington visibility.

Large wildfires are occurring more frequently. The largest recorded wildfires in Washington have occurred since 2000. The impact of wildfires is discussed in Appendix D, where the effects of wildfires show up as measured concentrations of OMC on specific days.

Wildfires cause organic carbon concentrations to increase significantly on days when wildfire smoke reaches a Class I area, often remaining high for several consecutive days or even weeks. Organic carbon is the largest contribution to light extinction on those days, sometimes making the dv level high enough to affect the values of both the annual Worst Days average and the 5-year average. Further analysis of which haze-causing pollutant species cause the Worst Days,

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[10] Kotchenruther, Robert A., "The effects of marine vessel fuel sulfur regulations on ambient PM2.5 along the west coast of the U.S.," *Atmospheric Environment*, Volume 103, pp. 121-128, February 2015.

and their timing, clearly implicates wildfire smoke as a challenge that impacts Washington on a regular basis.

In 2012 and 2014, Northern Central Washington was particularly affected by a large number of wildfires. In 2014, lightening sparked numerous wildfires in Yakima and Chelan counties starting in late September. The fires did not die out until after the end of October.

Figure 3 is a MODIS Terra satellite image showing the smoke from fires and the extent of the adverse impacts on September 27, 2012. Some of the specific fires continued to burn and smolder until fall rains and snow put them out, well beyond their official containment date. This smoke directly impacted the Class I areas and had an overwhelming impact on visibility progress at most monitoring sites throughout the state.

The smoke plumes in Figure 5 also show how fires located east of the Cascade Mountains can travel and adversely affect visibility and air quality in Western Washington.

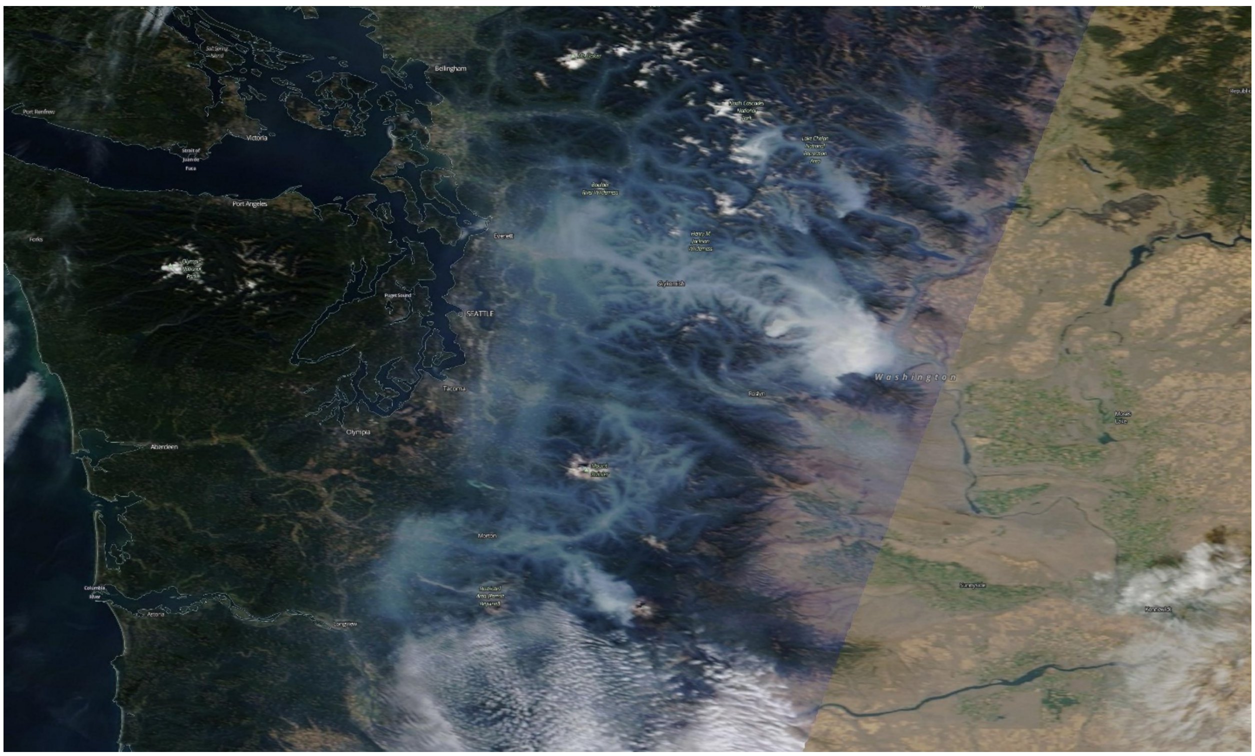


**Figure 11. September 27, 2012 MODIS Terra satellite image showing fire plumes**

The satellite image in Figure 4 shows the extent of smoke plumes on August 9, 2014, primarily smoke from the fires that made up what was called the Carlton Complex in Okanogan and Chelan counties. At the same time there were two other groups of fires burning, one in Chelan and Kittitas counties called the Table Mountain fire and another group in Yakima County called the Wm. O. Douglass Wilderness complex. These fires impacted the monitors representing the Pasayten, North Cascades, Alpine Lakes, and Goat Rocks areas. The analysis of long-term dv trends in the monitoring data in Appendix D demonstrates that visibility impacts due to other air pollutants has otherwise improved significantly at these locations.


**Figure 12. MODIS Terra satellite on August 9, 2014**

# 5. Assessment of Current Control Strategy

The RH Plan Control Strategies are sufficient for meeting Washington's 2018 RPGs. The recent IMPROVE data for 2010–2014, shows that the 5-year average of the Worst Days at all sites are below the RPGs. Washington continues to maintain existing control measures. Washington currently has no nonattainment areas, providing evidence that anthropogenic emission levels are being maintained or decreased throughout the state and that there is a probability of continuing to meet the 2018 RPGs.

One commitment of the RH Plan was to perform a RACT evaluation of one or more source categories. Washington State's Clean Air Act requires us to utilize the process in RCW 70.94.154 whenever we are evaluating potential emission controls on a category of sources with three or more members. While the federal Clean Air Act and EPA's regulations require us to use a less inclusive 4-factor analysis, we must follow the more detained process included in state law.  The primary difference between the two analyses is that Washington State law requires us to evaluate the impact and benefits of controls on ambient air quality.

Utilizing the requirements in state law, we have evaluated the effects of imposing a more stringent, BACT-like level of emission control on the chemical pulp mill combustion sources in Washington.  This analysis indicates that the reduction in emissions due to the BACT level controls evaluated would result in less than 100 tons of emission reduction at each pulp mill and that the visibility improvement on the 8th Worst Days would be less than 0.05 dv at any Class I area in Washington, Oregon, or Idaho.  Our conclusion was that the cost of imposing the proposed RACT level of control would not be cost effective for the small potential emission reductions and visibility benefits of installing those controls.  A copy of this RACT review is available on request to Ecology.

Washington evaluated the effectiveness of the RH Plan control strategies on the Mt. Hood Class I area in Oregon and found it was sufficient to lessen Washington's impact on Oregon.  In the RH Plan, Washington determined that in 2002 on the Worst Days, the state contributed 33.5 percent nitrate and 21.6 percent of the sulfate on the Worst Days at Mt. Hood Wilderness in Oregon.  Washington's contribution was projected to go down by 2018 to 25.9 percent and 17.5 percent on the Worst Days.  Similar impacts and reductions were modeled for the Cabinet Mountains Wilderness in Montana.  WRAP developed a 2002 emission inventory for modeling purposes.  This inventory was used to project the effects of the known emission reduction requirements, population and motor vehicle growth, and industrial retirements to projection emissions in 2018.  The WRAP projection proposed that $SO_X$ emissions would decrease by 40 percent over this time period, and $NO_X$ emissions would decrease by 46 percent almost entirely due to reductions in mobile source emissions.  This plus the improvements in visibility at the Class I monitors indicate that Washington should meet or exceed the RPGs.

# 6. Visibility Monitoring Strategy

Washington will continue to rely on the existing IMPROVE network to collect and analyze the visibility data.  We will encourage EPA, FLMs, and the IMPROVE Steering Committee to maintain the existing monitoring network.  Ecology has not developed any formal recommendations for additions to the current monitoring locations.  Should federal or state funding become available for siting and operating additional IMPROVE monitors, Ecology will be able to propose some specific additional sites for consideration.

However, as a starting list of suggested locations to consider for a new IMPROVE monitoring site if funding for one or more additional monitors were to come available, the following locations should be considered:  the SW portion of Olympic National Park to assess visibility conditions on that portion of the Park; Stevens Pass or Stehekin (on Lake Chelan) to better reflect conditions at Glacier Peak Wilderness.

# 7. RH Plan Commitments and Continued Consultation

In the RH Plan, Washington committed to update the 2018 RPGs with the latest WRAP modeling if appropriate. Since submission of the RH Plan, WRAP has not updated the modeling for the Washington 2018 RPGs. Washington will continue to evaluate the Natural Conditions targets to reflect changes in the emission inventory and increases in the numbers and severity of wildfires in Washington, Oregon, and British Columbia.

Ecology staff regularly confer with other western states to discuss mutual concerns and strategies for reducing haze, through the WRAP and the Western States Air Resources Council (WESTAR). Ecology staff participated in the WESTAR Regional Haze Subcommittee, which developed recommendations to EPA regarding continued implementation of the RHR. These recommendations were presented to EPA in August 2013. Ecology has consulted with our neighboring states, regarding whether anthropogenic or controllable sources in Washington affected the progress toward 2018 RPGs of those states. Ecology also consulted with our neighboring states on the effects of their anthropogenic or other controllable sources on Washington.

Smoke emissions from Oregon wildfires sometimes impact the southernmost Washington Class 1 Area monitors. Conversely, wildfires in Washington have affected Class I area monitors in Oregon and Idaho. Washington's analysis of these impacts indicates that these natural wildfire smoke impacts have resulted in high dv values at Washington and out-of-state Class I areas. If the effects of these wildfires is removed from the analysis, visibility is improving due to reduction of anthropogenic emissions, both in state and out of state.

Ecology staff also meets periodically with the FLMs with Class I areas in Washington to review visibility progress, to share technical and research information, and to discuss policies leading to air quality improvement. This also occurs in the context of daily evaluations of air quality and weather conditions used to make decisions of whether or not to allow permitted fires to occur.

Per the requirements of the RHR, Washington provided the draft Progress Report to the FLMs for 60 days prior to advertising the public notice of the hearing on the Progress Report, for their review and comments. Appendix E includes the written comments received from the FLMs and how Ecology responded to them.

# 8. Adequacy of RH Plan

Washington is making adequate progress overall in improving visibility due to reductions in anthropogenic emissions.

The trends for Worst Days' averages show visibility improving at every Class I area monitoring site. Even including the effects of wildfires, all sites show improving visibility on the average of the Worst Days, and in fact are already better than the 2018 RPGs for Washington.

Current Best Days are all better than the baseline period. This is due to the reductions in anthropogenic source emissions in Washington resulting in a concurrent improvement in Best Days visibility at all of Washington's Class 1 area IMPROVE monitors.

Washington determines the control strategies in its current RH plan are sufficient for Washington and its neighboring states to meet or exceed their 2018 RPGs. In accordance with the requirements of the RHR, Washington has determined that no substantive revision of the RH Plan is warranted at this time in order to achieve Washington's 2018 RPGs for visibility improvement.

# Appendices

# Appendix A.  Western Regional Air Partnership: "Regional Haze Rule Reasonable Progress Summary Report"

## 6.0 STATE AND CLASS I AREA SUMMARIES

As described in Section 2.0, each state is required to submit progress reports at interim points between submittals of Regional Haze Rule (RHR) State Implementation Plans (SIPs), which assess progress towards visibility improvement goals in each state's mandatory Federal Class I areas (CIAs). Data summaries for each CIA in each Western Regional Air Partnership (WRAP) state, which address Regional Haze Rule (RHR) requirements for visibility measurements and emissions inventories are provided in this section. These summaries are intended to provide individual states with the technical information they need to determine if current RHR implementation plan elements and strategies are sufficient to meet all established reasonable progress goals, as defined in their respective initial RHR implementation plans.

## 6.14 WASHINGTON

The goal of the RHR is to ensure that visibility on the 20% most impaired, or worst, days continues to improve at each Federal Class I area (CIA), and that visibility on the 20% least impaired, or best, days does not get worse, as measured at representative Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring sites. Washington has 8 mandatory Federal CIAs, which are depicted in Figure 6.14-1 and listed in Table 6.14-1, along with the associated IMPROVE monitor locations.

This section addresses differences between the 2000-2004 baseline and 2005-2009 period, for both monitored data and emission inventory estimates. Monitored data are presented for the 20% most impaired, or worst, days and for the 20% least impaired, or best, days, as per Regional Haze Rule (RHR) requirements. Annual average trend statistics for the 2000-2009 10-year period are also presented here to support assessments of changes in each monitored species that contributes to visibility impairment. Some of the highlights regarding these comparisons are listed below, and more detailed state specific information is provided in monitoring and emissions sub-sections that follow.

- For the best days, the 5-year average deciview metric decreased at all Washington Federal CIA IMPROVE sites except the WHPA1 site.
  - The increase on best days at the WHPA1 site was small (0.1 dv), and due to an increase in average ammonium sulfate, which was partially offset by a decrease in ammonium nitrate. This was not consistent emissions inventory comparisons which showed decreases in state-wide emissions of $SO_2$, and decreases in annual averages of $SO_2$ from EGU sources.
- For the worst days, the 5-year average deciview metric decreased at all sites.
  - For the worst days, all sites measured lower 5-year averages of ammonium nitrate, and all sites measured either decreasing or insignificant annual average trends in ammonium sulfate and ammonium nitrate. This was consistent with emission inventory comparison results that showed net decreases in $NO_X$ and $SO_2$ emissions, mostly due to reductions from point and mobile sources.
  - All sites except WHPA1 showed decreasing trends in elemental carbon. Emissions inventory comparisons showed decreasing off-road mobile sources of elemental carbon, but increasing on-road sources. Other on-road species (e.g. oxides of nitrogen, $SO_2$, and volatile organic carbon) decreased, so inventory increases in elemental carbon may be due to methodology differences.

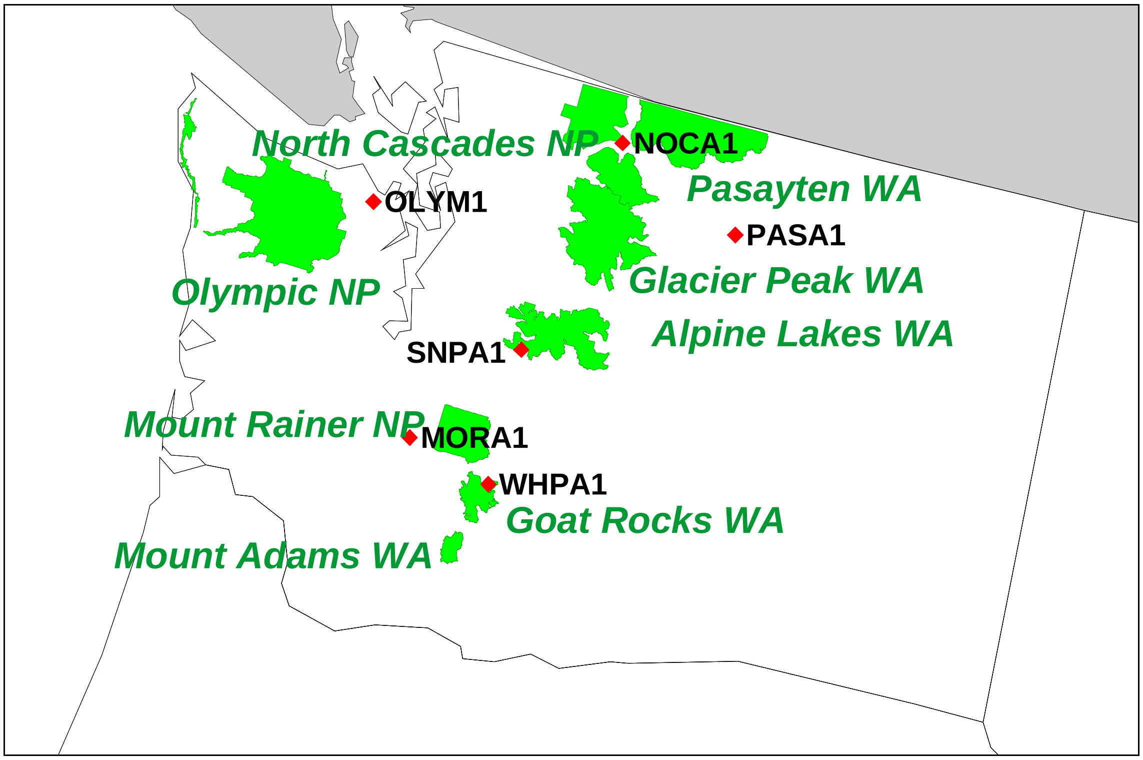



Figure 6.14-1. Map Depicting Federal CIAs and Representative IMPROVE Monitors in Washington.

Table 6.14-1
Washington CIAs and Representative IMPROVE Monitors

| Class I Area | Representative IMPROVE Site | Latitude | Longitude | Elevation (m) |
|---|---|---|---|---|
| Mount Rainer NP | MORA1 | 46.76 | -122.12 | 439 |
| North Cascades NP<br>Glacier Peak WA | NOCA1 | 48.73 | -121.06 | 568 |
| Olympic NP | OLYM1 | 48.01 | -122.97 | 599 |
| Pasayten WA | PASA1 | 48.39 | -119.93 | 1627 |
| Alpine Lakes WA | SNPA1 | 47.42 | -121.43 | 1049 |
| Goat Rocks WA<br>Mount Adams WA | WHPA1 | 46.62 | -121.39 | 1827 |

### 6.14.1 Monitoring Data

This section addresses RHR regulatory requirements for monitored data as measured by IMPROVE monitors representing Federal CIAs in Washington. These summaries are supported by regional data presented in Section 4.0 and by more detailed site specific tables and charts in Appendix N.

As described in Section 3.1, regional haze progress in Federal CIAs is tracked using calculations based on speciated aerosol mass as collected by IMPROVE monitors. The RHR calls for tracking haze in units of deciviews (dv), where the deciview metric was designed to be linearly associated with human perception of visibility. In a pristine atmosphere, the deciview metric is near zero, and a one deciview change is approximately equivalent to a 10% change in cumulative species extinction. To better understand visibility conditions, summaries here include both the deciview metric, and the apportionment of haze into extinction due to the various measured species in units of inverse megameters ($Mm^{-1}$).

#### 6.14.1.1 Current Conditions

This section addresses the regulatory question, ***what are the current visibility conditions for the most impaired and least impaired days (40 CFR 51.308 (g)(3)(i))?*** RHR guidance specifies that 5-year averages be calculated over successive 5-year periods, i.e. 2000-2004, 2005-2009, 2010-2014, etc.[1] Current visibility conditions are represented here as the most recent successive 5-year average period available, or the 2005-2009 period average, although the most recent IMPROVE monitoring data currently available includes 2010 data.

Tables 6.14-2 and 6.14-3 present the calculated deciview values for current conditions at each site, along with the percent contribution to extinction from each aerosol species for the 20% most impaired, or worst, and 20% least impaired, or best, days for each of the Federal CIA IMPROVE monitors in Washington. Figure 6.14-2 presents 5-year average extinction for the current progress period for both the 20% most impaired and 20% least impaired days. Note that the percentages in the tables consider only the aerosol species which contribute to extinction, while the charts also show Rayleigh, or scattering due to background gases in the atmosphere.

Specific observations for the current visibility conditions on the 20% most impaired days are as follows:

- The largest contributors to aerosol extinction at Washington sites were ammonium sulfate and particulate organic mass.
- The highest aerosol extinction (16.4 dv) was measured at the MORA1 site, where ammonium sulfate was the largest contributor to aerosol extinction, followed by particulate organic mass. The lowest aerosol extinction (12.7 dv) was measured at the WHPA1 site.

[1] EPA's September 2003 *Guidance for Tracking Progress Under the Regional Haze Rule* specifies that progress is tracked against the 2000-2004 baseline period using corresponding averages over successive 5-year periods, i.e. 2005-2009, 2010-2014, etc. (See page 4-2 in the Guidance document.)

Specific observations for the current visibility conditions on the 20% least impaired days are as follows:

- The aerosol contribution to total extinction on the best days was less than Rayleigh, or the background scattering that would occur in clear air. Average extinction (including Rayleigh) ranged from 1.8 dv (WHPA1) to 5.0 dv (OLYM1).
- For all sites, ammonium sulfate was the largest contributor to the non-Rayleigh species of aerosol extinction

Table 6.14-2
Washington Class I Area IMPROVE Sites
Current Visibility Conditions
2005-2009 Progress Period, 20% Most Impaired Days

| Site | Deciviews (dv) | Percent Contribution to Aerosol Extinction by Species (Excludes Rayleigh) ($\%$ of $Mm^{-1}$) and Rank* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Ammonium Sulfate** | **Ammonium Nitrate** | **Particulate Organic Mass** | **Elemental Carbon** | **Soil** | **Coarse Mass** | **Sea Salt** |
| MORA1 | 16.4 | **41% (1)** | 9% (4) | 31% (2) | 10% (3) | 1% (6) | 6% (5) | 1% (7) |
| NOCA1 | 13.7 | **46% (1)** | 8% (3) | 32% (2) | 7% (4) | 1% (6) | 5% (5) | 1% (7) |
| OLYM1 | 15.2 | **45% (1)** | 18% (3) | 22% (2) | 6% (4) | 1% (7) | 5% (5) | 4% (6) |
| PASA1 | 14.1 | 25% (2) | 8% (3) | **51% (1)** | 8% (4) | 2% (6) | 5% (5) | 0% (7) |
| SNPA1 | 16.1 | 37% (1) | 22% (3) | 27% (2) | 8% (4) | 1% (7) | 4% (5) | 1% (6) |
| WHPA1 | 12.7 | 32% (2) | 10% (3) | **39% (1)** | 7% (5) | 2% (6) | 9% (4) | 0% (7) |

*Highest aerosol species contribution per site is highlighted in bold.

Table 6.14-3
Washington Class I Area IMPROVE Sites
Current Visibility Conditions
2005-2009 Progress Period, 20% Least Impaired Days

| Site | Deciviews (dv) | Percent Contribution to Aerosol Extinction by Species (Excludes Rayleigh) ($\%$ of $Mm^{-1}$) and Rank* | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Ammonium Sulfate** | **Ammonium Nitrate** | **Particulate Organic Mass** | **Elemental Carbon** | **Soil** | **Coarse Mass** | **Sea Salt** |
| MORA1 | 4.9 | **45% (1)** | 7% (6) | 19% (2) | 9% (4) | 1% (7) | 8% (5) | 11% (3) |
| NOCA1 | 3.2 | **57% (1)** | 9% (3) | 17% (2) | 5% (5) | 1% (7) | 6% (4) | 5% (6) |
| OLYM1 | 5.0 | **40% (1)** | 14% (3) | 19% (2) | 7% (5) | 1% (7) | 5% (6) | 14% (4) |
| PASA1 | 2.5 | **53% (1)** | 15% (2) | 13% (3) | 5% (6) | 2% (7) | 6% (4) | 6% (5) |
| SNPA1 | 4.9 | **39% (1)** | 18% (2) | 15% (3) | 12% (4) | 1% (7) | 3% (6) | 12% (5) |
| WHPA1 | 1.8 | **55% (1)** | 9% (4) | 12% (2) | 6% (6) | 1% (7) | 9% (3) | 8% (5) |

*Highest aerosol species contribution per site is highlighted in bold.

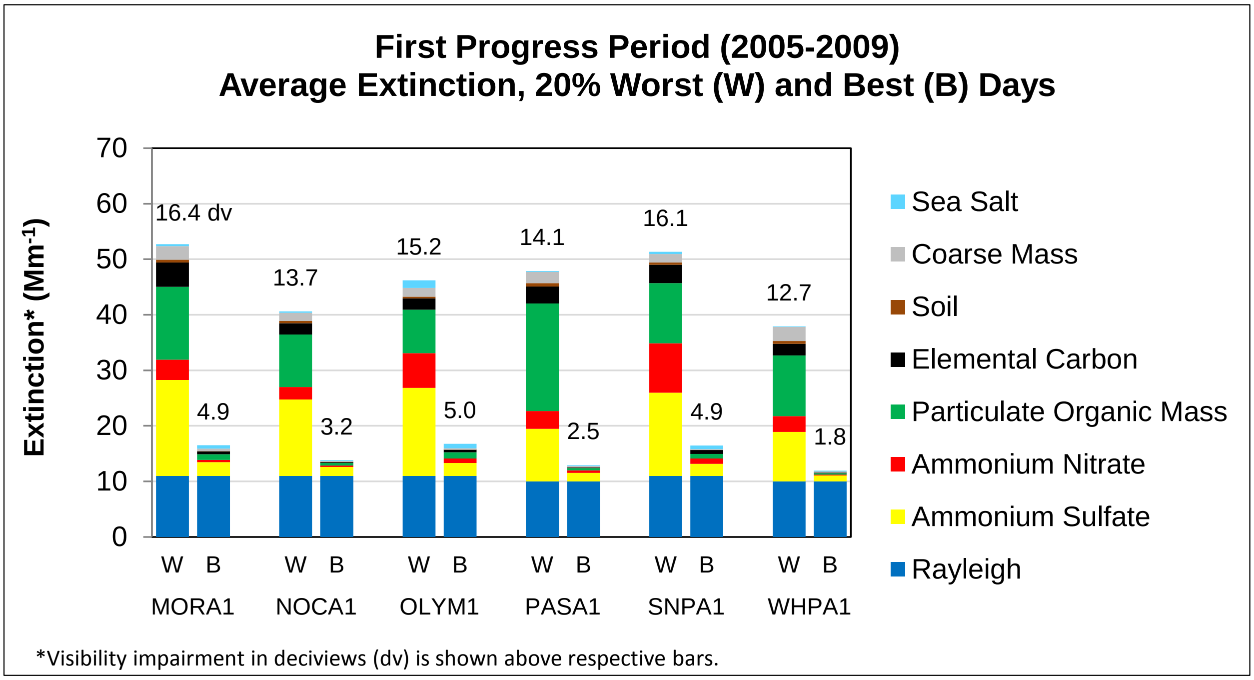



Figure 6.14-2. Average Extinction for Current Progress Period (2005-2009) for the Worst (Most Impaired) and Best (Least Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

#### 6.14.1.2 Differences between Current and Baseline Conditions

This section addresses the regulatory question, ***what is the difference between current visibility conditions for the most impaired and least impaired days and baseline visibility conditions (40 CFR 51.308 (g)(3)(ii))?*** Included here are comparisons between the 5-year average baseline conditions (2000-2004) and current progress period extinction (2005-2009).

Table 6.14-4 presents the differences between the 2000-2004 baseline period average extinction and the 2005-2009 progress period average for each site in Washington for the 20% most impaired days, and Table 6.14-5 presents similar data for the least impaired days. Averages that increased are depicted in red text and averages that decreased in blue.

Figure 6.14-3 presents the 5-year average extinction for the baseline and current progress period averages for the worst days and Figure 6.14-4 presents the differences in averages by aerosol species, with increases represented above the zero line and decreases below the zero line. Figures 6.14-5 and 6.14-6 present similar plots for the best days.

For the 20% most impaired days, the 5-year average deciview metric decreased between the 2000-2004 and 2005-2009 periods at all Washington sites. Notable differences for individual species averages were as follows:

- All sites measured decreases in particulate organic mass, with the largest decreases measured at the NOCA1 site.

- Ammonium nitrate averages decreased at all sites.
- Particulate organic mass and elemental carbon averages decreased at all except the WHPA1 site.
- Ammonium sulfate decreased at all expect the PASA1 site, with the largest decrease in ammonium sulfate measured at the MORA1 site.

For the 20% least impaired days, the 5-year average deciview metric decreased at all sites except WHPA1, where the measured deciview average increased by 0.1 dv. Notable differences for individual species averages on the 20% least impaired days were as follows:

- At WHPA1, ammonium sulfate contributed to the increase in deciviews. Ammonium sulfate also increased at the NOCA1 site, but decreased at the MORA1, OLYM1, and SNPA1 sites.
- Ammonium nitrate decreased at all sites, and particulate organic mass and elemental carbon decreased at all but the WHPA1 site, where average concentrations stayed the same.

Table 6.14-4
Washington Class I Area IMPROVE Sites
Difference in Aerosol Extinction by Species
2000-2004 Baseline Period to 2005-2009 Progress Period
20% Most Impaired Days

| Site | Deciview (dv) | | | Change in Extinction by Species ($Mm^{-1}$)* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2000-04 Baseline Period | 2005-09 Progress Period | Change in dv* | Amm. Sulfate | Amm. Nitrate | POM | EC | Soil | CM | Sea Salt |
| MORA1 | 18.2 | 16.4 | -1.8 | -6.4 | -1.5 | -1.9 | -0.8 | 0.0 | +0.3 | +0.3 |
| NOCA1 | 16.0 | 13.7 | -2.3 | -1.1 | -0.4 | -23.6 | -1.7 | -0.1 | -0.2 | +0.2 |
| OLYM1 | 16.7 | 15.2 | -1.5 | -0.8 | -2.1 | -4.2 | -0.7 | 0.0 | -0.2 | -0.1 |
| PASA1 | 15.2 | 14.1 | -1.1 | +1.4 | -0.1 | -2.5 | -0.3 | -0.2 | 0.0 | 0.0 |
| SNPA1 | 17.8 | 16.1 | -1.7 | -2.1 | -2.7 | -4.6 | -0.9 | 0.0 | 0.0 | 0.0 |
| WHPA1 | 12.8 | 12.7 | -0.1 | -1.0 | -0.2 | +1.3 | +0.3 | 0.0 | +0.8 | -0.3 |

*Change is calculated as progress period average minus baseline period average. Values in red indicate increases in extinction and values in blue indicate decreases.

Table 6.14-5
Washington Class I Area IMPROVE Sites
Difference in Aerosol Extinction by Species
2000-2004 Baseline Period to 2005-2009 Progress Period
20% Least Impaired Days

| Site | Deciview (dv) | | | Change in Extinction by Species ($Mm^{-1}$)* | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 2000-04 Baseline Period | 2005-09 Progress Period | Change in dv* | Amm. Sulfate | Amm. Nitrate | POM | EC | Soil | CM | Sea Salt |
| MORA1 | 5.5 | 4.9 | -0.6 | -0.1 | -0.2 | -0.4 | -0.1 | 0.0 | -0.1 | +0.1 |
| NOCA1 | 3.4 | 3.2 | -0.2 | +0.2 | -0.2 | -0.2 | -0.1 | 0.0 | 0.0 | 0.0 |
| OLYM1 | 6.0 | 5.0 | -1.0 | -0.4 | -0.4 | -0.8 | -0.2 | 0.0 | -0.1 | +0.2 |
| PASA1 | 2.7 | 2.5 | -0.2 | 0.0 | -0.1 | -0.2 | -0.1 | 0.0 | 0.0 | +0.1 |
| SNPA1 | 5.5 | 4.9 | -0.6 | -0.5 | -0.2 | -0.2 | -0.2 | 0.0 | -0.1 | +0.2 |
| WHPA1 | 1.7 | 1.8 | +0.1 | +0.2 | -0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |

*Change is calculated as progress period average minus baseline period average. Values in red indicate increases in extinction and values in blue indicate decreases.

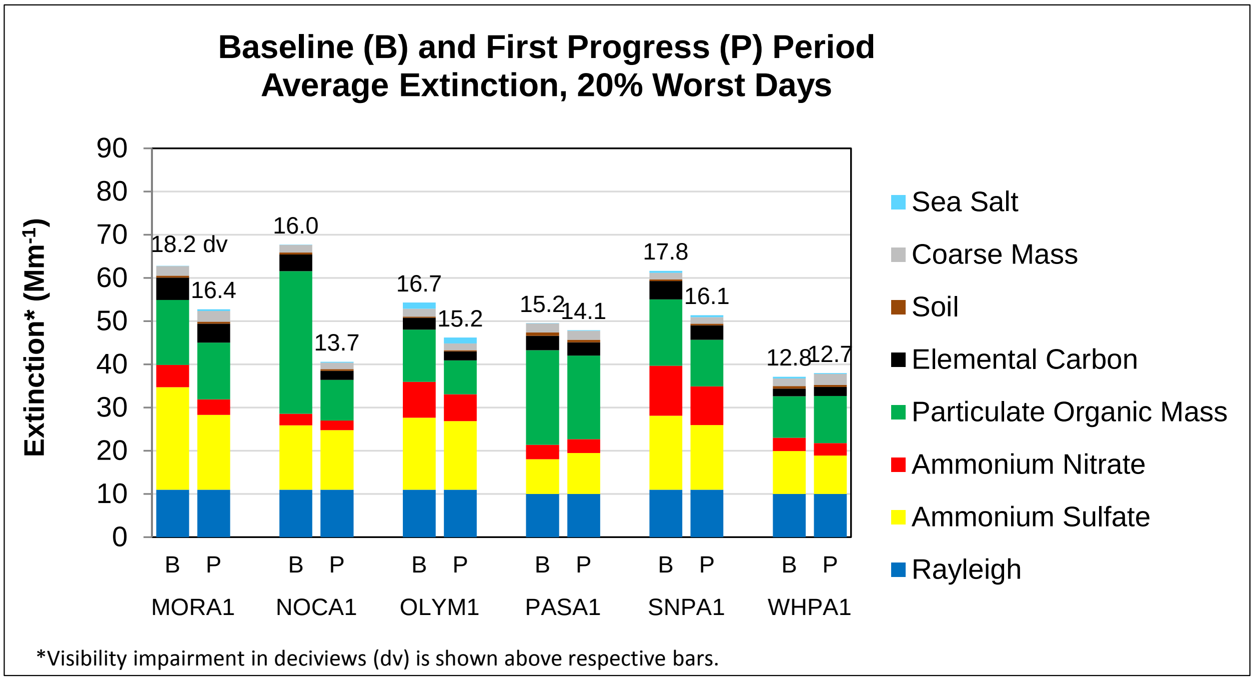



Figure 6.14-3. Average Extinction for Baseline and Progress Period Extinction for Worst (Most Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

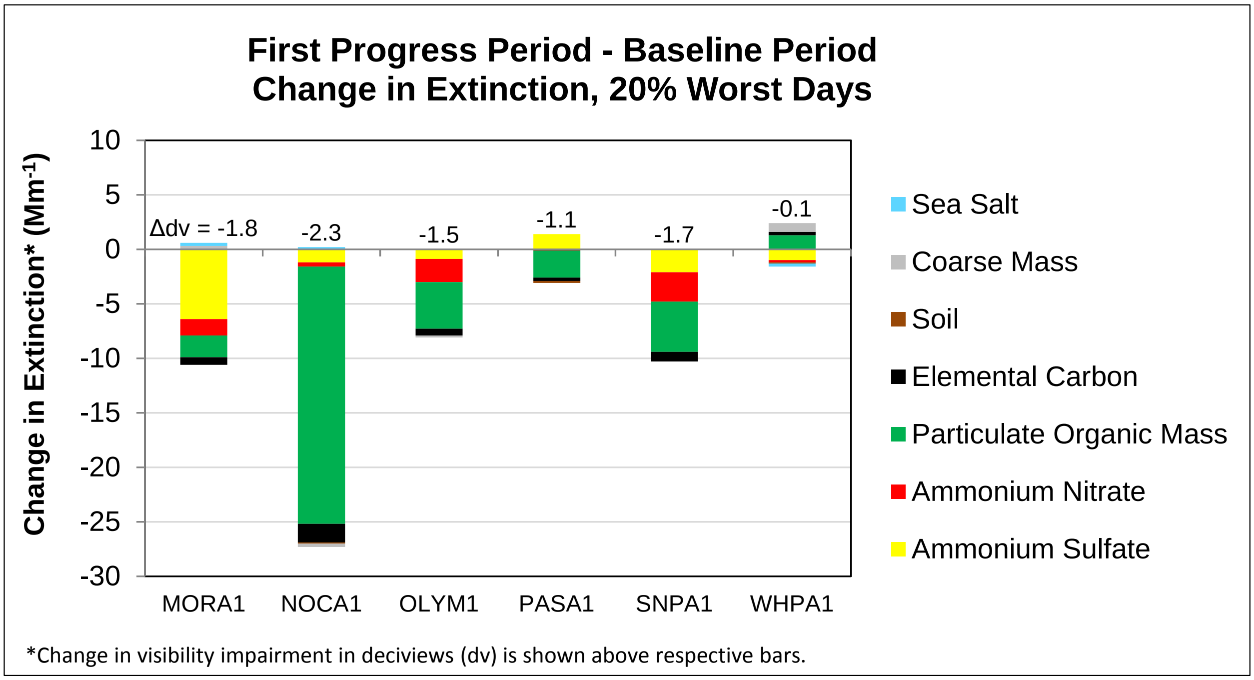



Figure 6.14-4. Difference between Average Extinction for Current Progress Period (2005-2009) and Baseline Period (2000-2004) for the Worst (Most Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

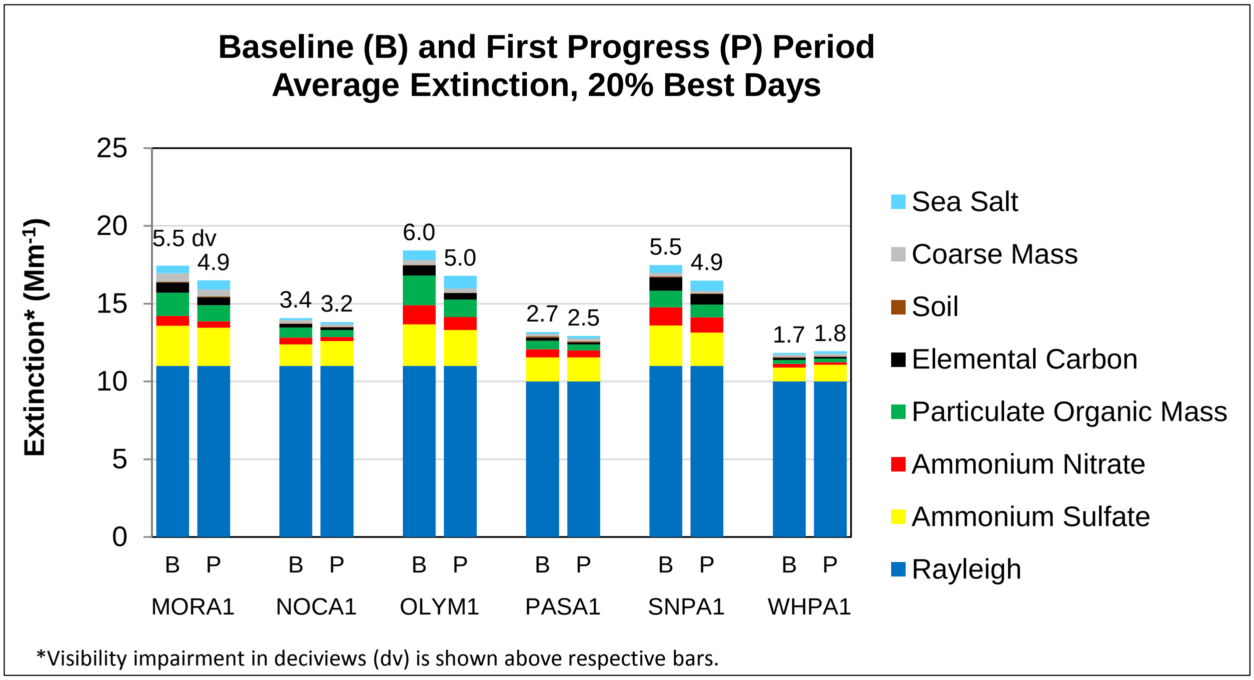



Figure 6.14-5. Average Extinction for Baseline and Progress Period Extinction for Best (Least Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

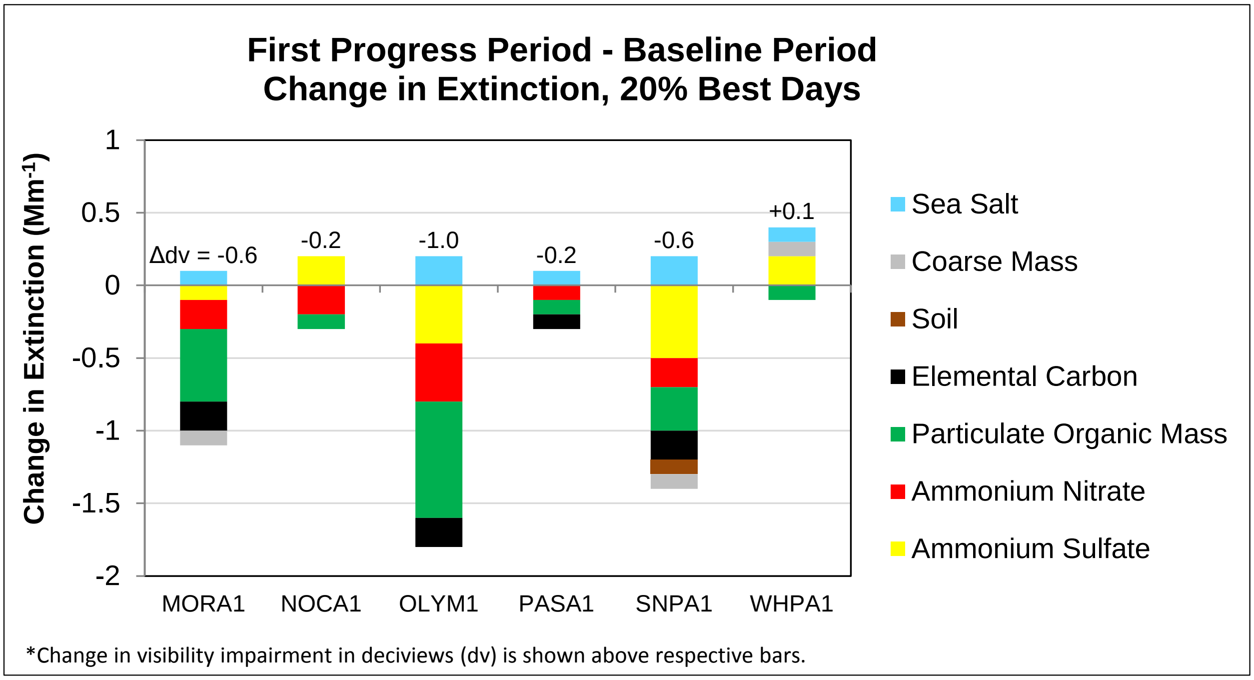



Figure 6.14-6. Difference between Average Extinction for Current Progress Period (2005-2009) and Baseline Period (2000-2004) for the Best (Least Impaired) Days Measured at Washington Class I Area IMPROVE Sites.

#### 6.14.1.3 Changes in Visibility Impairment

This section addresses the regulatory question, ***what is the change in visibility impairment for the most impaired and least impaired days over the past 5 years (40 CFR 51.308 (g)(3)(iii))?*** Included here are changes in visibility impairment as characterized by annual average trend statistics, and some general observations regarding local and regional events and outliers on a daily and annual basis that affected the current 5-year progress period. The regulatory requirement asks for a description of changes over the past 5-year period, but trend analysis is better suited to longer periods of time, so trends for the entire 10-year planning period are presented here.

Trend statistics for the years 2000-2009 for each species at each site in Washington are summarized in Table 6.14-6, and regional trends were presented earlier in Section 4.1.1.[2] Only trends for aerosol species trends with p-value statistics less than 0.15 (85% confidence level) are presented in the table here, with increasing slopes in red and decreasing slopes in blue.[3] In some cases, trends may show decreasing tendencies while the difference between the 5-year averages do not (or vice versa), as discussed in Section 3.1.2.2. In these cases, the 5-year average for the best and worst days is the important metric for RHR regulatory purposes, but trend statistics may be of value to understand and address visibility impairment issues for planning purposes.

For each site, a more comprehensive list of all trends for all species, including the associated p-values, is provided in Appendix N. Additionally, the appendix includes plots depicting 5-year, annual, monthly and daily average extinction for each site. These plots are intended to provide a fairly comprehensive compilation of reference information for individual states to investigate local and regional events and outliers that may have influenced changes in visibility impairment as tracked using the 5-year deciview metrics. Note that similar summary products are also available from the WRAP TSS website (http://vista.cira.colostate.edu/tss/). Some general observations regarding changes in visibility impairment at sites in Washington are as follows:

- The largest changes in 5-year averages at the sites was a decrease in average particulate organic mass measured at the NOCA1 site. This difference was influenced by a high particulate organic mass event in September and October of 2003 which raised the baseline average high.
- Ammonium sulfate, ammonium nitrate, particulate organic mass, and elemental carbon all showed either decreasing or insignificant trends at all sites, with the

[2] Annual trends were calculated for the years 2000-2009, with a trend defined as the slope derived using Theil statistics. Trends derived from Theil statistics are useful in analyzing changes in air quality data because these statistics can show the overall tendency of measurements over long periods of time, while minimizing the effects of year-to-year fluctuations which are common in air quality data. Theil statistics are also used in EPA's National Air EPA's National Air Quality Trends Reports (http://www.epa.gov/airtrends/) and the IMPROVE program trend reports (http://vista.cira.colostate.edu/improve/Publications/improve_reports.htm)

[3] The significance of the trend is represented with p-values calculated using Mann-Kendall trend statistics. Determining a significance level helps to distinguish random variability in data from a real tendency to increase or decrease over time, where lower p-values indicate higher confidence levels in the computed slopes.

exception of elemental carbon on the worst days at the WHPA1 site, which showed an increasing trend.

Table 6.14-6
Washington Class I Area IMPROVE Sites
Change in Aerosol Extinction by Species
2000-2009 Annual Average Trends

| Site | Group | Annual Trend* (Mm$^{-1}$/year) | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | **Ammonium Sulfate** | **Ammonium Nitrate** | **Particulate Organic Mass** | **Elemental Carbon** | **Soil** | **Coarse Mass** | **Sea Salt** |
| MORA1 | 20% Best | -- | 0.0 | -0.1 | 0.0 | -- | 0.0 | -- |
| | 20% Worst | -0.8 | -0.2 | -- | -0.2 | -- | -- | 0.0 |
| | All Days | -0.4 | -0.1 | -0.3 | -0.1 | -- | -- | -- |
| NOCA1 | 20% Best | -- | 0.0 | 0.0 | 0.0 | -- | -- | -- |
| | 20% Worst | -0.2 | -- | -- | -- | -- | 0.0 | 0.0 |
| | All Days | -- | 0.0 | -- | -- | -- | 0.0 | 0.0 |
| OLYM1 | 20% Best | -- | -0.1 | -0.2 | 0.0 | -- | 0.0 | -- |
| | 20% Worst | -0.3 | -0.5 | -0.7 | -0.2 | -- | -- | 0.1 |
| | All Days | -0.1 | -0.2 | -0.3 | -0.1 | -- | 0.0 | 0.0 |
| PASA1 | 20% Best | -- | 0.0 | 0.0 | 0.0 | -- | -- | -- |
| | 20% Worst | -- | -0.2 | -- | -0.2 | 0.0 | -- | -- |
| | All Days | -- | -0.1 | -- | -0.1 | -- | -- | -- |
| SNPA1 | 20% Best | -0.1 | -0.1 | 0.0 | 0.0 | -- | 0.0 | 0.1 |
| | 20% Worst | -0.5 | -0.7 | -0.5 | -0.2 | -- | -- | -- |
| | All Days | -0.3 | -0.3 | -0.2 | -0.1 | -- | -- | 0.1 |
| WHPA1 | 20% Best | -- | 0.0 | -- | -- | -- | -- | -- |
| | 20% Worst | -- | -- | -- | 0.1 | -- | 0.1 | -0.1 |
| | All Days | -- | -- | -- | -- | -- | -- | -- |

*(--) Indicates statistically insignificant trend (<85% confidence level). Annual averages and complete trend statistics for all significance levels are included for each site in Appendix N.

### 6.14.2 Emissions Data

Included here are summaries depicting differences between two emission inventory years that are used to represent the 5-year baseline and current progress periods. The baseline period is represented using a 2002 inventory developed by the WRAP for use in the initial WRAP state SIPs, and the progress period is represented by a 2008 inventory which leverages recent WRAP inventory work for modeling efforts, as referenced in Section 3.2.1. For reference, Table 6.14-7 lists the major emitted pollutants inventoried, the related aerosol species, some of the major sources for each pollutant, and some notes regarding implications of these pollutants. Differences between these baseline and progress period inventories, and a separate summary of annual emissions from electrical generating units (EGUs), are presented in this section.

Table 6.14-7
Washington
Pollutants, Aerosol Species and Major Sources

| Emitted Pollutant | Related Aerosol | Major Sources | Notes |
|---|---|---|---|
| Sulfur Dioxide ($SO_2$) | Ammonium Sulfate | Point Sources; On- and Off-Road Mobile Sources | $SO_2$ emissions are generally associated with anthropogenic sources such as coal-burning power plants, other industrial sources such and refineries and cement plants, and both on- and off-road diesel engines. |
| Oxides of Nitrogen ($NO_X$) | Ammonium Nitrate | On- and Off-Road Mobile Sources; Point Sources; Area Sources | $NO_X$ emissions are generally associated with anthropogenic sources. Common sources include virtually all combustion activities, especially those involving cars, trucks, power plants, and other industrial processes. |
| Ammonia ($NH_3$) | Ammonium Sulfate and Ammonium Nitrate | Area Sources; On-Road Mobile Sources | Gaseous $NH_3$ has implications in particle formation because it can form particulate ammonium. Ammonium is not directly measured by the IMPROVE program, but affects formation potential of ammonium sulfate and ammonium nitrate. All measured nitrate and sulfate is assumed to be associated with ammonium for IMPROVE reporting purposes. |
| Volatile Organic Compounds (VOCs) | Particulate Organic Mass (POM) | Biogenic Emissions; Vehicle Emissions; Area Sources | VOCs are gaseous emissions of carbon compounds, which are often converted to POM through chemical reactions in the atmosphere.<br><br>Estimates for biogenic emissions of VOCs have undergone significant updates since 2002, so changes reported here are more reflective of methodology changes than actual changes in emissions (see Section 3.2.1). |
| Primary Organic Aerosol (POA) | POM | Wildfires; Area Sources | POA represents organic aerosols that are emitted directly as particles, as opposed to gases. Wildfires in the west generally dominate POA emissions, and large wildfire events are generally sporadic and highly variable from year-to-year. |
| Elemental Carbon (EC) | EC | Wildfires; On- and Off-Road Mobile Sources | Large EC events are often associated with large POM events during wildfires. Other sources include both on- and off-road diesel engines. |
| Fine Soil | Soil | Windblown Dust; Fugitive Dust; Road Dust; Area Sources | Fine soil is reported here as the crustal or soil components of $PM_{2.5}$. |
| Coarse Mass (PMC) | Coarse Mass | Windblown Dust; Fugitive Dust | Coarse mass is reported by the IMPROVE Network as the difference between $PM_{10}$ and $PM_{2.5}$ mass measurements. Coarse mass is not separated by species in the same way that $PM_{2.5}$ is speciated, but these measurements are generally associated with crustal components. Similar to crustal $PM_{2.5}$, natural windblown dust is often the largest contributor to PMC. |

#### 6.14.2.1 Changes in Emissions

This section addresses the regulatory question, ***what is the change over the past 5 years in emissions of pollutants contributing to visibility impairment from all sources and activities within the State (40 CFR 51.308 (g)(4))?*** For these summaries, emissions during the baseline years are represented using a 2002 inventory, which was developed with support from the WRAP for use in the original RHR SIP strategy development (termed plan02d). Differences between inventories are represented as the difference between the 2002 inventory, and a 2008 inventory which leverages recent inventory development work performed by the WRAP for the WestJumpAQMS and DEASCO$_3$ modeling projects (termed WestJump2008). Note that the comparisons of differences between inventories does not necessarily reflect a change in emissions, as a number of methodology changes and enhancements have occurred between development of the individual inventories, as referenced in Section 3.2.1. Inventories for all major visibility impairing pollutants are presented for major source categories, and categorized as either anthropogenic or natural emissions. State-wide inventories totals and differences are presented here, and inventory totals on a county level basis are available on the WRAP Technical Support System website (http://vista.cira.colostate.edu/tss/).

Table 6.14-8 and Figure 6.14-7 present the differences between the 2002 and 2008 sulfur dioxide ($SO_2$) inventories by source category. Tables 6.14-9 and Figure 6.14-8 present data for oxides of nitrogen ($NO_X$), and subsequent tables and figures (Tables 6.14-10 through 6.14-15 and Figures 6.14-9 through 6.14-14) present data for ammonia ($NH_3$), volatile organic compounds (VOCs), primary organic aerosol (POA), elemental carbon (EC), fine soil, and coarse mass. General observations regarding emissions inventory comparisons are listed below.

- Decreases for point source inventories were reported for all parameters, with the largest decreases in $SO_2$, $NO_X$, VOCs, fine soil, and coarse mass. Note that decreases in $SO_2$ and $NO_X$ are consistent with the summary of annual EGU emissions included in Section 6.14.2.2.
- Area source inventories showed decreases in all parameters except $NO_X$, with the largest decreases reported for $SO_2$ and VOCs. These changes may be due to a combination of population changes and differences in methodologies used to estimate these emissions, as referenced in Section 3.2.1. One methodology change was the reclassification of some off-road mobile sources (such as some types of marine vessels and locomotives) into the area source category in 2008, which may have contributed to increases in area source inventory totals, but decreases in off-road mobile totals.
- On-road mobile source inventory comparisons showed decreases in most parameters, especially $NO_X$ and VOCs, with slight increases in POA, EC, and coarse mass. Reductions in $NO_X$ and VOC are likely influenced by federal and state emissions standards that have already been implemented. The increases in POA, EC, and coarse mass occurred in all of the WRAP states for on-road mobile inventories, regardless of reductions in $NO_X$ and VOCs, indicating that these increases were likely due use of different on-road models, as referenced in Section 3.2.1.

- Off-road mobile source inventories showed decreases in $NO_X$, $SO_2$, and VOCs, and increases in fine soil and coarse mass, which was consistent with most contiguous WRAP states. These differences were likely due to a combination of actual changes in source contributions and methodology differences, as referenced in Section 3.2.1. As noted previously, one major methodology difference was the reclassification of some off-road mobile sources (such as some types of marine vessels and locomotives) into the area source category in 2008, which may have contributed to decreases in the off-road inventory totals, but increases in area source totals.
- For most parameters, especially POAs, VOCs, and EC, natural fire emission inventory estimates decreased (except for a slight increase in fine soil), and anthropogenic fire estimates increased (except for a decrease in VOCs). Note that these differences are not necessarily reflective of changes in monitored data, as the baseline period is represented by an average of 2000-2004 fire emissions, and the progress period is represented only by the fires that occurred in 2008, as referenced in Section 3.2.1. Also, methodology differences likely contributed to fine soil (for natural fire) and VOCs (for anthropogenic fire) not tracking with the other parameters.
- Comparisons between VOC inventories showed large decreases in biogenic emissions, which was consistent with other contiguous WRAP states. Estimates for biogenic emissions of VOCs have undergone significant updates since 2002, so changes reported here are more reflective of methodology changes than actual changes in emissions, as referenced in Section 3.2.1.
- Coarse mass decreased for the windblown dust inventory comparisons and the combined fugitive/road dust inventories. Large variability in changes in windblown dust was observed for the contiguous WRAP states, which was likely due in large part to enhancements in dust inventory methodology, as referenced in Section 3.2.1, rather than changes in actual emissions.

Table 6.14-8
Washington
Sulfur Dioxide Emissions by Category

| Source Category | Sulfur Dioxide Emissions (tons/year) | | |
|---|---|---|---|
| | **2002 (Plan02d)** | **2008 (WestJump2008)** | **Difference (Percent Change)** |
| **Anthropogenic Sources** | | | |
| Point | 52,885 | 15,465 | -37,420 |
| Area | 7,311 | 3,220 | -4,090 |
| On-Road Mobile | 5,543 | 994 | -4,548 |
| Off-Road Mobile | 13,913 | 703 | -13,210 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 0 | 0 | 0 |
| Anthropogenic Fire | 1,411 | 1,450 | 39 |
| **Total Anthropogenic** | **81,063** | **21,833** | **-59,229 (-73%)** |
| **Natural Sources** | | | |
| Natural Fire | 1,641 | 315 | -1,325 |
| Biogenic | 0 | 0 | 0 |
| Wind Blown Dust | 0 | 0 | 0 |
| **Total Natural** | **1,641** | **315** | **-1,325 (-81%)** |
| **All Sources** | | | |
| **Total Emissions** | **82,703** | **22,149** | **-60,555 (-73%)** |

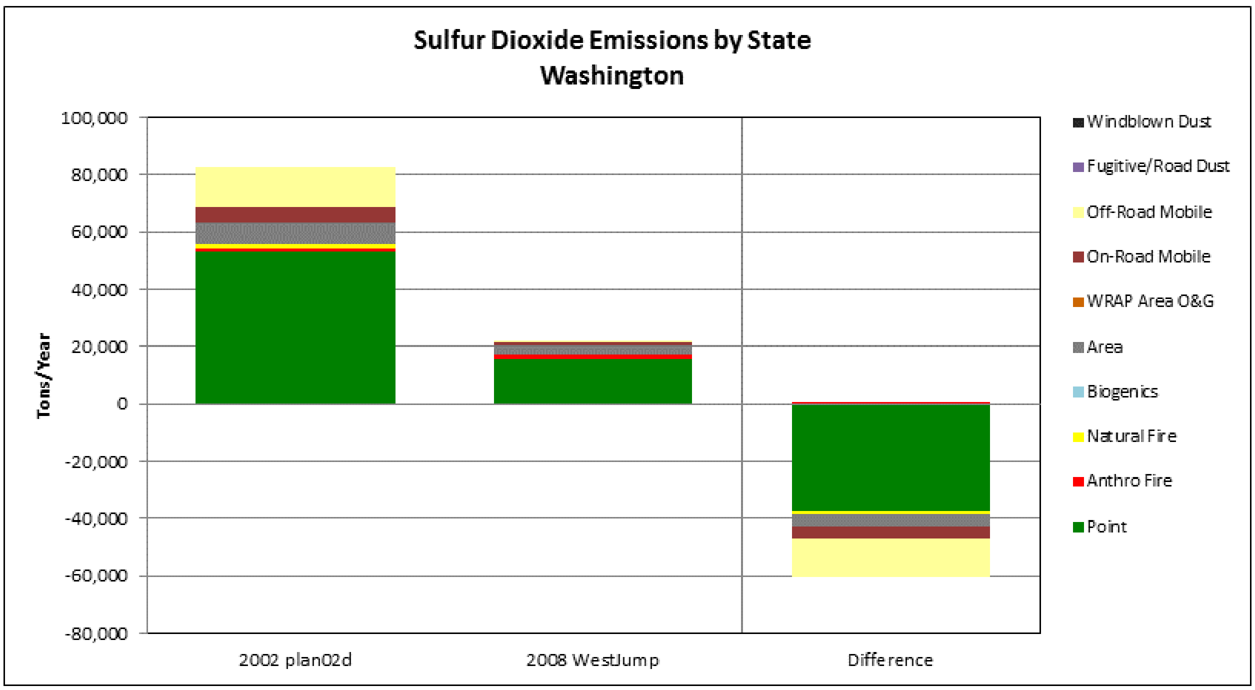



Figure 6.14-7. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Sulfur Dioxide by Source Category for Washington.

Table 6.14-9
Washington
Nitrogen Oxide Emissions by Category

| Source Category | Oxides of nitrogen Emissions (tons/year) | | |
|---|---|---|---|
| | **2002 (Plan02d)** | **2008 (WestJump2008)** | **Difference (Percent Change)** |
| **Anthropogenic Sources** | | | |
| Point | 43,355 | 38,418 | -4,937 |
| Area | 17,587 | 50,287 | 32,700 |
| On-Road Mobile | 201,991 | 141,442 | -60,548 |
| Off-Road Mobile | 84,710 | 38,096 | -46,613 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 0 | 0 | 0 |
| Anthropogenic Fire | 6,821 | 10,269 | 3,448 |
| **Total Anthropogenic** | **354,464** | **278,512** | **-75,952 (-21%)** |
| **Natural Sources** | | | |
| Natural Fire | 5,997 | 2,236 | -3,761 |
| Biogenic | 17,923 | 3,845 | -14,077 |
| Wind Blown Dust | 0 | 0 | 0 |
| **Total Natural** | **23,920** | **6,081** | **-17,839 (-75%)** |
| **All Sources** | | | |
| **Total Emissions** | **378,384** | **284,593** | **-93,790 (-25%)** |

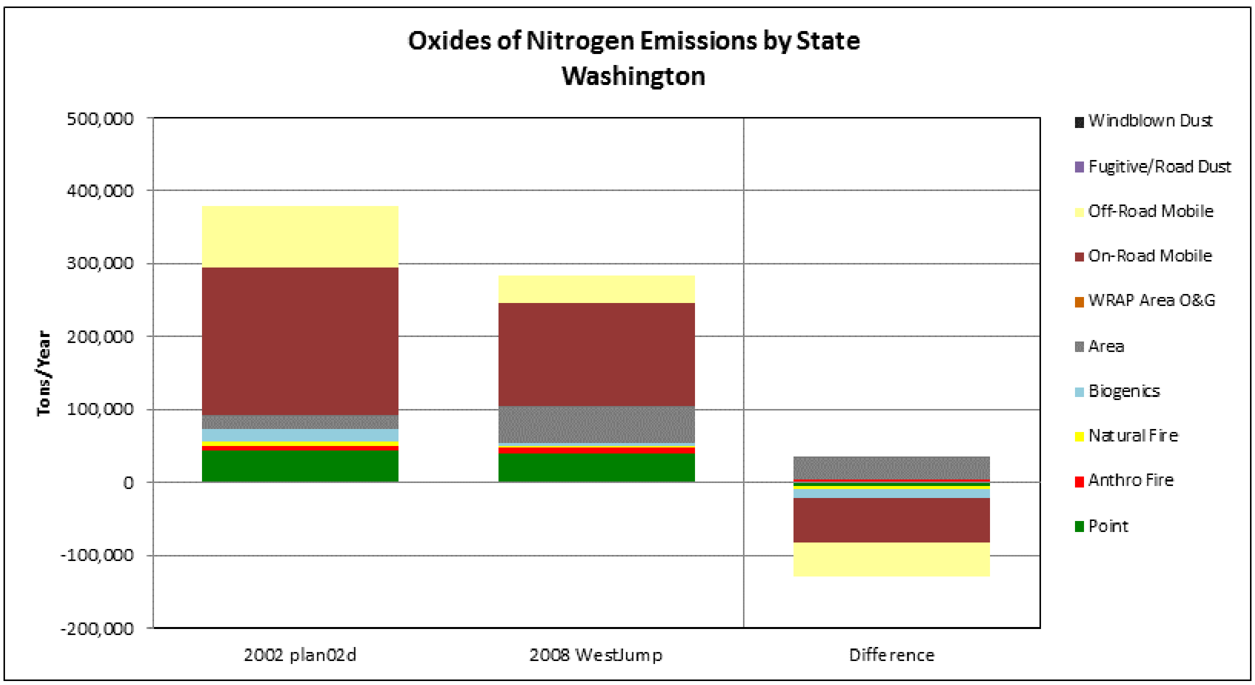



Figure 6.14-8. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Oxides of nitrogen by Source Category for Washington.

Table 6.14-10
Washington
Ammonia Emissions by Category

| Source Category | Ammonia Emissions (tons/year) | | |
|---|---|---|---|
| | **2002 (Plan02d)** | **2008 (WestJump2008)** | **Difference (Percent Change)** |
| **Anthropogenic Sources** | | | |
| Point | 3,863 | 441 | -3,422 |
| Area | 45,218 | 44,368 | -851 |
| On-Road Mobile | 5,211 | 2,543 | -2,668 |
| Off-Road Mobile | 57 | 43 | -14 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 0 | 0 | 0 |
| Anthropogenic Fire | 3,439 | 7,152 | 3,713 |
| **Total Anthropogenic** | **57,789** | **54,548** | **-3,241 (-6%)** |
| **Natural Sources** | | | |
| Natural Fire | 1,265 | 1,556 | 291 |
| Biogenic | 0 | 0 | 0 |
| Wind Blown Dust | 0 | 0 | 0 |
| **Total Natural** | **1,265** | **1,556** | **291 (23%)** |
| **All Sources** | | | |
| **Total Emissions** | **59,054** | **56,104** | **-2,950 (-5%)** |

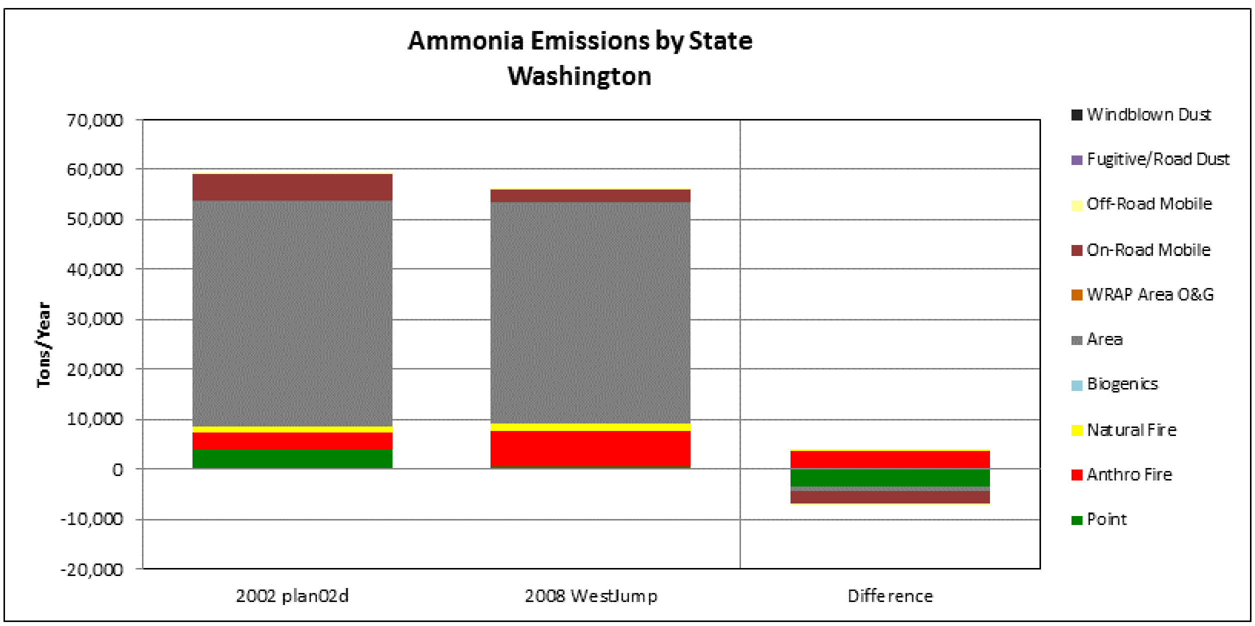



Figure 6.14-9. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Ammonia by Source Category for Washington.

Table 6.14-11
Washington
Volatile Organic Compound Emissions by Category

| Source Category | Volatile Organic Compound Emissions (tons/year) | | |
|---|---|---|---|
| | **2002 (Plan02d)** | **2008 (WestJump2008)** | **Difference (Percent Change)** |
| **Anthropogenic Sources** | | | |
| Point | 18,651 | 12,706 | -5,945 |
| Area | 151,680 | 102,173 | -49,507 |
| On-Road Mobile | 140,181 | 59,343 | -80,838 |
| Off-Road Mobile | 61,601 | 52,264 | -9,337 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 0 | 0 | 0 |
| Anthropogenic Fire | 14,858 | 10,258 | -4,600 |
| **Total Anthropogenic** | **386,971** | **236,744** | **-150,227 (-39%)** |
| **Natural Sources** | | | |
| Natural Fire | 13,160 | 2,301 | -10,859 |
| Biogenic | 642,736 | 224,471 | -418,264 |
| Wind Blown Dust | 0 | 0 | 0 |
| **Total Natural** | **655,896** | **226,772** | **-429,124 (-65%)** |
| **All Sources** | | | |
| **Total Emissions** | **1,042,867** | **463,516** | **-579,351 (-56%)** |

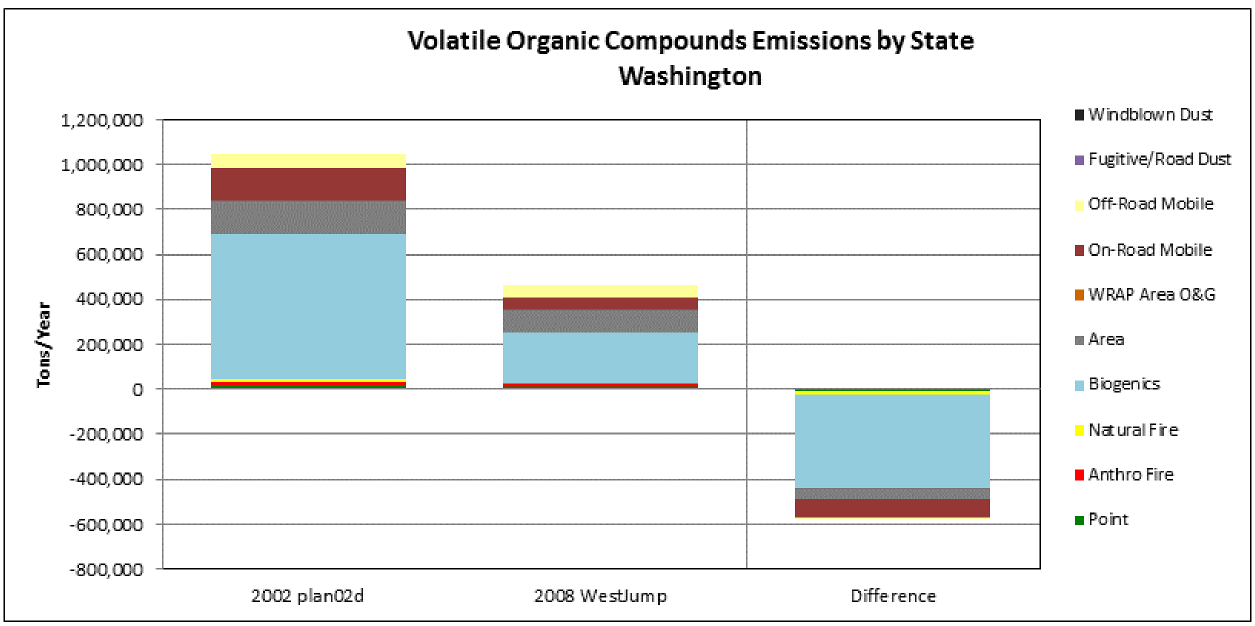


Figure 6.14-10. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Volatile Organic Compounds by Source Category for Washington.

Table 6.14-12
Washington
Primary Organic Aerosol Emissions by Category

| Source Category | Primary Organic Aerosol Emissions (tons/year) | | |
|---|---|---|---|
| | **2002 (Plan02d)** | **2008 (WestJump2008)** | **Difference (Percent Change)** |
| **Anthropogenic Sources** | | | |
| Point* | 763 | 24 | -739 |
| Area | 16,577 | 12,392 | -4,185 |
| On-Road Mobile | 1,821 | 3,557 | 1,737 |
| Off-Road Mobile | 1,948 | 1,559 | -389 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 928 | 825 | -103 |
| Anthropogenic Fire | 10,305 | 20,461 | 10,156 |
| **Total Anthropogenic** | **32,341** | **38,818** | **6,477 (20%)** |
| **Natural Sources** | | | |
| Natural Fire | 17,931 | 4,399 | -13,532 |
| Biogenic | 0 | 0 | 0 |
| Wind Blown Dust | 0 | 0 | 0 |
| **Total Natural** | **17,931** | **4,399** | **-13,532 (-75%)** |
| **All Sources** | | | |
| **Total Emissions** | **50,273** | **43,218** | **-7,055 (-14%)** |

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

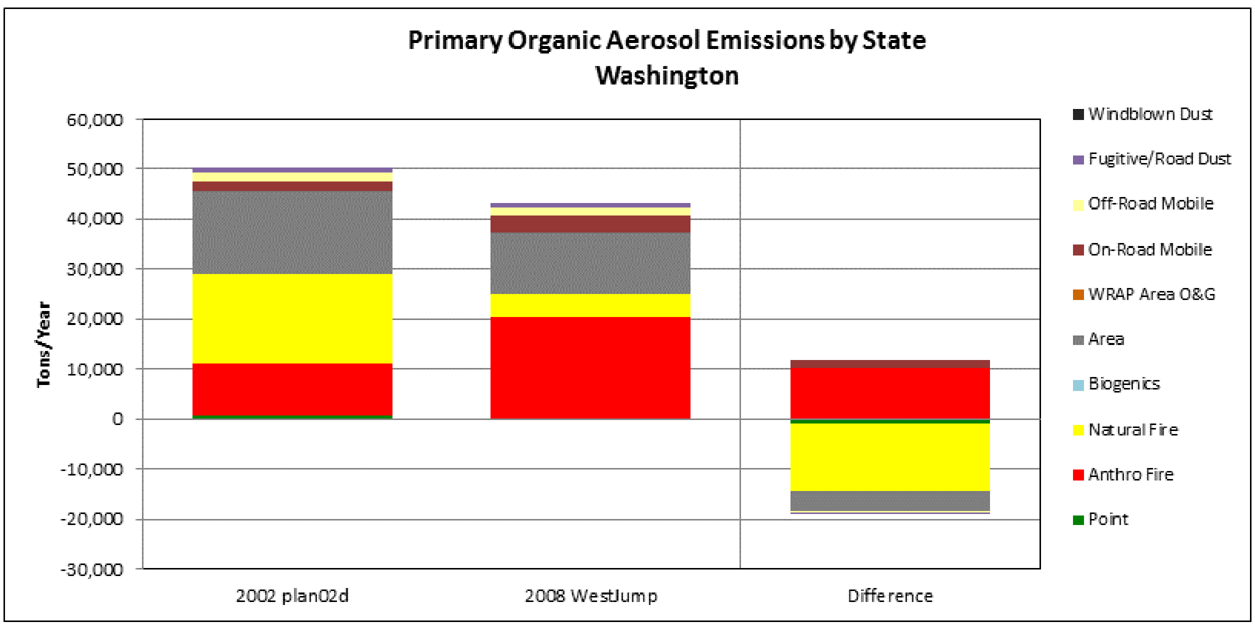



Figure 6.14-11. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Primary Organic Aerosol by Source Category for Washington.

Table 6.14-13
Washington
Elemental Carbon Emissions by Category

| Source Category | Elemental Carbon Emissions (tons/year) | | |
|---|---|---|---|
| | **2002 (Plan02d)** | **2008 (WestJump2008)** | **Difference (Percent Change)** |
| **Anthropogenic Sources** | | | |
| Point* | 144 | 22 | -122 |
| Area | 2,180 | 2,284 | 103 |
| On-Road Mobile | 2,003 | 5,698 | 3,695 |
| Off-Road Mobile | 4,213 | 1,948 | -2,265 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 64 | 24 | -40 |
| Anthropogenic Fire | 780 | 3,033 | 2,253 |
| **Total Anthropogenic** | **9,385** | **13,008** | **3,623 (39%)** |
| **Natural Sources** | | | |
| Natural Fire | 3,717 | 721 | -2,996 |
| Biogenic | 0 | 0 | 0 |
| Wind Blown Dust | 0 | 0 | 0 |
| **Total Natural** | **3,717** | **721** | **-2,996 (-81%)** |
| **All Sources** | | | |
| **Total Emissions** | **13,102** | **13,729** | **627 (5%)** |

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

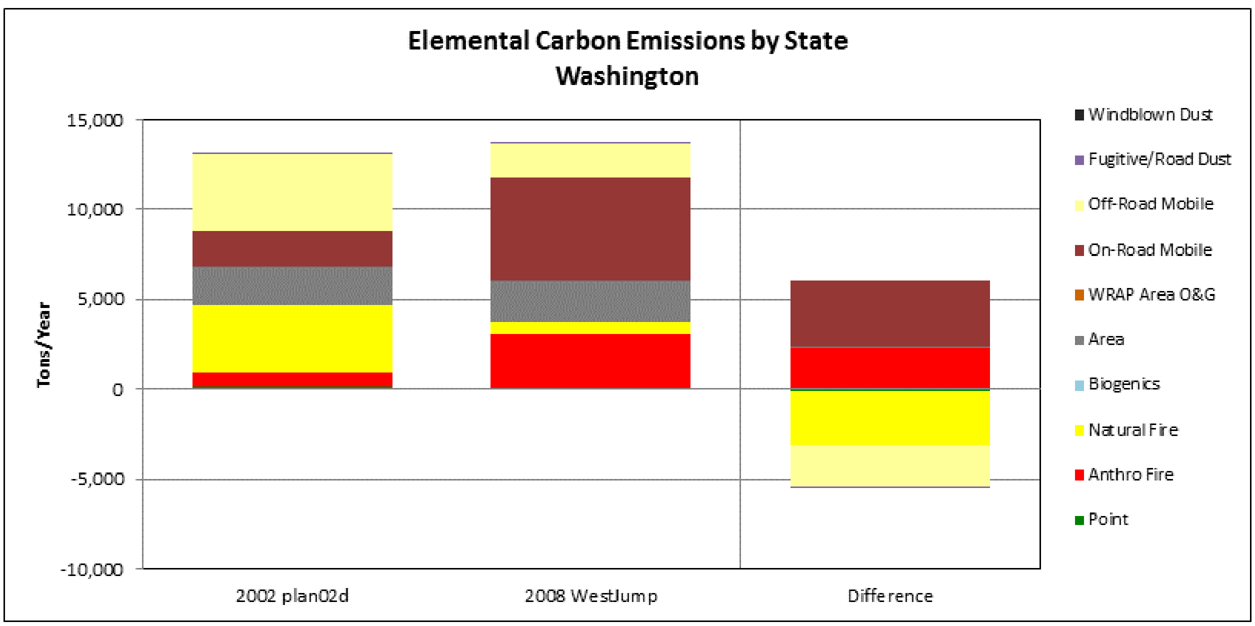



Figure 6.14-12. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Elemental Carbon by Source Category for Washington.

Table 6.14-14
Washington
Fine Soil Emissions by Category

| Source Category | Fine Soil Emissions (tons/year) | | |
|---|---|---|---|
| | 2002 (Plan02d) | 2008 (WestJump2008) | Difference (Percent Change) |
| **Anthropogenic Sources** | | | |
| Point* | 2,257 | 355 | -1,902 |
| Area | 12,708 | 5,726 | -6,982 |
| On-Road Mobile | 1,154 | 602 | -552 |
| Off-Road Mobile | 0 | 109 | 109 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 15,776 | 15,158 | -619 |
| Anthropogenic Fire | 3,869 | 7,479 | 3,610 |
| **Total Anthropogenic** | **35,764** | **29,428** | **-6,336 (-18%)** |
| **Natural Sources** | | | |
| Natural Fire | 1,139 | 1,637 | 498 |
| Biogenic | 0 | 0 | 0 |
| Wind Blown Dust | 5,401 | 4,520 | -882 |
| **Total Natural** | **6,540** | **6,156** | **-384 (-6%)** |
| **All Sources** | | | |
| **Total Emissions** | **42,304** | **35,585** | **-6,719 (-16%)** |

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

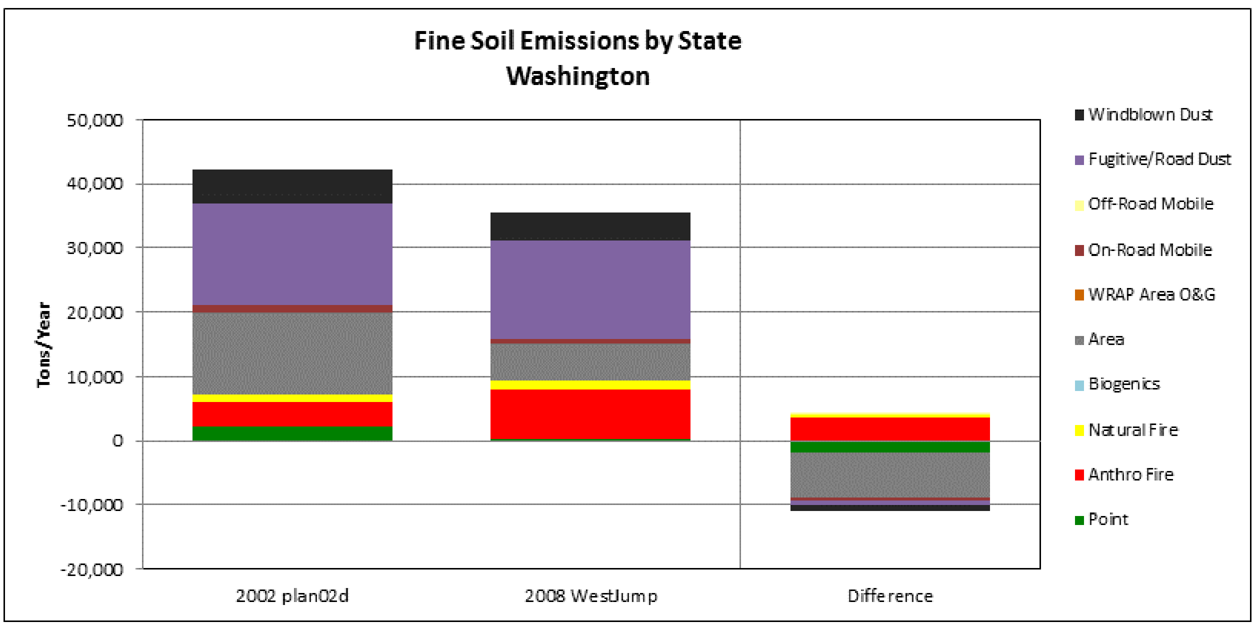



Figure 6.14-13. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Fine Soil by Source Category for Washington.

Table 6.14-15
Washington
Coarse Mass Emissions by Category

| Source Category | Coarse Mass Emissions (tons/year) | | |
|---|---|---|---|
| | **2002 (Plan02d)** | **2008 (WestJump2008)** | **Difference (Percent Change)** |
| **Anthropogenic Sources** | | | |
| Point* | 6,244 | 866 | -5,377 |
| Area | 2,083 | 650 | -1,433 |
| On-Road Mobile | 1,079 | 6,313 | 5,234 |
| Off-Road Mobile | 0 | 181 | 181 |
| Area Oil and Gas | 0 | 0 | 0 |
| Fugitive and Road Dust | 92,749 | 81,331 | -11,417 |
| Anthropogenic Fire | 806 | 3,925 | 3,119 |
| **Total Anthropogenic** | **102,961** | **93,267** | **-9,694 (-9%)** |
| **Natural Sources** | | | |
| Natural Fire | 3,856 | 844 | -3,012 |
| Biogenic | 0 | 0 | 0 |
| Wind Blown Dust | 48,612 | 40,679 | -7,934 |
| **Total Natural** | **52,469** | **41,523** | **-10,946 (-21%)** |
| **All Sources** | | | |
| **Total Emissions** | **155,430** | **134,789** | **-20,640 (-13%)** |

*Point source data includes only oil and gas and regulated CEM sources. More comprehensive point source data were not available at the time this report was prepared but will be made available through the WRAP TSS (http://vista.cira.colostate.edu/tss/).

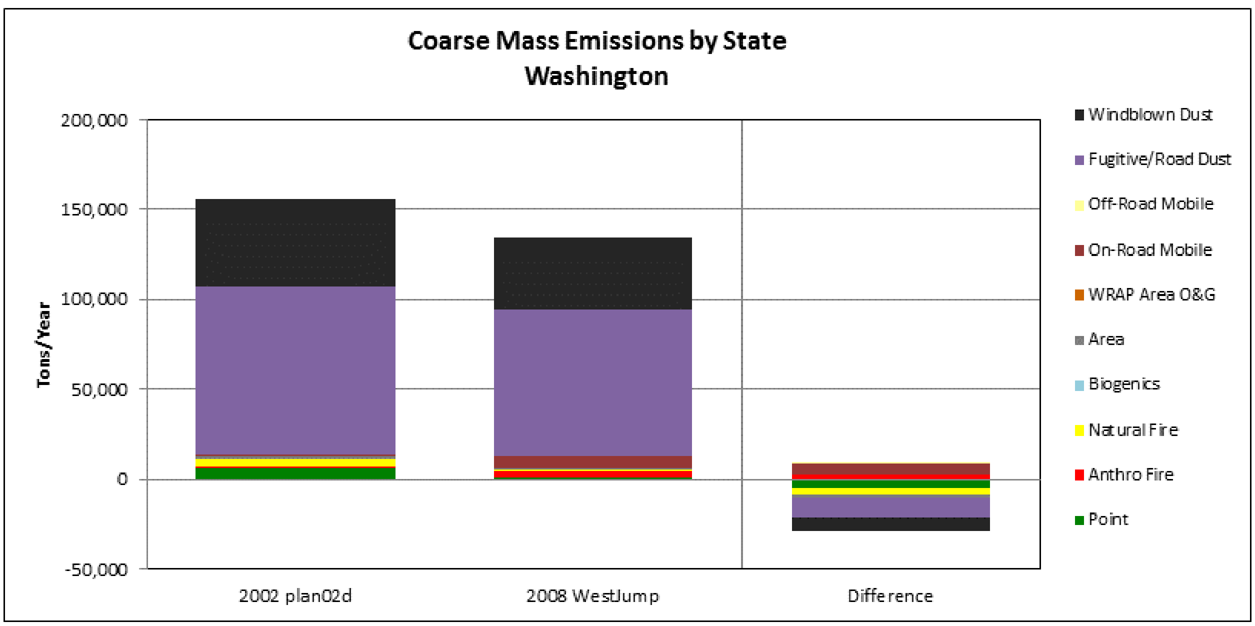



Figure 6.14-14. 2002 and 2008 Emission and Difference between Emissions Inventory Totals, for Coarse Mass by Source Category for Washington.

### 6.14.2.2 EGU Summary

As described in previous sections, differences between the baseline and progress period inventories presented here do not necessarily represent changes in actual emissions because numerous updates in inventory methodologies have occurred between the development of the separate inventories. Also, the 2002 baseline and 2008 progress period inventories represent only annual snapshots of emissions estimates, which may not be representative of the current 5-year monitoring period. To show a major example of year-to-year changes in emissions, annual emission totals for Washington coal-fired electrical generating units (EGU) are presented here. EGU emissions are some of the more consistently reported emissions, as tracked in EPA's Air Markets Program Database for permitted Title V facilities in the state (http://ampd.epa.gov/ampd/). RHR implementation plans are required to pay specific attention to certain major stationary sources, including EGUs, built between 1962 and 1977.

Figure 6.14-17 presents a sum of annual $NO_X$ and $SO_2$ emissions as reported for Washington coal-fired EGU sources between 1996 and 2010. While these types of facilities are targeted for controls in state regional haze SIPs, it should be noted that other controls separate from the RHR may have been implemented. The chart shows a sharp decline in $SO_2$ emissions between 2000 and 2003, and smaller but steady declines in $NO_X$. The decline in $SO_2$ during the baseline period is due to controls approved by the EPA as Reasonable Attributable Visibility Impairment (RAVI) BART. Note that RHR BART requirements for additional $NO_X$ emission reductions became effective on January 1, 2013.

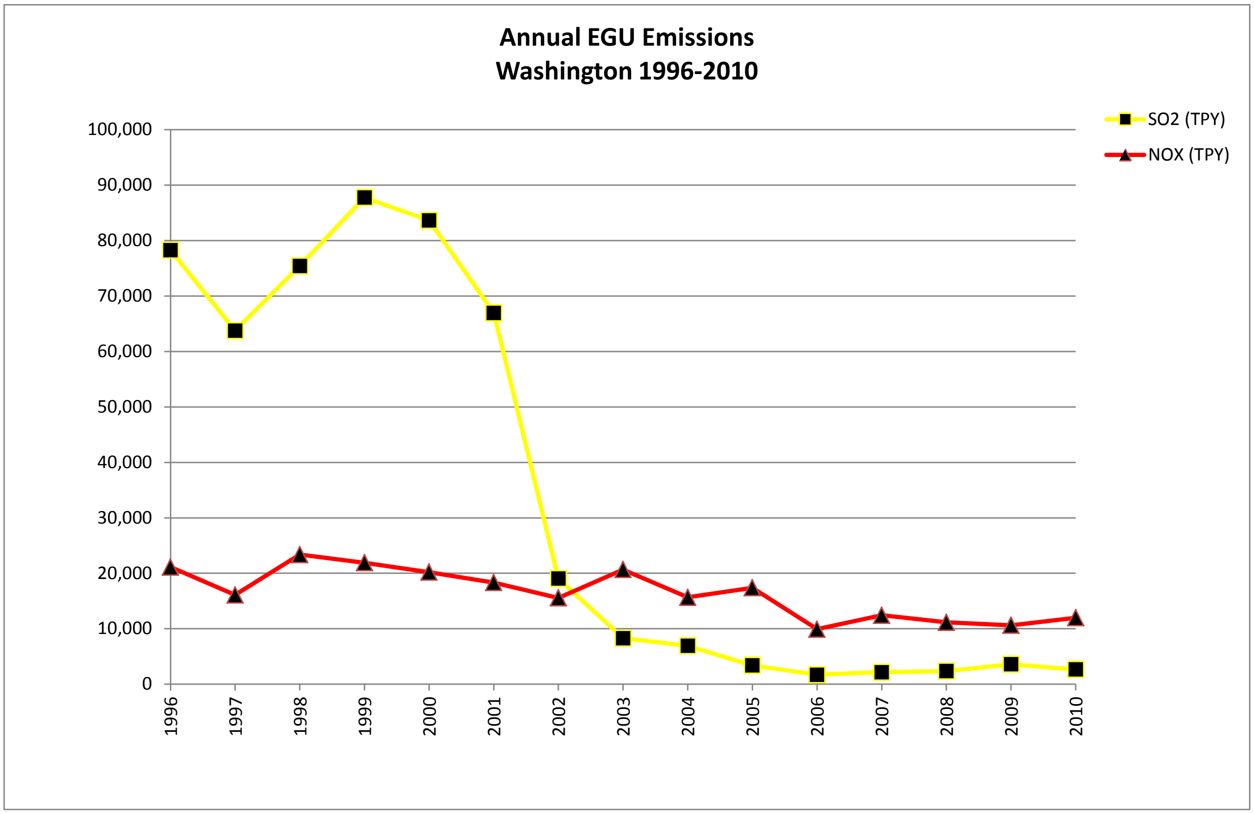



Figure 6.14-8. Sum of EGU Emissions of $SO_2$ and $NO_X$ reported between 1996 and 2010 for Washington.

# APPENDIX N:

# Washington Class I Area Monitoring Data Summary Tables and Charts

**Includes the following subsections:**

| Subsection | IMPROVE Monitor | Class I Area(s) Represented |
|---|---|---|
| N.1 | MORA1 | Mount Rainer NP |
| N.2 | NOCA1 | North Cascades NP and Glacier Peak WA |
| N.3 | OLYM1 | Olympic NP |
| N.4 | PASA1 | Pasayten WA |
| N.5 | SNPA1 | Alpine Lakes WA |
| N.6 | WHPA1 | Goat Rocks WA and Mount Adams WA |

## N.1. MOUNT RAINER NP (MORA1)

The following tables and figures are presented in this section for the Mount Rainer NP represented by the MORA1 IMPROVE Monitor:

- **Table N.1-1: Annual Averages, 5-Year Period Averages, and Trends:** Table of averages and other metrics for the 20% least impaired days, the 20% most impaired days, and all sampled days is presented.

- **Figure N.1-1: Annual and 5-Year Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.1-2: Annual and 5-Year Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.1-3: 20% Most Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component for the 20% most impaired days are presented.

- **Figure N.1-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure N.1-5: 2000-2004 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the baseline period are presented.

- **Figure N.1-6: 2005-2009 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the progress period are presented.

- **Figure N.1-7: 2000-2004 Progress Period Extinction, All Sampled Days:** Stacked bar charts depicting daily averages by year and component for the baseline period are presented.

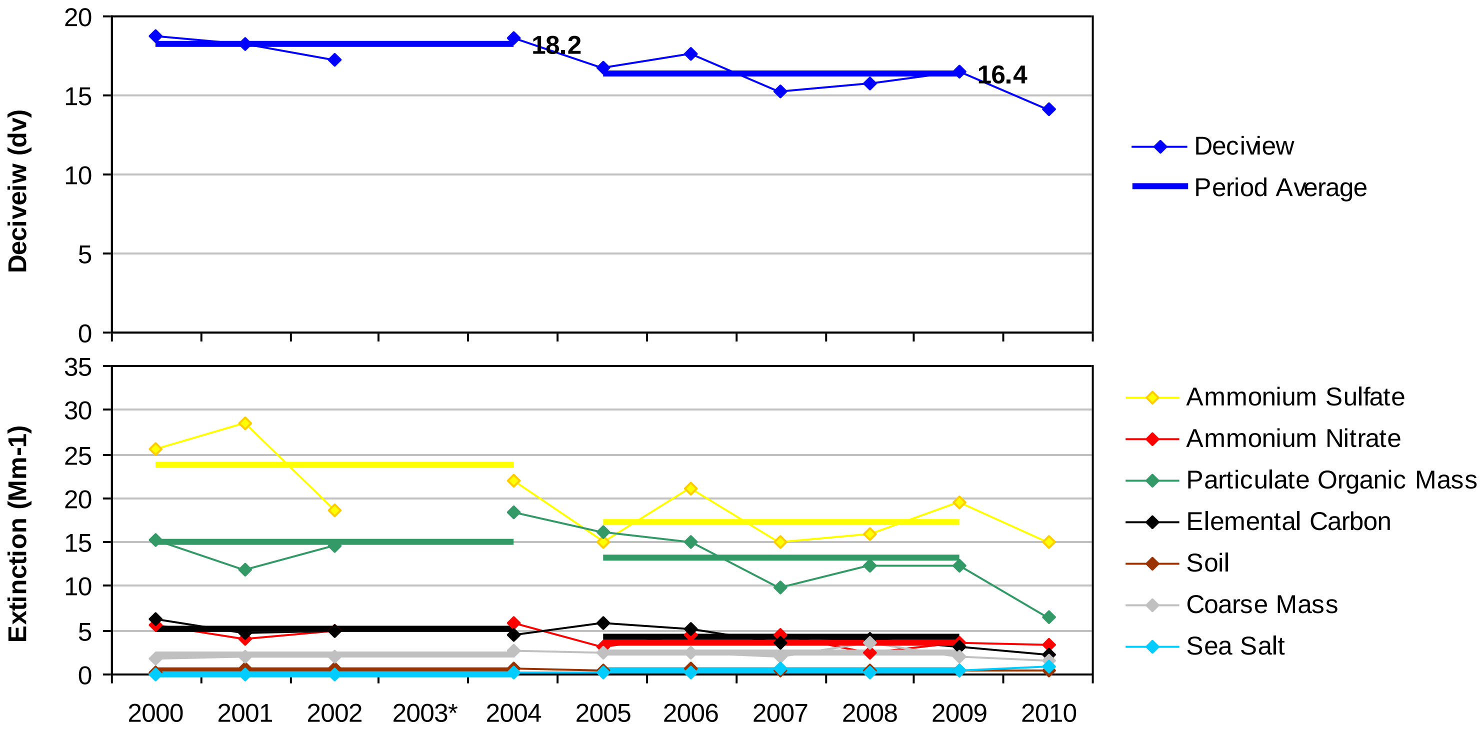
- **Figure N.1-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

## Table N.1-1
## Mount Rainier NP, WA (MORA1 Site)
## Annual Averages, 5-Year Period Averages and Trends

| Group | Baseline Period | | | | | Progress Period | | | | | | 2000-2009 Trend Statistics* | | Period Averages** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Slope (change/yr.) | p-value | Baseline (B) | Progress (P) | Difference (P -B) | Percent Change |
| **Deciview (dv)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 6.1 | 6.1 | 4.8 | --- | 4.9 | 5.7 | 4.8 | 5.1 | 4.7 | 4.3 | 3.5 | -0.2 | 0.0 | 5.5 | 4.9 | -0.6 | -11% |
| Worst 20% Days | 18.8 | 18.3 | 17.3 | --- | 18.6 | 16.8 | 17.6 | 15.3 | 15.8 | 16.5 | 14.1 | -0.4 | 0.0 | 18.2 | 16.4 | -1.8 | -10% |
| All Days | 12.6 | 12.0 | 11.4 | --- | 11.9 | 11.5 | 11.1 | 9.9 | 10.3 | 10.2 | 8.5 | -0.3 | 0.0 | 12.0 | 10.6 | -1.4 | -12% |
| **Total Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 18.5 | 18.4 | 16.3 | --- | 16.5 | 17.9 | 16.3 | 16.6 | 16.2 | 15.5 | 14.2 | -0.3 | 0.0 | 17.4 | 16.5 | -0.9 | -5% |
| Worst 20% Days | 66.0 | 62.9 | 56.7 | --- | 65.6 | 54.4 | 59.9 | 47.0 | 49.8 | 52.5 | 41.3 | -1.9 | 0.0 | 62.8 | 52.7 | -10.1 | -16% |
| All Days | 39.2 | 36.7 | 34.4 | --- | 37.1 | 34.3 | 33.9 | 28.9 | 30.5 | 30.5 | 25.4 | -1.0 | 0.0 | 36.8 | 31.6 | -5.2 | -14% |
| **Ammonium Sulfate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 3.1 | 3.0 | 2.1 | --- | 2.1 | 3.2 | 2.0 | 2.3 | 2.5 | 2.2 | 1.5 | -0.1 | 0.3 | 2.6 | 2.5 | -0.1 | -4% |
| Worst 20% Days | 25.6 | 28.6 | 18.6 | --- | 22.1 | 14.9 | 21.0 | 15.0 | 15.8 | 19.6 | 15.1 | -0.8 | 0.1 | 23.7 | 17.3 | -6.4 | -27% |
| All Days | 12.8 | 13.1 | 9.7 | --- | 10.3 | 9.4 | 10.1 | 7.6 | 8.8 | 9.1 | 7.1 | -0.4 | 0.0 | 11.5 | 9.0 | -2.5 | -22% |
| **Ammonium Nitrate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 0.7 | 0.8 | 0.6 | --- | 0.5 | 0.4 | 0.4 | 0.4 | 0.5 | 0.4 | 0.3 | 0.0 | 0.0 | 0.6 | 0.4 | -0.2 | -33% |
| Worst 20% Days | 5.7 | 4.1 | 4.9 | --- | 5.9 | 3.2 | 4.5 | 4.5 | 2.4 | 3.5 | 3.3 | -0.2 | 0.1 | 5.1 | 3.6 | -1.5 | -29% |
| All Days | 2.8 | 2.4 | 2.6 | --- | 2.5 | 1.7 | 2.1 | 1.8 | 1.8 | 1.7 | 1.4 | -0.1 | 0.0 | 2.6 | 1.8 | -0.8 | -31% |
| **Particulate Organic Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 1.9 | 1.7 | 1.2 | --- | 1.2 | 1.4 | 1.0 | 1.2 | 0.9 | 0.7 | 0.4 | -0.1 | 0.0 | 1.5 | 1.0 | -0.5 | -33% |
| Worst 20% Days | 15.3 | 11.8 | 14.7 | --- | 18.5 | 16.2 | 15.0 | 9.8 | 12.3 | 12.4 | 6.5 | -0.3 | 0.2 | 15.1 | 13.1 | -2.0 | -13% |
| All Days | 7.3 | 5.6 | 6.6 | --- | 8.0 | 7.0 | 5.7 | 4.4 | 4.8 | 5.1 | 2.8 | -0.3 | 0.1 | 6.9 | 5.4 | -1.5 | -22% |
| **Elemental Carbon Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 0.7 | 0.9 | 0.5 | --- | 0.5 | 0.7 | 0.7 | 0.5 | 0.3 | 0.4 | 0.3 | 0.0 | 0.0 | 0.7 | 0.5 | -0.2 | -29% |
| Worst 20% Days | 6.3 | 4.8 | 4.9 | --- | 4.6 | 5.9 | 5.2 | 3.6 | 3.9 | 3.2 | 2.2 | -0.2 | 0.0 | 5.1 | 4.4 | -0.7 | -14% |
| All Days | 3.1 | 2.5 | 2.6 | --- | 2.6 | 3.0 | 2.4 | 1.7 | 1.8 | 1.7 | 1.2 | -0.1 | 0.0 | 2.7 | 2.1 | -0.6 | -22% |
| **Soil Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 0.1 | 0.1 | 0.0 | --- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0% |
| Worst 20% Days | 0.3 | 0.6 | 0.6 | --- | 0.6 | 0.4 | 0.6 | 0.4 | 0.6 | 0.4 | 0.5 | 0.0 | 0.5 | 0.5 | 0.5 | 0.0 | 0% |
| All Days | 0.2 | 0.3 | 0.2 | --- | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.0 | 0.3 | 0.2 | 0.2 | 0.0 | 0% |
| **Coarse Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 0.5 | 0.6 | 0.6 | --- | 0.5 | 0.6 | 0.3 | 0.5 | 0.4 | 0.4 | 0.3 | 0.0 | 0.1 | 0.5 | 0.4 | -0.1 | -20% |
| Worst 20% Days | 1.9 | 2.1 | 2.1 | --- | 2.7 | 2.4 | 2.5 | 2.0 | 3.5 | 2.0 | 1.6 | 0.1 | 0.2 | 2.2 | 2.5 | 0.3 | 14% |
| All Days | 1.3 | 1.3 | 1.2 | --- | 1.7 | 1.4 | 1.3 | 1.2 | 1.4 | 1.1 | 1.0 | 0.0 | 0.4 | 1.4 | 1.3 | -0.1 | -7% |
| **Sea Salt Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | 0.5 | 0.5 | 0.4 | --- | 0.6 | 0.6 | 0.8 | 0.6 | 0.5 | 0.4 | 0.3 | 0.0 | 0.3 | 0.5 | 0.6 | 0.1 | 20% |
| Worst 20% Days | 0.0 | 0.0 | 0.0 | --- | 0.2 | 0.3 | 0.2 | 0.7 | 0.3 | 0.4 | 1.0 | 0.0 | 0.0 | 0.1 | 0.4 | 0.3 | >100% |
| All Days | 0.8 | 0.5 | 0.4 | --- | 0.8 | 0.6 | 1.1 | 0.9 | 0.6 | 0.7 | 0.7 | 0.0 | 0.4 | 0.6 | 0.8 | 0.2 | 33% |

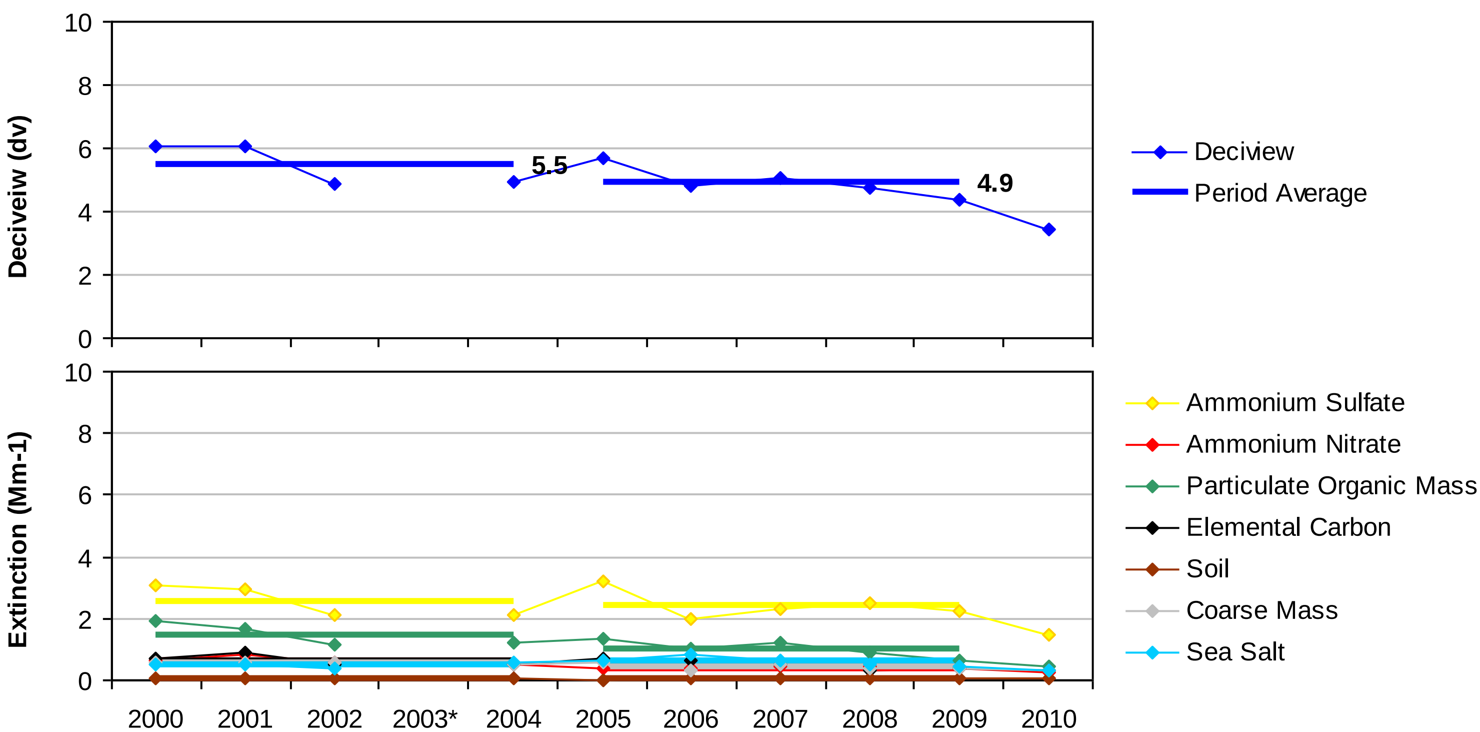
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---" Indicates a missing year that did not meet RHR data completeness criteria.

**Figure N.1-1**
**Mount Rainer NP, WA (MORA1 Site)**
**Annual and 5-Year Period Averages**
**20% Most Impaired Visibility Days**



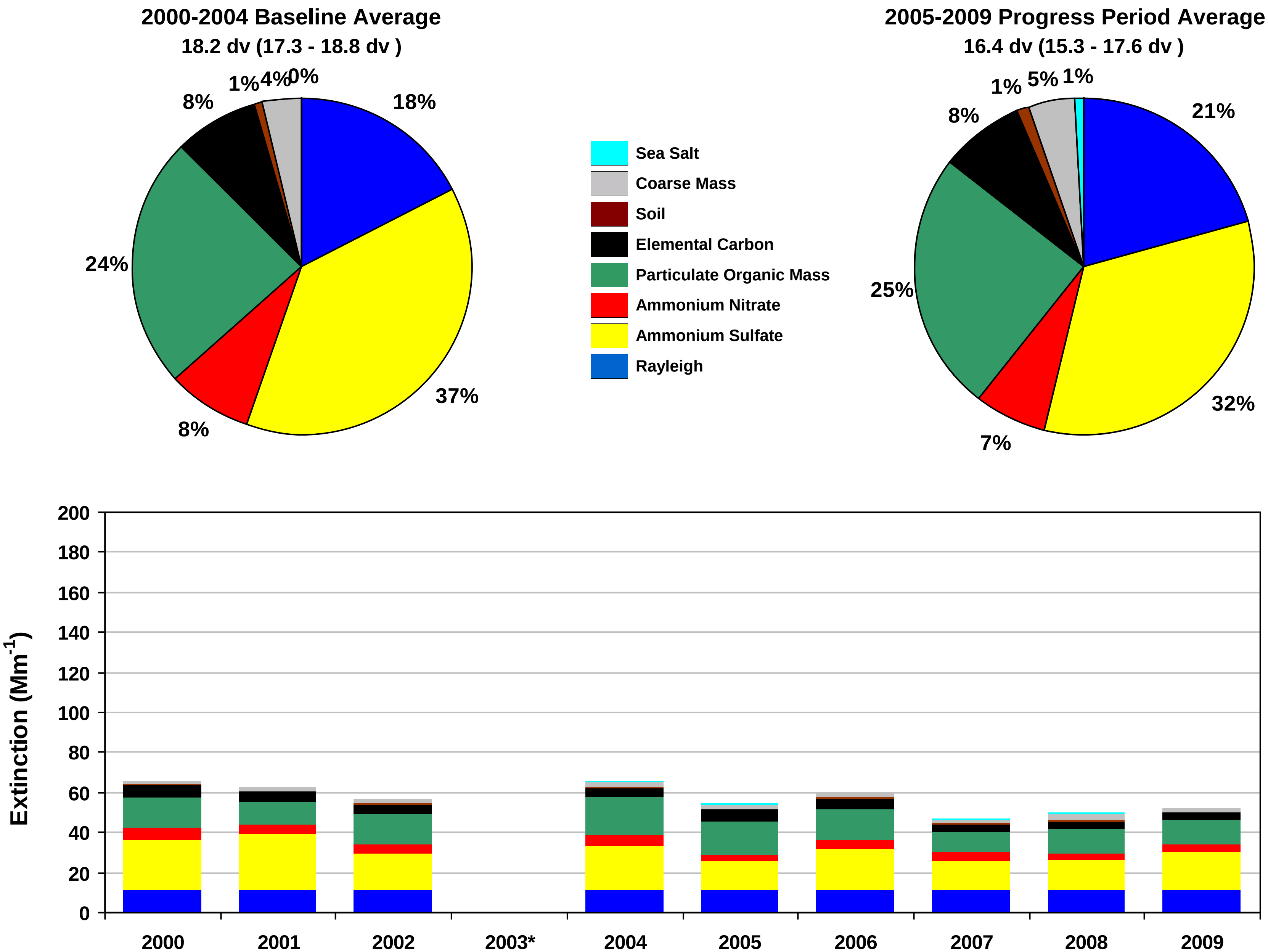

*Missing years did not meet RHR data completeness criteria.

**Figure N.1-2**
**Mount Rainer NP, WA (MORA1 Site)**
**Annual and 5-Year Period Averages**
**20% Least Impaired Visibility Days**



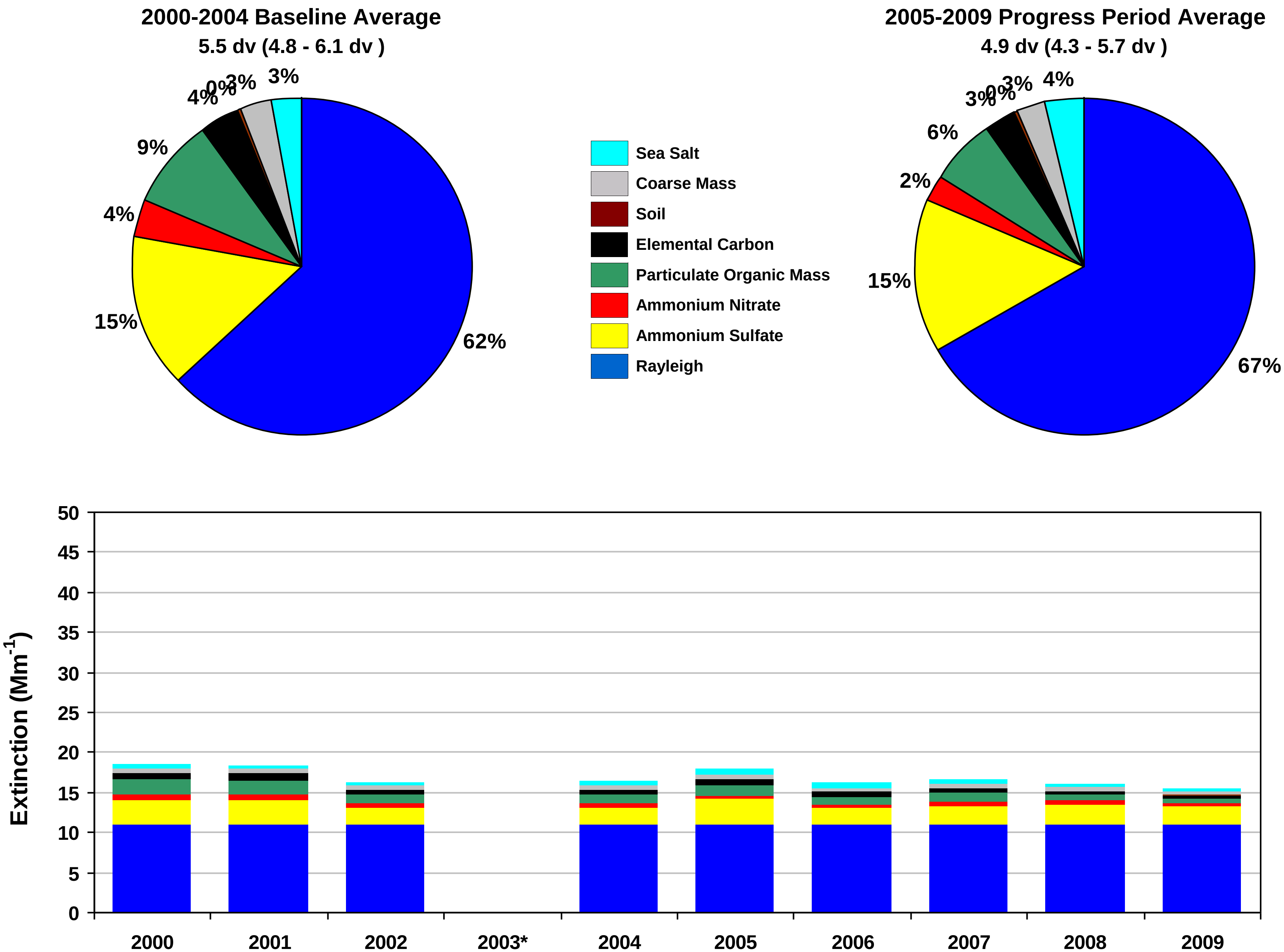

*Missing years did not meet RHR data completeness criteria.

## Figure N.1-3
## Mount Rainer NP, WA (MORA1 Site)
## 20% Most Impaired Visibility Days



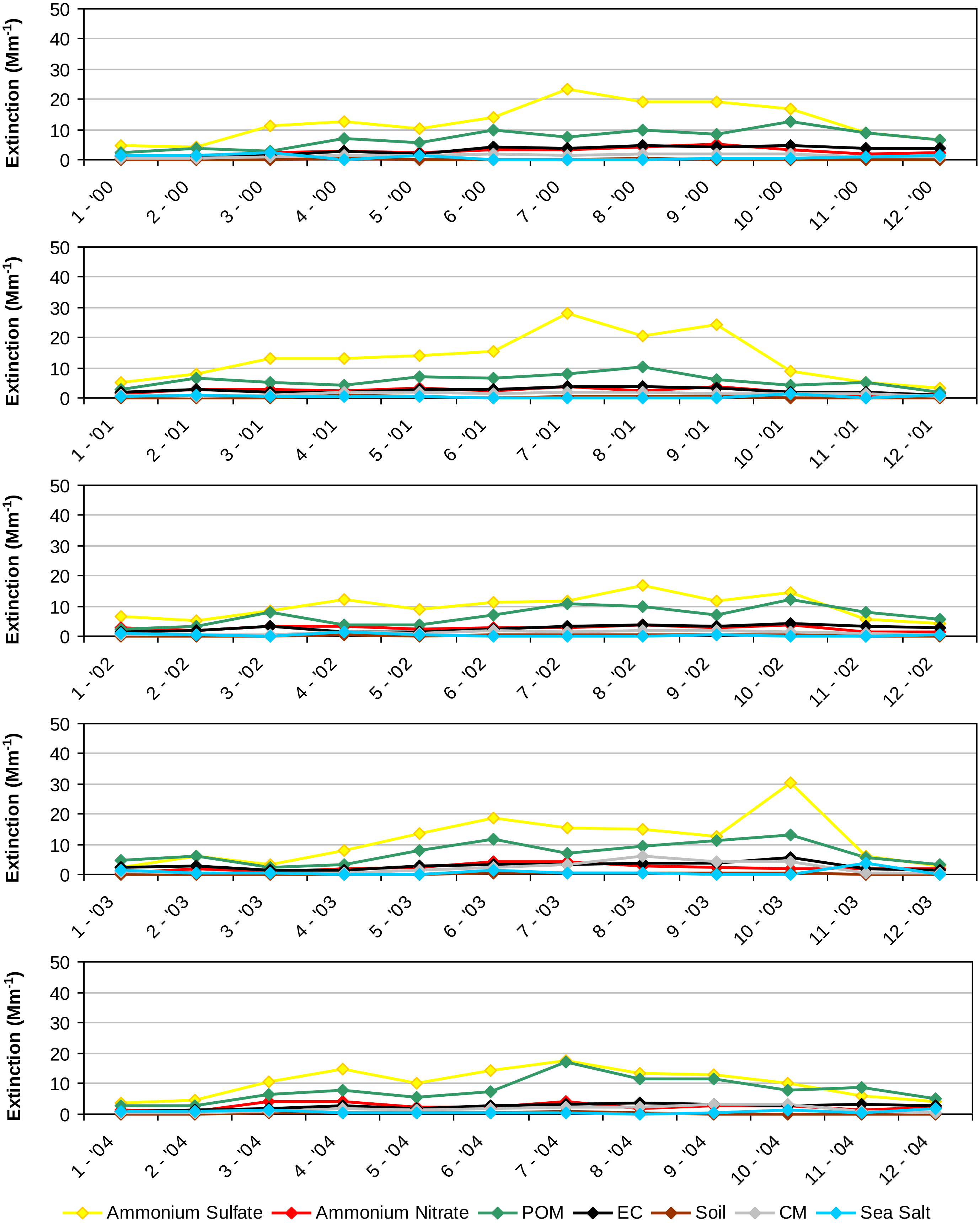

*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.1-4**
**Mount Rainer NP, WA (MORA1 Site)**
**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.1-5**
**Mount Rainer NP, WA (MORA1 Site)**
**2000-2004 Monthly Average Aerosol Extinction, All Monitored Days**




*Note that monthly averages for the year 2003 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.1-6**
**Mount Rainer NP, WA (MORA1 Site)**
**2005-2009 Monthly Average Aerosol Extinction, All Monitored Days**

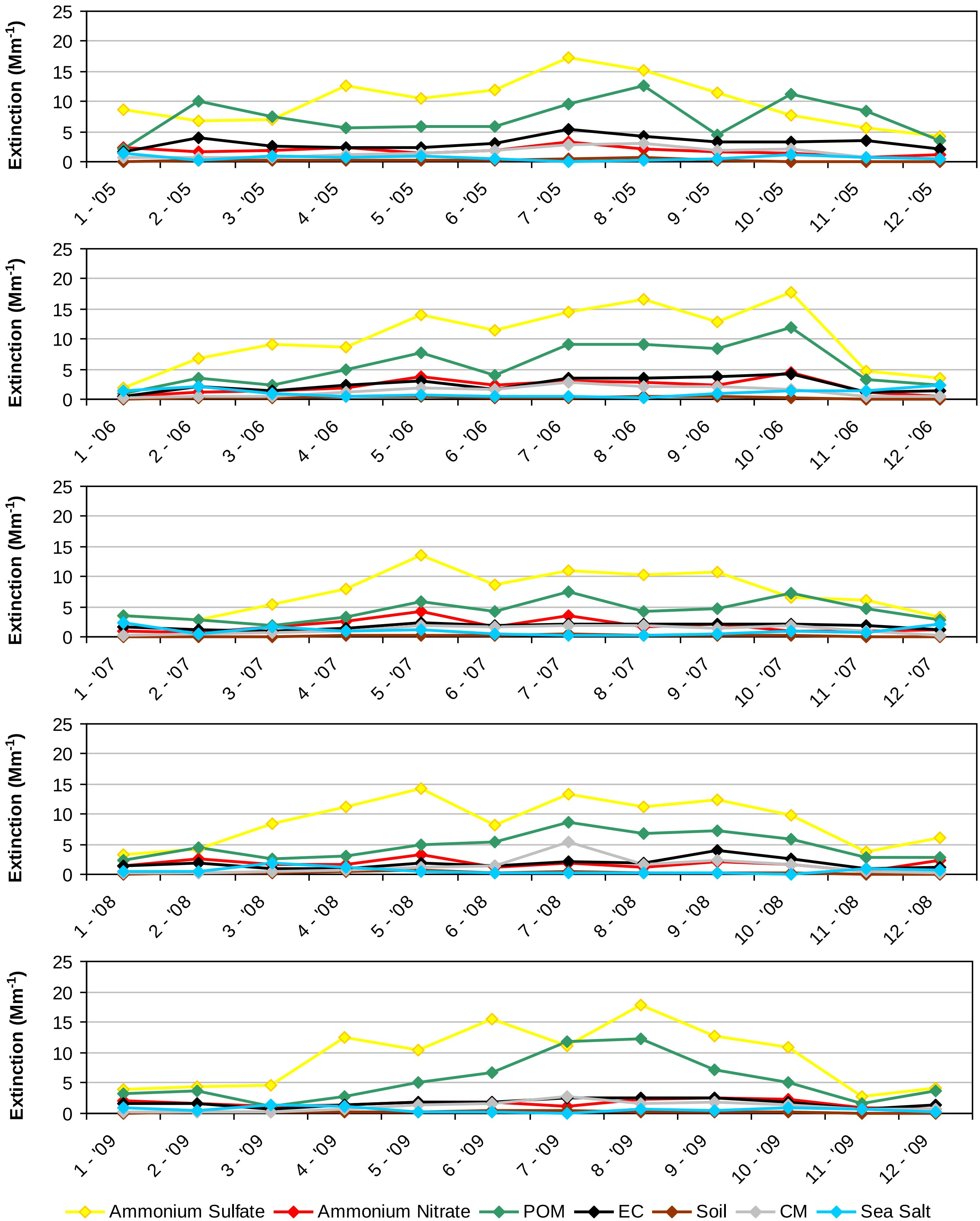
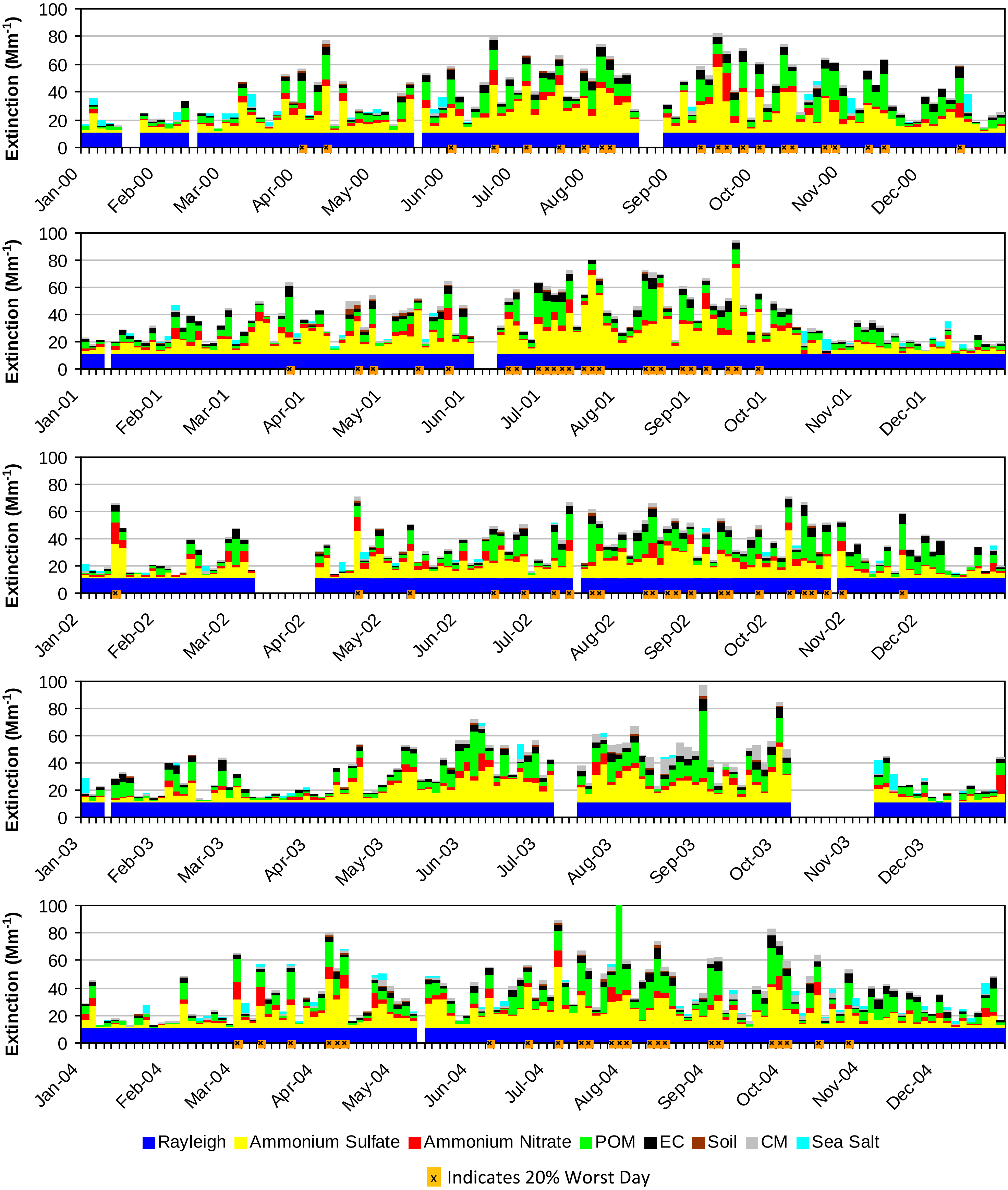
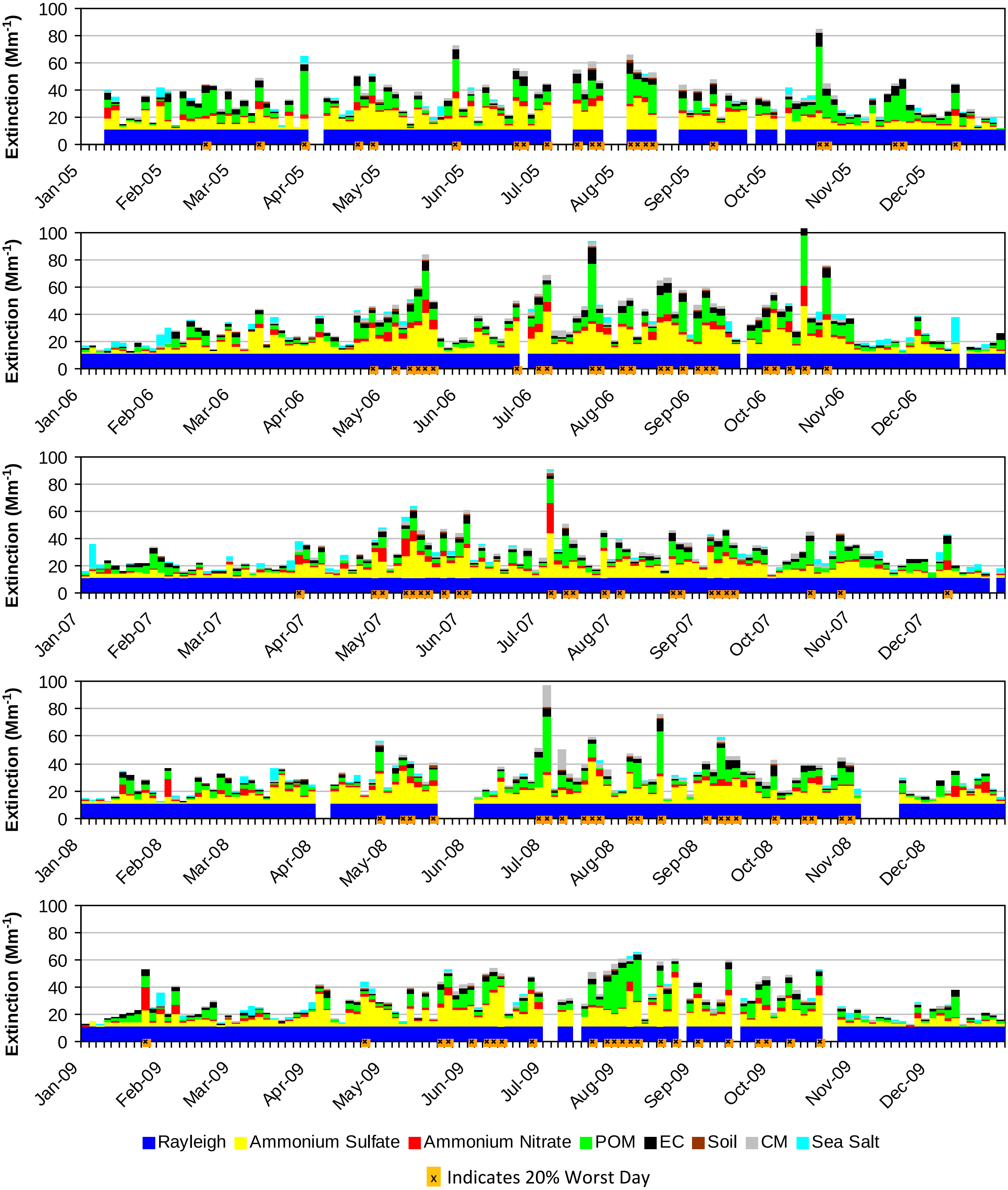


**Figure N.1-7**
**Mount Rainer NP, WA (MORA1 Site)**
**2000-2004 Progress Period Extinction, All Sampled Days**




*Note that daily averages for the year 2003 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.1-8**
**Mount Rainer NP, WA (MORA1 Site)**
**2005-2009 Progress Period Extinction, All Sampled Days**



## N.2. NORTH CASCADES NP AND GLACIER PEAK WA (NOCA1)

The following tables and figures are presented in this section for the North Cascades NP and Glacier Peak WA represented by the NOCA1 IMPROVE Monitor:

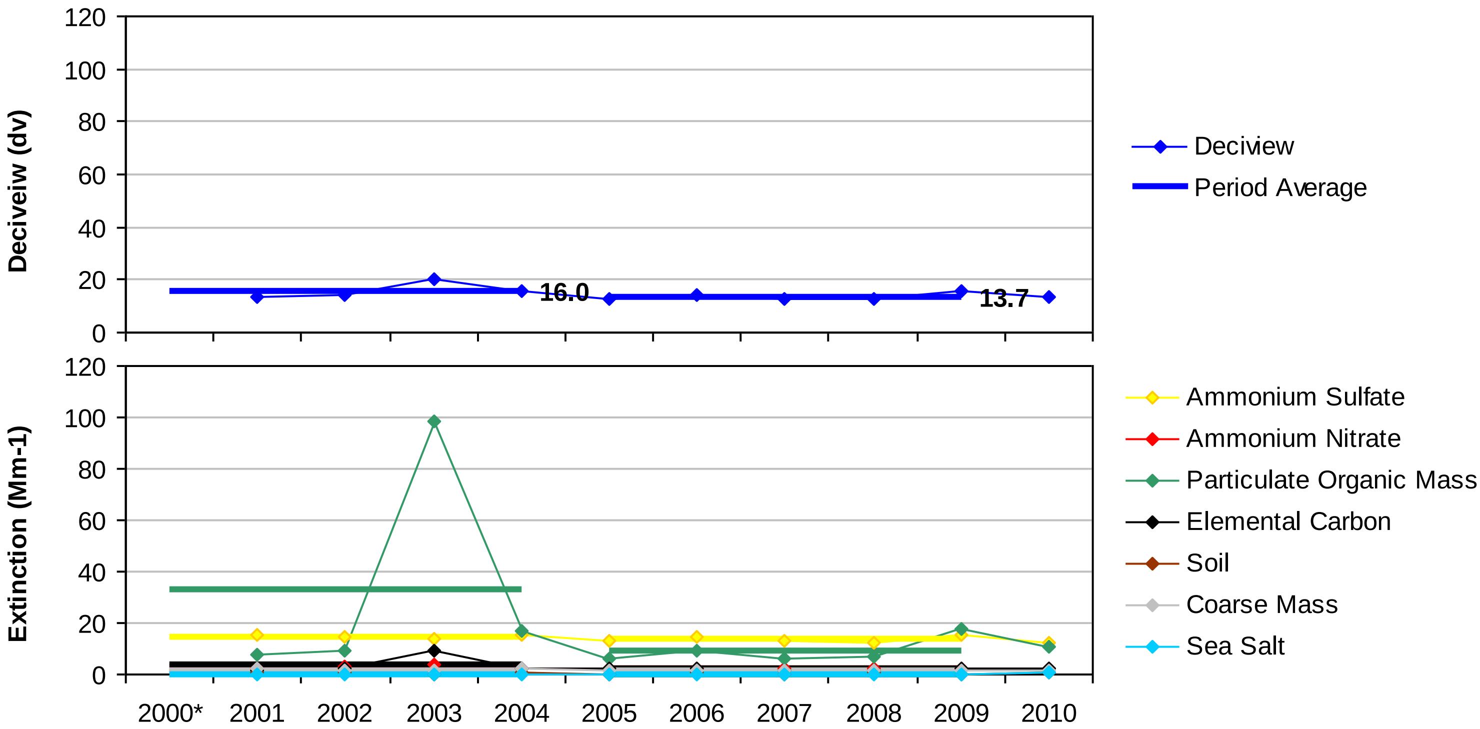
- **Table N.2-1: Annual Averages, 5-Year Period Averages, and Trends:** Table of averages and other metrics for the 20% least impaired days, the 20% most impaired days, and all sampled days is presented.
- **Figure N.2-1: Annual and 5-Year Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.
- **Figure N.2-2: Annual and 5-Year Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.
- **Figure N.2-3: 20% Most Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component for the 20% most impaired days are presented.
- **Figure N.2-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.
- **Figure N.2-5: 2000-2004 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the baseline period are presented.
- **Figure N.2-6: 2005-2009 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the progress period are presented.
- **Figure N.2-7: 2000-2004 Progress Period Extinction, All Sampled Days:** Stacked bar charts depicting daily averages by year and component for the baseline period are presented.
- **Figure N.2-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

## Table N.2-1
## North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)
## Annual Averages, 5-Year Period Averages and Trends

| | Baseline Period | | | | | Progress Period | | | | | | 2000-2009 Trend Statistics* | | Period Averages** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Group | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Slope (change/yr.) | p-value | Baseline (B) | Progress (P) | Difference (P -B) | Percent Change |
| **Deciview (dv)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 3.8 | 3.1 | 3.2 | 3.4 | 3.3 | 2.8 | 3.0 | 3.7 | 3.2 | 2.6 | 0.0 | 0.3 | 3.4 | 3.2 | -0.2 | -6% |
| Worst 20% Days | --- | 13.8 | 14.1 | 20.5 | 15.7 | 12.9 | 14.4 | 12.6 | 12.9 | 15.8 | 13.5 | -0.1 | 0.5 | 16.0 | 13.7 | -2.3 | -14% |
| All Days | --- | 8.3 | 8.3 | 9.7 | 8.4 | 7.8 | 8.3 | 7.4 | 8.0 | 8.8 | 7.1 | 0.0 | 0.3 | 8.7 | 8.1 | -0.6 | -7% |
| **Total Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 14.7 | 13.7 | 13.8 | 14.1 | 13.9 | 13.3 | 13.6 | 14.5 | 13.8 | 13.0 | 0.0 | 0.3 | 14.1 | 13.8 | -0.3 | -2% |
| Worst 20% Days | --- | 40.8 | 41.9 | 137.7 | 50.2 | 36.6 | 42.5 | 36.2 | 37.0 | 50.7 | 40.9 | -0.4 | 0.5 | 67.6 | 40.6 | -27.0 | -40% |
| All Days | --- | 24.6 | 24.9 | 44.6 | 26.1 | 23.3 | 25.0 | 22.5 | 23.5 | 27.0 | 22.6 | -0.2 | 0.5 | 30.1 | 24.3 | -5.8 | -19% |
| **Ammonium Sulfate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 1.8 | 1.3 | 1.2 | 1.2 | 1.6 | 1.2 | 1.4 | 2.2 | 1.6 | 1.1 | 0.0 | 0.4 | 1.4 | 1.6 | 0.2 | 14% |
| Worst 20% Days | --- | 15.6 | 14.9 | 13.6 | 15.4 | 12.9 | 14.7 | 13.5 | 12.4 | 15.2 | 12.2 | -0.2 | 0.1 | 14.9 | 13.7 | -1.2 | -8% |
| All Days | --- | 7.5 | 6.9 | 6.7 | 6.3 | 6.5 | 7.2 | 5.9 | 6.8 | 7.5 | 5.4 | 0.0 | 0.5 | 6.8 | 6.8 | 0.0 | 0% |
| **Ammonium Nitrate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.5 | 0.4 | 0.4 | 0.5 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.0 | 0.0 | 0.4 | 0.2 | -0.2 | -50% |
| Worst 20% Days | --- | 2.1 | 2.8 | 3.7 | 2.2 | 2.2 | 2.5 | 2.2 | 2.4 | 2.1 | 2.5 | 0.0 | 0.3 | 2.7 | 2.3 | -0.4 | -15% |
| All Days | --- | 1.2 | 1.3 | 1.4 | 1.2 | 1.0 | 1.1 | 1.1 | 1.1 | 1.1 | 1.0 | 0.0 | 0.1 | 1.3 | 1.1 | -0.2 | -15% |
| **Particulate Organic Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.7 | 0.5 | 0.7 | 0.7 | 0.5 | 0.3 | 0.5 | 0.5 | 0.5 | 0.2 | 0.0 | 0.0 | 0.6 | 0.5 | -0.1 | -17% |
| Worst 20% Days | --- | 7.6 | 9.0 | 98.7 | 16.8 | 6.4 | 9.4 | 5.9 | 7.3 | 18.1 | 11.1 | -0.1 | 0.5 | 33.0 | 9.4 | -23.6 | -72% |
| All Days | --- | 2.9 | 3.7 | 22.0 | 5.2 | 2.7 | 3.4 | 2.7 | 2.8 | 5.4 | 3.3 | 0.0 | 0.4 | 8.5 | 3.4 | -5.1 | -60% |
| **Elemental Carbon Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.0 | 0.0 | 0.2 | 0.2 | 0.0 | 0% |
| Worst 20% Days | --- | 1.8 | 2.2 | 8.9 | 2.3 | 2.1 | 2.5 | 1.7 | 1.5 | 2.6 | 2.0 | 0.0 | 0.5 | 3.8 | 2.1 | -1.7 | -45% |
| All Days | --- | 0.8 | 1.1 | 2.5 | 1.0 | 1.0 | 1.1 | 0.8 | 0.7 | 1.0 | 0.7 | 0.0 | 0.2 | 1.3 | 0.9 | -0.4 | -31% |
| **Soil Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.3 | 0.0 | 0.0 | 0.0 | 0% |
| Worst 20% Days | --- | 0.7 | 0.4 | 0.3 | 0.5 | 0.3 | 0.5 | 0.3 | 0.5 | 0.3 | 0.5 | 0.0 | 0.3 | 0.5 | 0.4 | -0.1 | -20% |
| All Days | --- | 0.3 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.0 | 0.4 | 0.2 | 0.2 | 0.0 | 0% |
| **Coarse Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.0 | 0.3 | 0.2 | 0.2 | 0.0 | 0% |
| Worst 20% Days | --- | 1.9 | 1.6 | 1.5 | 2.0 | 1.5 | 1.8 | 1.3 | 1.6 | 1.3 | 1.2 | 0.0 | 0.1 | 1.8 | 1.5 | -0.3 | -17% |
| All Days | --- | 0.8 | 0.7 | 0.8 | 0.9 | 0.7 | 0.7 | 0.6 | 0.7 | 0.7 | 0.6 | 0.0 | 0.1 | 0.8 | 0.7 | -0.1 | -13% |
| **Sea Salt Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 | 0% |
| Worst 20% Days | --- | 0.0 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0.3 | 0.3 | 0.1 | 0.4 | 0.0 | 0.0 | 0.0 | 0.2 | 0.2 | 0% |
| All Days | --- | 0.1 | 0.1 | 0.2 | 0.3 | 0.2 | 0.4 | 0.3 | 0.2 | 0.2 | 0.3 | 0.0 | 0.1 | 0.2 | 0.3 | 0.1 | 50% |

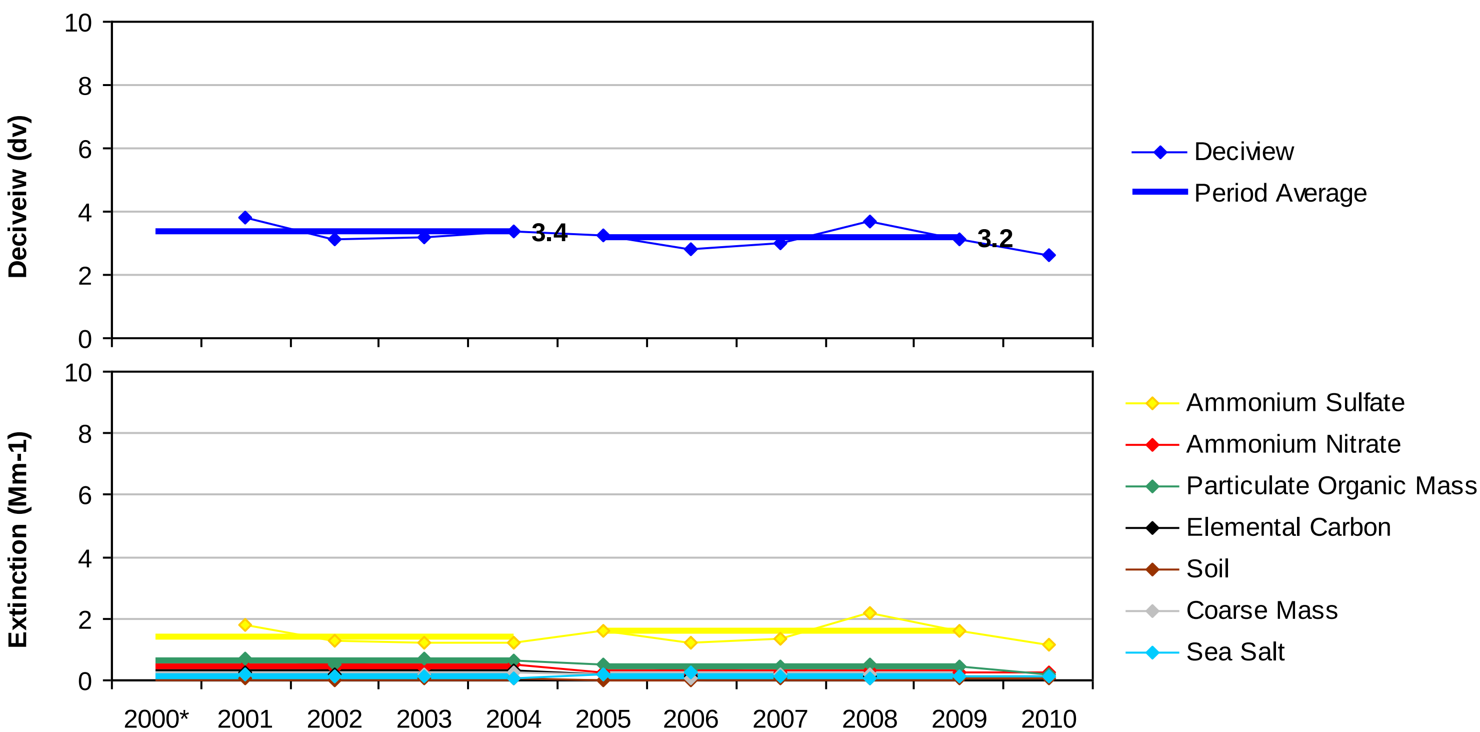
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---" Indicates a missing year that did not meet RHR data completeness criteria.

**Figure N.2-1**
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**
**Annual and 5-Year Period Averages**
**20% Most Impaired Visibility Days**



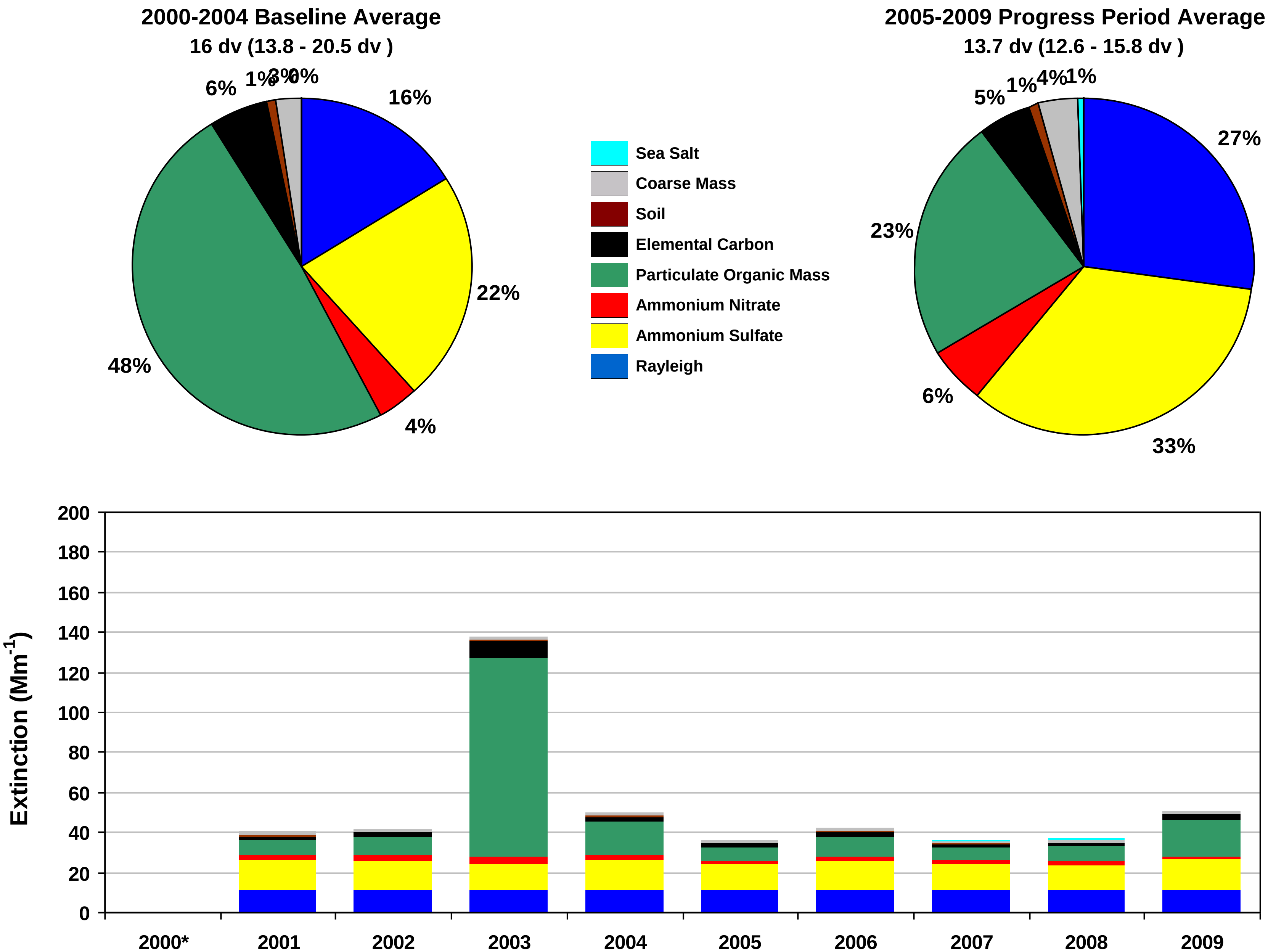

*Missing years did not meet RHR data completeness criteria.

**Figure N.2-2**
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**
**Annual and 5-Year Period Averages**
**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria.

**Figure N.2-3**
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**
**20% Most Impaired Visibility Days**

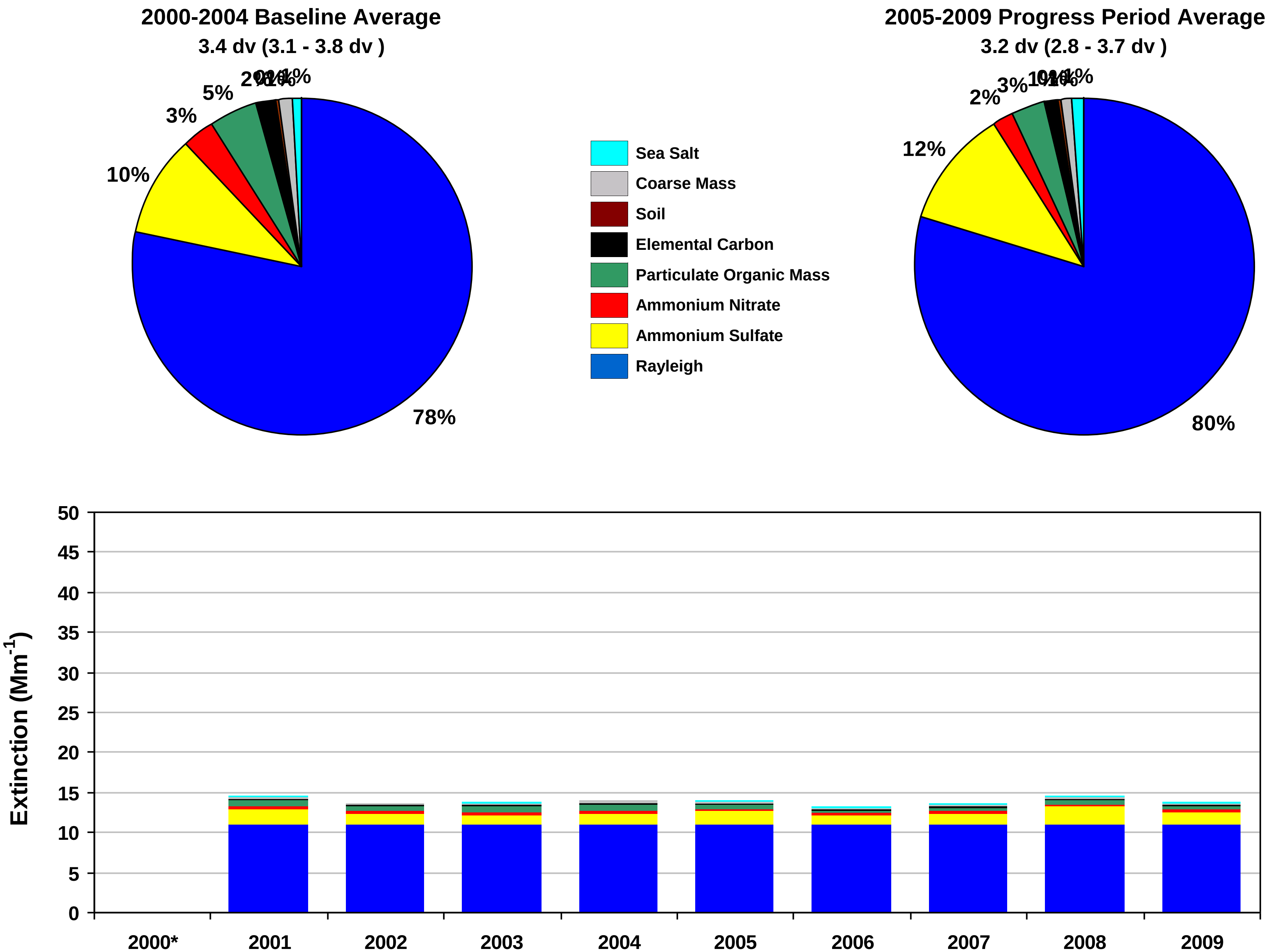



*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.2-4**

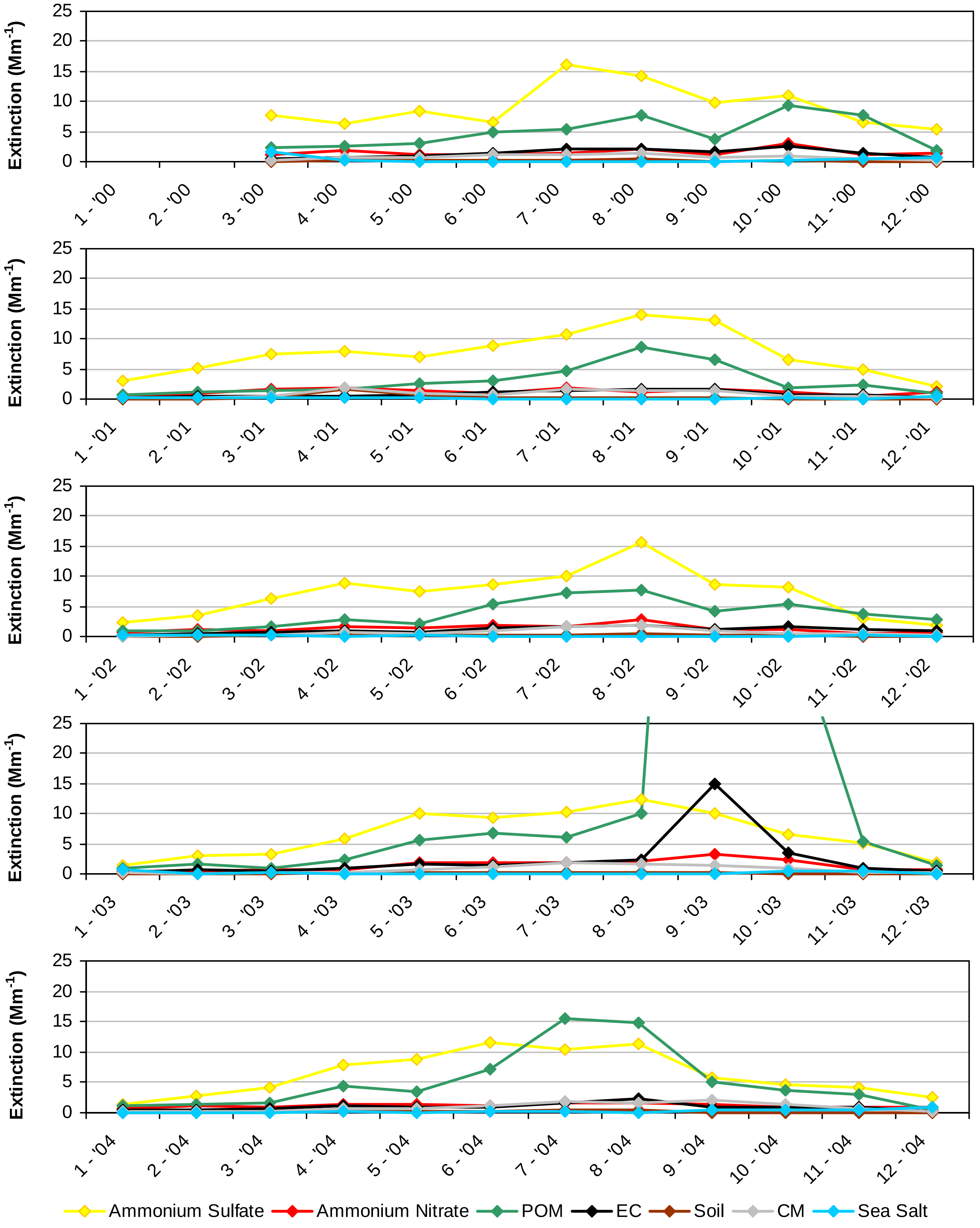
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**

**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.2-5**
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**
**2000-2004 Monthly Average Aerosol Extinction, All Monitored Days**




*Note that monthly averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.2-6**
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**
**2005-2009 Monthly Average Aerosol Extinction, All Monitored Days**

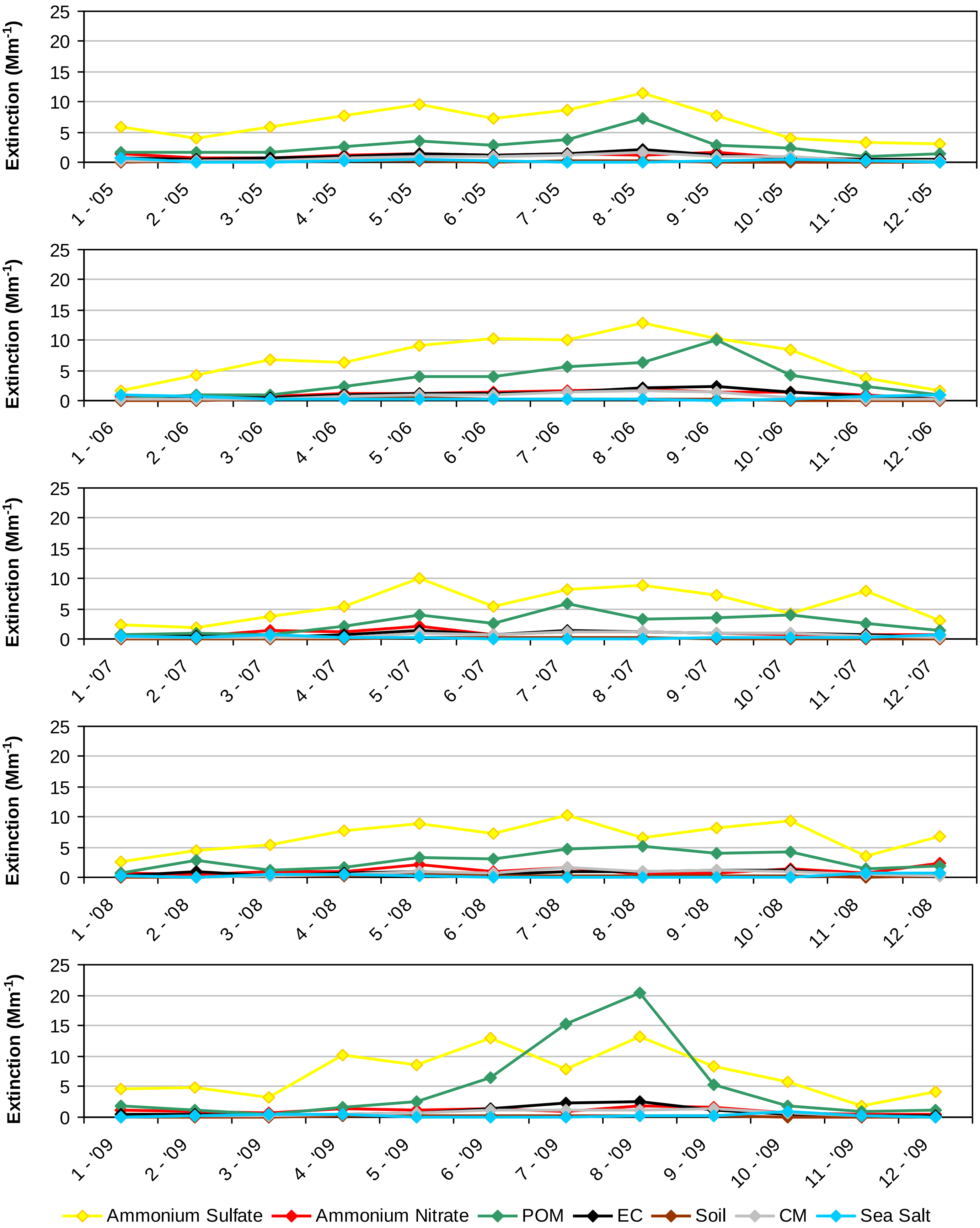
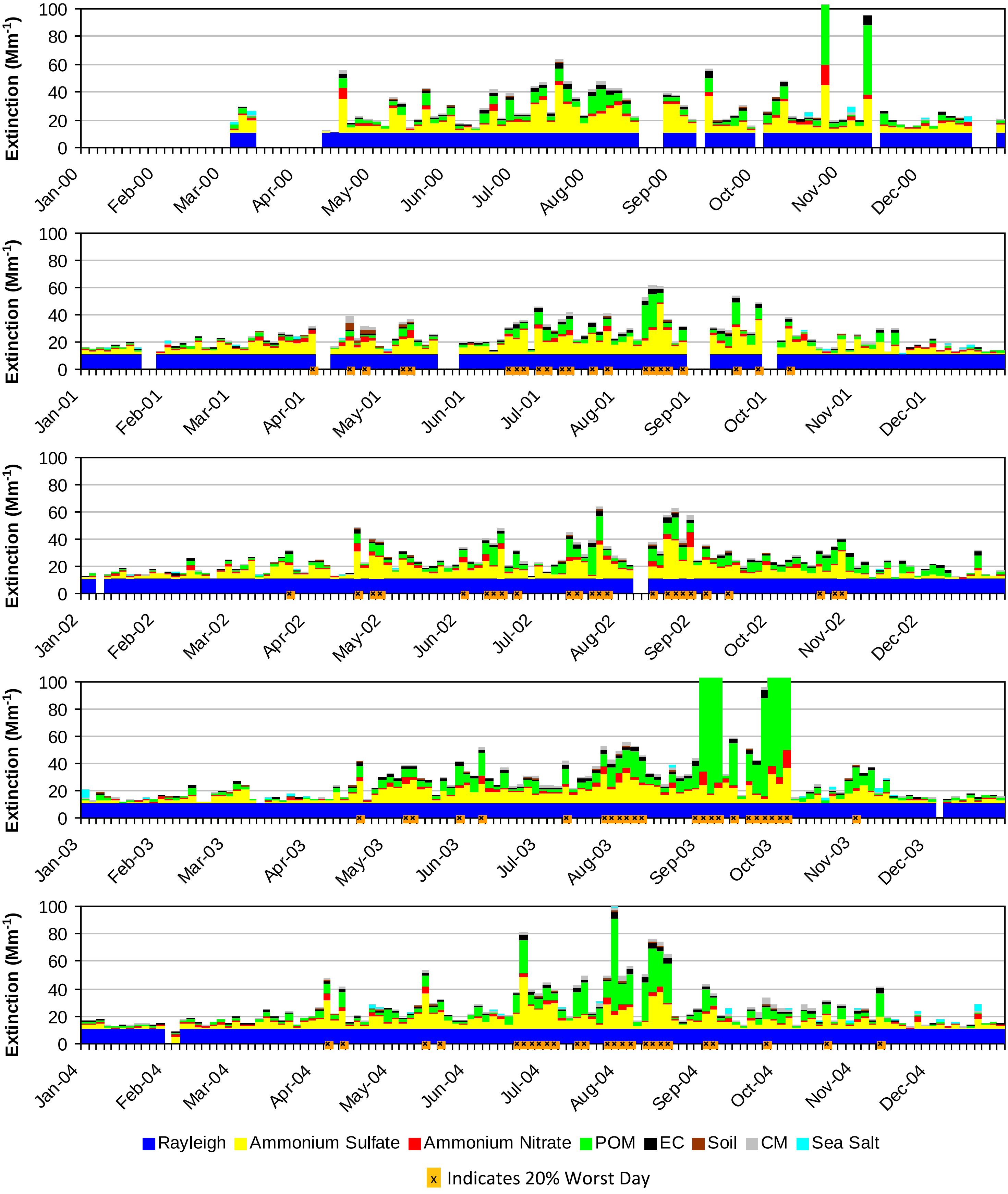
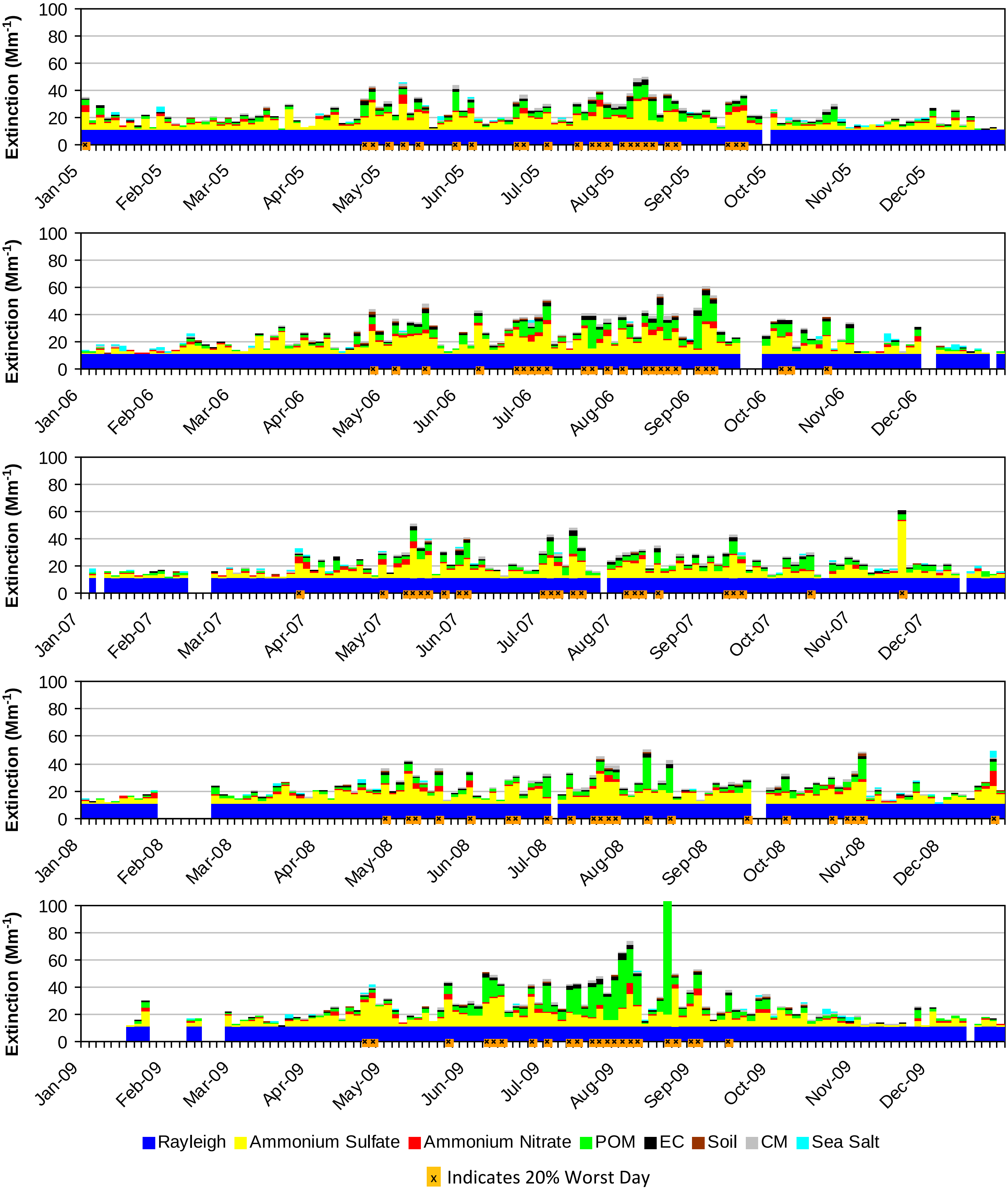


**Figure N.2-7**
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**
**2000-2004 Progress Period Extinction, All Sampled Days**




*Note that daily averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.2-8**
**North Cascades NP and Glacier Peak WA, WA (NOCA1 Site)**
**2005-2009 Progress Period Extinction, All Sampled Days**



## N.3. OLYMPIC NP (OLYM1)

The following tables and figures are presented in this section for the Olympic NP represented by the OLYM1 IMPROVE Monitor:

- **Table N.3-1: Annual Averages, 5-Year Period Averages, and Trends:** Table of averages and other metrics for the 20% least impaired days, the 20% most impaired days, and all sampled days is presented.

- **Figure N.3-1: Annual and 5-Year Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.3-2: Annual and 5-Year Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.3-3: 20% Most Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component for the 20% most impaired days are presented.

- **Figure N.3-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure N.3-5: 2000-2004 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the baseline period are presented.

- **Figure N.3-6: 2005-2009 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the progress period are presented.

- **Figure N.3-7: 2000-2004 Progress Period Extinction, All Sampled Days:** Stacked bar charts depicting daily averages by year and component for the baseline period are presented.

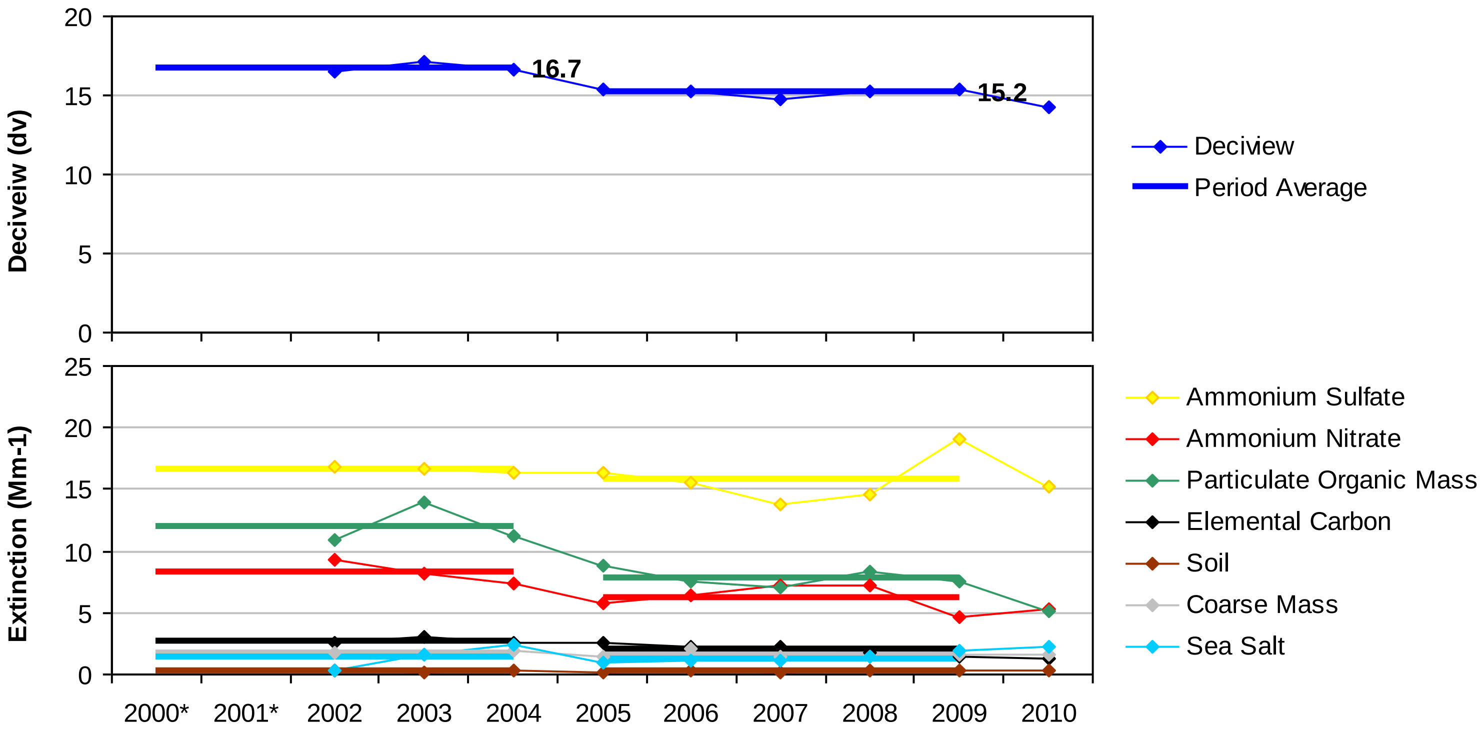
- **Figure N.3-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

## Table N.3-1
## Olympic NP, WA (OLYM1 Site)
## Annual Averages, 5-Year Period Averages and Trends

| Group | Baseline Period | | | | | Progress Period | | | | | | 2000-2009 Trend Statistics* | | Period Averages** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Slope (change/yr.) | p-value | Baseline (B) | Progress (P) | Difference (P -B) | Percent Change |
| **Deciview (dv)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 5.5 | 6.0 | 6.5 | 5.9 | 5.2 | 5.1 | 5.0 | 4.1 | 3.5 | -0.3 | 0.0 | 6.0 | 5.0 | -1.0 | -17% |
| Worst 20% Days | --- | --- | 16.5 | 17.2 | 16.6 | 15.4 | 15.2 | 14.8 | 15.2 | 15.4 | 14.2 | -0.3 | 0.1 | 16.7 | 15.2 | -1.5 | -9% |
| All Days | --- | --- | 11.4 | 11.6 | 11.7 | 11.1 | 10.6 | 10.2 | 10.4 | 10.4 | 9.1 | -0.2 | 0.0 | 11.6 | 10.5 | -1.1 | -10% |
| **Total Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 17.6 | 18.3 | 19.4 | 18.3 | 17.0 | 16.7 | 16.7 | 15.2 | 14.2 | -0.4 | 0.0 | 18.4 | 16.8 | -1.6 | -9% |
| Worst 20% Days | --- | --- | 53.1 | 56.5 | 53.2 | 47.0 | 46.3 | 44.1 | 46.1 | 47.5 | 41.9 | -1.5 | 0.1 | 54.3 | 46.2 | -8.1 | -15% |
| All Days | --- | --- | 33.7 | 34.4 | 34.4 | 31.9 | 30.8 | 29.3 | 30.2 | 30.7 | 26.6 | -0.7 | 0.0 | 34.2 | 30.6 | -3.6 | -11% |
| **Ammonium Sulfate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 2.6 | 2.6 | 2.9 | 2.8 | 2.0 | 2.1 | 2.6 | 2.0 | 1.4 | -0.1 | 0.2 | 2.7 | 2.3 | -0.4 | -15% |
| Worst 20% Days | --- | --- | 16.9 | 16.7 | 16.4 | 16.3 | 15.6 | 13.7 | 14.5 | 19.1 | 15.2 | -0.3 | 0.1 | 16.7 | 15.8 | -0.9 | -5% |
| All Days | --- | --- | 9.6 | 9.3 | 9.2 | 9.5 | 9.1 | 7.7 | 8.9 | 9.6 | 7.4 | -0.1 | 0.1 | 9.4 | 9.0 | -0.4 | -4% |
| **Ammonium Nitrate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 1.0 | 1.4 | 1.4 | 1.1 | 0.8 | 0.9 | 0.7 | 0.7 | 0.5 | -0.1 | 0.0 | 1.2 | 0.8 | -0.4 | -33% |
| Worst 20% Days | --- | --- | 9.3 | 8.2 | 7.4 | 5.7 | 6.5 | 7.2 | 7.2 | 4.6 | 5.2 | -0.5 | 0.0 | 8.3 | 6.2 | -2.1 | -25% |
| All Days | --- | --- | 4.2 | 4.2 | 4.0 | 3.5 | 3.1 | 3.3 | 3.3 | 3.0 | 2.6 | -0.2 | 0.0 | 4.1 | 3.2 | -0.9 | -22% |
| **Particulate Organic Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 1.6 | 1.9 | 2.2 | 1.4 | 1.1 | 1.3 | 1.2 | 0.6 | 0.5 | -0.2 | 0.0 | 1.9 | 1.1 | -0.8 | -42% |
| Worst 20% Days | --- | --- | 10.9 | 14.0 | 11.2 | 8.8 | 7.5 | 7.0 | 8.3 | 7.5 | 5.2 | -0.7 | 0.0 | 12.1 | 7.8 | -4.3 | -36% |
| All Days | --- | --- | 5.4 | 6.0 | 5.9 | 4.4 | 3.8 | 3.8 | 3.9 | 3.8 | 2.7 | -0.3 | 0.0 | 5.8 | 3.9 | -1.9 | -33% |
| **Elemental Carbon Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 0.6 | 0.6 | 0.8 | 0.5 | 0.5 | 0.5 | 0.4 | 0.2 | 0.3 | 0.0 | 0.0 | 0.6 | 0.4 | -0.2 | -33% |
| Worst 20% Days | --- | --- | 2.6 | 3.1 | 2.5 | 2.6 | 2.2 | 2.3 | 1.8 | 1.4 | 1.2 | -0.2 | 0.0 | 2.7 | 2.1 | -0.6 | -22% |
| All Days | --- | --- | 1.5 | 1.6 | 1.5 | 1.5 | 1.3 | 1.3 | 1.0 | 1.0 | 0.8 | -0.1 | 0.0 | 1.6 | 1.2 | -0.4 | -25% |
| **Soil Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.0 | 0.0 | 0% |
| Worst 20% Days | --- | --- | 0.4 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.4 | 0.3 | 0.4 | 0.0 | 0.5 | 0.3 | 0.3 | 0.0 | 0% |
| All Days | --- | --- | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.0 | 0.3 | 0.2 | 0.2 | 0.0 | 0% |
| **Coarse Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 0.4 | 0.3 | 0.3 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 0.2 | 0.0 | 0.0 | 0.3 | 0.3 | 0.0 | 0% |
| Worst 20% Days | --- | --- | 1.7 | 1.7 | 1.9 | 1.4 | 2.1 | 1.4 | 1.5 | 1.6 | 1.5 | 0.0 | 0.4 | 1.8 | 1.6 | -0.2 | -11% |
| All Days | --- | --- | 1.2 | 1.1 | 1.1 | 0.9 | 1.0 | 0.8 | 0.8 | 0.9 | 0.8 | 0.0 | 0.0 | 1.1 | 0.9 | -0.2 | -18% |
| **Sea Salt Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | --- | 0.4 | 0.6 | 0.9 | 1.2 | 1.2 | 0.6 | 0.5 | 0.5 | 0.2 | 0.0 | 0.6 | 0.6 | 0.8 | 0.2 | 33% |
| Worst 20% Days | --- | --- | 0.3 | 1.6 | 2.5 | 1.0 | 1.1 | 1.2 | 1.4 | 2.0 | 2.2 | 0.1 | 0.1 | 1.4 | 1.4 | 0.0 | 0% |
| All Days | --- | --- | 0.6 | 1.0 | 1.6 | 1.1 | 1.4 | 1.2 | 1.1 | 1.3 | 1.2 | 0.0 | 0.1 | 1.1 | 1.2 | 0.1 | 9% |

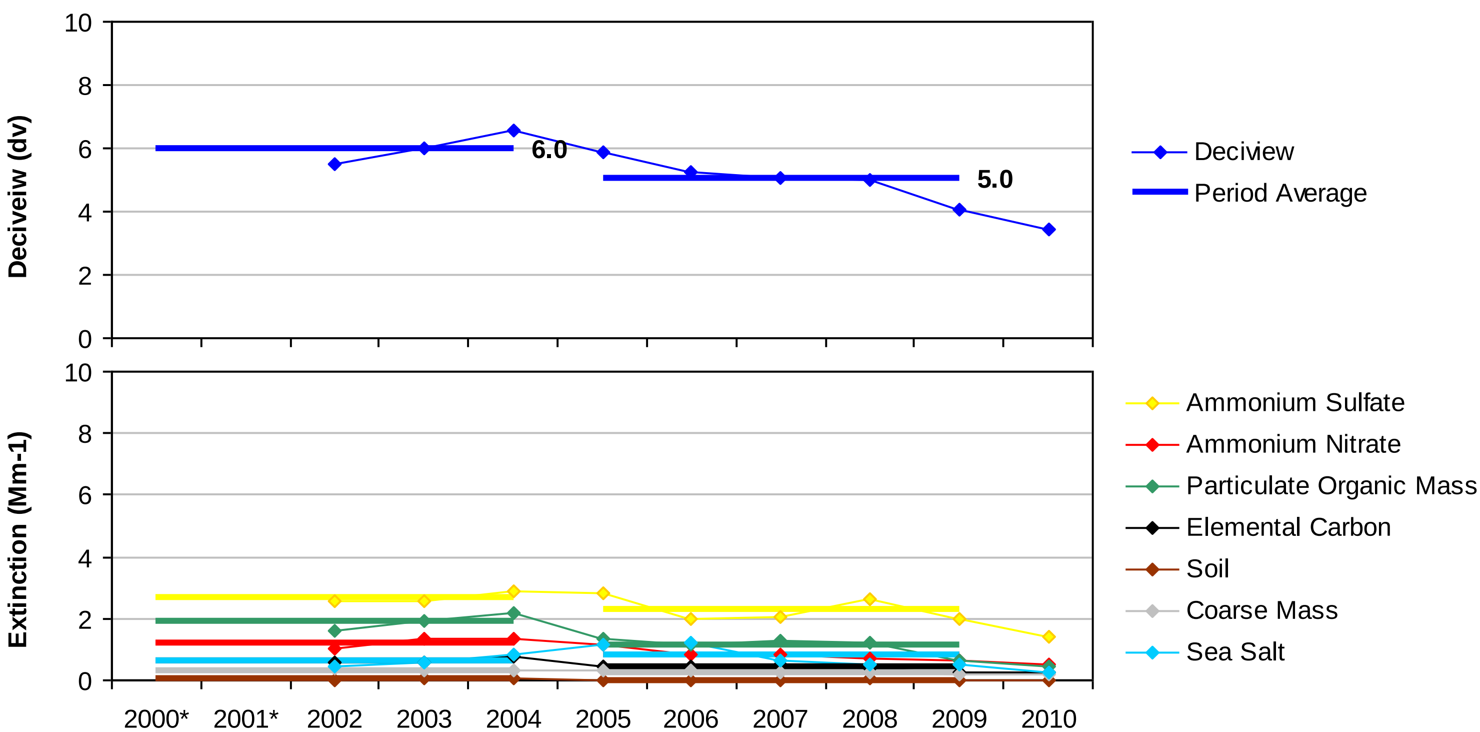
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---" Indicates a missing year that did not meet RHR data completeness criteria.

**Figure N.3-1**
**Olympic NP, WA (OLYM1 Site)**
**Annual and 5-Year Period Averages**
**20% Most Impaired Visibility Days**



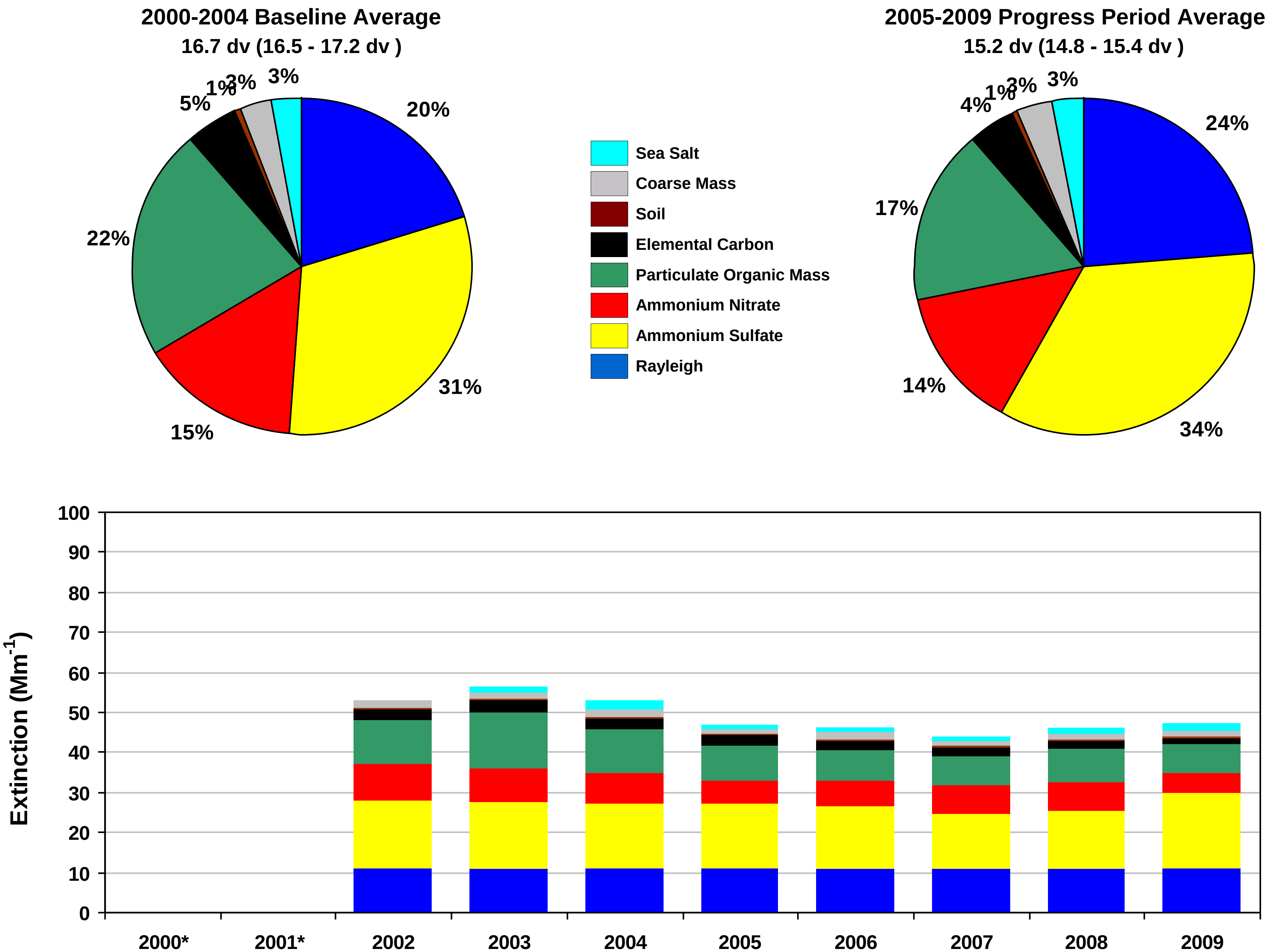

*Missing years did not meet RHR data completeness criteria.

**Figure N.3-2**
**Olympic NP, WA (OLYM1 Site)**
**Annual and 5-Year Period Averages**
**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria.

**Figure N.3-3**
**Olympic NP, WA (OLYM1 Site)**
**20% Most Impaired Visibility Days**

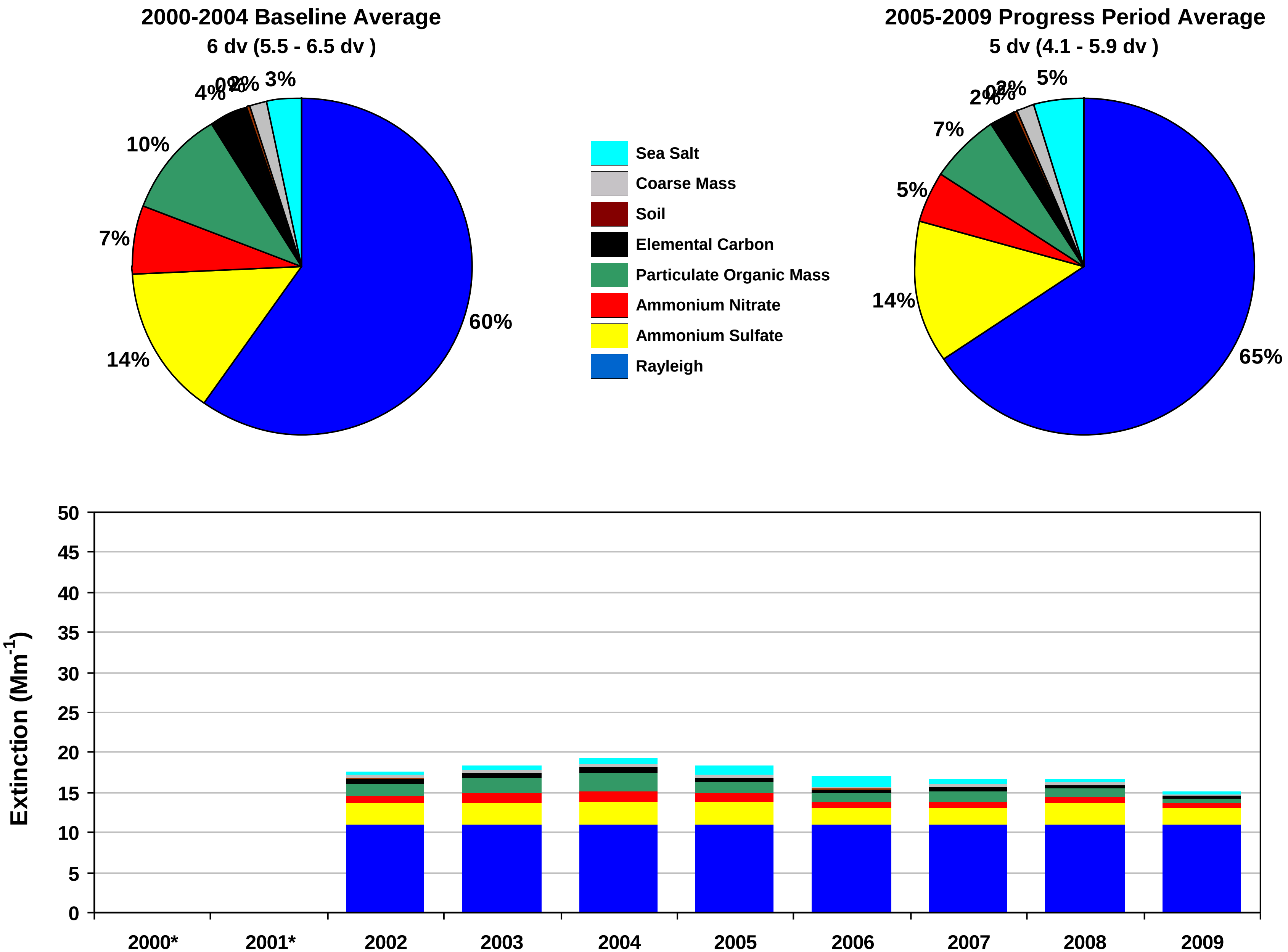



*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.3-4**

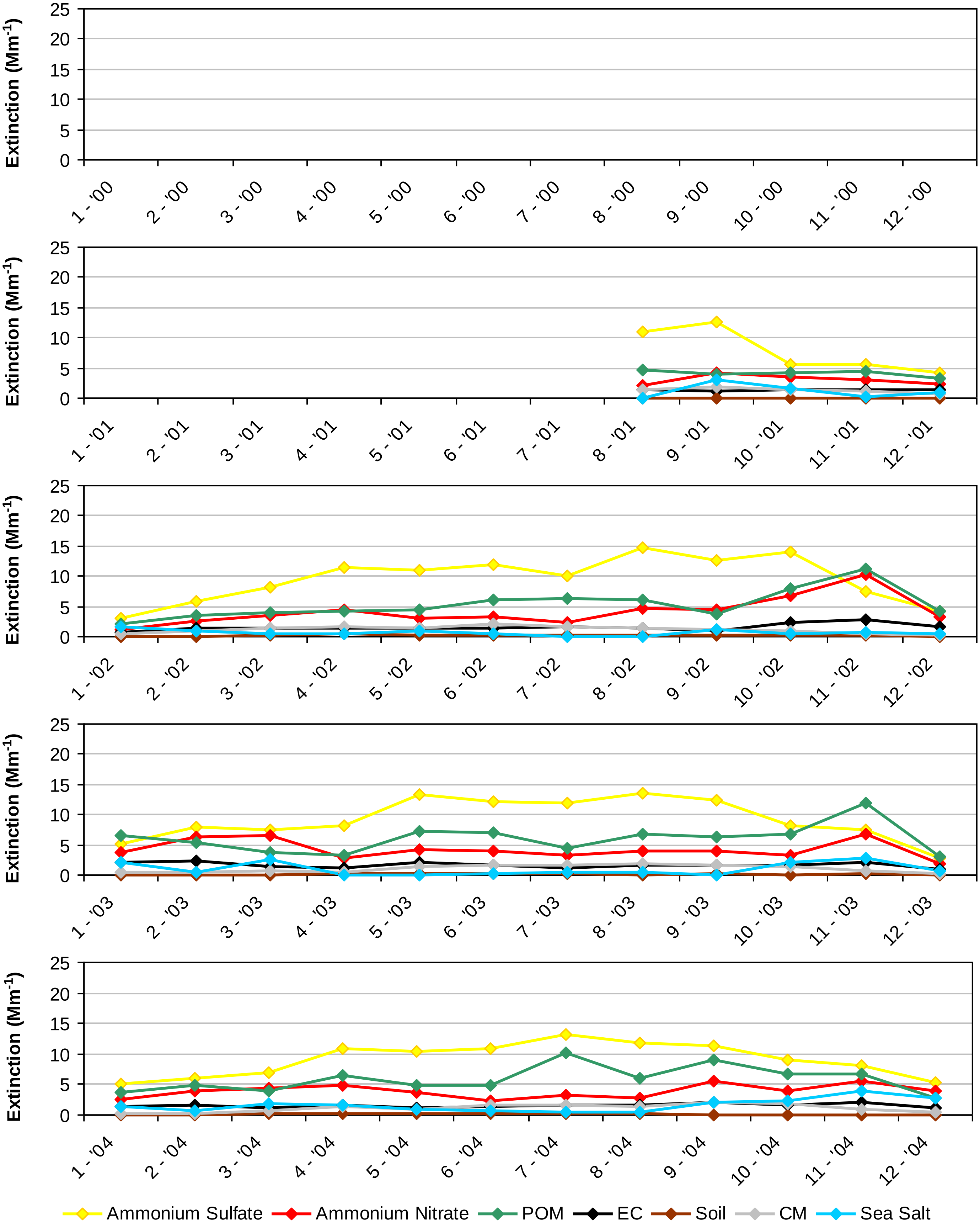
**Olympic NP, WA (OLYM1 Site)**

**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.3-5**
**Olympic NP, WA (OLYM1 Site)**
**2000-2004 Monthly Average Aerosol Extinction, All Monitored Days**




*Note that monthly averages for the years 2000 and 2001 are shown here, but these years did not meet RHR data completeness criteria.

**Figure N.3-6**
**Olympic NP, WA (OLYM1 Site)**
**2005-2009 Monthly Average Aerosol Extinction, All Monitored Days**

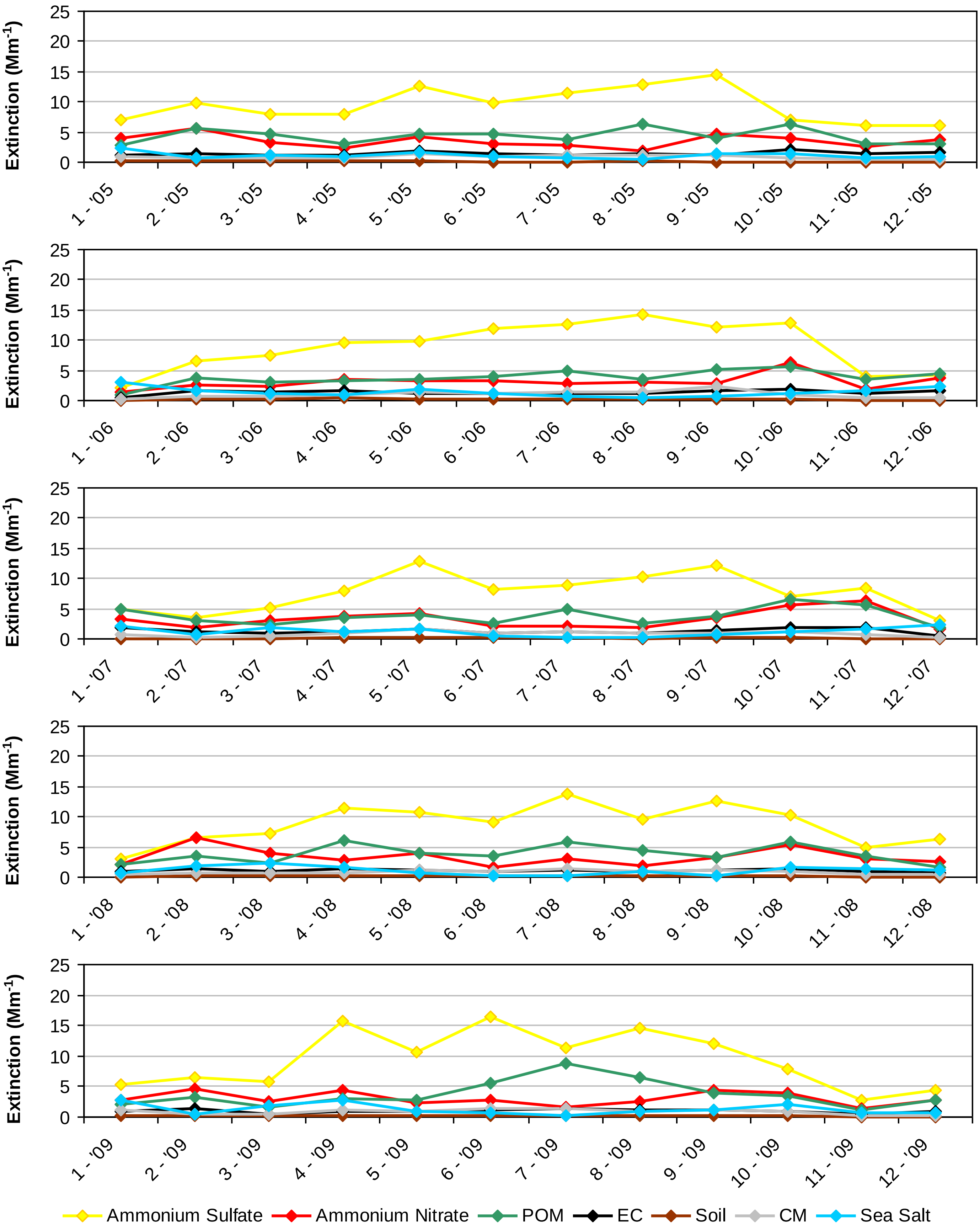
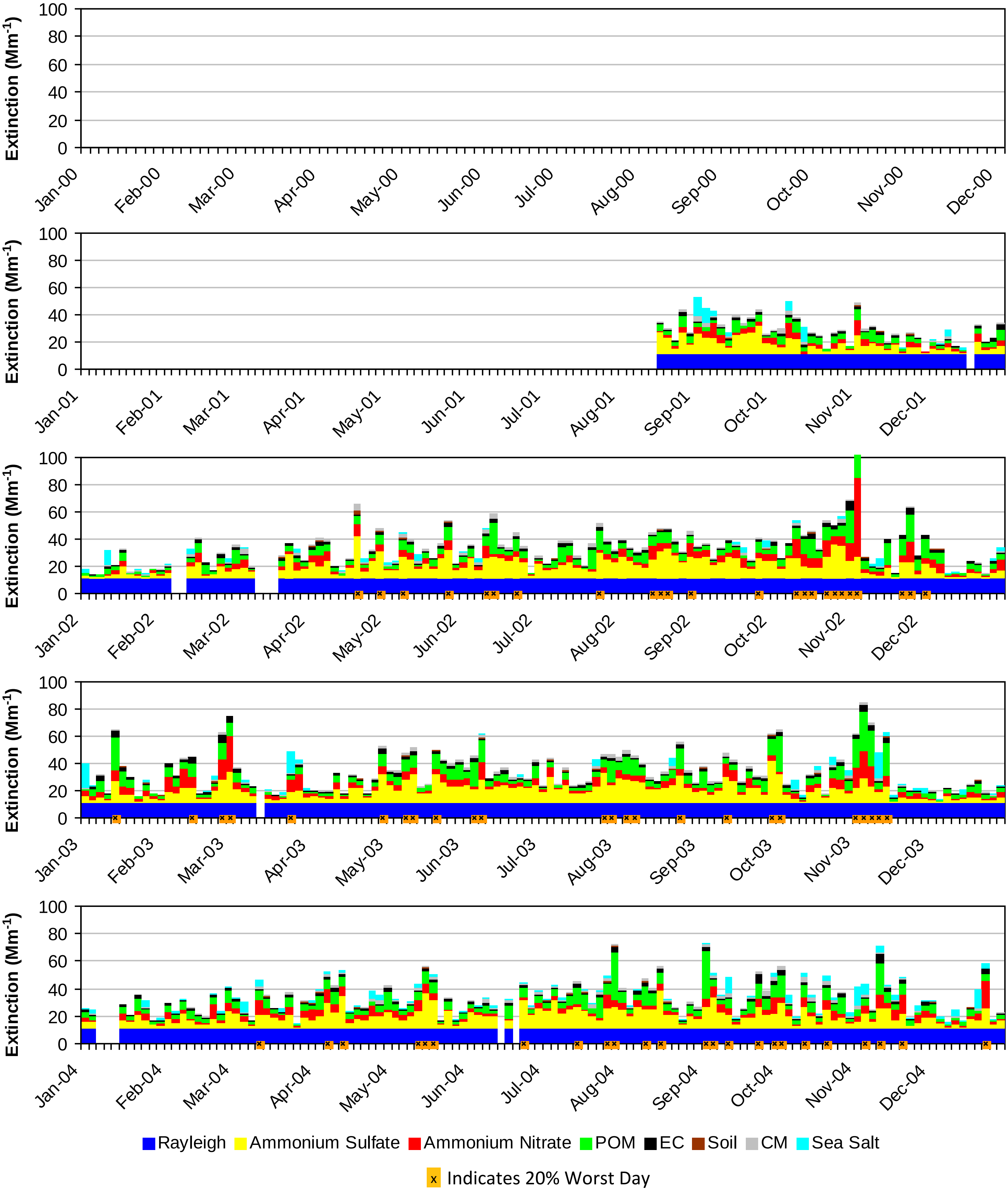
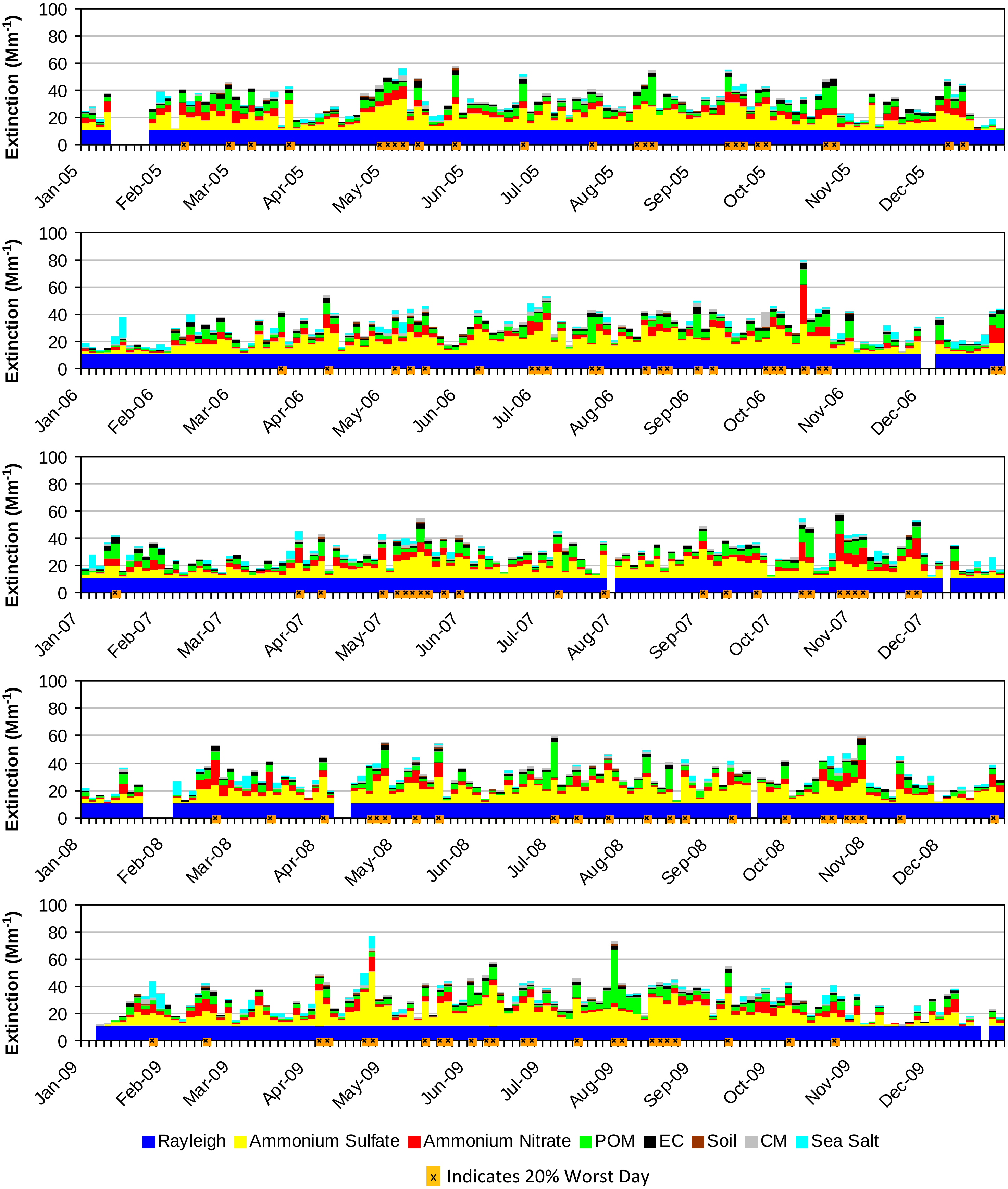


**Figure N.3-7**
**Olympic NP, WA (OLYM1 Site)**
**2000-2004 Progress Period Extinction, All Sampled Days**




*Note that daily averages for the years 2000 and 2001 are shown here, but these years did not meet RHR data completeness criteria.

**Figure N.3-8**
**Olympic NP, WA (OLYM1 Site)**
**2005-2009 Progress Period Extinction, All Sampled Days**



## N.4. PASAYTEN WA (PASA1)

The following tables and figures are presented in this section for the Pasayten WA represented by the PASA1 IMPROVE Monitor:

- **Table N.4-1: Annual Averages, 5-Year Period Averages, and Trends:** Table of averages and other metrics for the 20% least impaired days, the 20% most impaired days, and all sampled days is presented.

- **Figure N.4-1: Annual and 5-Year Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.4-2: Annual and 5-Year Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.4-3: 20% Most Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component for the 20% most impaired days are presented.

- **Figure N.4-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure N.4-5: 2000-2004 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the baseline period are presented.

- **Figure N.4-6: 2005-2009 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the progress period are presented.

- **Figure N.4-7: 2000-2004 Progress Period Extinction, All Sampled Days:** Stacked bar charts depicting daily averages by year and component for the baseline period are presented.

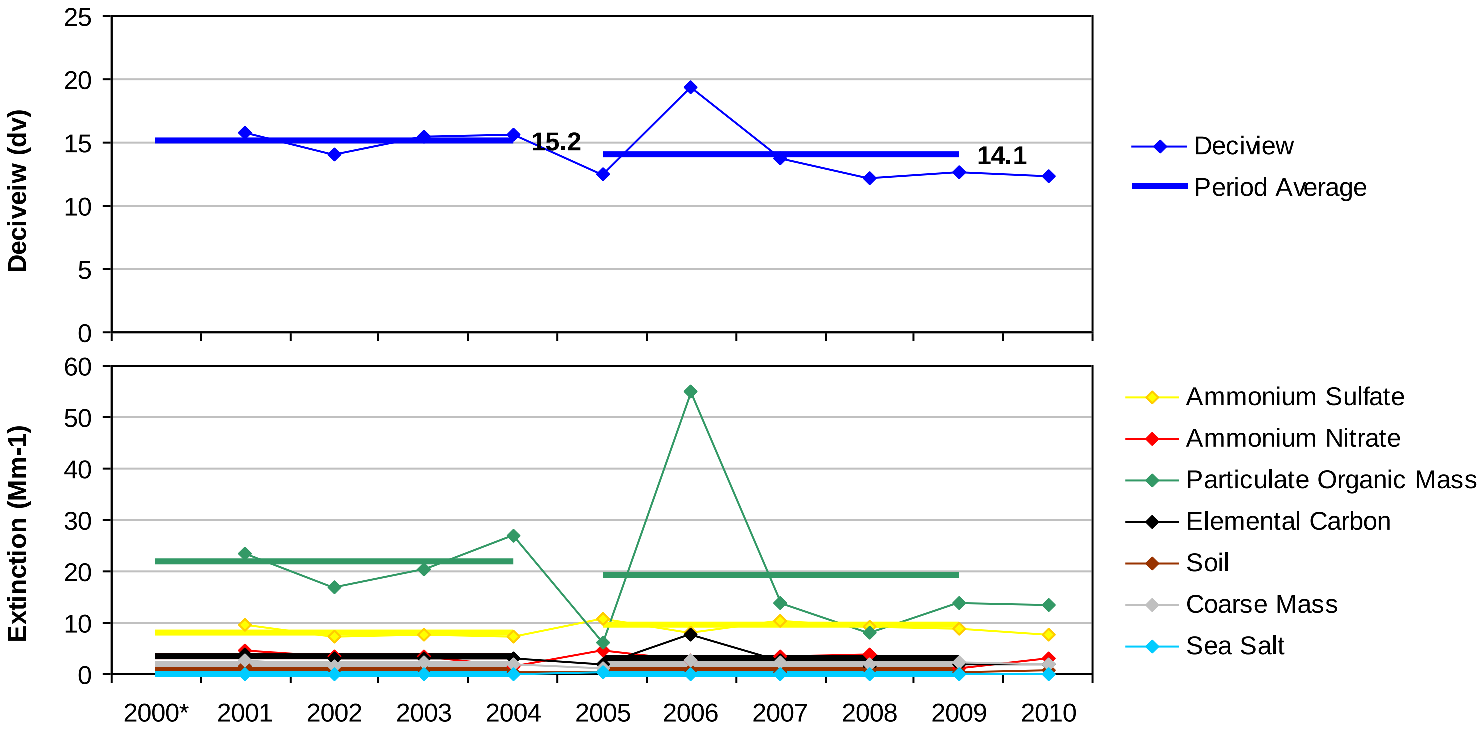
- **Figure N.4-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

## Table N.4-1
## Pasayten WA, WA (PASA1 Site)
## Annual Averages, 5-Year Period Averages and Trends

| Group | Baseline Period | | | | | Progress Period | | | | | | 2000-2009 Trend Statistics* | | Period Averages** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Slope (change/yr.) | p-value | Baseline (B) | Progress (P) | Difference (P -B) | Percent Change |
| **Deciview (dv)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 2.9 | 2.6 | 2.5 | 2.9 | 3.2 | 2.0 | 2.4 | 2.7 | 2.3 | 1.5 | 0.0 | 0.1 | 2.7 | 2.5 | -0.2 | -7% |
| Worst 20% Days | --- | 15.7 | 14.1 | 15.4 | 15.7 | 12.4 | 19.4 | 13.8 | 12.2 | 12.7 | 12.4 | -0.4 | 0.1 | 15.2 | 14.1 | -1.1 | -7% |
| All Days | --- | 8.1 | 7.8 | 7.9 | 7.9 | 7.3 | 8.6 | 6.9 | 6.9 | 7.1 | 6.0 | -0.1 | 0.1 | 7.9 | 7.4 | -0.5 | -6% |
| **Total Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 13.5 | 13.1 | 12.8 | 13.3 | 13.9 | 12.3 | 12.7 | 13.1 | 12.7 | 11.7 | -0.1 | 0.1 | 13.2 | 12.9 | -0.3 | -2% |
| Worst 20% Days | --- | 55.9 | 42.9 | 47.8 | 51.6 | 35.6 | 87.2 | 43.0 | 35.1 | 38.6 | 38.7 | -1.8 | 0.1 | 49.5 | 47.9 | -1.6 | -3% |
| All Days | --- | 26.6 | 24.1 | 24.8 | 25.4 | 22.0 | 32.8 | 22.4 | 21.4 | 22.4 | 20.4 | -0.5 | 0.1 | 25.2 | 24.2 | -1.0 | -4% |
| **Ammonium Sulfate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 1.7 | 1.4 | 1.4 | 1.6 | 1.9 | 1.1 | 1.4 | 1.9 | 1.4 | 0.9 | 0.0 | 0.5 | 1.5 | 1.5 | 0.0 | 0% |
| Worst 20% Days | --- | 9.7 | 7.1 | 7.9 | 7.5 | 10.9 | 8.1 | 10.3 | 9.3 | 8.8 | 7.6 | 0.2 | 0.2 | 8.1 | 9.5 | 1.4 | 17% |
| All Days | --- | 5.4 | 4.4 | 4.3 | 4.4 | 5.4 | 4.6 | 4.5 | 5.1 | 4.9 | 3.6 | 0.1 | 0.2 | 4.6 | 4.9 | 0.3 | 7% |
| **Ammonium Nitrate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.6 | 0.6 | 0.4 | 0.5 | 0.5 | 0.3 | 0.5 | 0.4 | 0.5 | 0.3 | 0.0 | 0.0 | 0.5 | 0.4 | -0.1 | -20% |
| Worst 20% Days | --- | 4.8 | 3.5 | 3.5 | 1.3 | 4.7 | 2.8 | 3.3 | 3.8 | 1.3 | 2.9 | -0.2 | 0.1 | 3.3 | 3.2 | -0.1 | -3% |
| All Days | --- | 2.1 | 1.6 | 1.5 | 1.2 | 1.9 | 1.6 | 1.5 | 1.4 | 1.3 | 1.3 | -0.1 | 0.0 | 1.6 | 1.5 | -0.1 | -6% |
| **Particulate Organic Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.6 | 0.5 | 0.6 | 0.6 | 0.6 | 0.4 | 0.3 | 0.4 | 0.2 | 0.2 | 0.0 | 0.1 | 0.5 | 0.4 | -0.1 | -20% |
| Worst 20% Days | --- | 23.3 | 16.9 | 20.3 | 27.1 | 6.2 | 55.1 | 13.9 | 7.9 | 13.8 | 13.6 | -1.3 | 0.2 | 21.9 | 19.4 | -2.5 | -11% |
| All Days | --- | 6.3 | 5.8 | 6.5 | 7.4 | 2.8 | 13.1 | 4.2 | 3.1 | 4.1 | 3.8 | -0.3 | 0.2 | 6.5 | 5.5 | -1.0 | -15% |
| **Elemental Carbon Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 | 0.1 | -0.1 | -50% |
| Worst 20% Days | --- | 3.9 | 3.0 | 3.2 | 3.2 | 1.8 | 7.5 | 2.5 | 1.4 | 1.9 | 2.0 | -0.2 | 0.1 | 3.3 | 3.0 | -0.3 | -9% |
| All Days | --- | 1.3 | 1.1 | 1.2 | 1.1 | 0.8 | 2.0 | 0.9 | 0.6 | 0.7 | 0.7 | -0.1 | 0.0 | 1.2 | 1.0 | -0.2 | -17% |
| **Soil Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 | 0.1 | 0.1 | 0.0 | 0% |
| Worst 20% Days | --- | 1.4 | 0.7 | 0.6 | 0.5 | 0.5 | 0.8 | 0.6 | 0.7 | 0.5 | 0.7 | 0.0 | 0.1 | 0.8 | 0.6 | -0.2 | -25% |
| All Days | --- | 0.5 | 0.3 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.0 | 0.2 | 0.3 | 0.3 | 0.0 | 0% |
| **Coarse Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.1 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.1 | 0.0 | 0.2 | 0.2 | 0.2 | 0.0 | 0% |
| Worst 20% Days | --- | 2.6 | 1.6 | 2.2 | 1.9 | 1.3 | 2.8 | 2.2 | 1.9 | 2.2 | 1.9 | 0.0 | 0.5 | 2.1 | 2.1 | 0.0 | 0% |
| All Days | --- | 1.0 | 0.9 | 0.9 | 0.8 | 0.6 | 1.0 | 0.9 | 0.9 | 1.0 | 0.8 | 0.0 | 0.5 | 0.9 | 0.9 | 0.0 | 0% |
| **Sea Salt Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.1 | 0.2 | 0.1 | 0.1 | 0.3 | 0.1 | 0.3 | 0.1 | 0.1 | 0.1 | 0.0 | 0.4 | 0.1 | 0.2 | 0.1 | 100% |
| Worst 20% Days | --- | 0.2 | 0.0 | 0.1 | 0.0 | 0.2 | 0.0 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | 0.4 | 0.1 | 0.1 | 0.0 | 0% |
| All Days | --- | 0.1 | 0.0 | 0.2 | 0.1 | 0.2 | 0.2 | 0.1 | 0.1 | 0.2 | 0.0 | 0.0 | 0.2 | 0.1 | 0.2 | 0.1 | 100% |

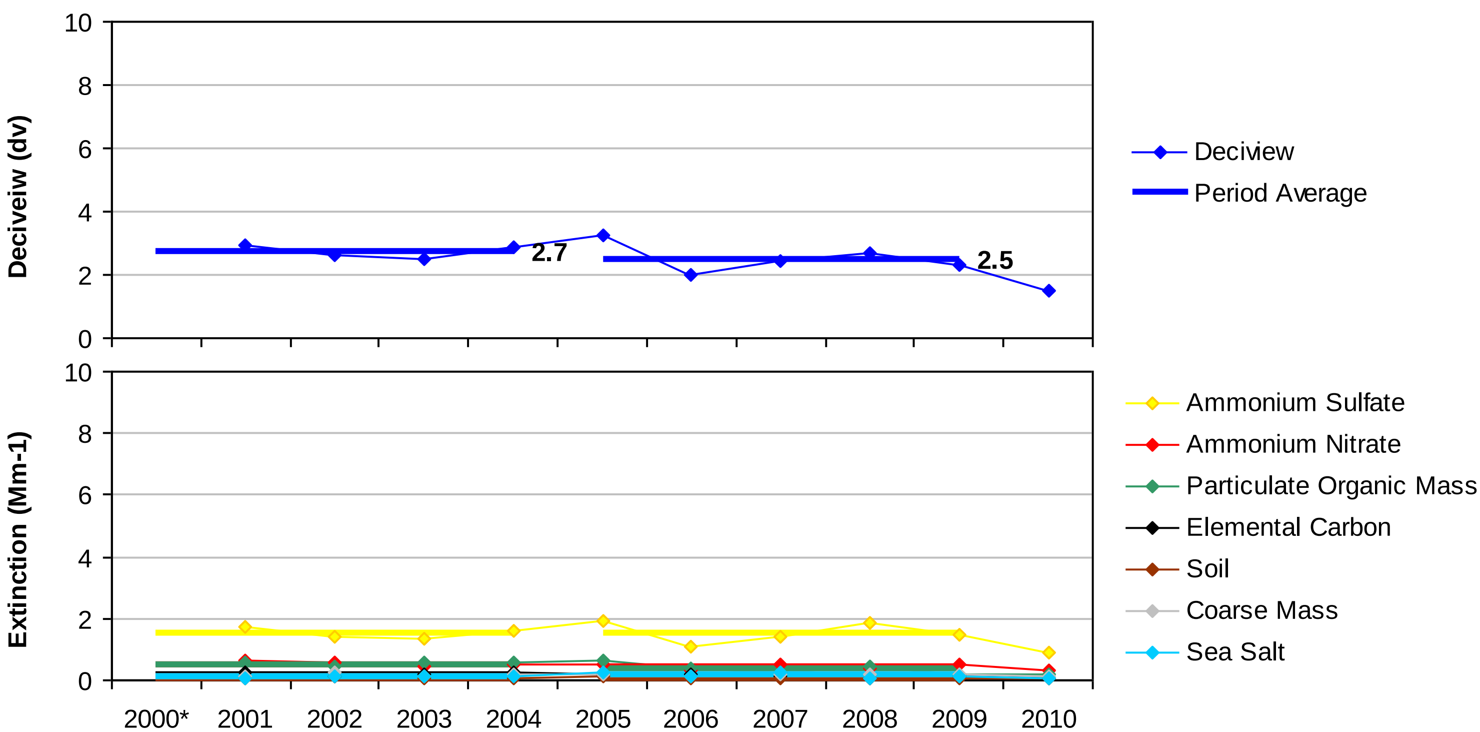
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---" Indicates a missing year that did not meet RHR data completeness criteria.

**Figure N.4-1**
**Pasayten WA, WA (PASA1 Site)**
**Annual and 5-Year Period Averages**
**20% Most Impaired Visibility Days**



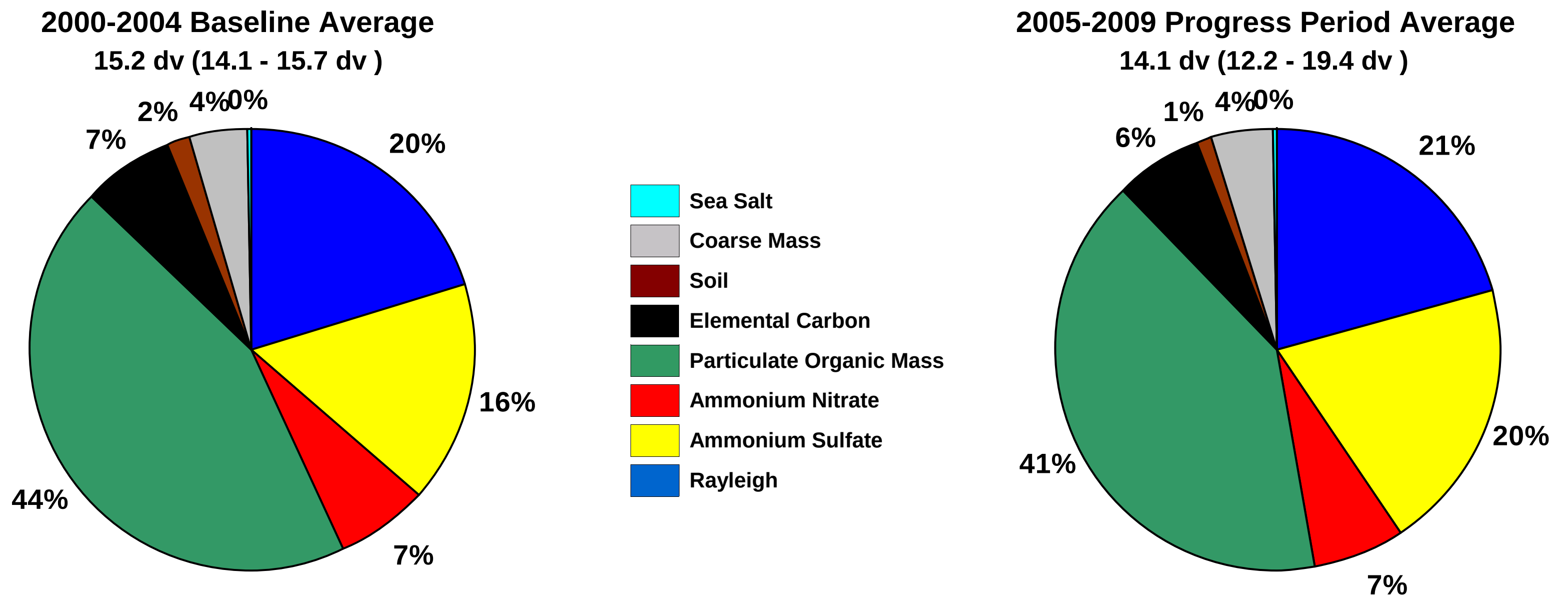

*Missing years did not meet RHR data completeness criteria.

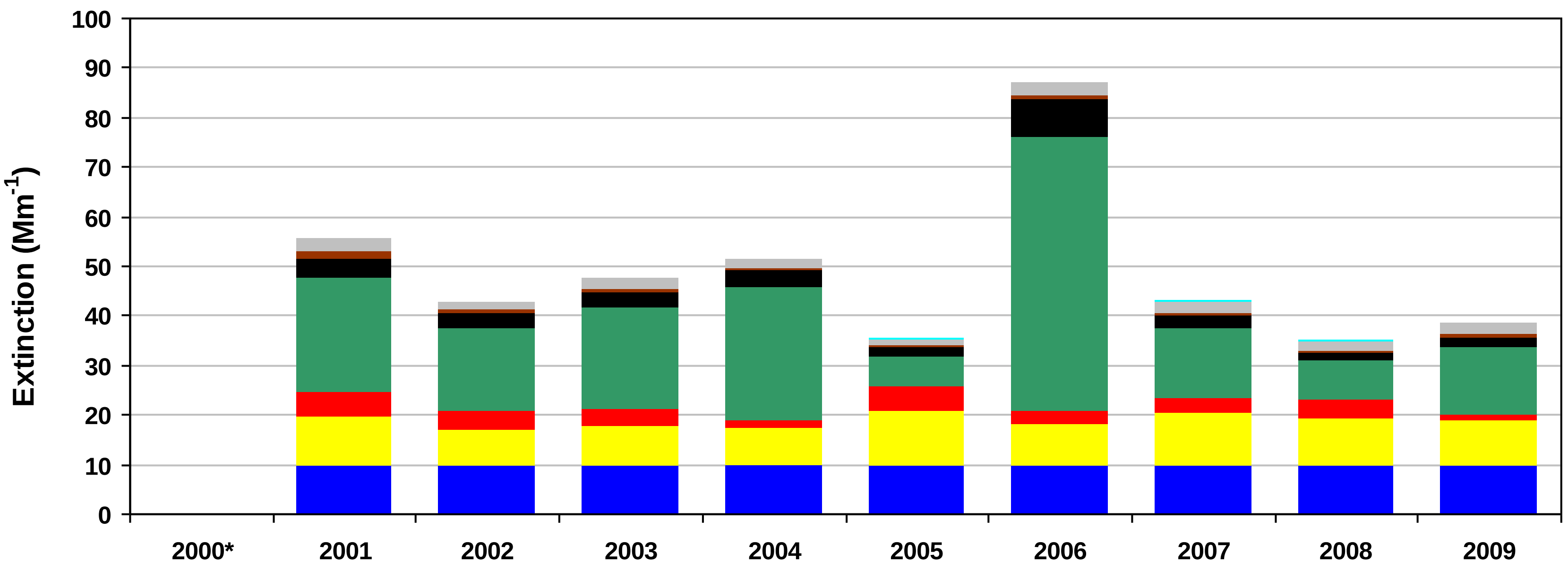
**Figure N.4-2**
**Pasayten WA, WA (PASA1 Site)**
**Annual and 5-Year Period Averages**
**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria.

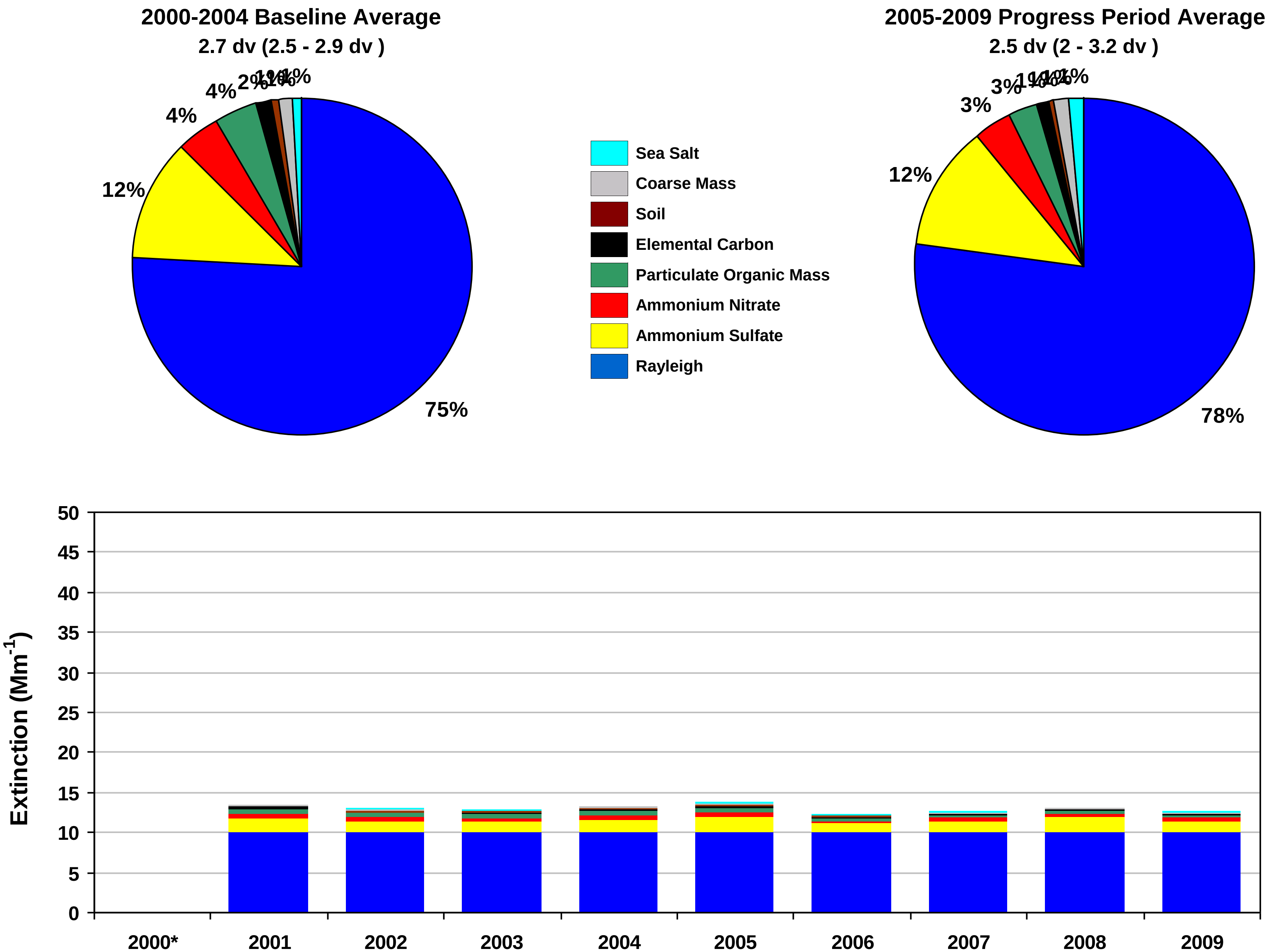
**Figure N.4-3**
**Pasayten WA, WA (PASA1 Site)**
**20% Most Impaired Visibility Days**



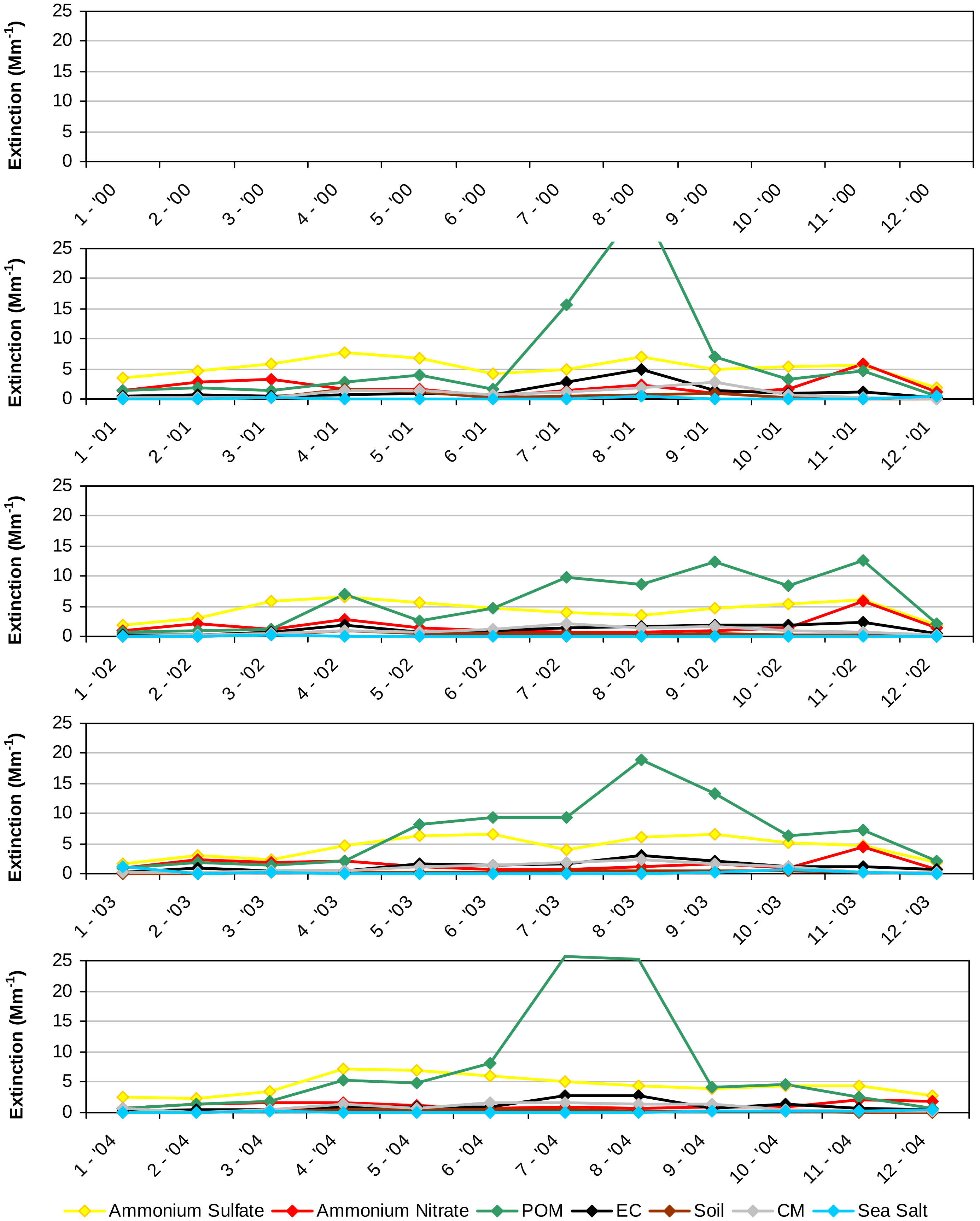

*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.4-4**
**Pasayten WA, WA (PASA1 Site)**
**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.4-5**
**Pasayten WA, WA (PASA1 Site)**
**2000-2004 Monthly Average Aerosol Extinction, All Monitored Days**




*Note that monthly averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.4-6**
**Pasayten WA, WA (PASA1 Site)**
**2005-2009 Monthly Average Aerosol Extinction, All Monitored Days**

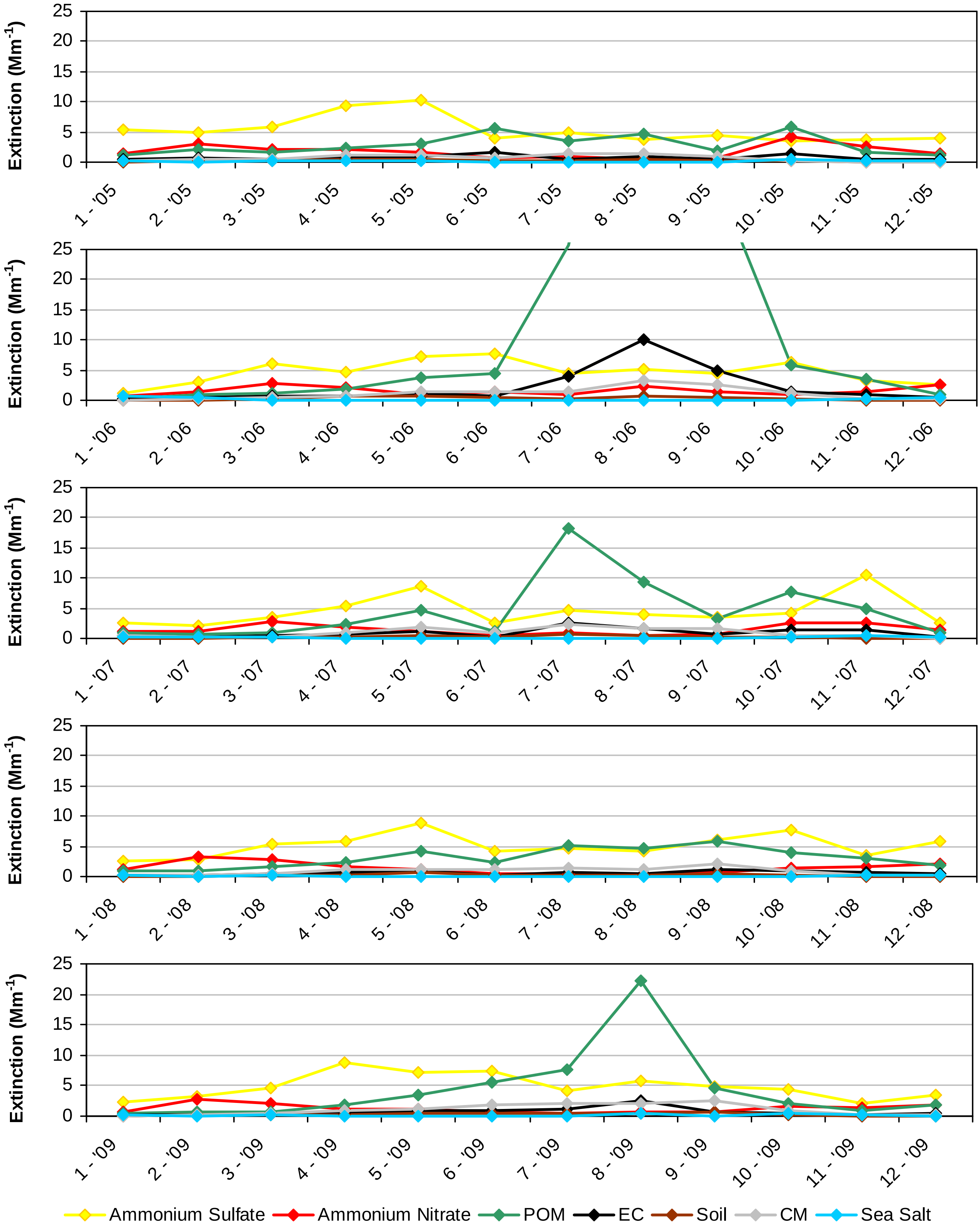
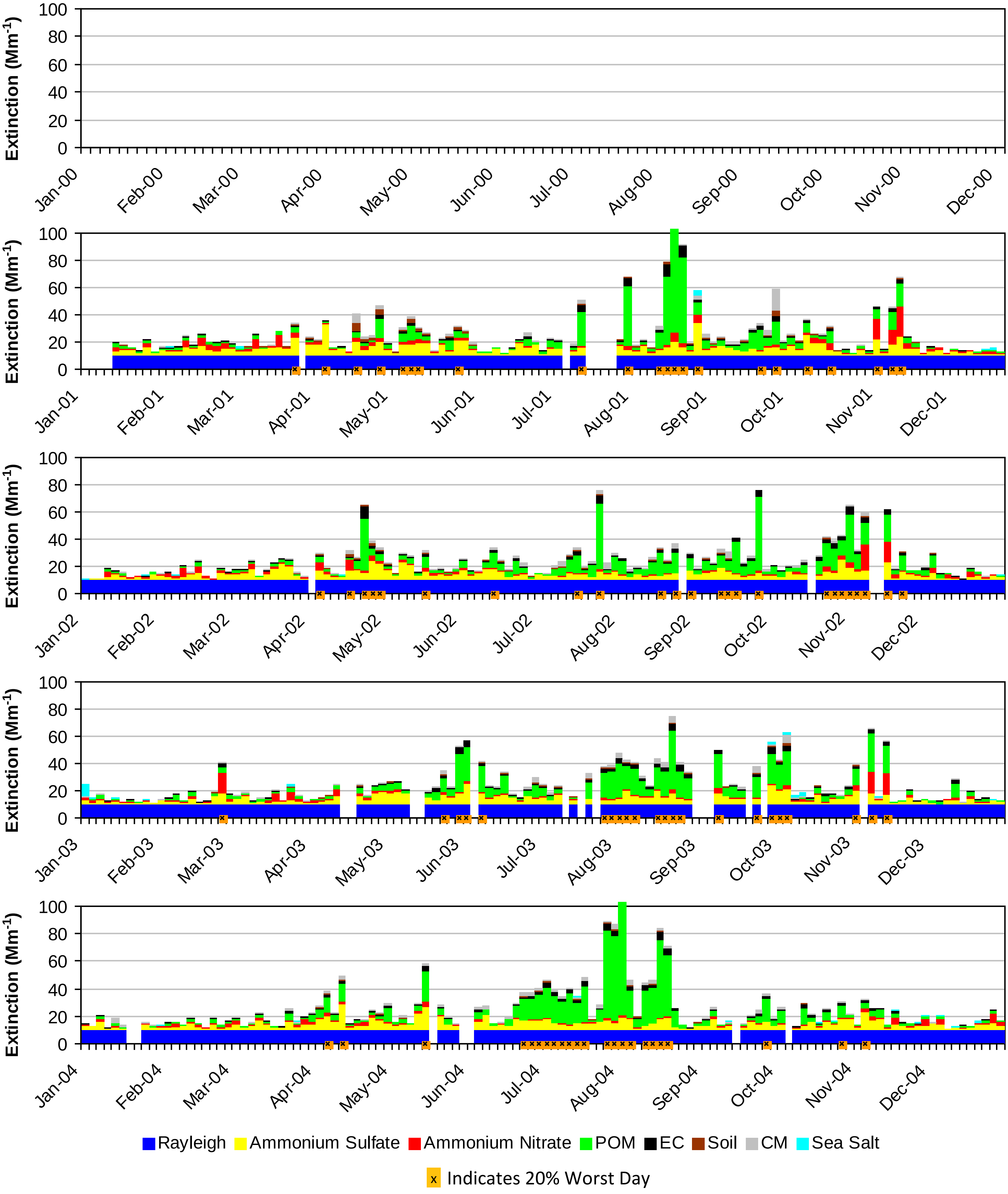
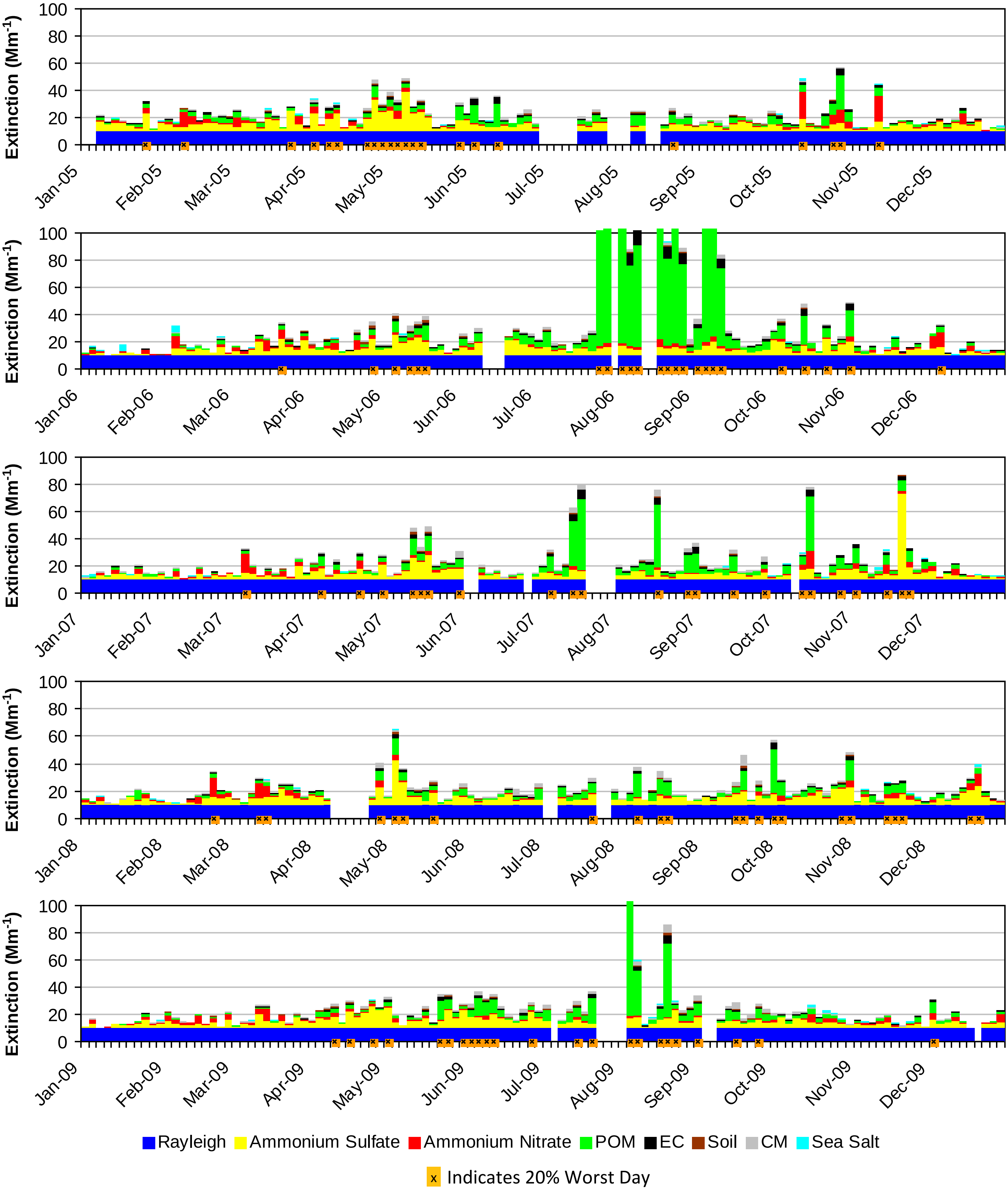


**Figure N.4-7**
**Pasayten WA, WA (PASA1 Site)**
**2000-2004 Progress Period Extinction, All Sampled Days**




*Note that daily averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.4-8**
**Pasayten WA, WA (PASA1 Site)**
**2005-2009 Progress Period Extinction, All Sampled Days**



## N.5. ALPINE LAKES WA (SNPA1)

The following tables and figures are presented in this section for the Alpine Lakes WA represented by the SNPA1 IMPROVE Monitor:

- **Table N.5-1: Annual Averages, 5-Year Period Averages, and Trends:** Table of averages and other metrics for the 20% least impaired days, the 20% most impaired days, and all sampled days is presented.

- **Figure N.5-1: Annual and 5-Year Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.5-2: Annual and 5-Year Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure N.5-3: 20% Most Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component for the 20% most impaired days are presented.

- **Figure N.5-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure N.5-5: 2000-2004 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the baseline period are presented.

- **Figure N.5-6: 2005-2009 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the progress period are presented.

- **Figure N.5-7: 2000-2004 Progress Period Extinction, All Sampled Days:** Stacked bar charts depicting daily averages by year and component for the baseline period are presented.

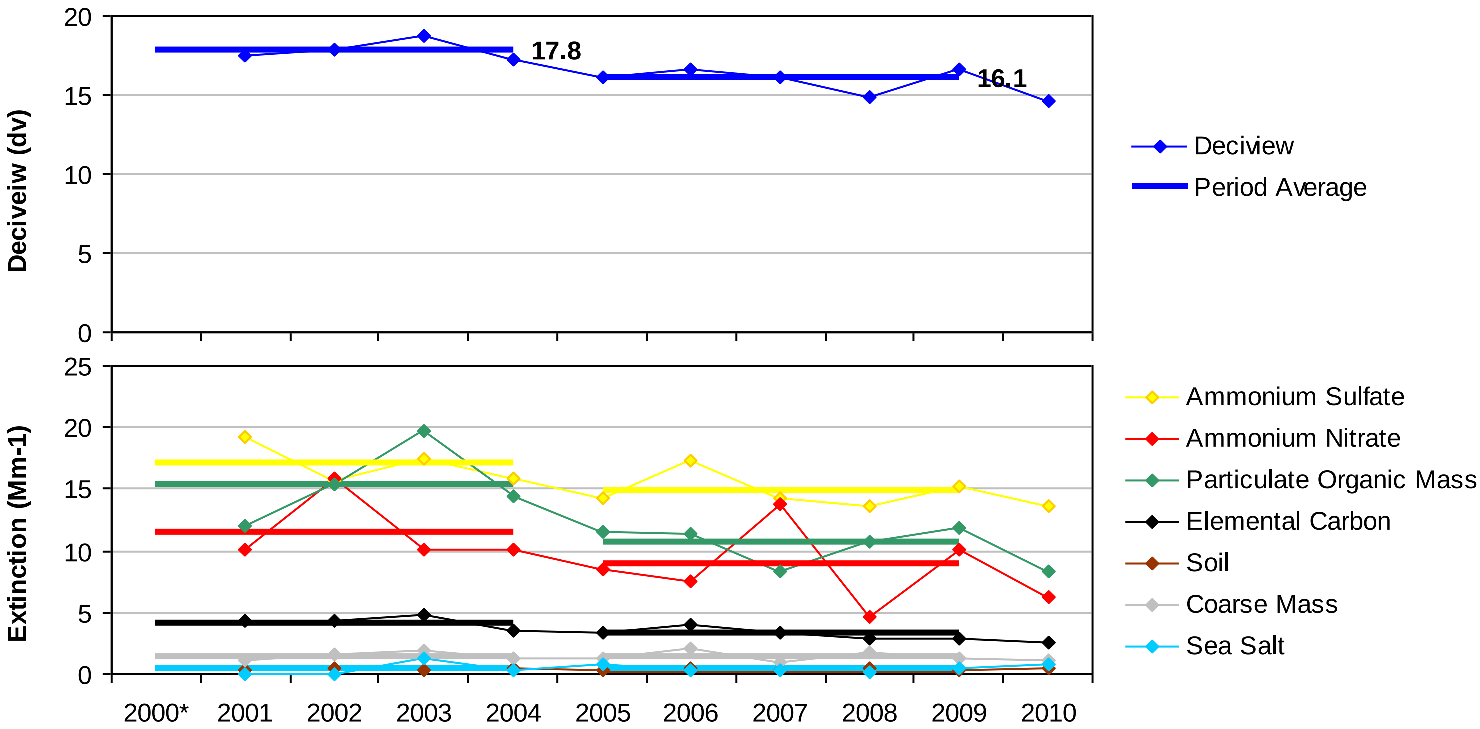
- **Figure N.5-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

**Table N.5-1**
**Alpine Lakes WA, WA (SNPA1 Site)**
**Annual Averages, 5-Year Period Averages and Trends**

| Group | Baseline Period | | | | | Progress Period | | | | | | 2000-2009 Trend Statistics* | | Period Averages** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Slope (change/yr.) | p-value | Baseline (B) | Progress (P) | Difference (P -B) | Percent Change |
| **Deciview (dv)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 6.5 | 5.4 | 4.7 | 5.4 | 5.4 | 4.9 | 4.9 | 4.5 | 4.9 | 3.3 | -0.1 | 0.0 | 5.5 | 4.9 | -0.6 | -11% |
| Worst 20% Days | --- | 17.5 | 17.9 | 18.7 | 17.2 | 16.1 | 16.7 | 16.2 | 14.9 | 16.6 | 14.6 | -0.3 | 0.0 | 17.8 | 16.1 | -1.7 | -10% |
| All Days | --- | 11.8 | 11.6 | 11.2 | 11.1 | 10.7 | 10.5 | 10.0 | 9.6 | 10.6 | 8.6 | -0.3 | 0.0 | 11.5 | 10.3 | -1.2 | -10% |
| **Total Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 19.2 | 17.3 | 16.2 | 17.2 | 17.3 | 16.5 | 16.3 | 15.8 | 16.5 | 14.0 | -0.2 | 0.0 | 17.5 | 16.5 | -1.0 | -6% |
| Worst 20% Days | --- | 58.2 | 64.5 | 66.7 | 57.0 | 51.2 | 54.1 | 52.5 | 45.5 | 53.4 | 44.3 | -1.7 | 0.0 | 61.6 | 51.3 | -10.3 | -17% |
| All Days | --- | 35.2 | 36.1 | 34.9 | 33.3 | 31.6 | 31.2 | 30.0 | 28.1 | 31.6 | 25.9 | -1.1 | 0.0 | 34.9 | 30.5 | -4.4 | -13% |
| **Ammonium Sulfate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 3.6 | 2.5 | 1.9 | 2.3 | 2.6 | 1.9 | 1.9 | 2.2 | 2.0 | 1.3 | -0.1 | 0.1 | 2.6 | 2.1 | -0.5 | -19% |
| Worst 20% Days | --- | 19.3 | 15.8 | 17.4 | 15.8 | 14.3 | 17.3 | 14.2 | 13.7 | 15.3 | 13.7 | -0.5 | 0.0 | 17.1 | 15.0 | -2.1 | -12% |
| All Days | --- | 10.8 | 9.2 | 8.5 | 8.1 | 8.4 | 8.1 | 7.0 | 7.7 | 8.3 | 6.2 | -0.3 | 0.0 | 9.1 | 7.9 | -1.2 | -13% |
| **Ammonium Nitrate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 1.5 | 1.2 | 0.9 | 1.0 | 1.3 | 1.2 | 1.0 | 0.5 | 0.9 | 0.6 | -0.1 | 0.0 | 1.2 | 1.0 | -0.2 | -17% |
| Worst 20% Days | --- | 10.1 | 15.8 | 10.1 | 10.2 | 8.4 | 7.5 | 13.8 | 4.7 | 10.1 | 6.3 | -0.7 | 0.1 | 11.6 | 8.9 | -2.7 | -23% |
| All Days | --- | 5.2 | 6.3 | 4.6 | 4.8 | 4.2 | 3.5 | 5.0 | 2.3 | 4.3 | 3.0 | -0.3 | 0.0 | 5.2 | 3.8 | -1.4 | -27% |
| **Particulate Organic Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 1.3 | 0.9 | 0.9 | 1.1 | 0.8 | 0.9 | 0.7 | 1.0 | 0.8 | 0.3 | 0.0 | 0.0 | 1.1 | 0.8 | -0.3 | -27% |
| Worst 20% Days | --- | 12.0 | 15.4 | 19.8 | 14.5 | 11.6 | 11.4 | 8.4 | 10.8 | 11.9 | 8.3 | -0.5 | 0.0 | 15.4 | 10.8 | -4.6 | -30% |
| All Days | --- | 4.6 | 6.0 | 6.8 | 5.7 | 4.3 | 4.4 | 3.7 | 4.2 | 4.7 | 3.0 | -0.2 | 0.1 | 5.8 | 4.3 | -1.5 | -26% |
| **Elemental Carbon Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 1.1 | 0.7 | 0.8 | 1.0 | 0.7 | 0.7 | 0.8 | 0.6 | 0.5 | 0.5 | 0.0 | 0.0 | 0.9 | 0.7 | -0.2 | -22% |
| Worst 20% Days | --- | 4.3 | 4.4 | 4.7 | 3.5 | 3.4 | 3.9 | 3.4 | 2.9 | 2.9 | 2.6 | -0.2 | 0.0 | 4.2 | 3.3 | -0.9 | -21% |
| All Days | --- | 2.1 | 2.3 | 2.4 | 1.9 | 1.9 | 2.0 | 1.8 | 1.6 | 1.6 | 1.3 | -0.1 | 0.0 | 2.2 | 1.8 | -0.4 | -18% |
| **Soil Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.1 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.1 | 0.0 | 0.0 | 0.0 | 0.2 | 0.1 | 0.0 | -0.1 | -100% |
| Worst 20% Days | --- | 0.4 | 0.5 | 0.4 | 0.4 | 0.3 | 0.5 | 0.3 | 0.5 | 0.4 | 0.5 | 0.0 | 0.5 | 0.4 | 0.4 | 0.0 | 0% |
| All Days | --- | 0.3 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.0 | 0.2 | 0.2 | 0.2 | 0.0 | 0% |
| **Coarse Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.3 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.2 | 0.1 | -0.1 | -50% |
| Worst 20% Days | --- | 1.2 | 1.6 | 1.9 | 1.3 | 1.4 | 2.1 | 1.0 | 1.7 | 1.4 | 1.2 | 0.0 | 0.4 | 1.5 | 1.5 | 0.0 | 0% |
| All Days | --- | 0.8 | 0.8 | 0.8 | 0.7 | 0.7 | 0.9 | 0.5 | 0.7 | 0.8 | 0.6 | 0.0 | 0.2 | 0.8 | 0.7 | -0.1 | -13% |
| **Sea Salt Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.4 | 0.6 | 0.5 | 0.6 | 0.7 | 0.6 | 0.8 | 0.3 | 1.0 | 0.2 | 0.1 | 0.1 | 0.5 | 0.7 | 0.2 | 40% |
| Worst 20% Days | --- | 0.0 | 0.1 | 1.3 | 0.3 | 0.9 | 0.3 | 0.3 | 0.2 | 0.5 | 0.8 | 0.0 | 0.3 | 0.4 | 0.4 | 0.0 | 0% |
| All Days | --- | 0.4 | 0.3 | 0.6 | 0.8 | 0.9 | 1.1 | 0.9 | 0.4 | 0.8 | 0.6 | 0.1 | 0.1 | 0.5 | 0.8 | 0.3 | 60% |

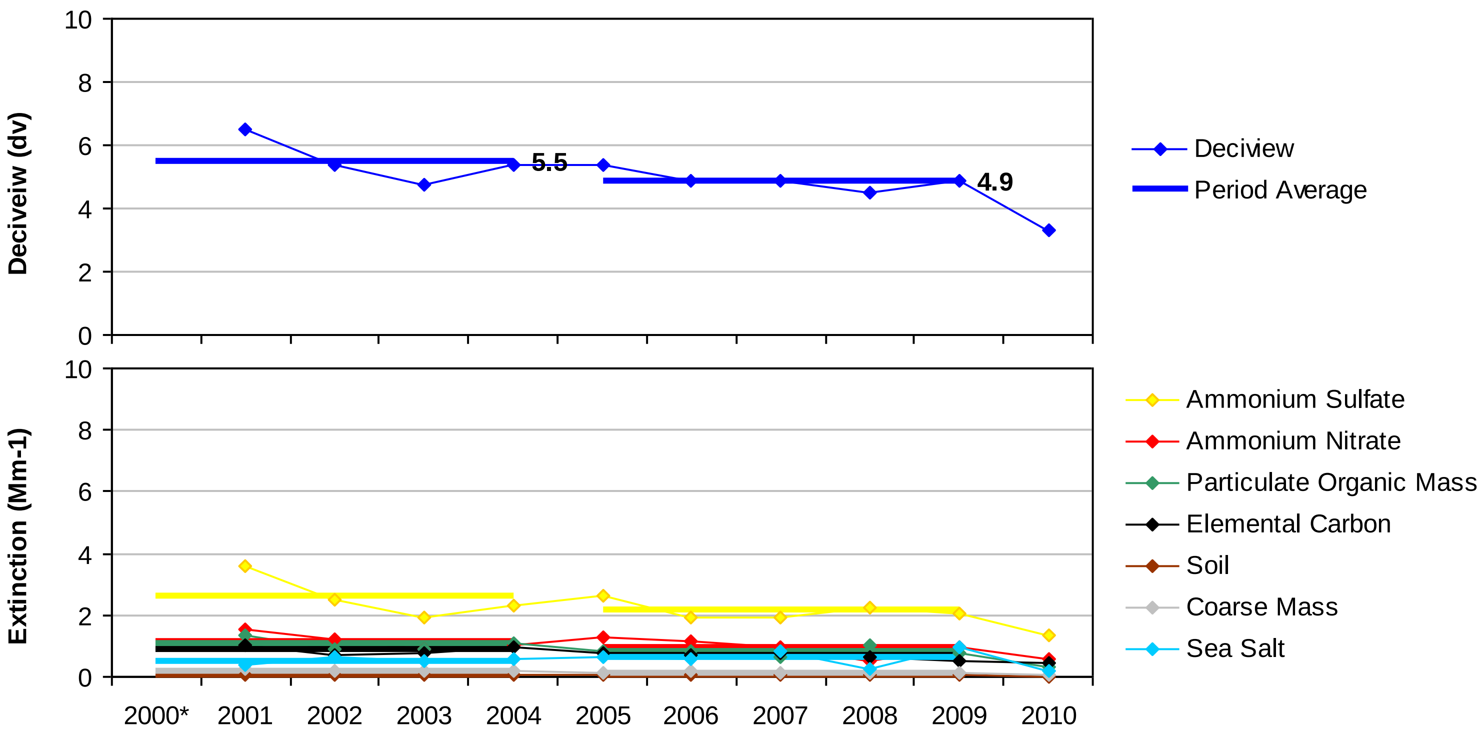
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---" Indicates a missing year that did not meet RHR data completeness criteria.

**Figure N.5-1**
**Alpine Lakes WA, WA (SNPA1 Site)**
**Annual and 5-Year Period Averages**
**20% Most Impaired Visibility Days**



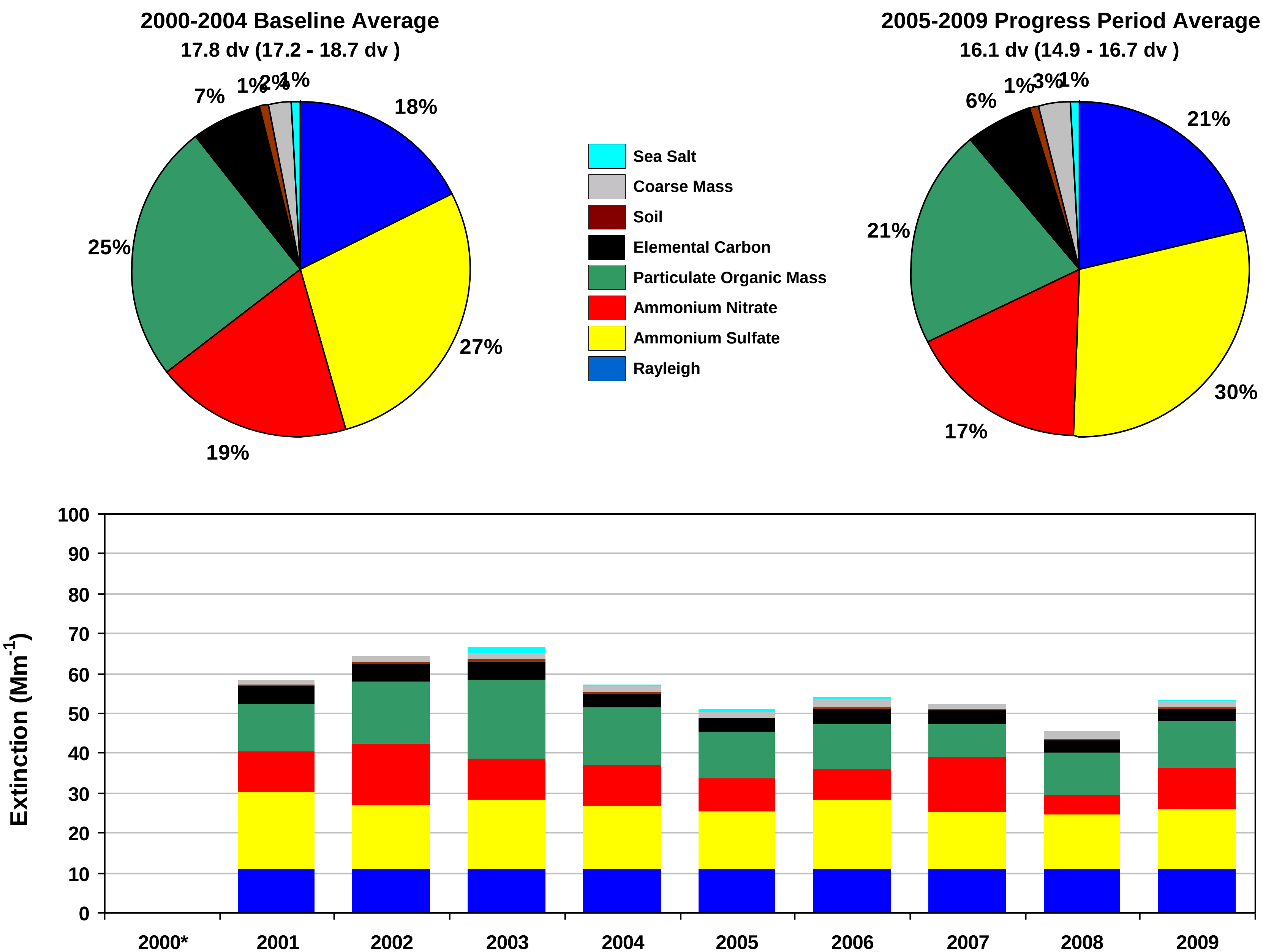

*Missing years did not meet RHR data completeness criteria.

**Figure N.5-2**
**Alpine Lakes WA, WA (SNPA1 Site)**
**Annual and 5-Year Period Averages**
**20% Least Impaired Visibility Days**



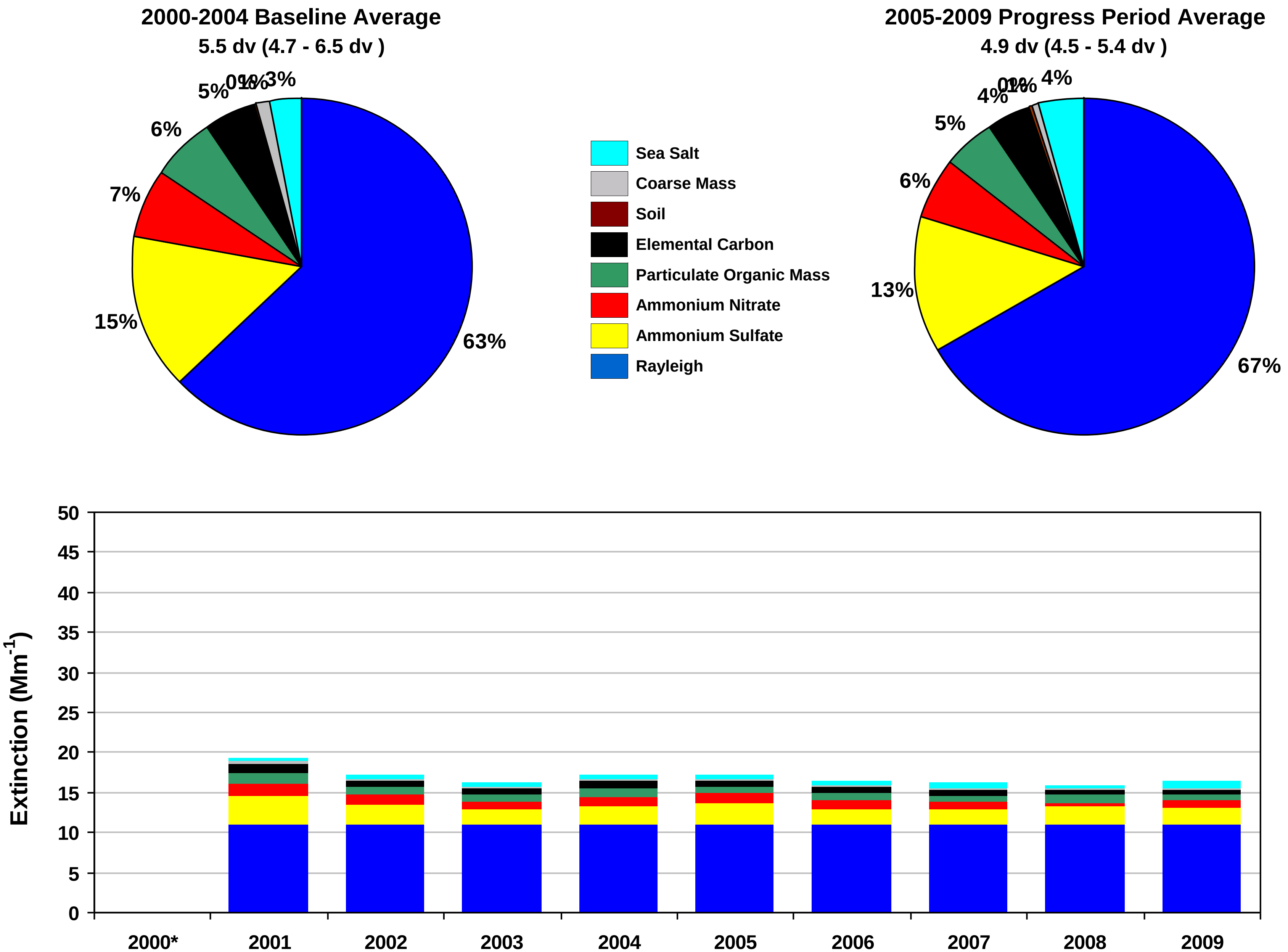

*Missing years did not meet RHR data completeness criteria.

**Figure N.5-3**
**Alpine Lakes WA, WA (SNPA1 Site)**
**20% Most Impaired Visibility Days**



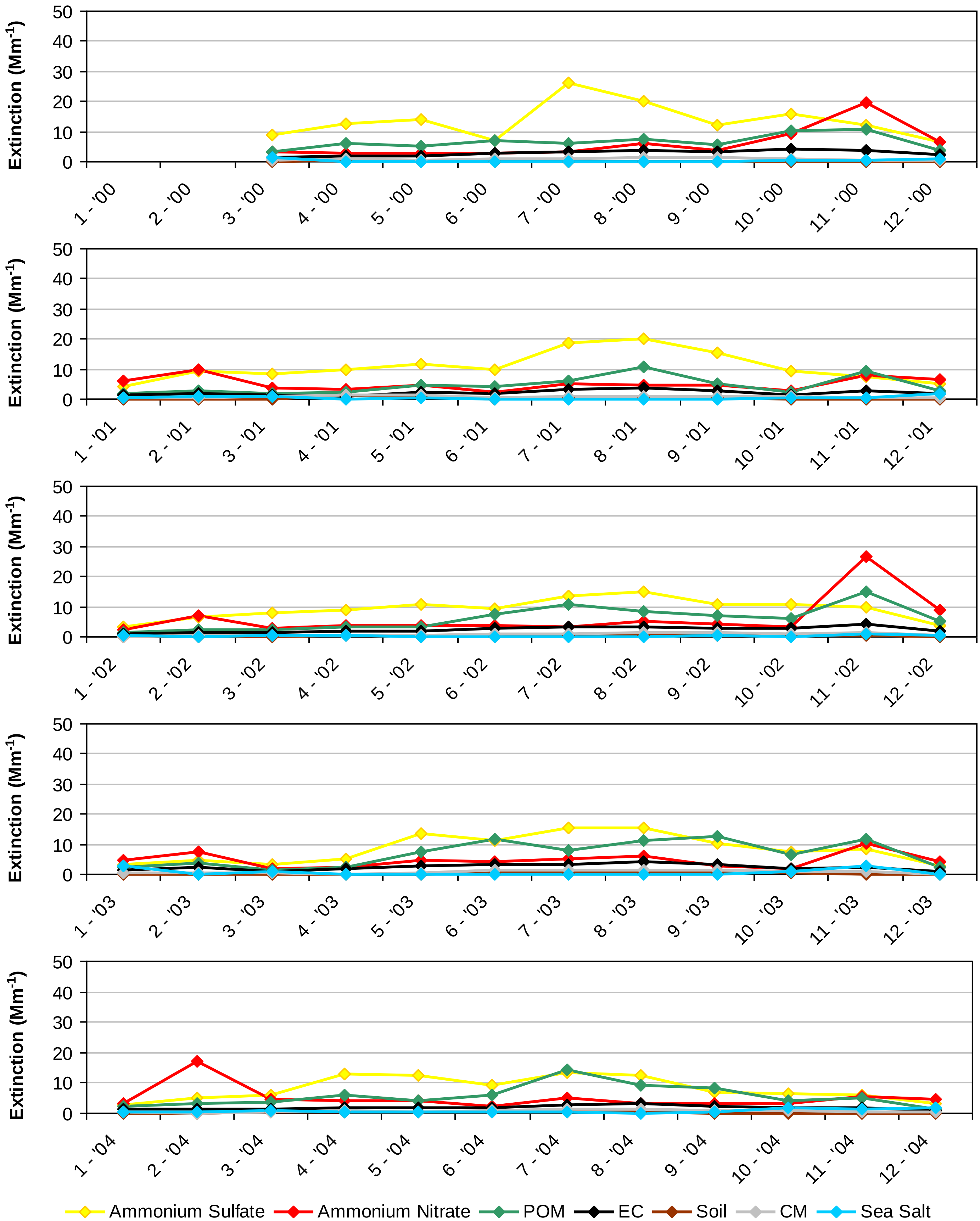

*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.5-4**
**Alpine Lakes WA, WA (SNPA1 Site)**
**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.5-5**
**Alpine Lakes WA, WA (SNPA1 Site)**
**2000-2004 Monthly Average Aerosol Extinction, All Monitored Days**




*Note that monthly averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.5-6**
**Alpine Lakes WA, WA (SNPA1 Site)**
**2005-2009 Monthly Average Aerosol Extinction, All Monitored Days**

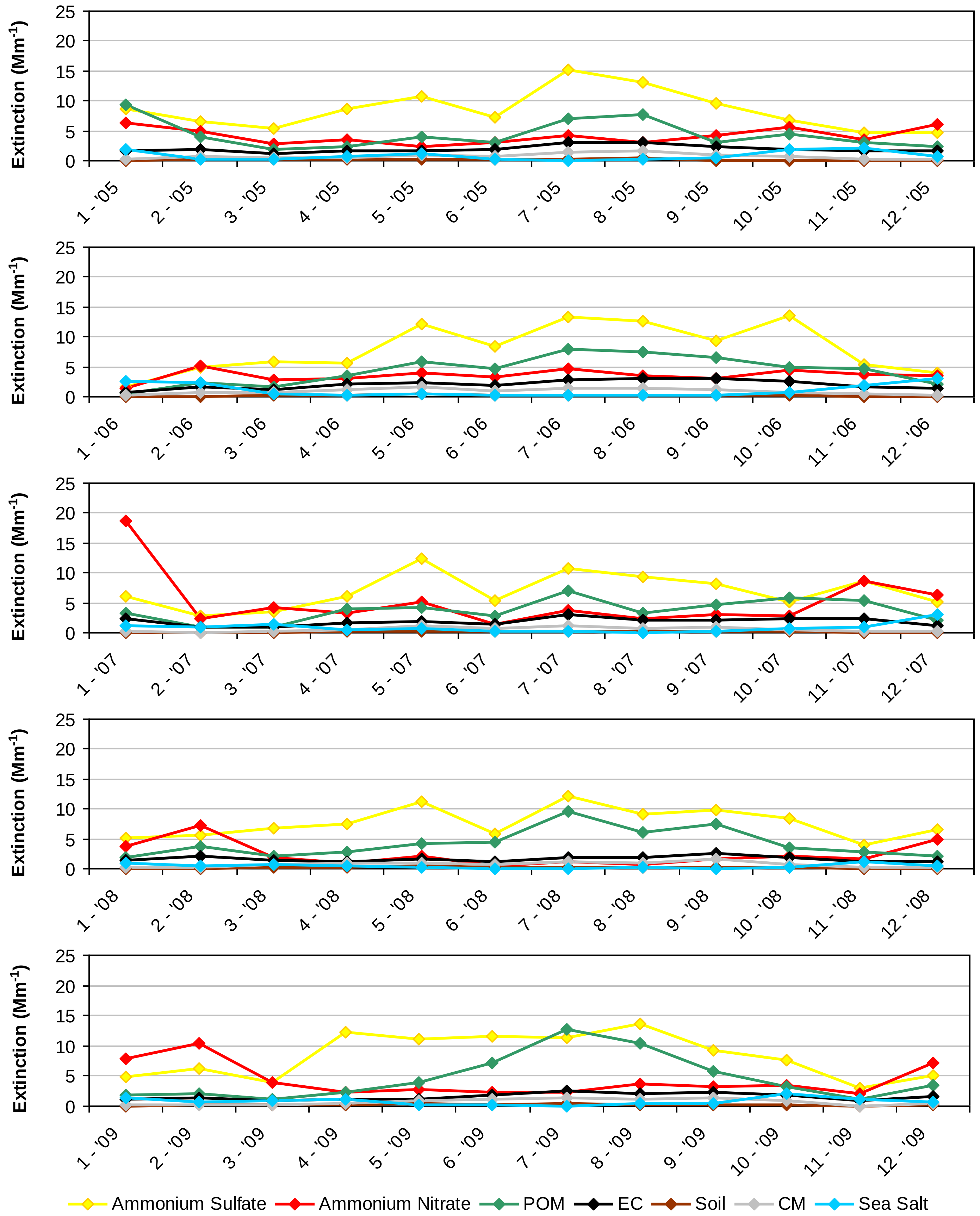
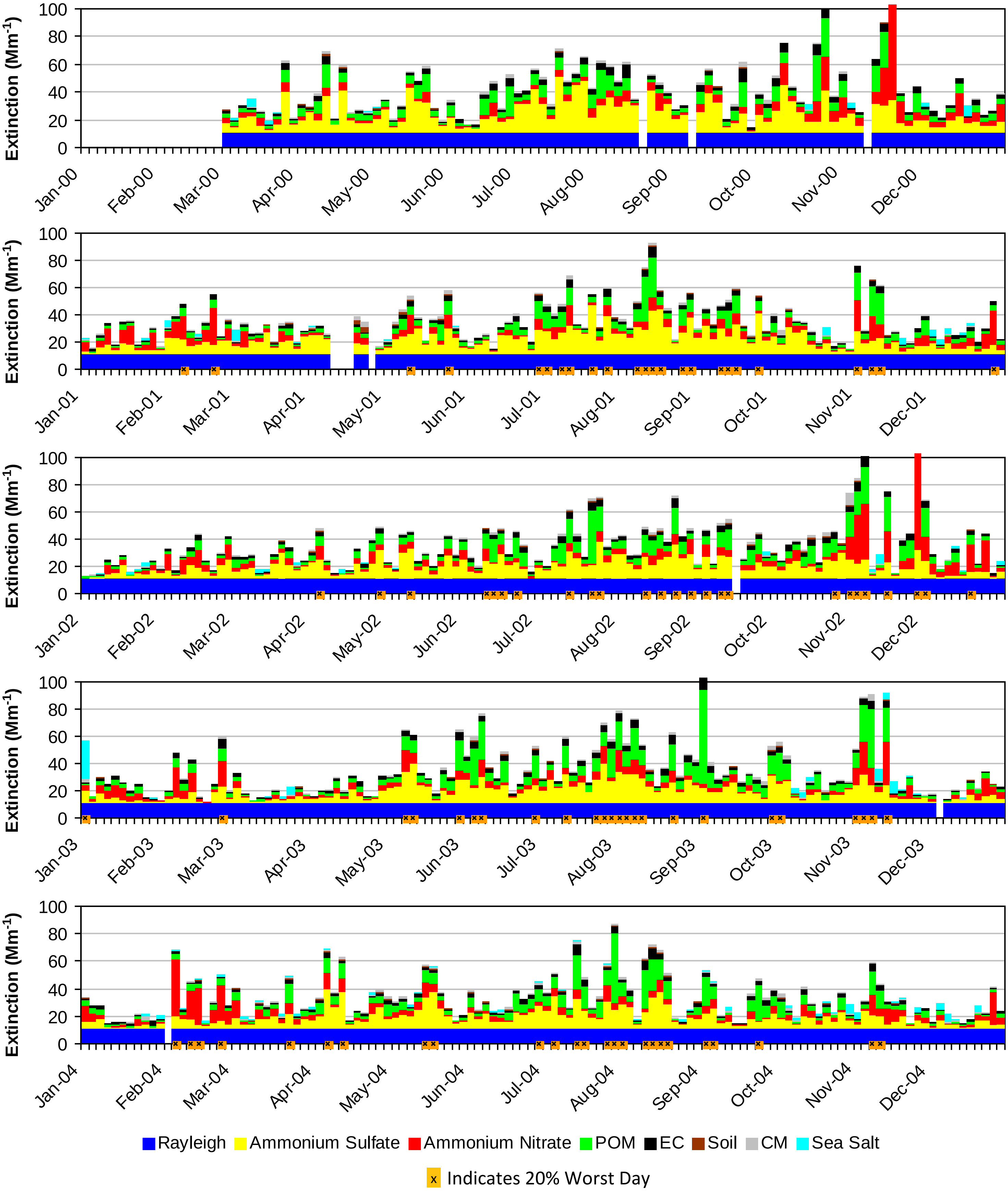
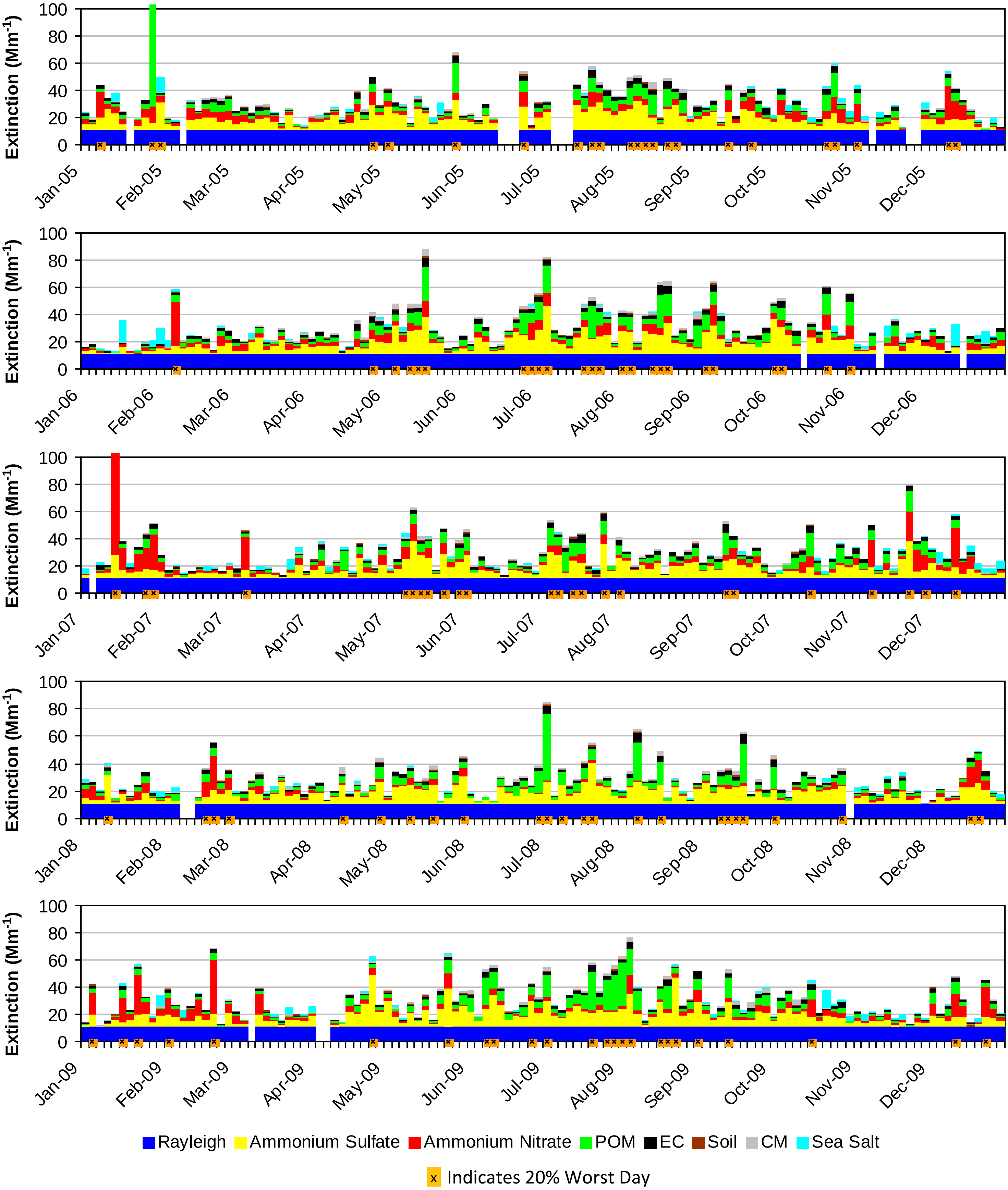


**Figure N.5-7**
**Alpine Lakes WA, WA (SNPA1 Site)**
**2000-2004 Progress Period Extinction, All Sampled Days**




*Note that daily averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.5-8**
**Alpine Lakes WA, WA (SNPA1 Site)**
**2005-2009 Progress Period Extinction, All Sampled Days**



## N.6. GOAT ROCKS WA AND MOUNT ADAMS WA (WHPA1)

The following tables and figures are presented in this section for the Goat Rocks WA and Mount Adams WA represented by the WHPA1 IMPROVE Monitor:

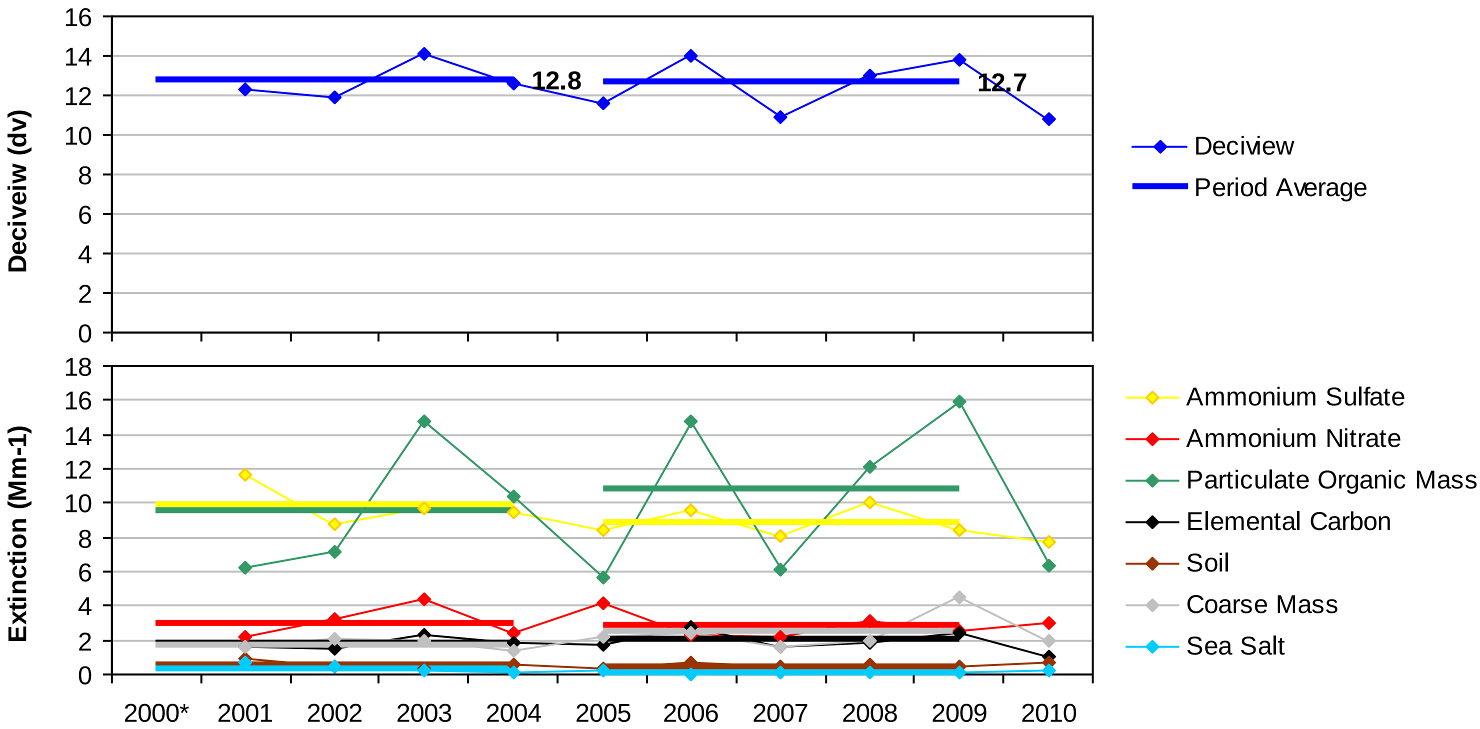
- **Table N.6-1: Annual Averages, 5-Year Period Averages, and Trends:** Table of averages and other metrics for the 20% least impaired days, the 20% most impaired days, and all sampled days is presented.
- **Figure N.6-1: Annual and 5-Year Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.
- **Figure N.6-2: Annual and 5-Year Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.
- **Figure N.6-3: 20% Most Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component for the 20% most impaired days are presented.
- **Figure N.6-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.
- **Figure N.6-5: 2000-2004 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the baseline period are presented.
- **Figure N.6-6: 2005-2009 Monthly Average Aerosol Extinction, All Monitored Days:** Line graphs depicting monthly averages by year and component for the progress period are presented.
- **Figure N.6-7: 2000-2004 Progress Period Extinction, All Sampled Days:** Stacked bar charts depicting daily averages by year and component for the baseline period are presented.
- **Figure N.6-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

## Table N.6-1
## Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)
## Annual Averages, 5-Year Period Averages and Trends

| Group | Baseline Period | | | | | Progress Period | | | | | | 2000-2009 Trend Statistics* | | Period Averages** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | Slope (change/yr.) | p-value | Baseline (B) | Progress (P) | Difference (P -B) | Percent Change |
| **Deciview (dv)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 2.2 | 1.9 | 1.1 | 1.5 | 1.9 | 1.8 | 1.8 | 1.5 | 1.7 | 0.8 | 0.0 | 0.2 | 1.7 | 1.8 | 0.1 | 6% |
| Worst 20% Days | --- | 12.3 | 11.9 | 14.1 | 12.6 | 11.6 | 14.0 | 10.9 | 13.0 | 13.8 | 10.8 | 0.1 | 0.5 | 12.8 | 12.7 | -0.1 | -1% |
| All Days | --- | 6.8 | 6.3 | 6.6 | 6.5 | 6.4 | 6.9 | 5.6 | 6.4 | 7.2 | 5.0 | 0.0 | 0.5 | 6.5 | 6.5 | 0.0 | 0% |
| **Total Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 12.5 | 12.1 | 11.2 | 11.6 | 12.2 | 12.0 | 12.0 | 11.6 | 11.9 | 10.9 | 0.0 | 0.2 | 11.8 | 11.9 | 0.1 | 1% |
| Worst 20% Days | --- | 34.8 | 33.6 | 43.8 | 36.1 | 32.7 | 42.5 | 30.2 | 39.9 | 44.4 | 30.9 | 0.7 | 0.3 | 37.1 | 37.9 | 0.8 | 2% |
| All Days | --- | 21.1 | 20.1 | 22.2 | 20.9 | 20.1 | 22.3 | 18.6 | 21.3 | 23.7 | 18.0 | 0.2 | 0.2 | 21.1 | 21.2 | 0.1 | 1% |
| **Ammonium Sulfate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 1.4 | 1.0 | 0.5 | 0.6 | 1.4 | 0.9 | 1.1 | 0.9 | 1.0 | 0.5 | 0.0 | 0.5 | 0.9 | 1.1 | 0.2 | 22% |
| Worst 20% Days | --- | 11.7 | 8.8 | 9.7 | 9.5 | 8.4 | 9.5 | 8.1 | 10.1 | 8.4 | 7.7 | -0.2 | 0.2 | 9.9 | 8.9 | -1.0 | -10% |
| All Days | --- | 5.7 | 4.3 | 4.3 | 4.5 | 4.8 | 4.7 | 4.0 | 4.9 | 4.7 | 3.4 | 0.0 | 0.4 | 4.7 | 4.6 | -0.1 | -2% |
| **Ammonium Nitrate Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.4 | 0.3 | 0.1 | 0.2 | 0.3 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.0 | 0.1 | 0.2 | 0.2 | 0.0 | 0% |
| Worst 20% Days | --- | 2.2 | 3.3 | 4.4 | 2.4 | 4.1 | 2.3 | 2.2 | 3.1 | 2.5 | 3.0 | 0.0 | 0.5 | 3.1 | 2.9 | -0.2 | -7% |
| All Days | --- | 1.2 | 1.4 | 1.6 | 1.3 | 1.5 | 1.2 | 0.9 | 1.1 | 1.2 | 1.1 | 0.0 | 0.2 | 1.4 | 1.2 | -0.2 | -14% |
| **Particulate Organic Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.2 | 0.4 | 0.2 | 0.2 | 0.2 | 0.3 | 0.2 | 0.3 | 0.1 | 0.1 | 0.0 | 0.5 | 0.3 | 0.2 | -0.1 | -33% |
| Worst 20% Days | --- | 6.2 | 7.1 | 14.8 | 10.4 | 5.6 | 14.7 | 6.1 | 12.1 | 16.0 | 6.3 | 0.8 | 0.2 | 9.6 | 10.9 | 1.3 | 14% |
| All Days | --- | 2.1 | 2.5 | 4.3 | 3.3 | 1.9 | 4.0 | 2.0 | 3.5 | 4.4 | 1.8 | 0.2 | 0.2 | 3.0 | 3.2 | 0.2 | 7% |
| **Elemental Carbon Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.1 | 0.3 | 0.1 | 0.1 | 0.1 | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 | 0.5 | 0.1 | 0.1 | 0.0 | 0% |
| Worst 20% Days | --- | 1.6 | 1.5 | 2.3 | 1.8 | 1.8 | 2.8 | 1.6 | 1.9 | 2.4 | 1.1 | 0.1 | 0.1 | 1.8 | 2.1 | 0.3 | 17% |
| All Days | --- | 0.7 | 0.7 | 0.8 | 0.7 | 0.7 | 1.0 | 0.6 | 0.6 | 0.8 | 0.4 | 0.0 | 0.5 | 0.7 | 0.7 | 0.0 | 0% |
| **Soil Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.4 | 0.0 | 0.0 | 0.0 | 0% |
| Worst 20% Days | --- | 0.9 | 0.4 | 0.4 | 0.5 | 0.4 | 0.7 | 0.4 | 0.6 | 0.5 | 0.6 | 0.0 | 0.5 | 0.6 | 0.5 | -0.1 | -17% |
| All Days | --- | 0.4 | 0.2 | 0.2 | 0.2 | 0.2 | 0.2 | 0.1 | 0.2 | 0.2 | 0.2 | 0.0 | 0.5 | 0.2 | 0.2 | 0.0 | 0% |
| **Coarse Mass Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.2 | 0.2 | 0.1 | 0.2 | 0.1 | 0.2 | 0.1 | 0.1 | 0.4 | 0.1 | 0.0 | 0.4 | 0.1 | 0.2 | 0.1 | 100% |
| Worst 20% Days | --- | 1.6 | 2.0 | 2.0 | 1.4 | 2.2 | 2.4 | 1.6 | 2.0 | 4.5 | 1.9 | 0.1 | 0.1 | 1.7 | 2.5 | 0.8 | 47% |
| All Days | --- | 0.8 | 0.7 | 0.7 | 0.7 | 0.9 | 0.9 | 0.7 | 0.8 | 2.0 | 0.8 | 0.0 | 0.2 | 0.7 | 1.0 | 0.3 | 43% |
| **Sea Salt Extinction (Mm-1)** | | | | | | | | | | | | | | | | | |
| Best 20% Days | --- | 0.2 | 0.1 | 0.1 | 0.2 | 0.1 | 0.3 | 0.2 | 0.1 | 0.1 | 0.0 | 0.0 | 0.5 | 0.1 | 0.2 | 0.1 | 100% |
| Worst 20% Days | --- | 0.7 | 0.5 | 0.3 | 0.1 | 0.3 | 0.0 | 0.1 | 0.2 | 0.1 | 0.3 | -0.1 | 0.0 | 0.4 | 0.1 | -0.3 | -75% |
| All Days | --- | 0.3 | 0.3 | 0.2 | 0.3 | 0.3 | 0.2 | 0.3 | 0.2 | 0.3 | 0.2 | 0.0 | 0.3 | 0.3 | 0.2 | -0.1 | -33% |

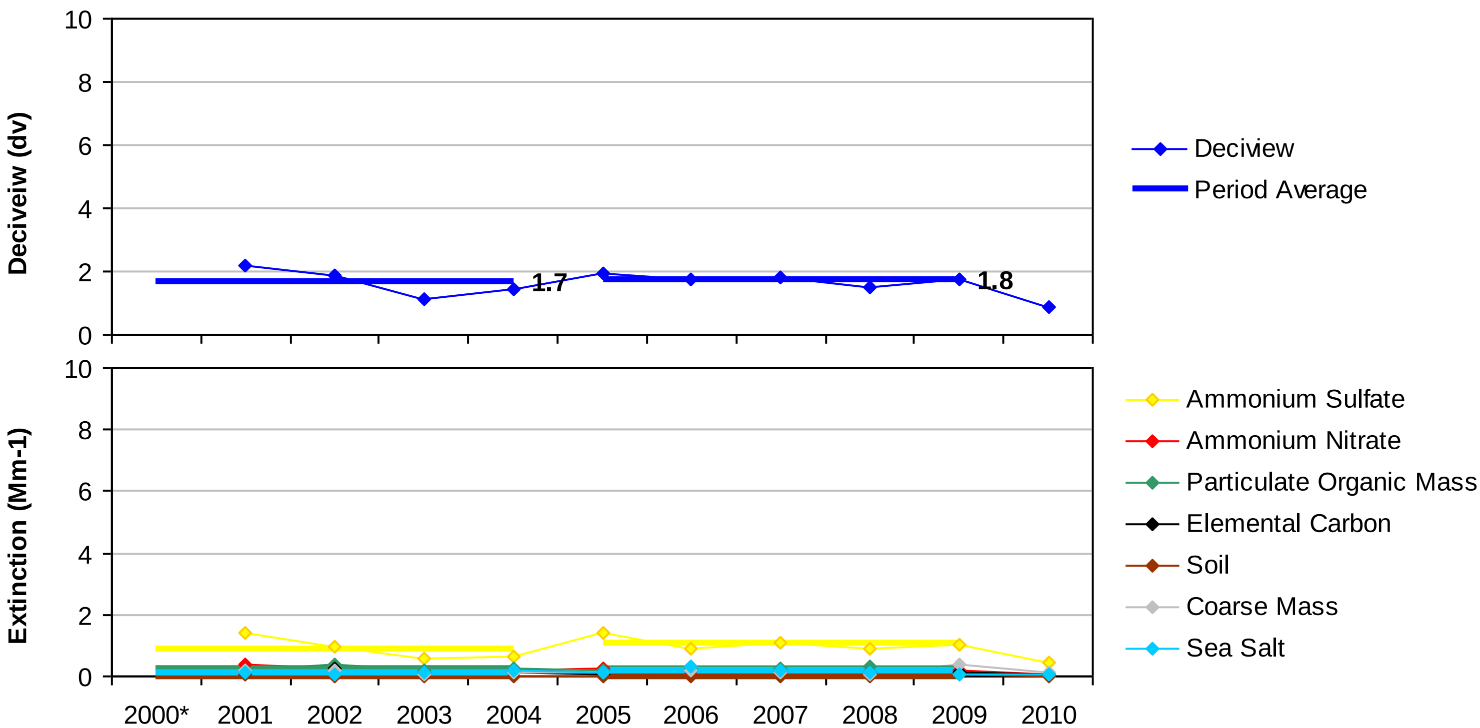
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---" Indicates a missing year that did not meet RHR data completeness criteria.

**Figure N.6-1**
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**
**Annual and 5-Year Period Averages**
**20% Most Impaired Visibility Days**



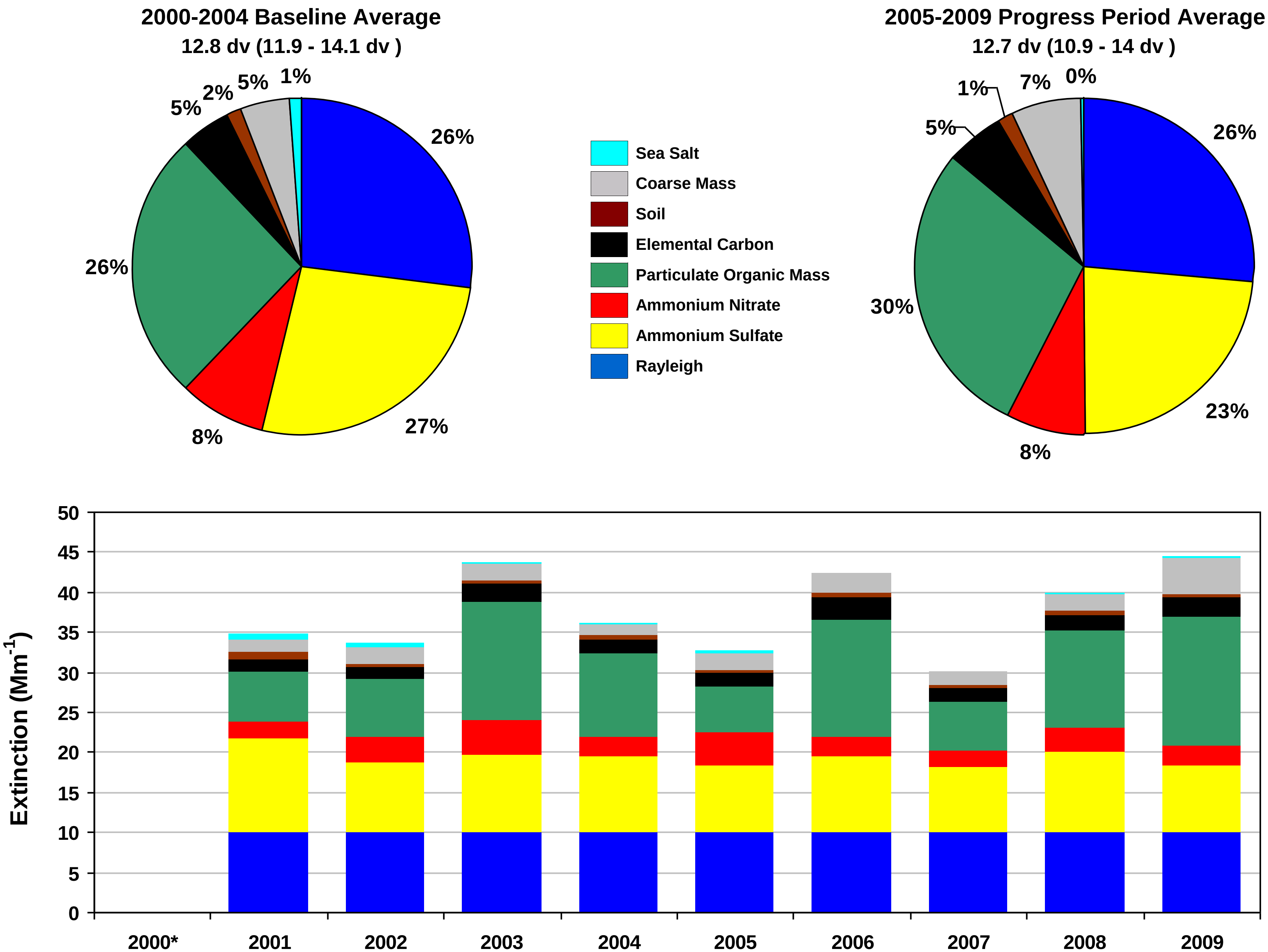

*Missing years did not meet RHR data completeness criteria.

**Figure N.7-2**
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**
**Annual and 5-Year Period Averages**
**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria.

**Figure N.6-3**
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**
**20% Most Impaired Visibility Days**

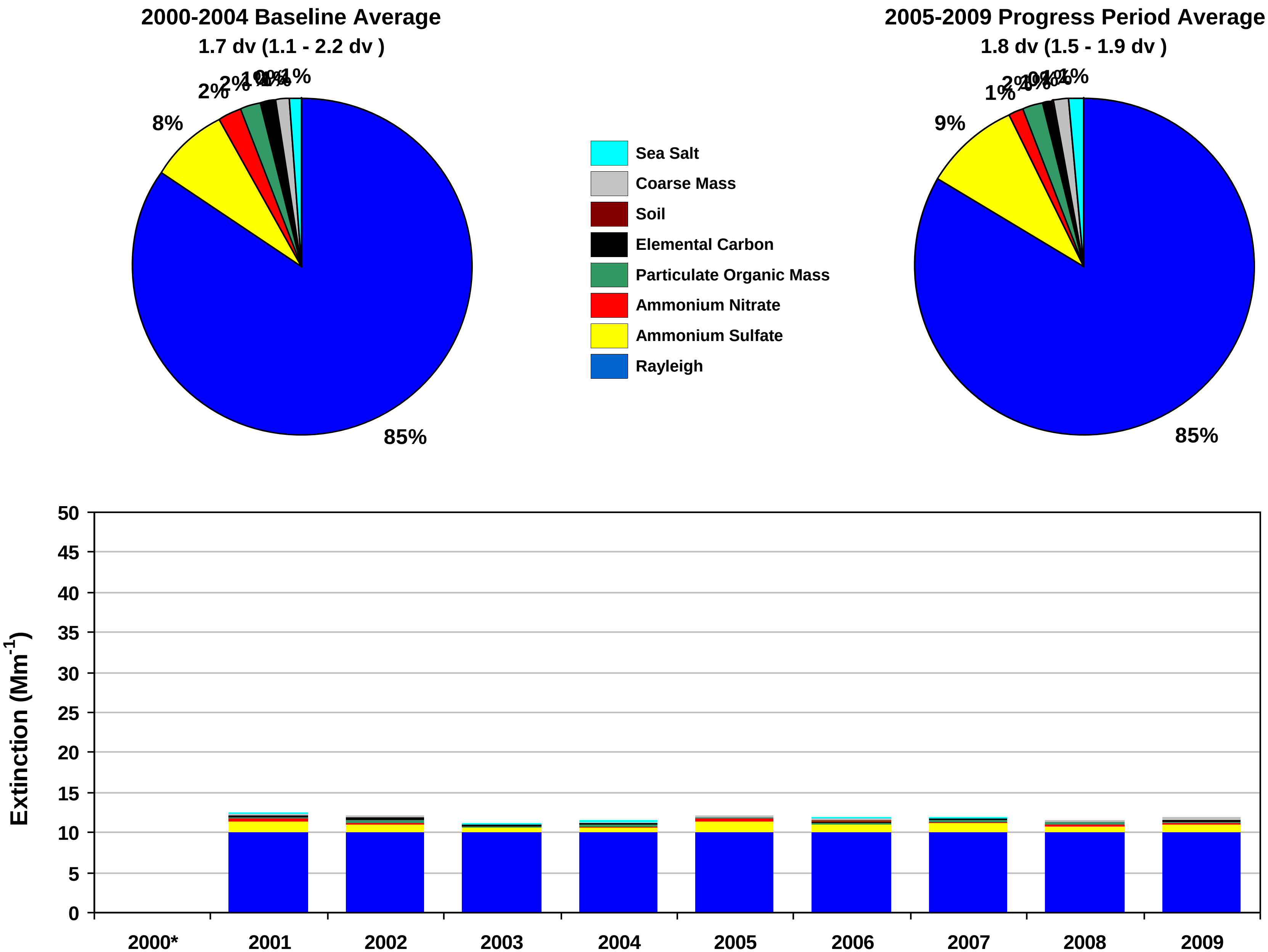



*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.6-4**

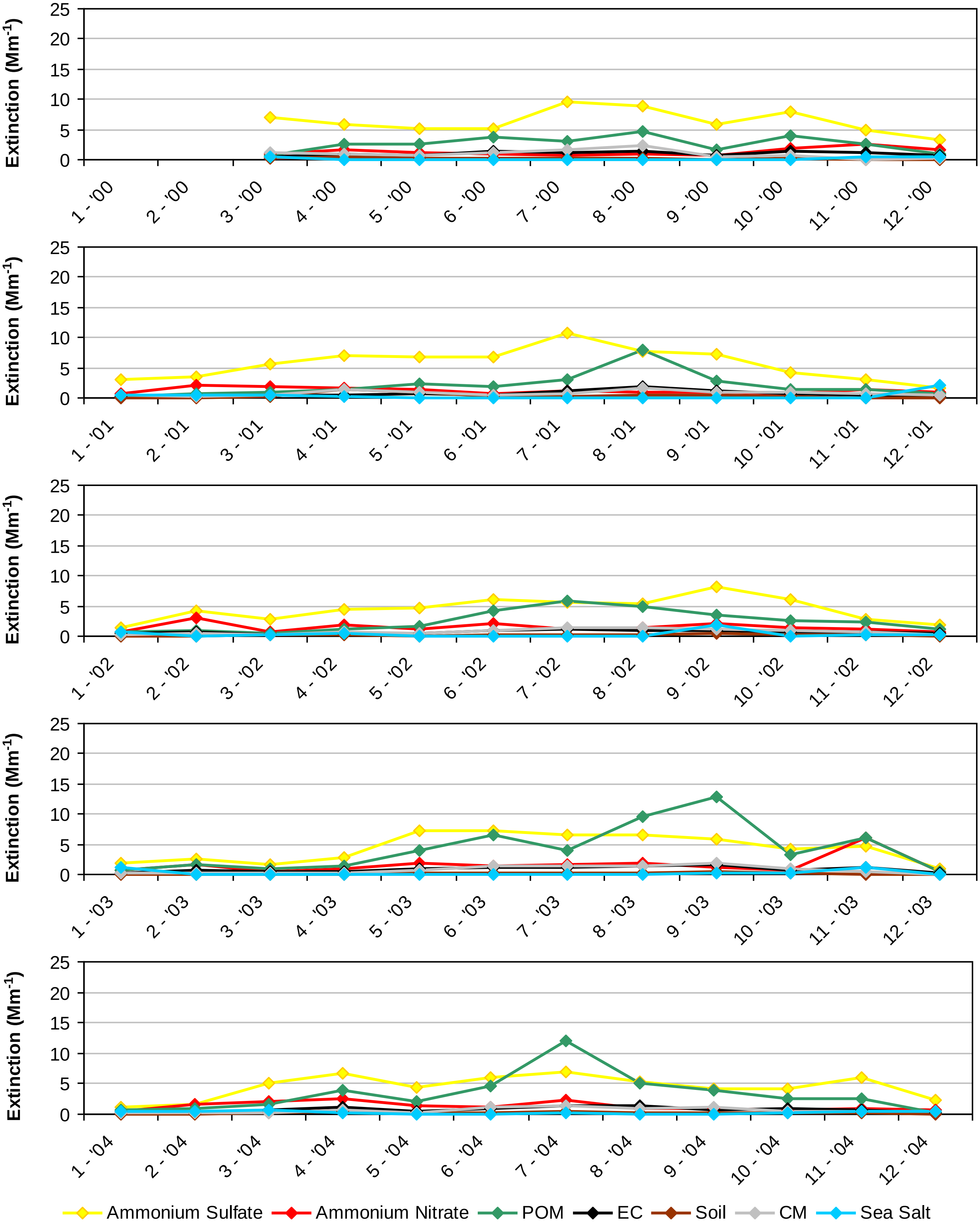
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**

**20% Least Impaired Visibility Days**




*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

**Figure N.6-5**
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**
**2000-2004 Monthly Average Aerosol Extinction, All Monitored Days**




*Note that monthly averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.6-6**
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**
**2005-2009 Monthly Average Aerosol Extinction, All Monitored Days**

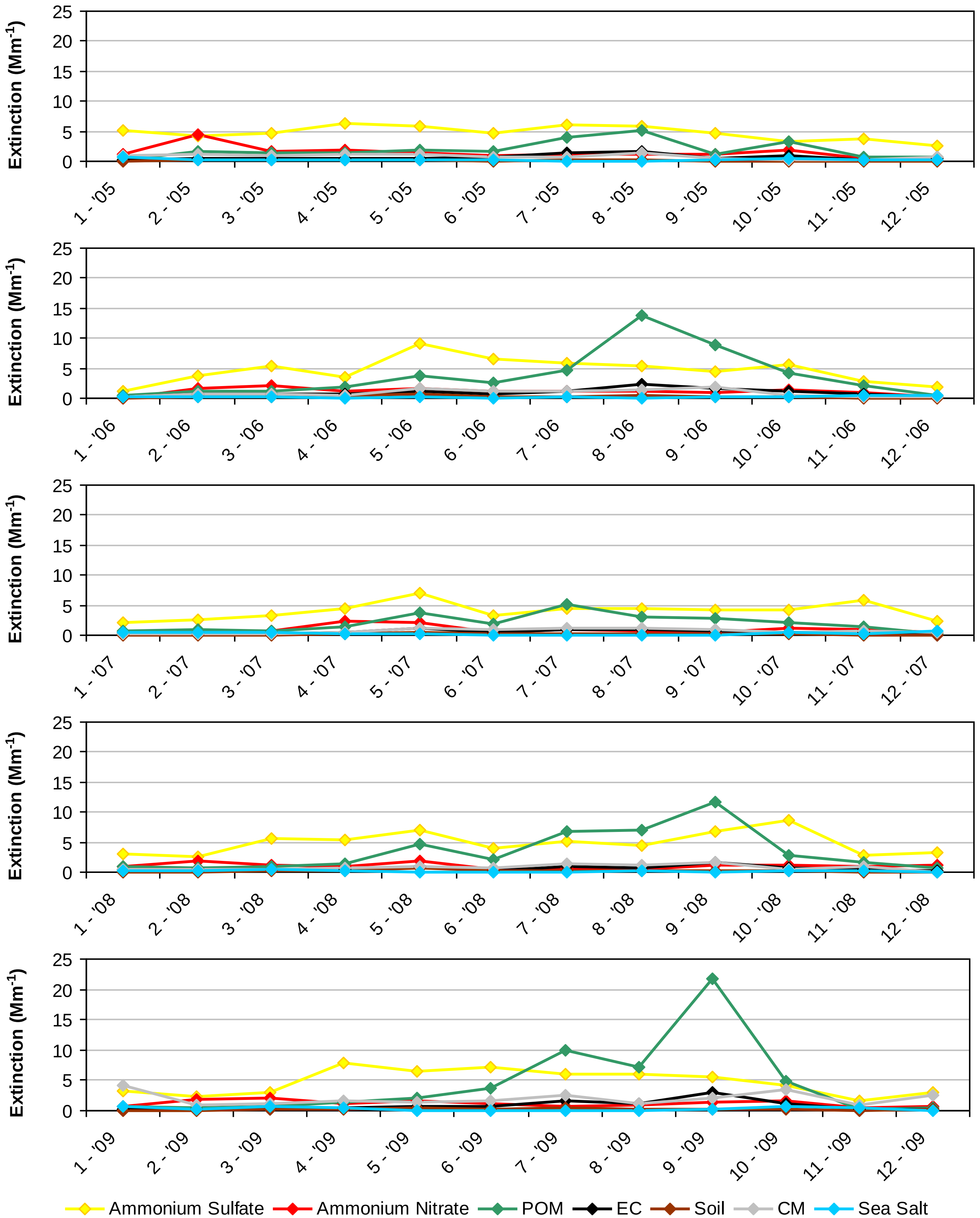
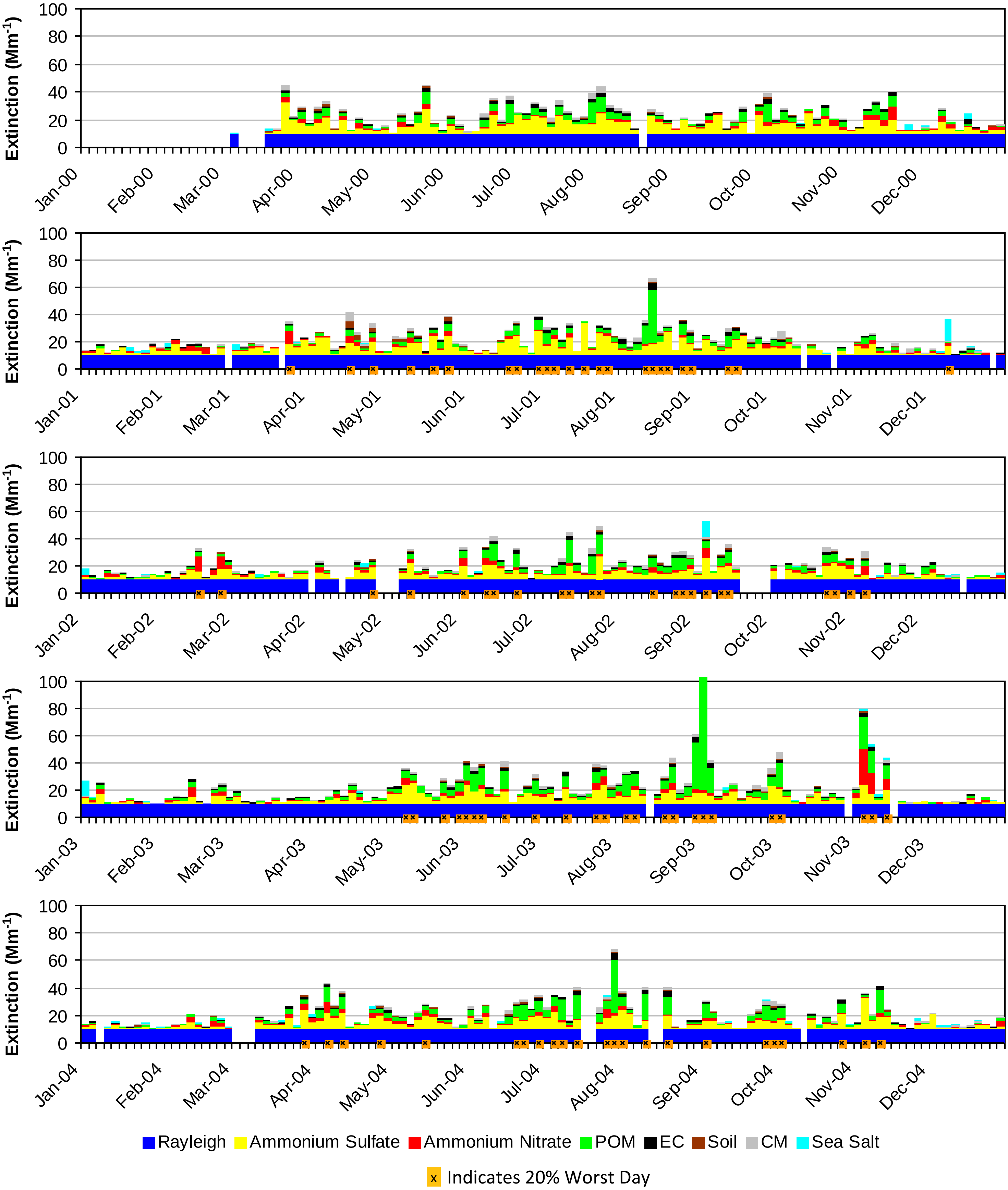
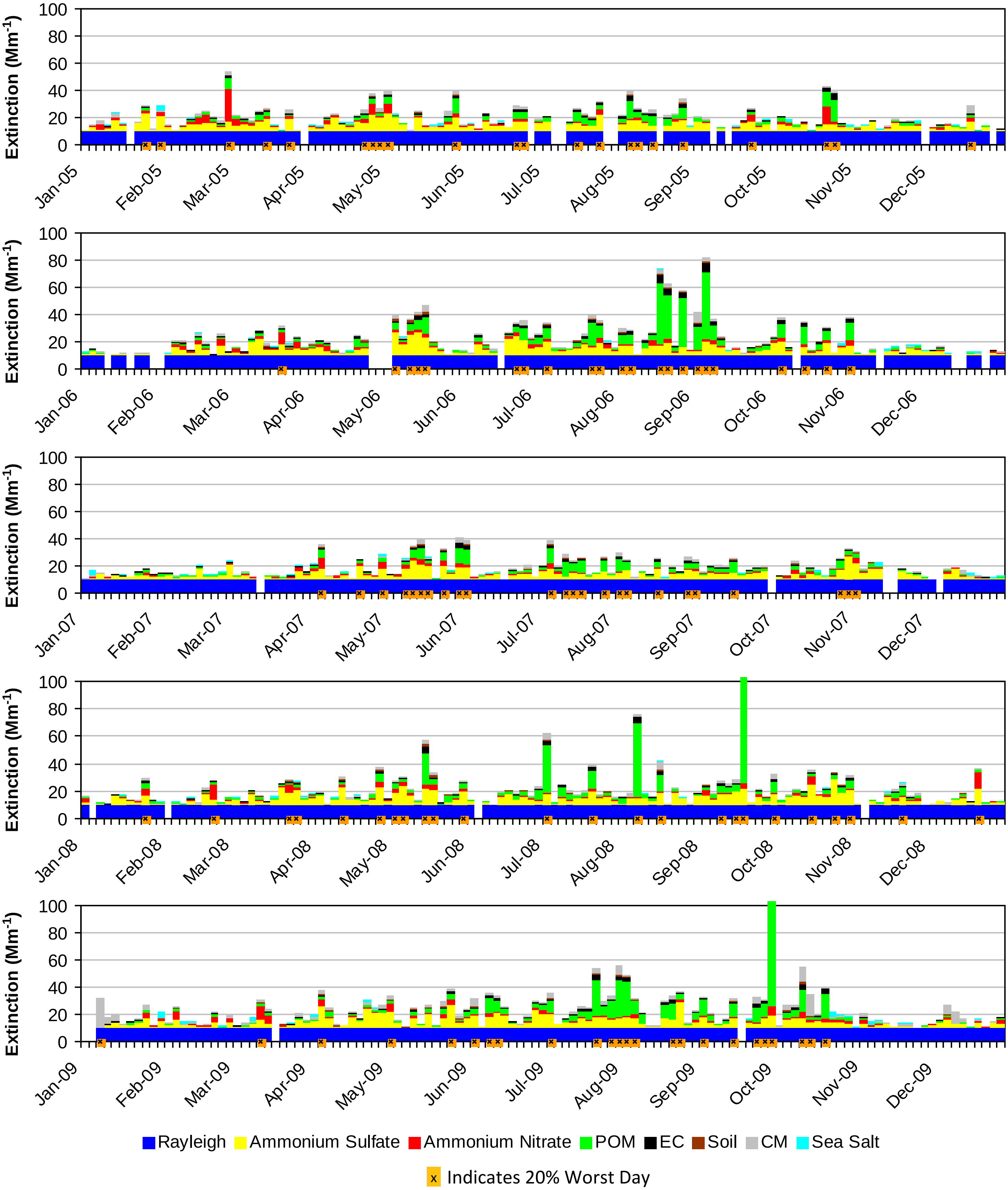


**Figure N.6-7**
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**
**2000-2004 Progress Period Extinction, All Sampled Days**




*Note that daily averages for the year 2000 are shown here, but this year did not meet RHR data completeness criteria.

**Figure N.6-8**
**Goat Rocks WA and Mount Adams WA, WA (WHPA1 Site)**
**2005-2009 Progress Period Extinction, All Sampled Days**



# Appendix B.  Emission Inventory

Appendix B: Emission Inventory Trends

The following shows the emission trends for Washington based on the emission inventory used in the 02d modeling and compares those emissions to the emissions in the 205 and 2011, Comprehensive Emission Inventories submitted to EPA.

Washington Statewide Inventory Summary (Tons Per year)

| Pollutant | Category | 2002d[1] | 2005 | 2011 |
|---|---|---|---|---|
| NOx | Stationary sources | 43,355 | 43,386 | 26,565 |
| | Area sources | 17,587 | 8,581 | 8,599 |
| | Wildfires | 5,997 | 5,714 | 679 |
| | Mobile Sources | 286,701 | 198,168 | 202,436 |
| | Locomotives | - | 18,973 | 15,026 |
| | Marine vessels | - | 29,142 | 20,486 |
| | Total | 95,609 | 305,968 | 275,802 |
| | | | | |
| SOx | Stationary sources | 52,885 | 23,367 | 13,832 |
| | Area sources | 7,311 | 1,562 | 1,472 |
| | Wildfires | 1,641 | 1,563 | 348 |
| | Mobile Sources | 19,436 | 7,505 | 1,059 |
| | Locomotives | - | 1,546 | 95 |
| | Marine vessels | - | 15,774 | 11,529 |
| | Total | 151,273 | 51,317 | 28,335 |
| | | | | |
| PM2.5 | Stationary sources | 2,257 | 5,773 | 3,958 |
| | Area sources | 12,708 | 39,822 | 55,060 |
| | Wildfires | 1,139 | 22,196 | 3,706 |
| | Mobile Sources | 2,819* | 6,944 | 8,757 |
| | Locomotives | - | 583 | 428 |
| | Marine vessels | - | 1,440 | 1,021 |
| | Total | 18,923 | 76,758 | 72,930 |
| | | | | |
| VOC | Stationary sources | 18,651 | 18,247 | 10,523 |
| | Area sources | 151,680 | 88,247 | 111,214 |
| | Wildfires | 13,160 | 12,538 | 9,954 |
| | Mobile Sources | 201,782 | 168,726 | 124,339 |
| | Locomotives | - | 984 | 810 |
| | Marine vessels | - | 833 | 782 |
| | Total | 440,887 | 289,575 | 257,622 |
| | | | | |
| NH3 | Stationary sources | 3,863 | 498 | 499 |

[1] As presented in Chapter 6 of the 2010 Regional Haze Plan.

| Pollutant | Category | 2002d[1] | 2005 | 2011 |
|---|---|---|---|---|
| | Area sources | 45,218 | 54,115 | 51,288 |
| | Wildfires | 1,265 | 1,206 | 692 |
| | Mobile Sources | 5,268 | 5,554 | 2,638 |
| | Locomotives | - | - | - |
| | Marine vessels | - | - | 1 |
| | Total | 55,614 | 61,373 | 55,118 |

Table Notes:
The 2002d emission inventory did not separately report emissions from locomotives or marine vessels.
Area sources includes residential open burning, structure fires, silvicultural and agricultural burning
Stationary sources include majors and many minor sources
Wildfires are only forest and range fires
Mobile sources includes cars trucks, recreational vehicles and watercraft, non road mobile sources, aviation
Locomotives is only locomotives
Marine vessels includes only emissions from vessels in Washington territorial waters, including Columbia River towboats.
* 2005 mobile source fine particulate is road dust only, not direct emissions. WRAP did not estimate direct PM2.5 from mobile sources.

The 2002d inventory did not separately breakout emissions from locomotives and marine shipping as inventory entries. However the modeling did include estimates in the 2002d modeling files that was adjusted to account for increased usage of these mobile sources and the effects of projected emission changes from these 2 categories of mobile sources in developing the 2018 emissions projection for modeling.

Discussion
As can be seen in the emissions table, in most cases emissions are trending downward since the 2002d inventory was finalized. However the ammonia emissions indicate an increased upward trend, but this is more of the effects of improved emission factors and models than actual changes in emissions.

The effects of the federal mobile source fuel sulfur reductions are clearly seen in the $SO_2$ inventory data when comparing the 2002d inventory to either the state 2005 or the 2011 inventories. While these fuel provisions have now been fully implemented for on-road vehicles, their effect will continue to be seen as the federal fuel economy standards for on-road motor vehicles continue to be implemented. Similarly the effects of the Maritime Emission Control Area sulfur oxides emission standards has not yet been reflected in the 2011 inventory and will become a major source of additional SO2 reductions from the marine vessel sector starting with the 2014 and later National inventories.

Emissions from heavy trucks serving the Ports of Seattle and Tacoma have reduced due to the effects of a variety of programs including anti-idling requirements and emission control retrofits, all of which tend to reduce emissions of particulates, NOx and $SO_2$.

The provision of shore power for vessels at dock at Seattle has reduced the emissions from marine vessels equipped to use shore power and shutdown onboard engines. Further development of shore power systems is occurring at other ports in Washington and British Columbia.

There have been plant closures since 2011. One notable source that closed was the Kimberley-Clarke pulp mill in Everett. The closure of this mill in 2012 eliminated a source of approximately 700 tpy of NOx and 380 tpy of $SO_2$. Similarly the replacement of a residual oil and wood fired boiler at the Nippon Paper plant in Port Angeles reduced approximately 300 tpy of $SO_2$ from a source located 10 miles away from the Olympic National Park.

One other notable emission reduction has occurred at the 5 petroleum refineries in Washington. Through a number of projects the $SO_2$ emissions from the refineries has dropped nearly 90% from the 2002d inventory to a 2011 total of approximately 250 tpy. The four refineries with the largest decreases in emissions are located in Skagit and Whatcom counties. The BART modeling done for these refineries shows that this emission reduction benefits Olympic and North Cascades National Parks.

The inventory indicates that most NOx emissions come from mobile sources. Most $SO_2$ comes from the two aluminum smelters and marine vessels. VOC is primarily from mobile sources and area sources (area sources are dominated by commercial and residential solvent usage). Ammonia emissions appear to be an area source issue.

See attached emission inventory spreadsheets for additional details that support the synopsis above.

# Appendix C. Supporting Information on Visibility Trends (aka Supporting Deciview Record)

Appendix C

Review of progress at each Class I area based on IMPROVE monitoring records

A. Discussion on progress in general

For all Class I areas in the state there has been progress in reducing visibility impacts. Progress in reducing impacts resulting from anthropogenic sources has occurred in all Class I Areas, though some areas, notable Goat Rocks Wilderness and Alpine Lakes Wilderness has been adversely affected by smoke from wildfires. The monitors for these two areas show significant reductions in sulfate and nitrate generated visibility impairment. But there have been extreme spikes of organic carbon (a signature for wildfires) that have masked the total progress in reducing impacts from anthropogenic sources. However, even with the adverse effects on progress caused by wildfires, all IMPROVE monitors in Washington have achieved visibility reductions greater than required to meet the 2018 reasonable progress goals established in the 2010 RH SIP.

Each section below discusses the conditions measured by each Class I Area Visibility monitor. The discussions provide graphs showing the annual visibility and shows how much each visibility impairing pollutant contributes to the daily total light extinction. At the end of each section is a graphical representation of the percent of visibility caused by each visibility impairing pollutant on the best and worst days. This information helps guide us in evaluating additional control measures that could affect emissions of the pollutants from sources under our control.

B. Review of individual Class I area IMPROVE data

- North Cascades NP and Glacier Peak Wilderness (aka NOCA1)
- Alpine Lakes Wilderness (aka (SNPA1)
- Mt Rainier NP (aka MORA1)
- Goat Rocks Wilderness and Mt. Adams Wilderness (aka WHPA1)
- Olympic NP (aka OLYM1)
- Pasayten Wilderness (aka PASA1)

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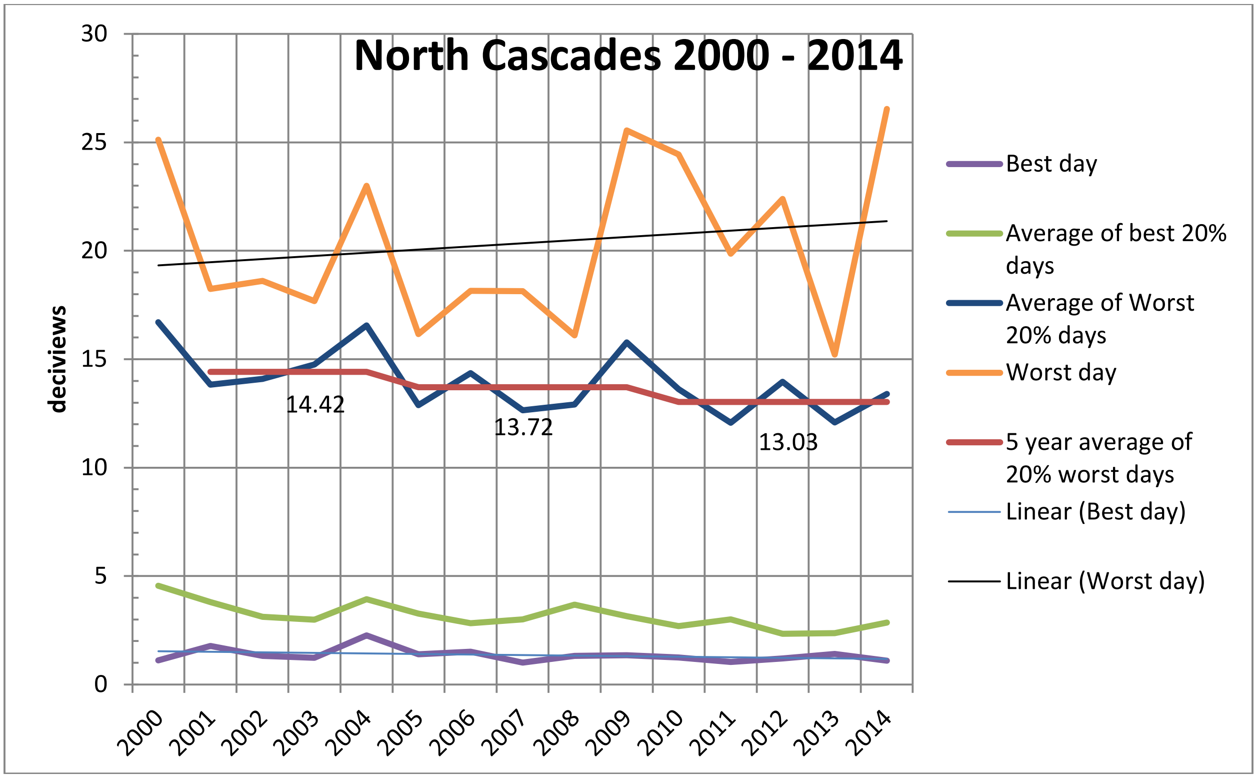
North Cascades National Park and Glacier Peak Wilderness IMPROVE monitor visibility trends




The North Cascades National Park and Glacier Peak Wilderness are represented by the NOCA1 IMPROVE monitor site.

The projected 2018 reasonable progress goal for the 20% worst days is 15.62 dv and the uniform glide path[1] value for 2018 was 14.23 dv. The calculated 2064 natural condition value for the average of the 20% worst days for this monitor is 7.62 dv.

The average visibility on the 20% worst days for 2010 – 2014 period was 13.03 dv, which is better visibility than the reasonable progress goal and the uniform rate of progress values. The continued visibility improvement on the 20% worst days was in spite of the high quantity of fire induced visibility impairment in 2010 and 2014.

The average visibility during the best 20% days over the most recent 5 years is 2.65 dv.

The graph at the top of this page depicts the visibility trends for this monitor since 2000. Even though the absolute worst day of each year shows year to year variability and the average of the worst 20% days each year varies between years, the 5 year average of the 20% worst days has continued a long term trend of visibility improvement. This improvement occurred in spite of significant wildfire events each year from 2008 – 2014. It also appears that $SO_2$ control projects at the 4 petroleum refineries in western Skagit and Whatcom counties may have reduced sulfate

[1] The uniform glide path value is the starting place to develop a Reasonable Progress Goal. The uniform rate of progress represents the linear rate of visibility improvement required to meet the 2064 visibility goal in 2064.

impacts on the monitor. Note the change in the relative contribution of sulfate to the total impairment starting in 2005 shown in the graphs below. On the best days, the visibility trend shows steady improvement in visibility.

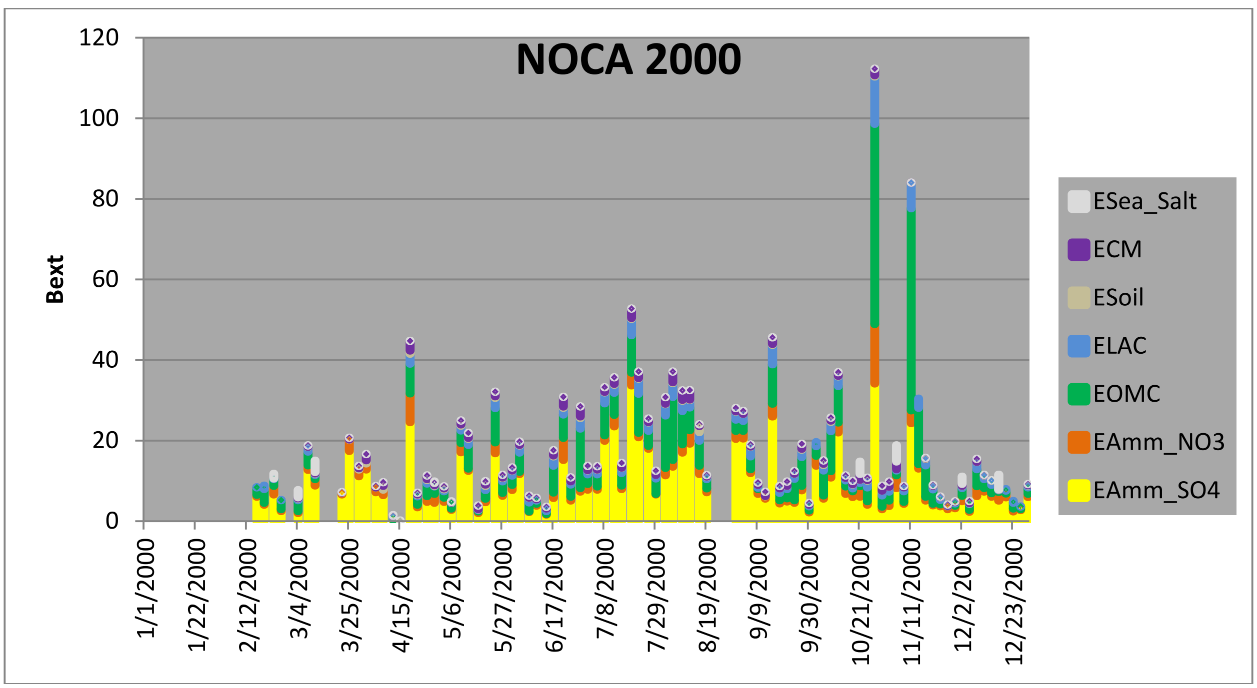
The following are graphs of the reconstructed light extinction ($B_{ext}$) for each year during the 2001 – 2014 period. The values show the relative contribution of the chemical types incorporated into the revised IMPROVE light extinction calculation. NOTE each graph has a different maximum value.

The projected 2018 visibility reasonable progress goal is 15.62 dv and the uniform glide path value would be 14.23 dv. The calculated 2064 natural condition value for this monitor is 7.62 dv.

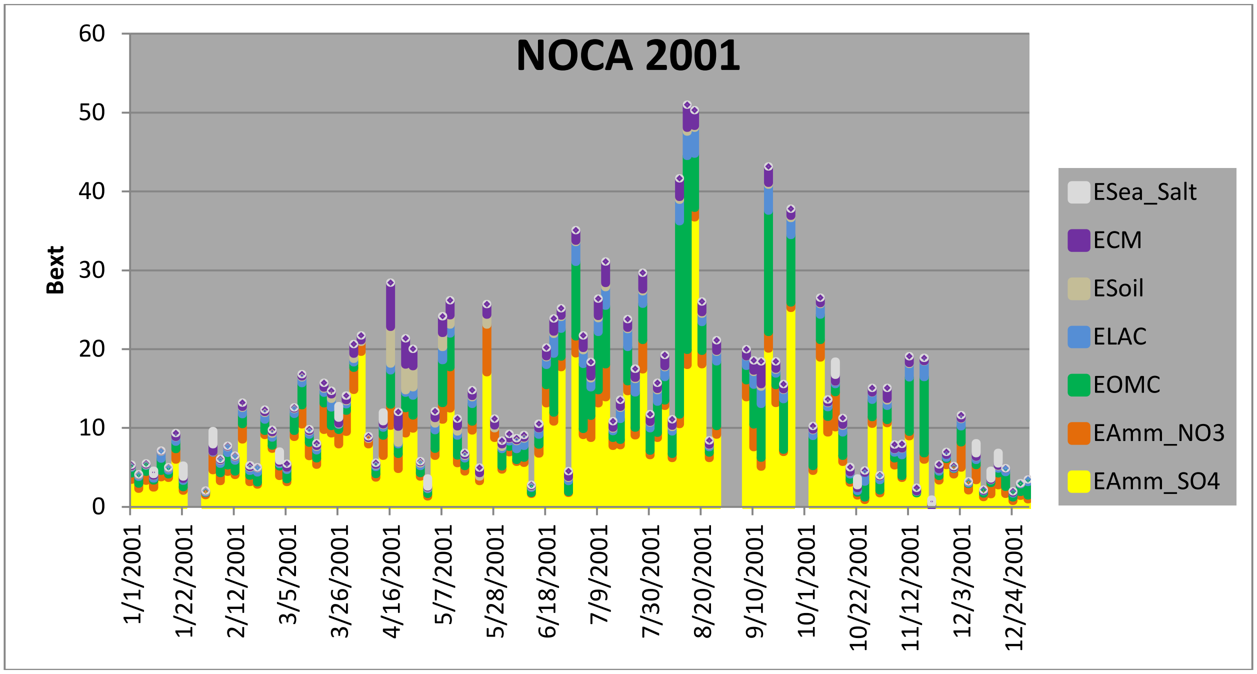
The average visibility improvement achieved for 2010 – 2014 is 13.03 dv, exceeding both the reasonable progress goal and the uniform glide path values. This improvement occurred in spite of significant wildfire events each year from 2008 – 2014. It also appears that $SO_2$ control projects at the 4 petroleum refineries in western Skagit and Whatcom counties may have reduced sulfate impacts on the monitor. Note the change in the relative contribution of sulfate to the total impairment starting in 2005 shown in the graphs below.

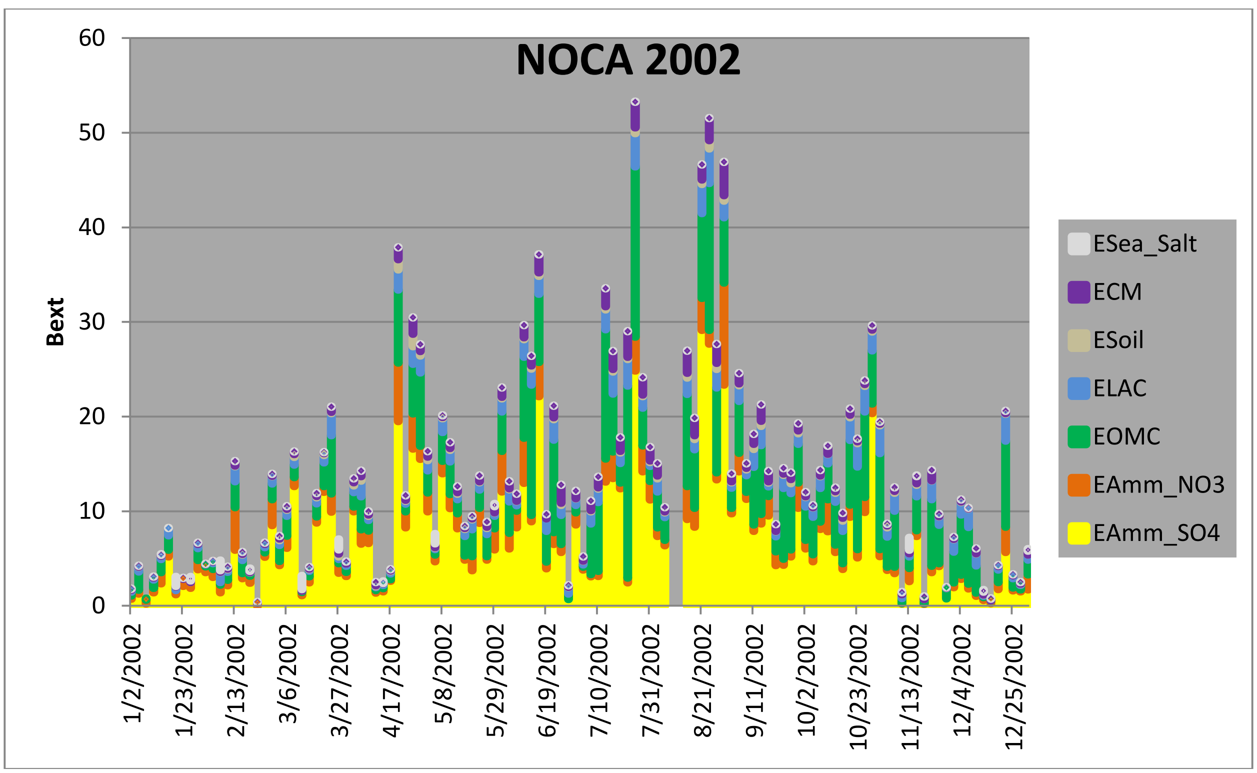
The average visibility during the best 20% days over the most recent 5 years is 2.65 dv.

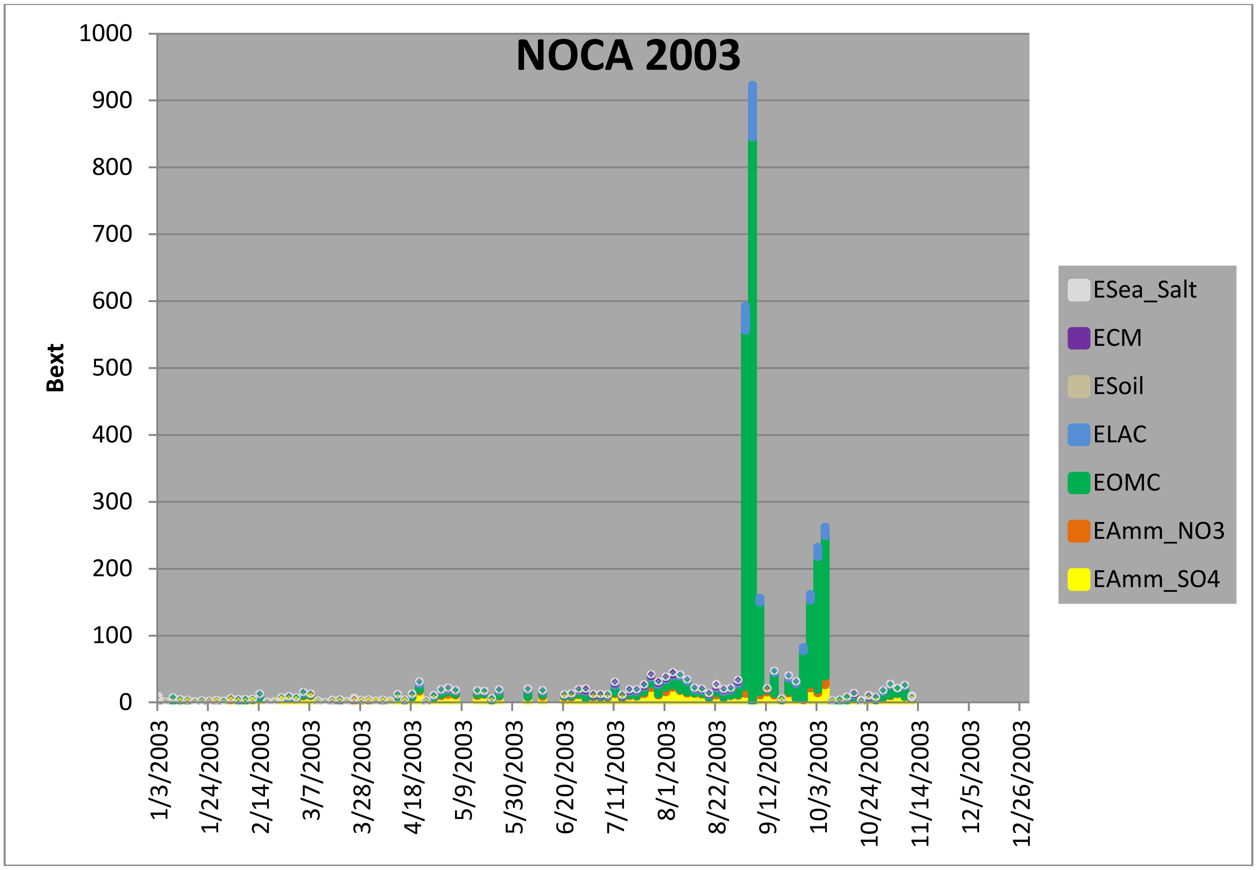
The following graphs are a depiction of reconstructed light extinction ($B_{ext}$) for each year depicted. The values show the relative contribution of the chemical types incorporated into the revised IMPROVE light extinction calculation. NOTE each graph has a different maximum value.



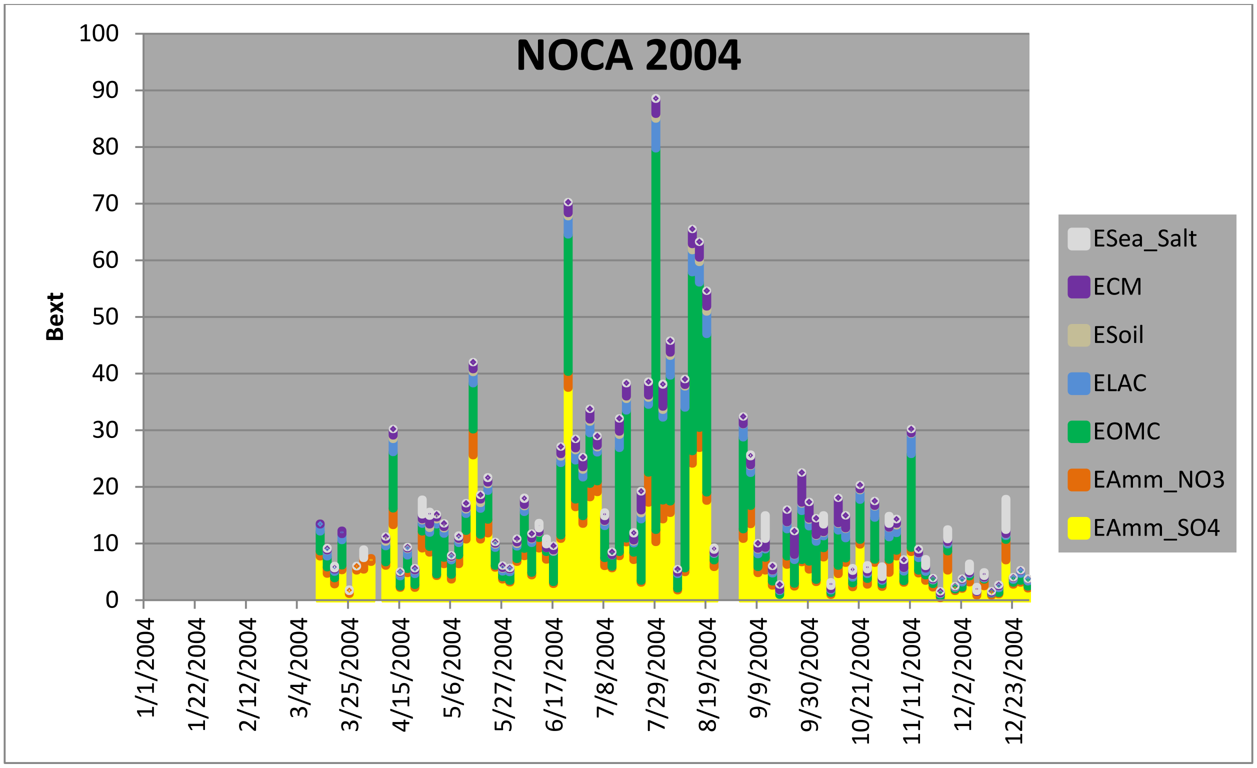
The year 2000 was an incomplete year of data collection. WRAP developed substitute data to generate the statistics used to determine the 5 year average visibility condition for this year. The data presented here does not contain that substituted data.



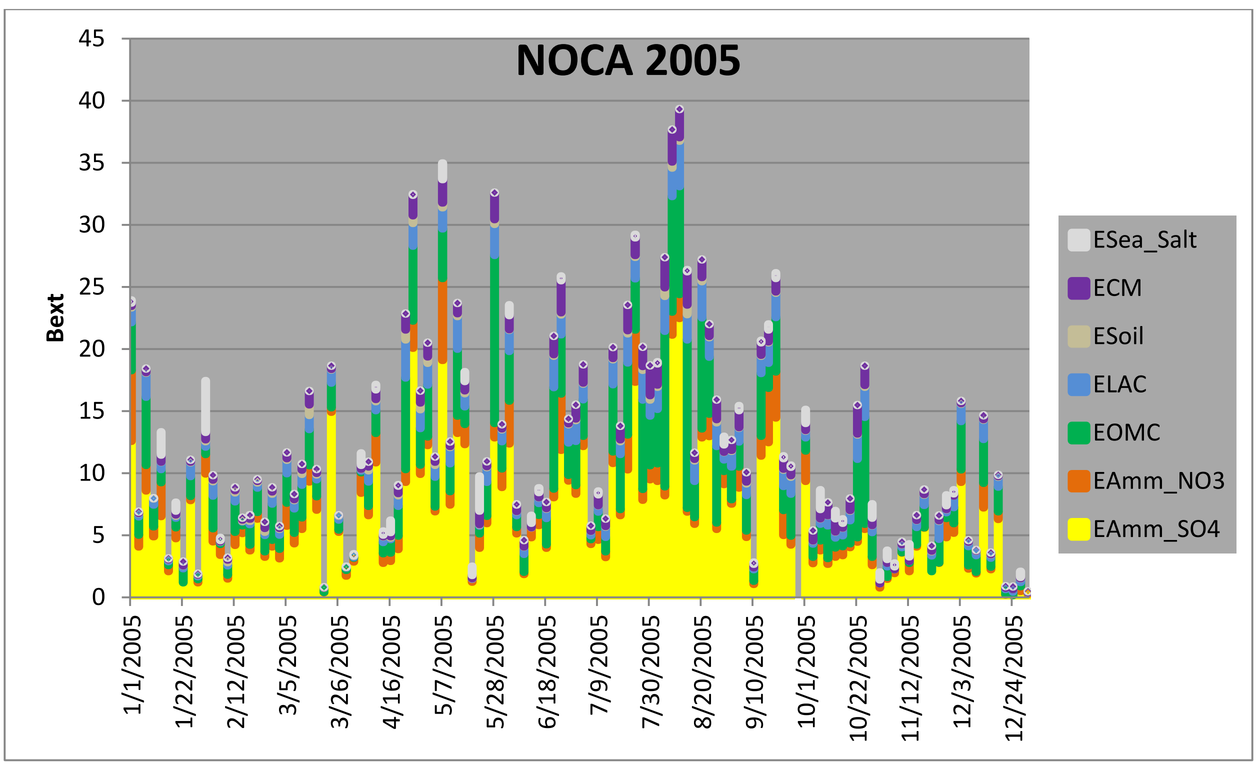



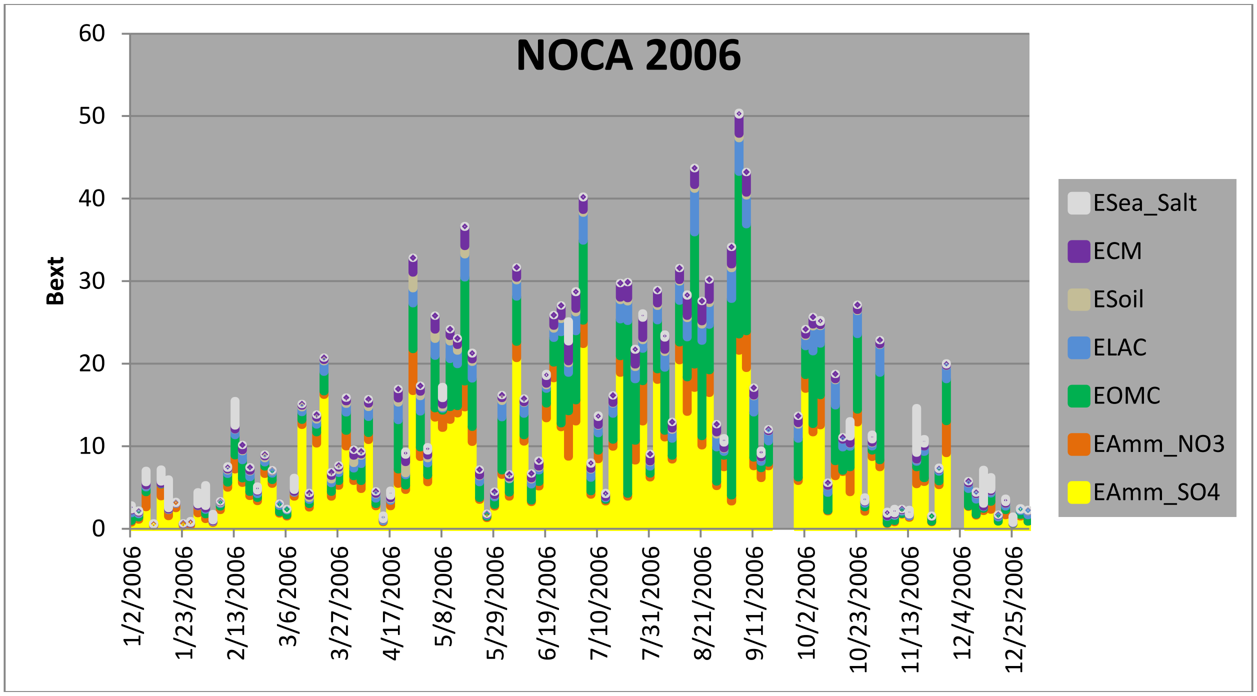



The year 2003 was an incomplete year of data collection. WRAP developed substitute data to generate the statistics used to determine the 5 year average visibility condition for this year. The data presented here does not contain that substituted data. As the graph indicates with its extremely high maximum scale value, this year's annual visibility and average of the 20% worst days values are severely influenced by wildfires in North Central Washington that fumigated the monitor in early September and early October.




The year 2004 was an incomplete year of data collection. WRAP developed substitute data to generate the statistics used to determine the 5 year average visibility condition for this year. The data presented here does not contain that substituted data.




NOCA 2006
Bext
60
50
40
30
20
10
0
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4
1/2/2006
1/23/2006
2/13/2006
3/6/2006
3/27/2006
4/17/2006
5/8/2006
5/29/2006
6/19/2006
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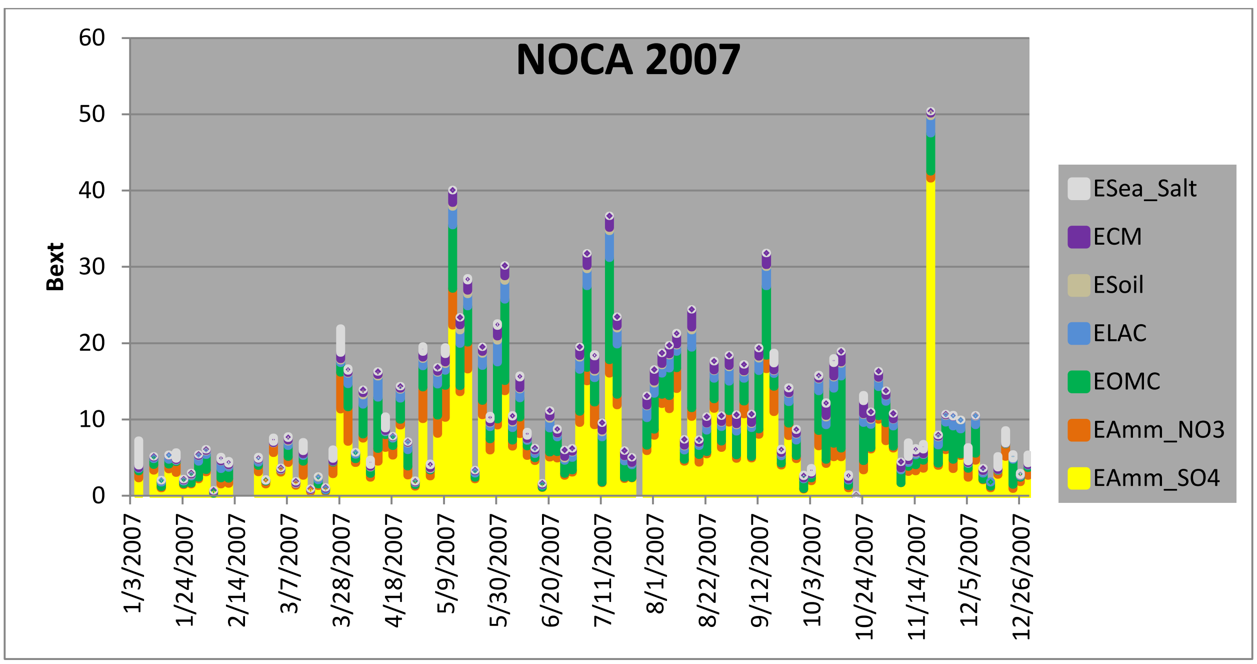
12/4/2006
12/25/2006


NOCA 2007
Bext
60
50
40
30
20
10
0
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4
1/3/2007
1/24/2007
2/14/2007
3/7/2007
3/28/2007
4/18/2007
5/9/2007
5/30/2007
6/20/2007
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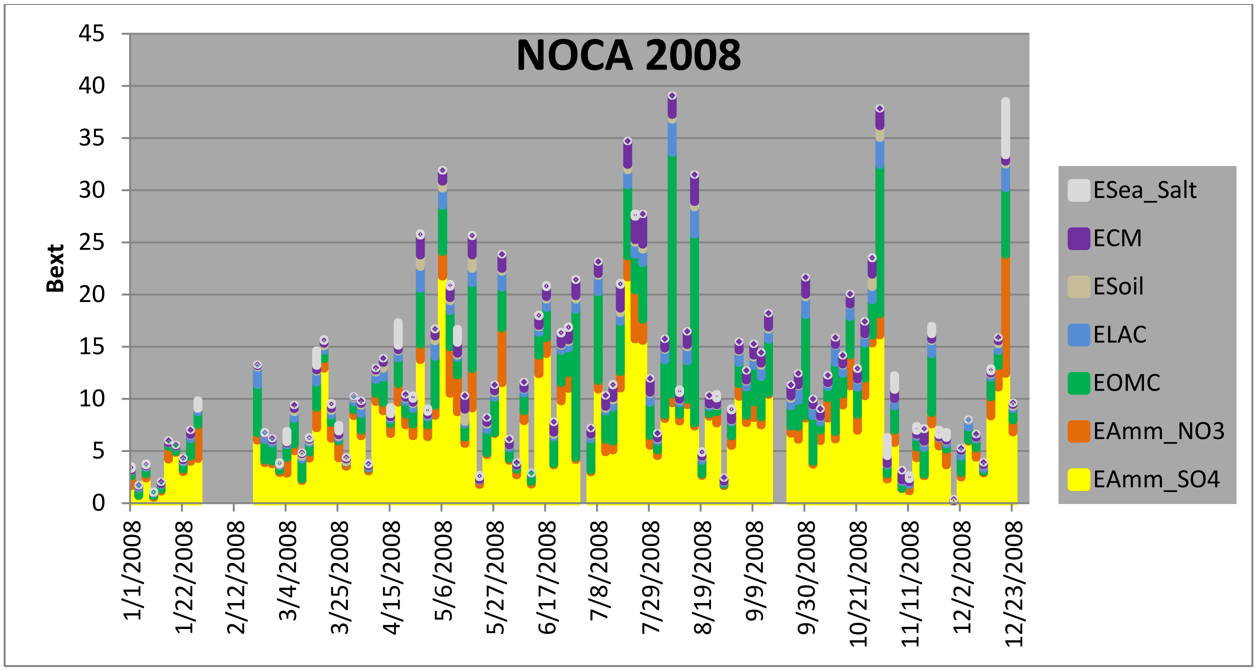
12/5/2007
12/26/2007


NOCA 2008
Bext
45
40
35
30
25
20
15
10
5
0
1/1/2008
1/22/2008
2/12/2008
3/4/2008
3/25/2008
4/15/2008
5/6/2008
5/27/2008
6/17/2008
7/8/2008
7/29/2008
8/19/2008
9/9/2008
9/30/2008
10/21/2008
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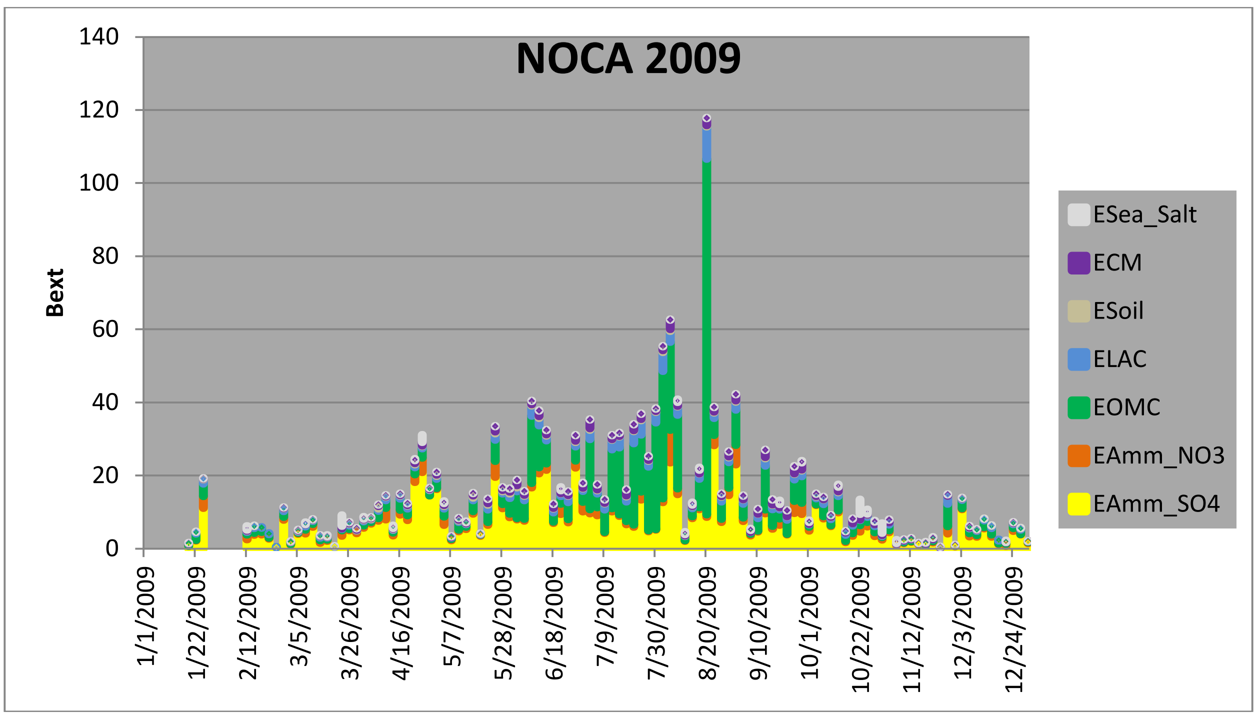
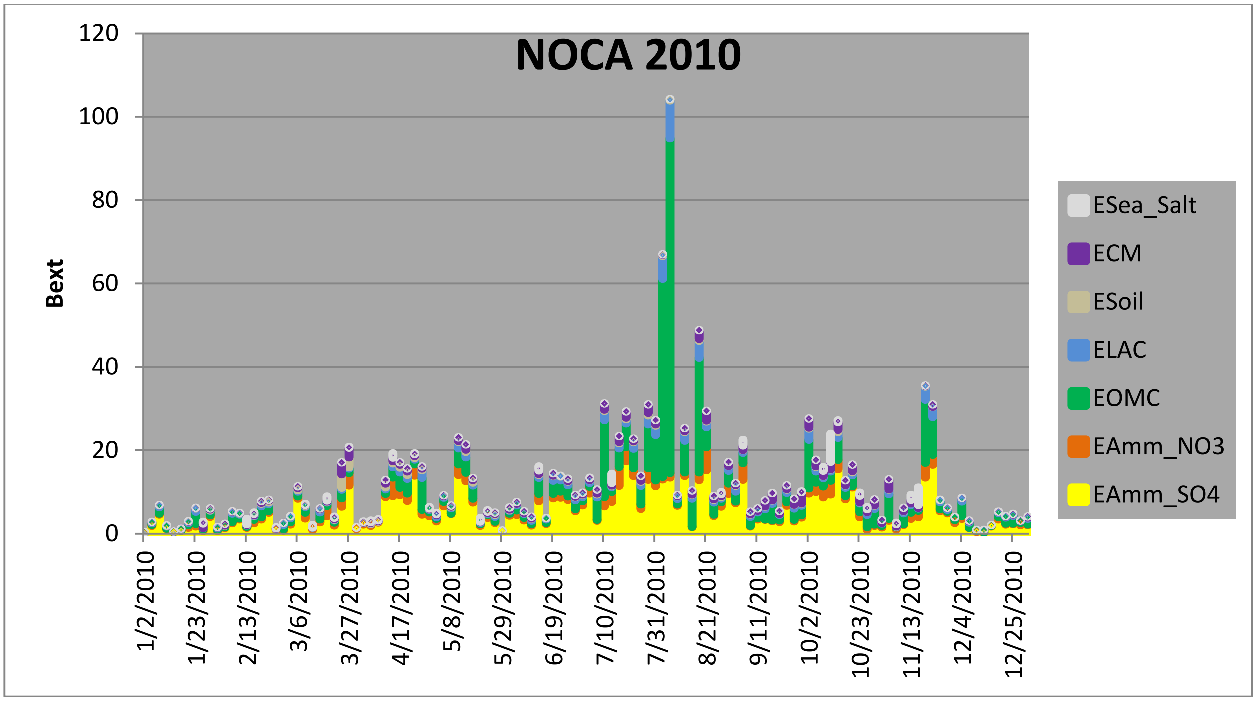
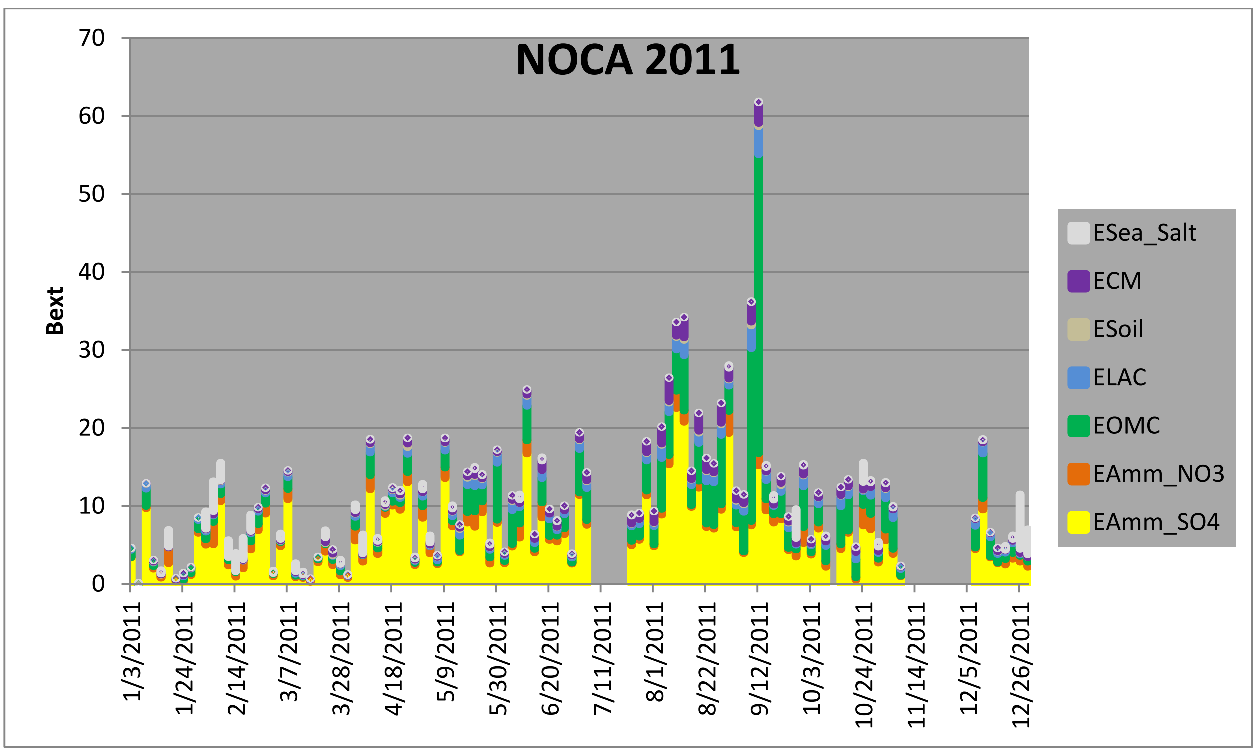
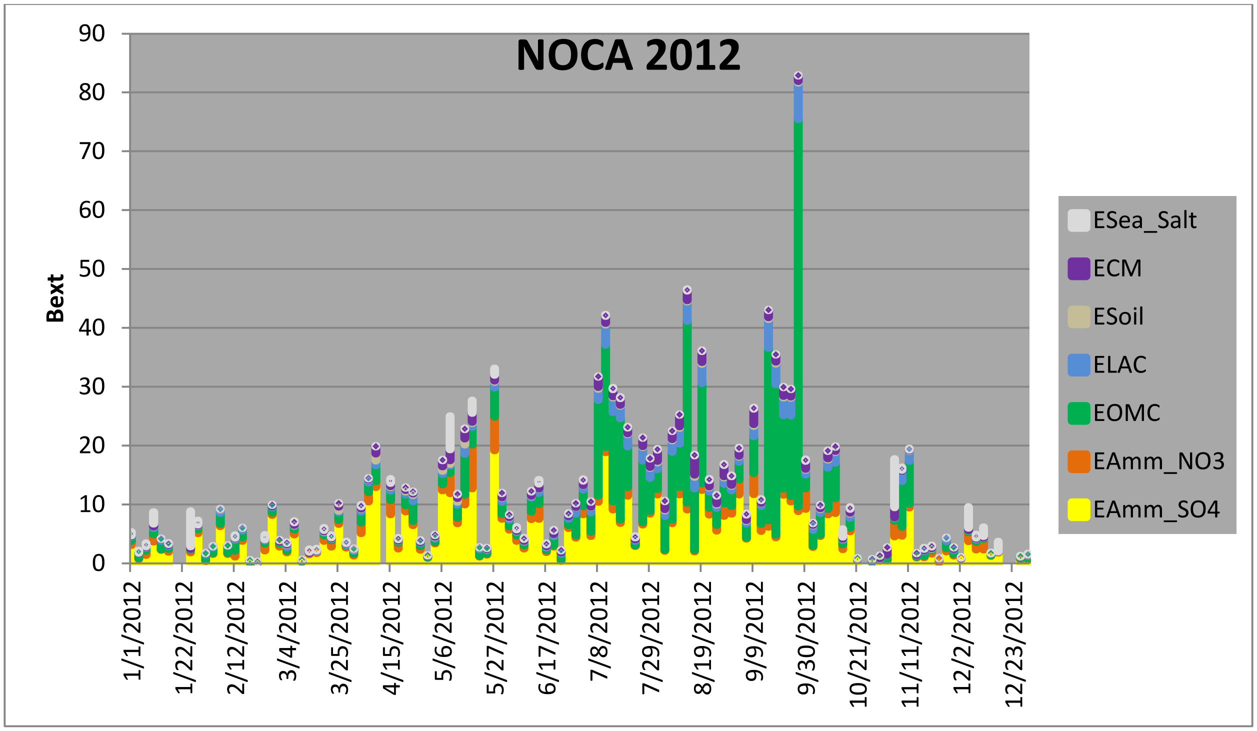
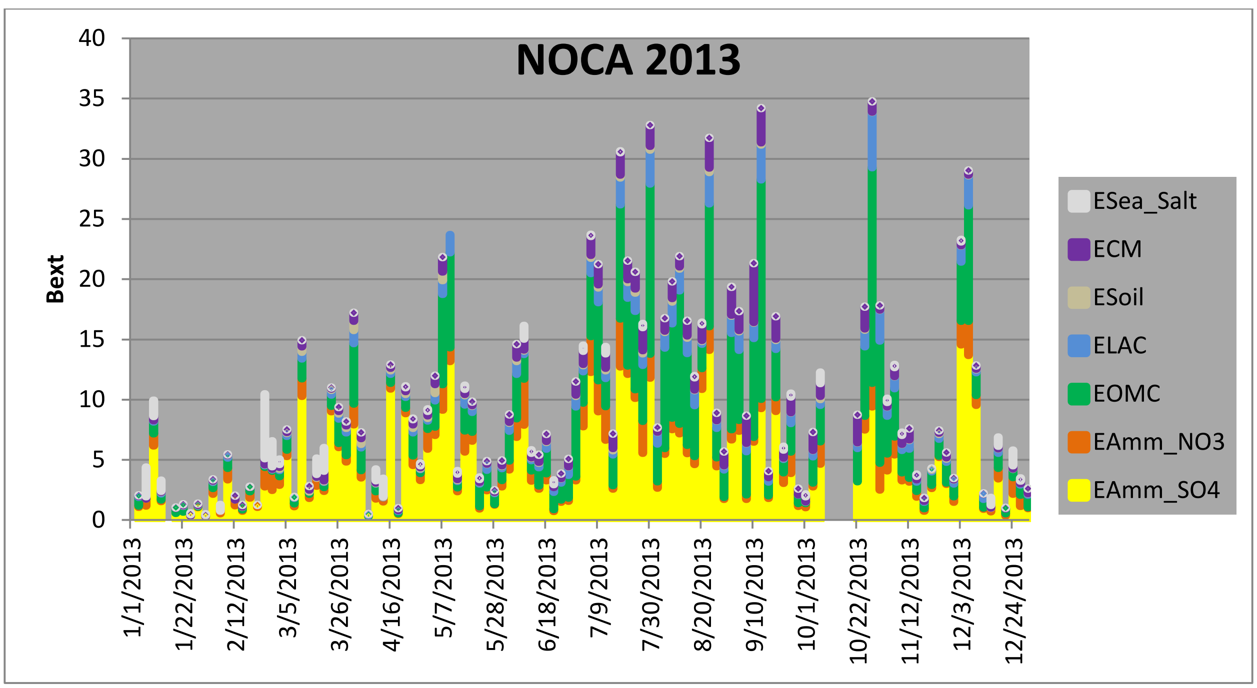
ELAC
EOMC
EAmm_NO3
EAmm_SO4


NOCA 2009
Bext
140
120
100
80
60
40
20
0
1/1/2009
1/22/2009
2/12/2009
3/5/2009
3/26/2009
4/16/2009
5/7/2009
5/28/2009
6/18/2009
7/9/2009
7/30/2009
8/20/2009
9/10/2009
10/1/2009
10/22/2009
11/12/2009
12/3/2009
12/24/2009
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


NOCA 2010
Bext
120
100
80
60
40
20
0
1/2/2010
1/23/2010
2/13/2010
3/6/2010
3/27/2010
4/17/2010
5/8/2010
5/29/2010
6/19/2010
7/10/2010
7/31/2010
8/21/2010
9/11/2010
10/2/2010
10/23/2010
11/13/2010
12/4/2010
12/25/2010
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


NOCA 2011
Bext
70
60
50
40
30
20
10
0
1/3/2011
1/24/2011
2/14/2011
3/7/2011
3/28/2011
4/18/2011
5/9/2011
5/30/2011
6/20/2011
7/11/2011
8/1/2011
8/22/2011
9/12/2011
10/3/2011
10/24/2011
11/14/2011
12/5/2011
12/26/2011
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


NOCA 2012
Bext
90
80
70
60
50
40
30
20
10
0
1/1/2012
1/22/2012
2/12/2012
3/4/2012
3/25/2012
4/15/2012
5/6/2012
5/27/2012
6/17/2012
7/8/2012
7/29/2012
8/19/2012
9/9/2012
9/30/2012
10/21/2012
11/11/2012
12/2/2012
12/23/2012
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


NOCA 2013
Bext
40
35
30
25
20
15
10
5
0
1/1/2013
1/22/2013
2/12/2013
3/5/2013
3/26/2013
4/16/2013
5/7/2013
5/28/2013
6/18/2013
7/9/2013
7/30/2013
8/20/2013
9/10/2013
10/1/2013
10/22/2013
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ELAC
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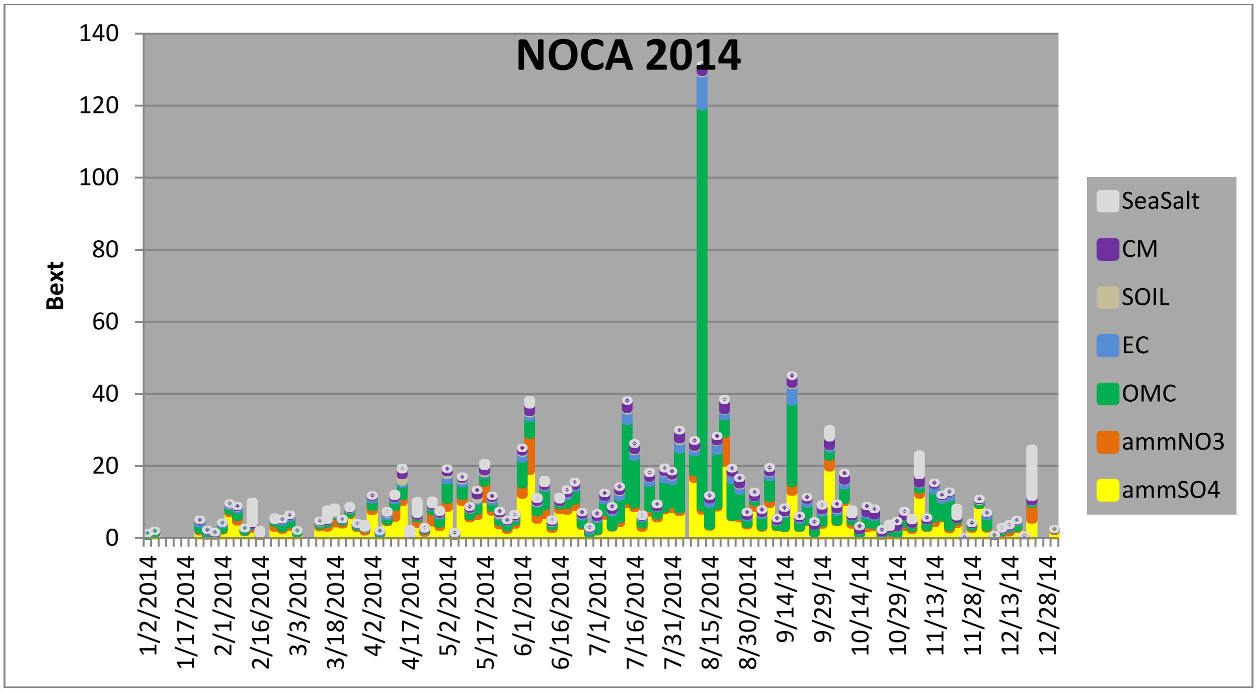
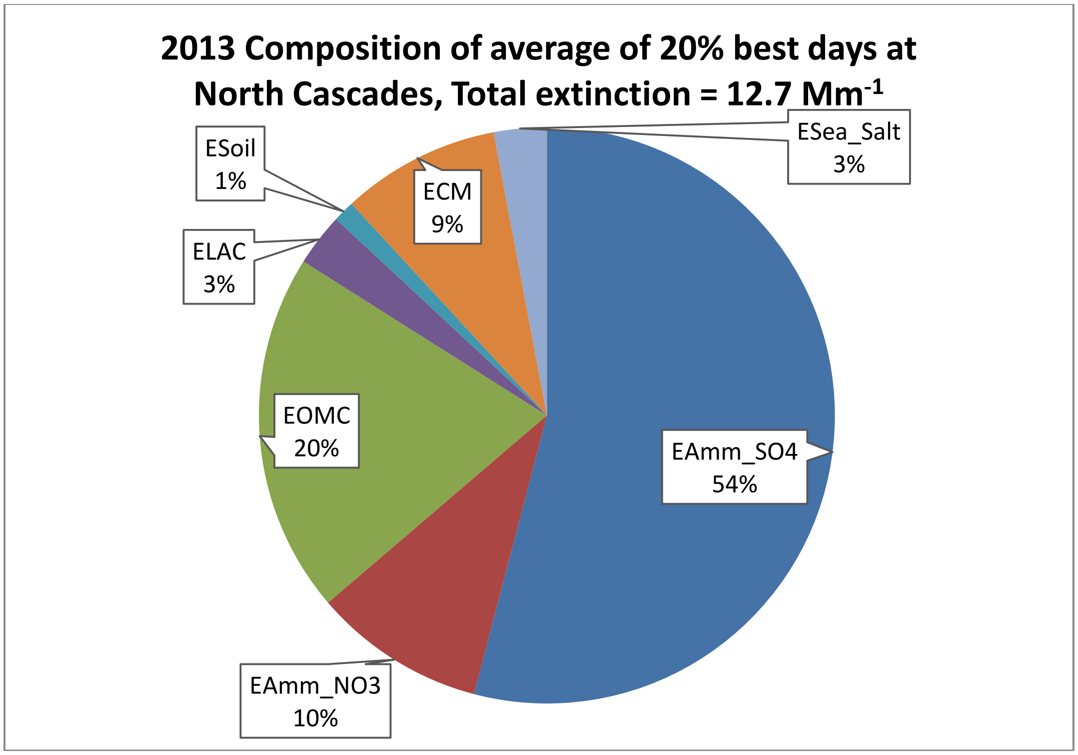
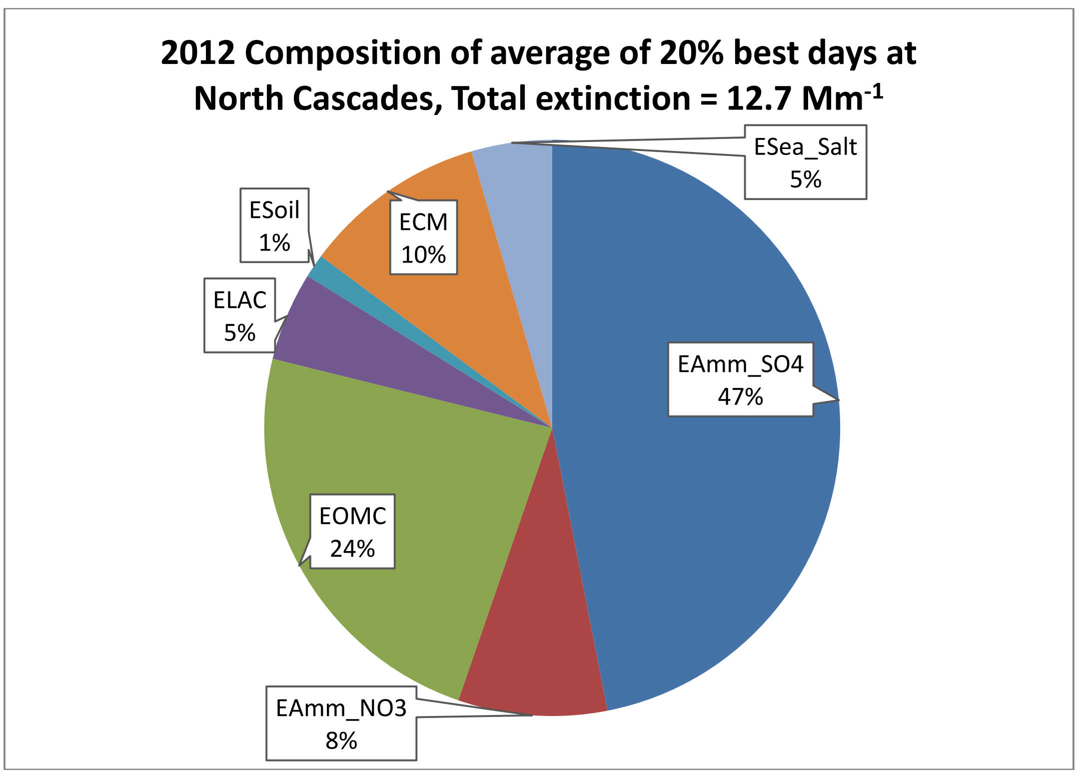
EAmm_NO3
EAmm_SO4

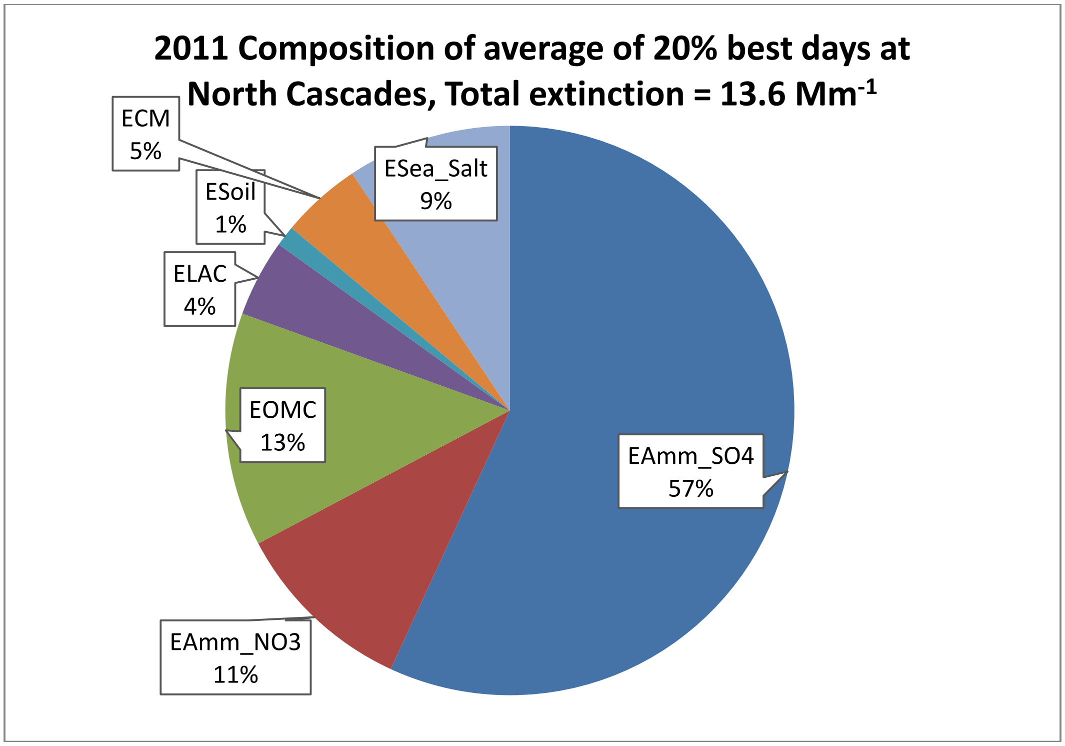


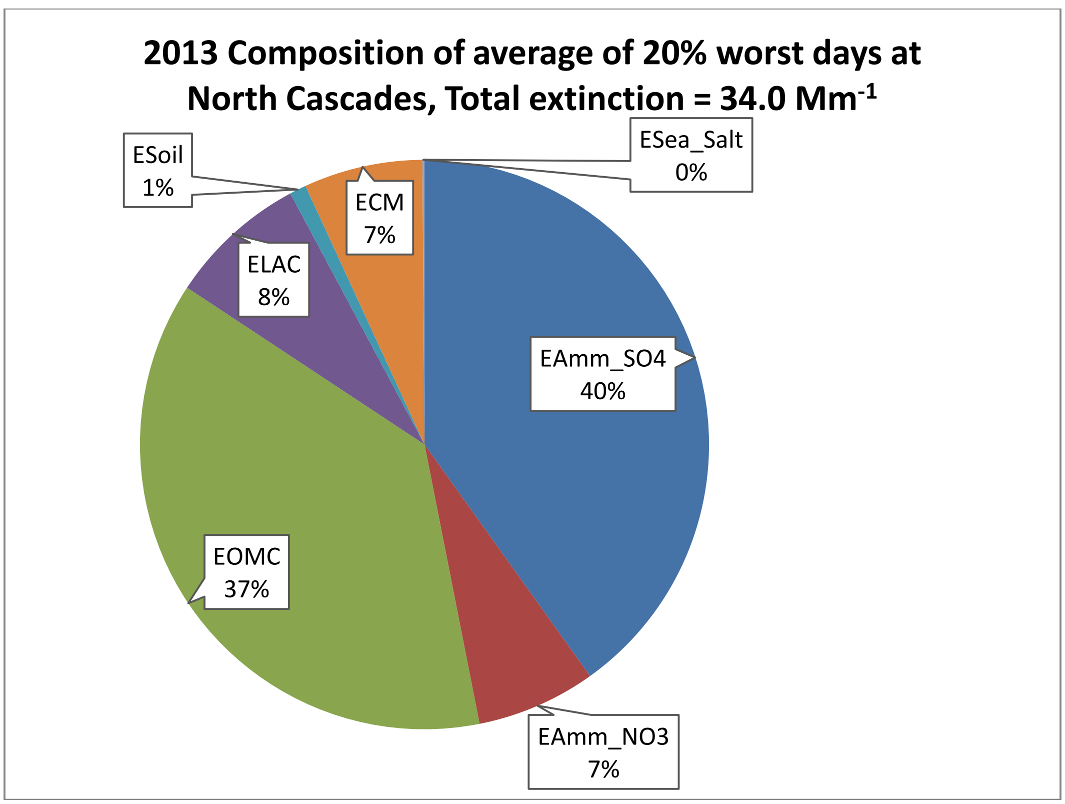

Similar to the Pasayten Wilderness monitor, this monitor was impacted by wildfires in Okanogan County during 2014 and wildfires in Okanogan County and British Columbia, Canada in 2012. The high value on one day in 2014 did not tend to skew the average value of the worst 20% days that year.

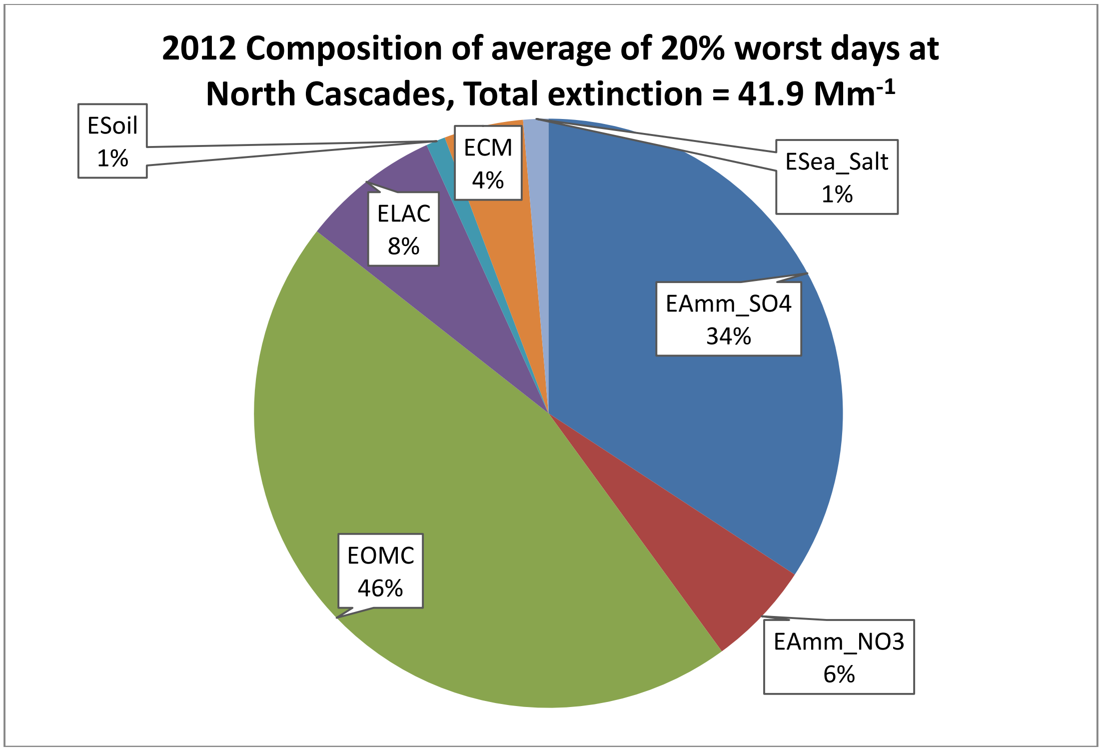
The following pie charts compare the average relative visibility impairment by the primary haze-causing pollutant species for years 2011 – 2013. The charts show the relative composition on the average of the 20% best and worst days for each of these years. This data indicates that most visibility impairment at this monitor is caused by sulfate, except for the worst days, where organic carbon from wildfires can be easily seen as the dominant contributor.

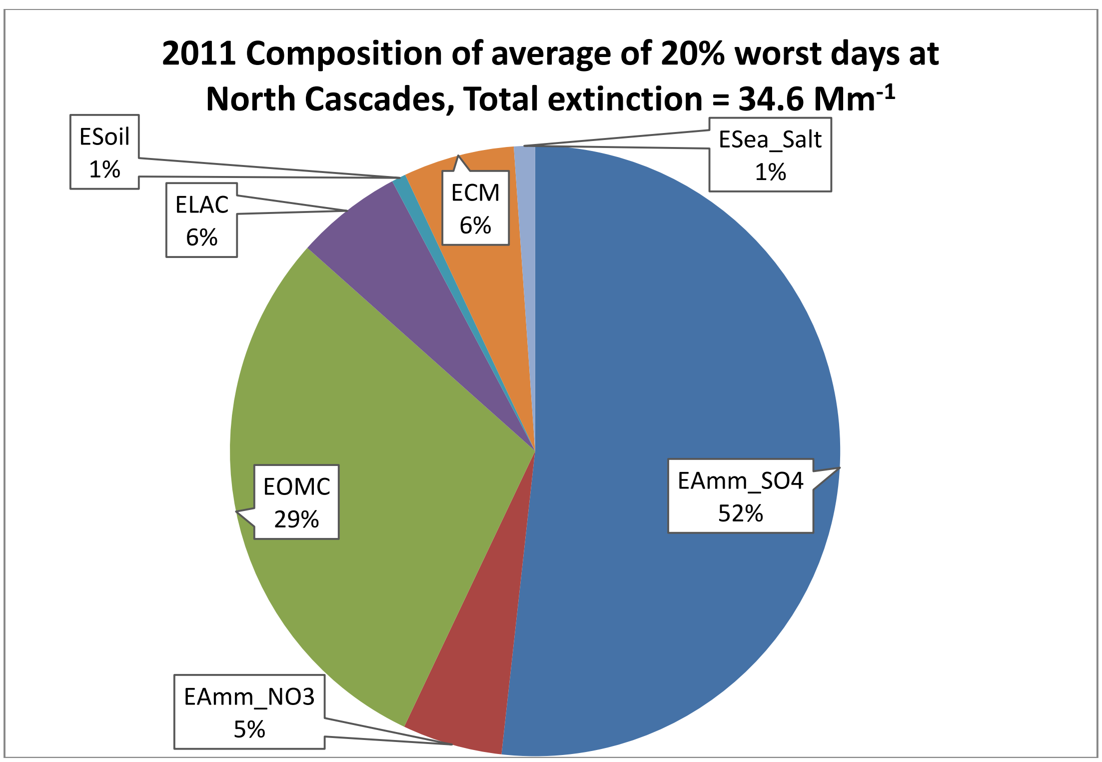

2013 Composition of average of 20% best days at North Cascades, Total extinction = 12.7 Mm-1
ESea_Salt 3%
ESoil 1%
ECM 9%
ELAC 3%
EOMC 20%
EAmm_SO4 54%
EAmm_NO3 10%


2012 Composition of average of 20% best days at North Cascades, Total extinction = 12.7 Mm-1
ESea_Salt 5%
ESoil 1%
ECM 10%
ELAC 5%
EAmm_SO4 47%
EOMC 24%
EAmm_NO3 8%

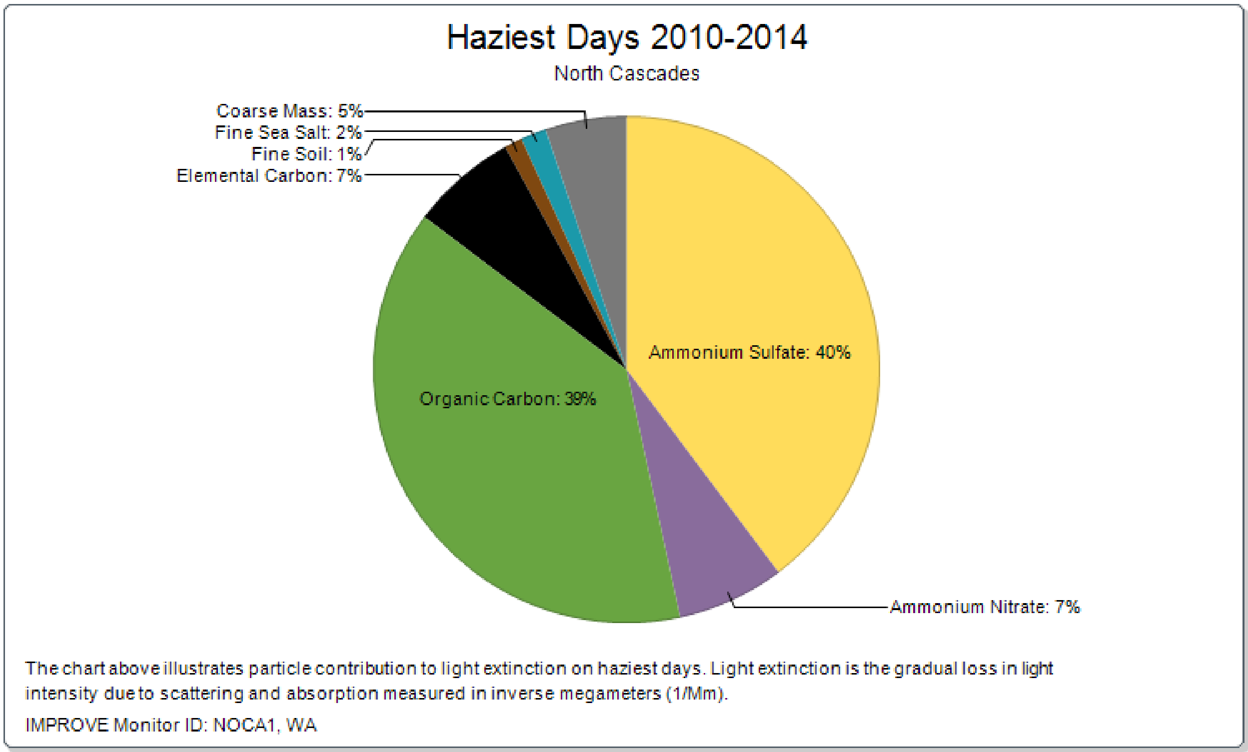

2011 Composition of average of 20% best days at North Cascades, Total extinction = 13.6 Mm-1
ECM 5%
ESoil 1%
ELAC 4%
EOMC 13%
EAmm_NO3 11%
ESea_Salt 9%
EAmm_SO4 57%


2013 Composition of average of 20% worst days at North Cascades, Total extinction = 34.0 Mm-1
ESoil 1%
ECM 7%
ELAC 8%
ESea_Salt 0%
EAmm_SO4 40%
EOMC 37%
EAmm_NO3 7%


2012 Composition of average of 20% worst days at North Cascades, Total extinction = 41.9 Mm-1
ESoil 1%
ECM 4%
ESea_Salt 1%
ELAC 8%
EAmm_SO4 34%
EOMC 46%
EAmm_NO3 6%


2011 Composition of average of 20% worst days at North Cascades, Total extinction = 34.6 Mm-1
ESoil 1%
ESea_Salt 1%
ELAC 6%
ECM 6%
EOMC 29%
EAmm_SO4 52%
EAmm_NO3 5%

The following graphs produced by WRAP software shows the 5 year average composition of the measured haze-causing pollutants on the worst 20% (haziest) and best 20% (clearest) days. Of note is the average composition of the aerosols producing visibility impairment on the worst days is equally dominated by ammonium sulfate and organic carbon, while on the best days, it is dominated by ammonium sulfate. We believe that this is due to the presence of SOx emissions from the 2 petroleum refineries located near the mouth of the Skagit River being transported eastward towards the monitor.



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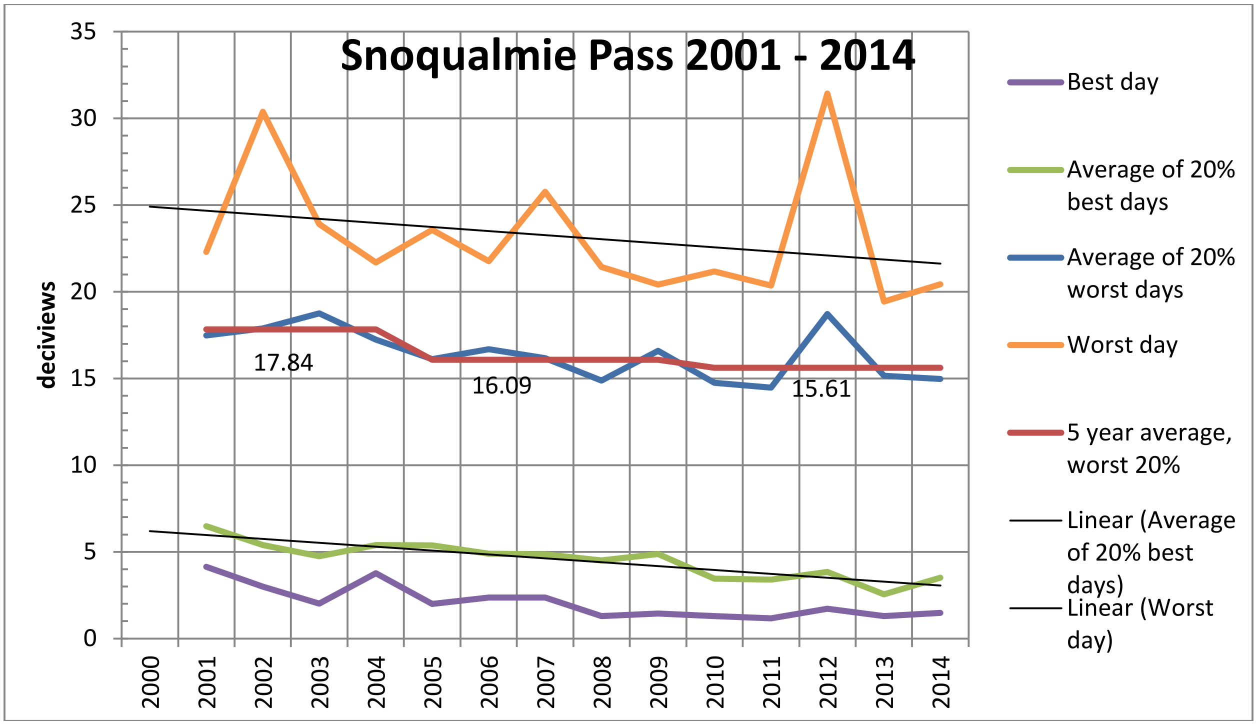
Alpine Lakes Wilderness IMPROVE Monitor Visibility Trend Graphs




The Alpine Lakes Wilderness is represented by the SNPA1 IMPROVE monitor site.

The projected 2018 reasonable progress goal for the 20% worst days is 16.32 dv and the uniform glide path[1] value for 2018 was 15.64 dv. The calculated 2064 natural condition value for the average of the 20% worst days for this monitor is 8.43 dv.

The average visibility on the 20% worst days for 2010 – 2014 period was 15.61 dv, which is better visibility than the reasonable progress goal and uniform rate of progress values. The continued visibility improvement on the 20% worst days was in spite of the high quantity of fire induced visibility impairment in 2012 and 2014.

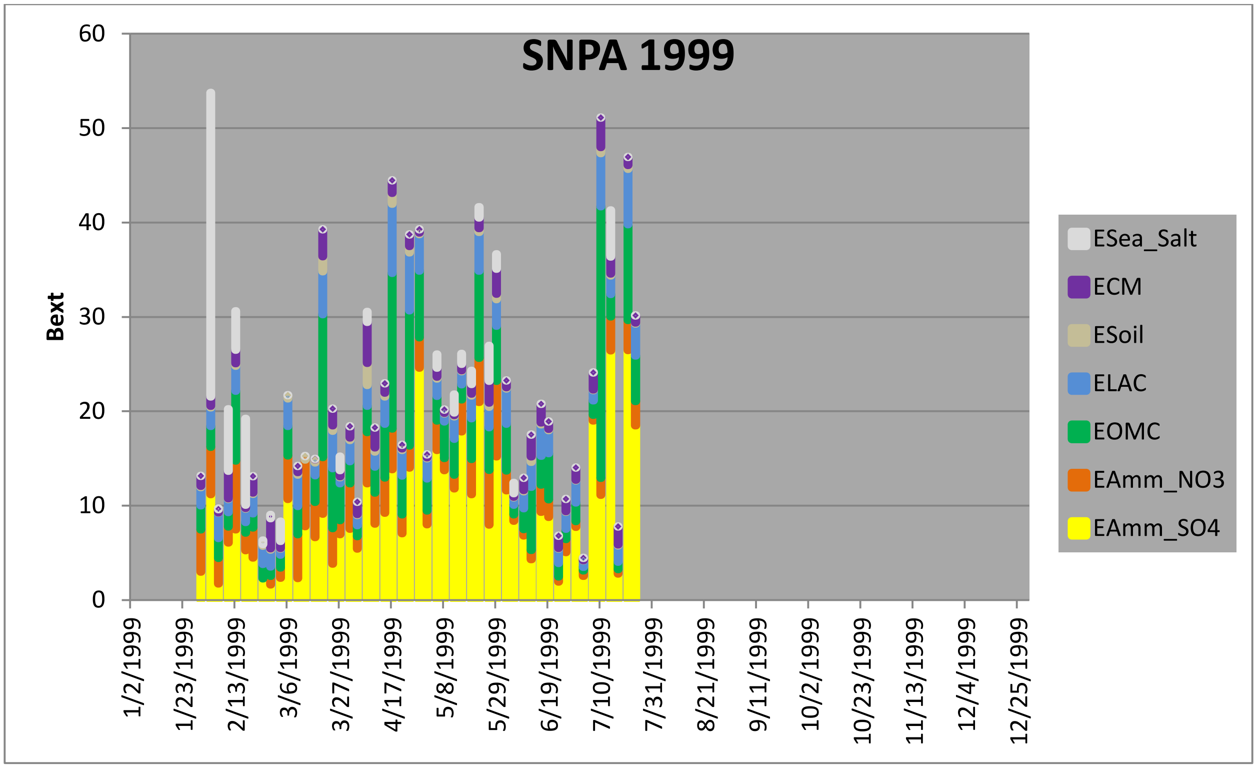
The average visibility during the best 20% days over the most recent 5 years is 3.35 dv.

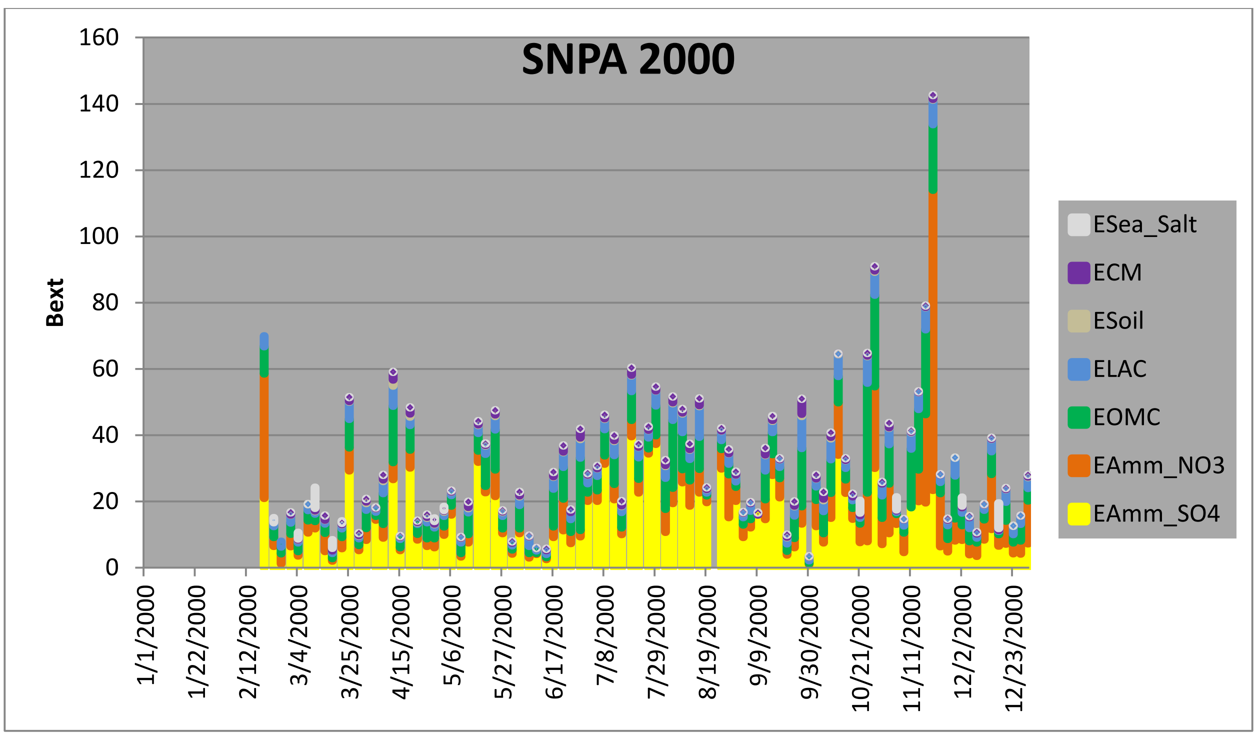
The graph at the top of this page depicts the visibility trends for this monitor since 2001. Even though the absolute worst day of each year shows significant year to year variability and the average of the worst 20% days each year varies between years, the 5 year average of the 20% worst days has continued a long term trend of visibility improvement. On the best days, the visibility trend shows steady improvement in visibility.

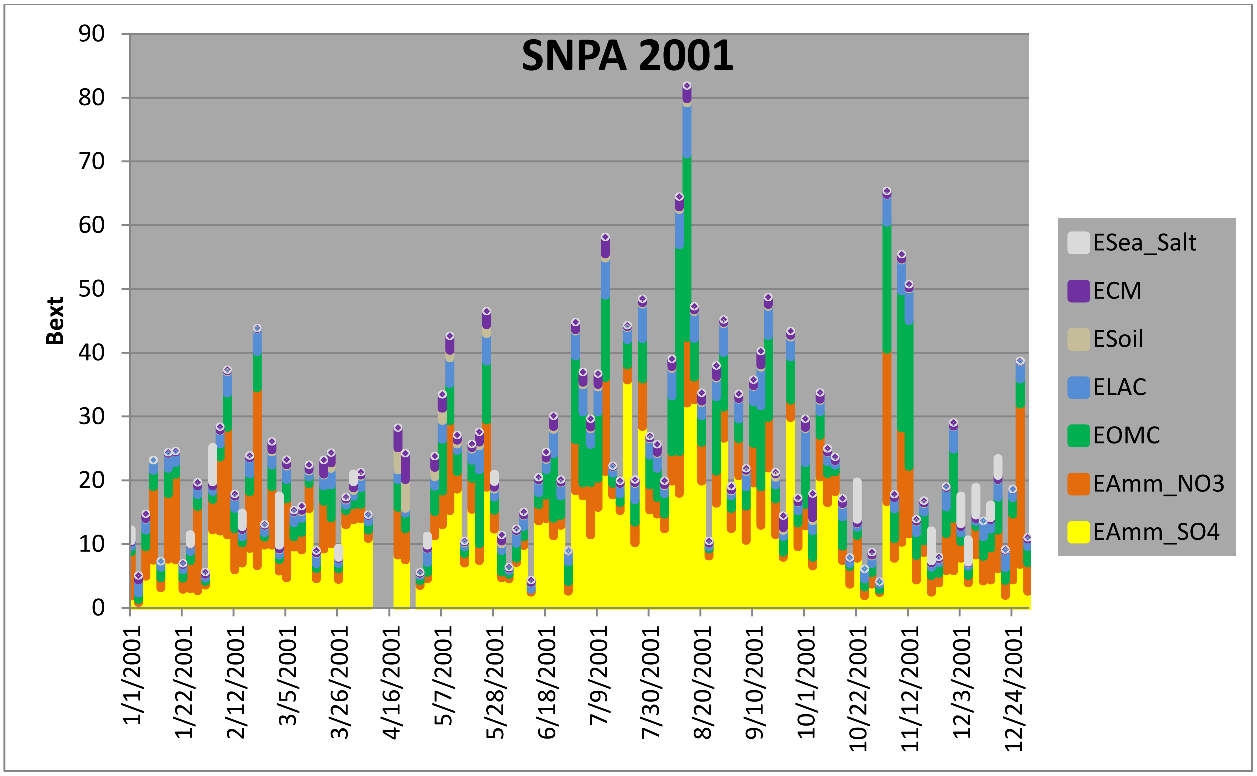
The following are graphs of the reconstructed light extinction ($B_{ext}$) for each year during the 2001 – 2014 period. The values show the relative contribution of the chemical types

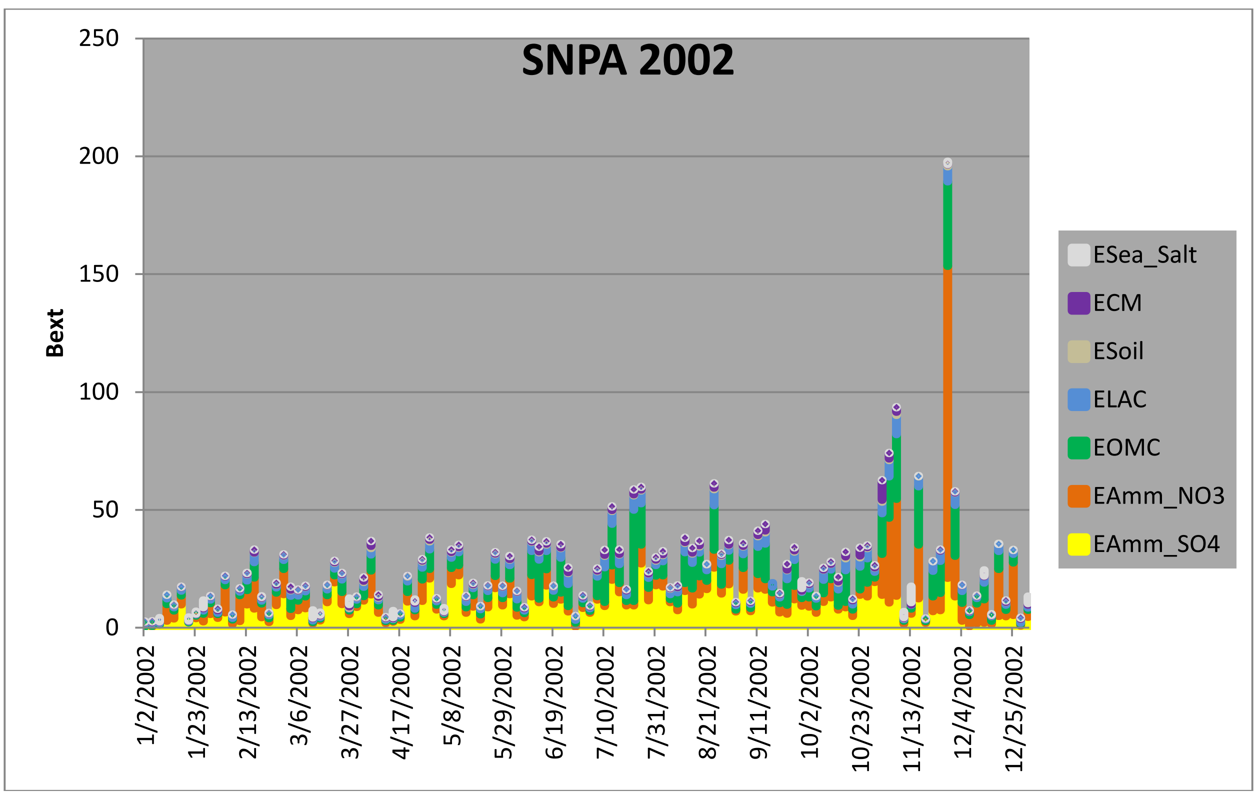
[1] The uniform glide path value is the starting place to develop a Reasonable Progress Goal. The uniform rate of progress represents the linear rate of visibility improvement required to meet the 2064 visibility goal in 2064.

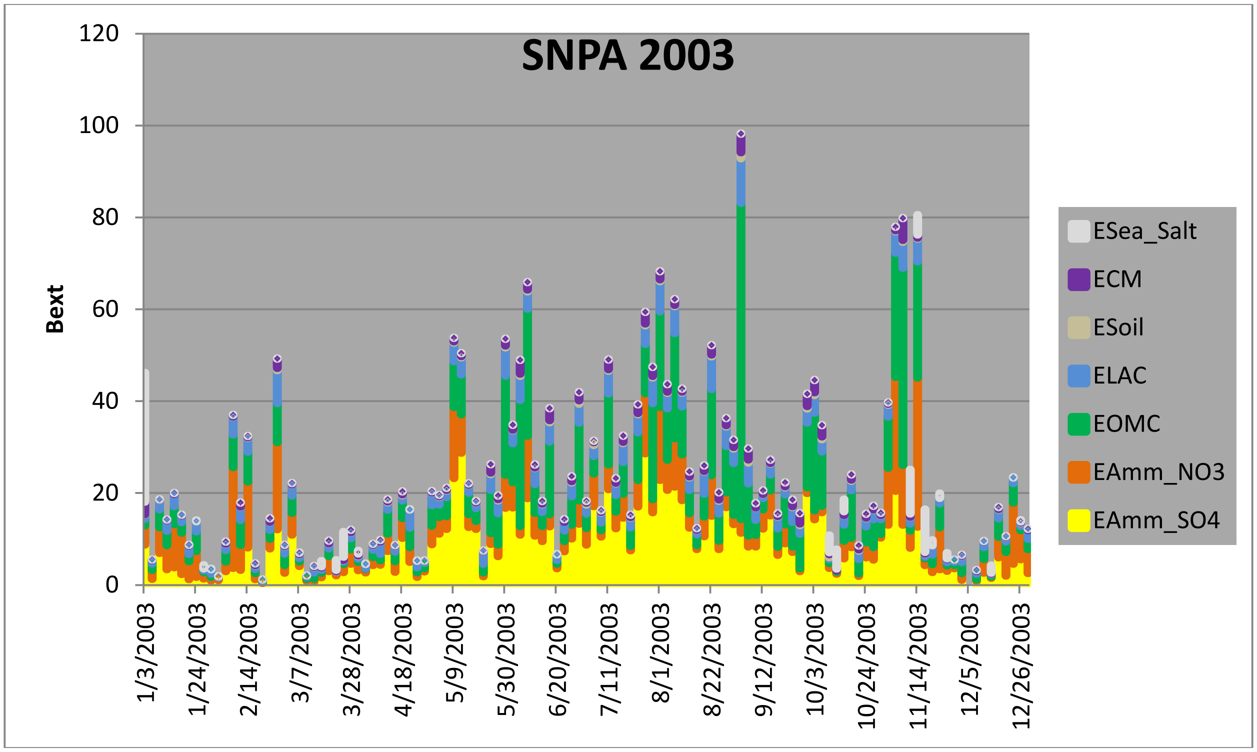
incorporated into the revised IMPROVE light extinction calculation.  NOTE each graph has a different maximum value.

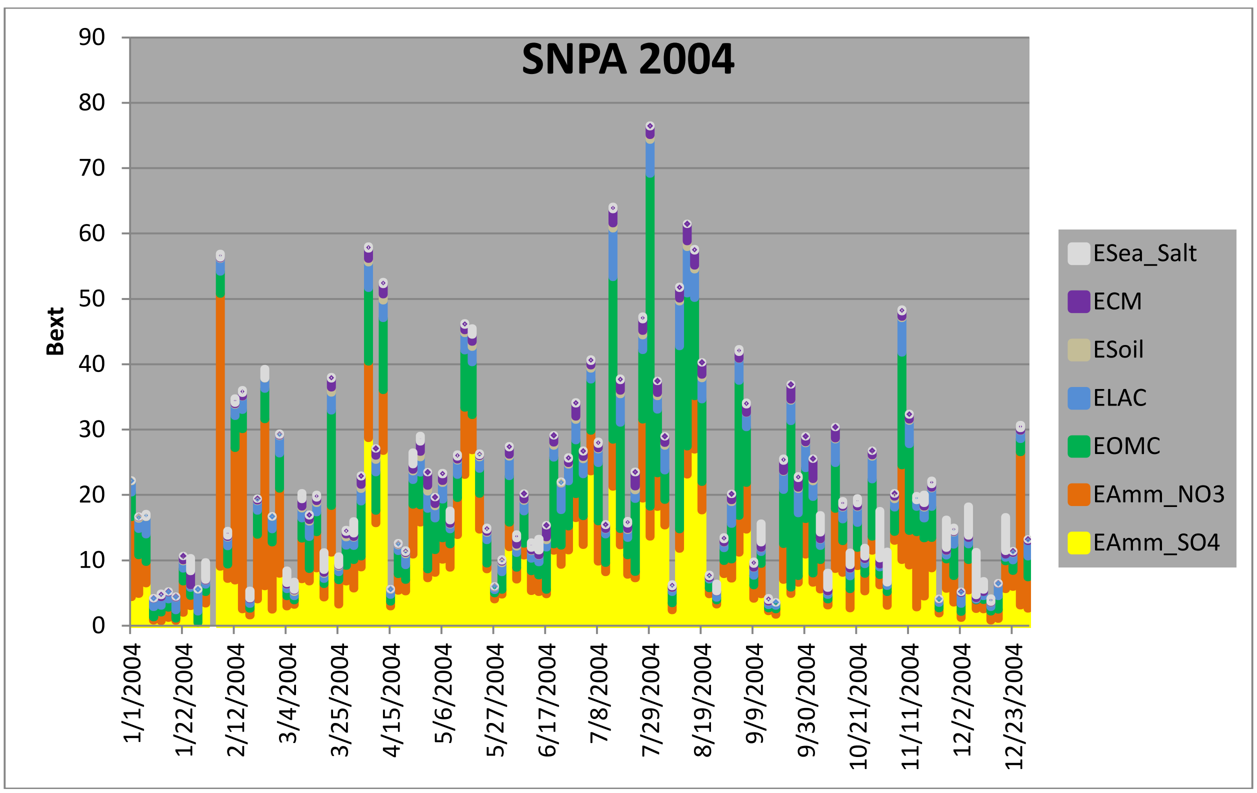


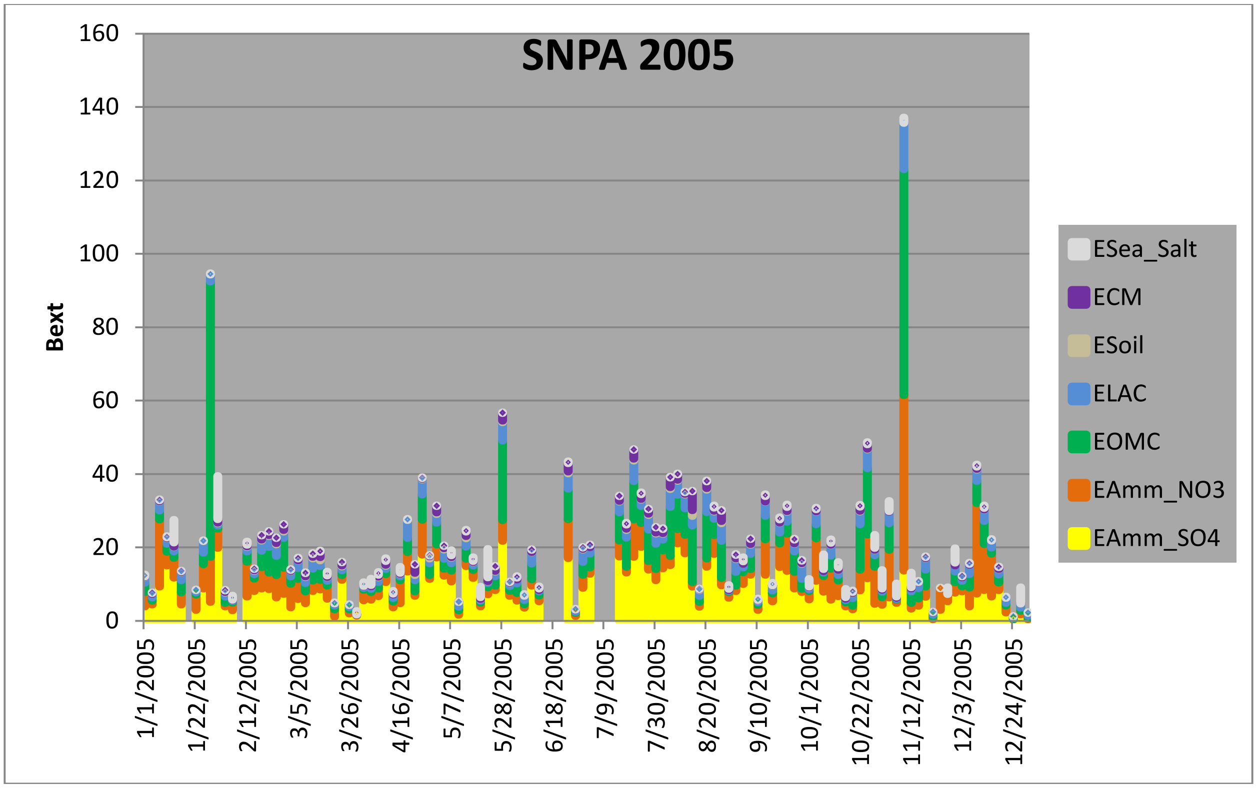



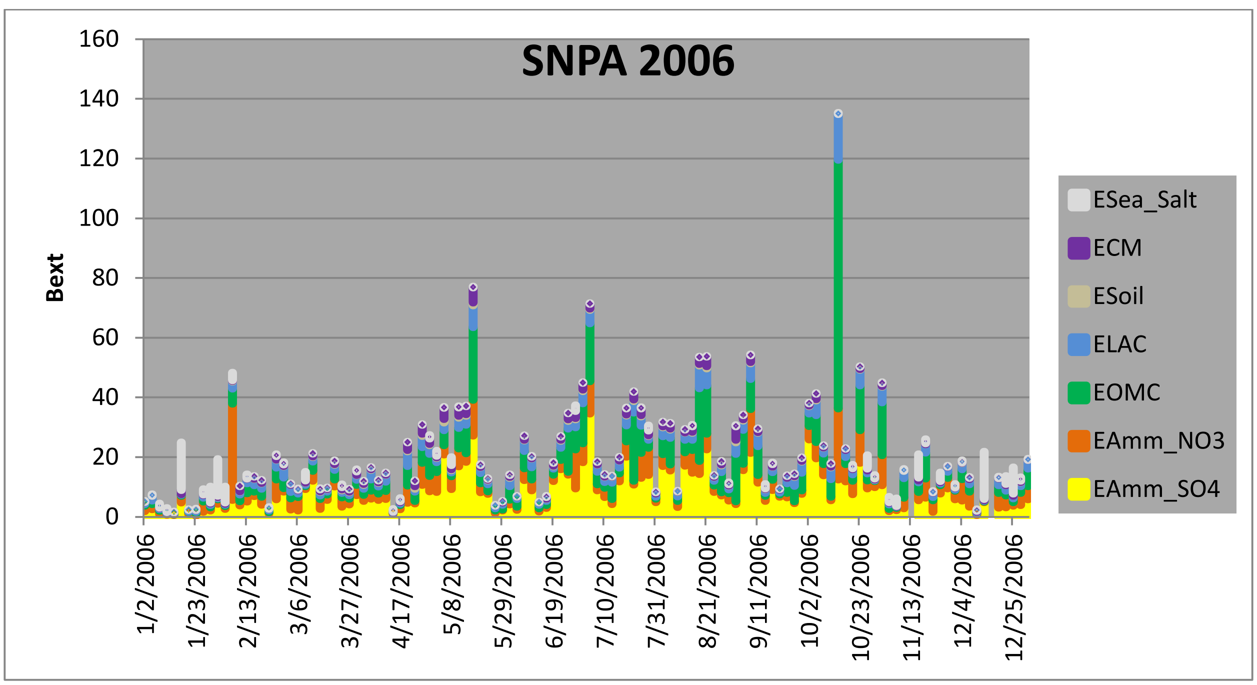

SNPA 2001
Bext
90
80
70
60
50
40
30
20
10
0
1/1/2001
1/22/2001
2/12/2001
3/5/2001
3/26/2001
4/16/2001
5/7/2001
5/28/2001
6/18/2001
7/9/2001
7/30/2001
8/20/2001
9/10/2001
10/1/2001
10/22/2001
11/12/2001
12/3/2001
12/24/2001
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


SNPA 2002
Bext
250
200
150
100
50
0
1/2/2002
1/23/2002
2/13/2002
3/6/2002
3/27/2002
4/17/2002
5/8/2002
5/29/2002
6/19/2002
7/10/2002
7/31/2002
8/21/2002
9/11/2002
10/2/2002
10/23/2002
11/13/2002
12/4/2002
12/25/2002
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


SNPA 2003
Bext
0
20
40
60
80
100
120
1/3/2003
1/24/2003
2/14/2003
3/7/2003
3/28/2003
4/18/2003
5/9/2003
5/30/2003
6/20/2003
7/11/2003
8/1/2003
8/22/2003
9/12/2003
10/3/2003
10/24/2003
11/14/2003
12/5/2003
12/26/2003
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


SNPA 2004
Bext
0
10
20
30
40
50
60
70
80
90
1/1/2004
1/22/2004
2/12/2004
3/4/2004
3/25/2004
4/15/2004
5/6/2004
5/27/2004
6/17/2004
7/8/2004
7/29/2004
8/19/2004
9/9/2004
9/30/2004
10/21/2004
11/11/2004
12/2/2004
12/23/2004
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


SNPA 2005
Bext
160
140
120
100
80
60
40
20
0
1/1/2005
1/22/2005
2/12/2005
3/5/2005
3/26/2005
4/16/2005
5/7/2005
5/28/2005
6/18/2005
7/9/2005
7/30/2005
8/20/2005
9/10/2005
10/1/2005
10/22/2005
11/12/2005
12/3/2005
12/24/2005
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


SNPA 2006
Bext
160
140
120
100
80
60
40
20
0
1/2/2006
1/23/2006
2/13/2006
3/6/2006
3/27/2006
4/17/2006
5/8/2006
5/29/2006
6/19/2006
7/10/2006
7/31/2006
8/21/2006
9/11/2006
10/2/2006
10/23/2006
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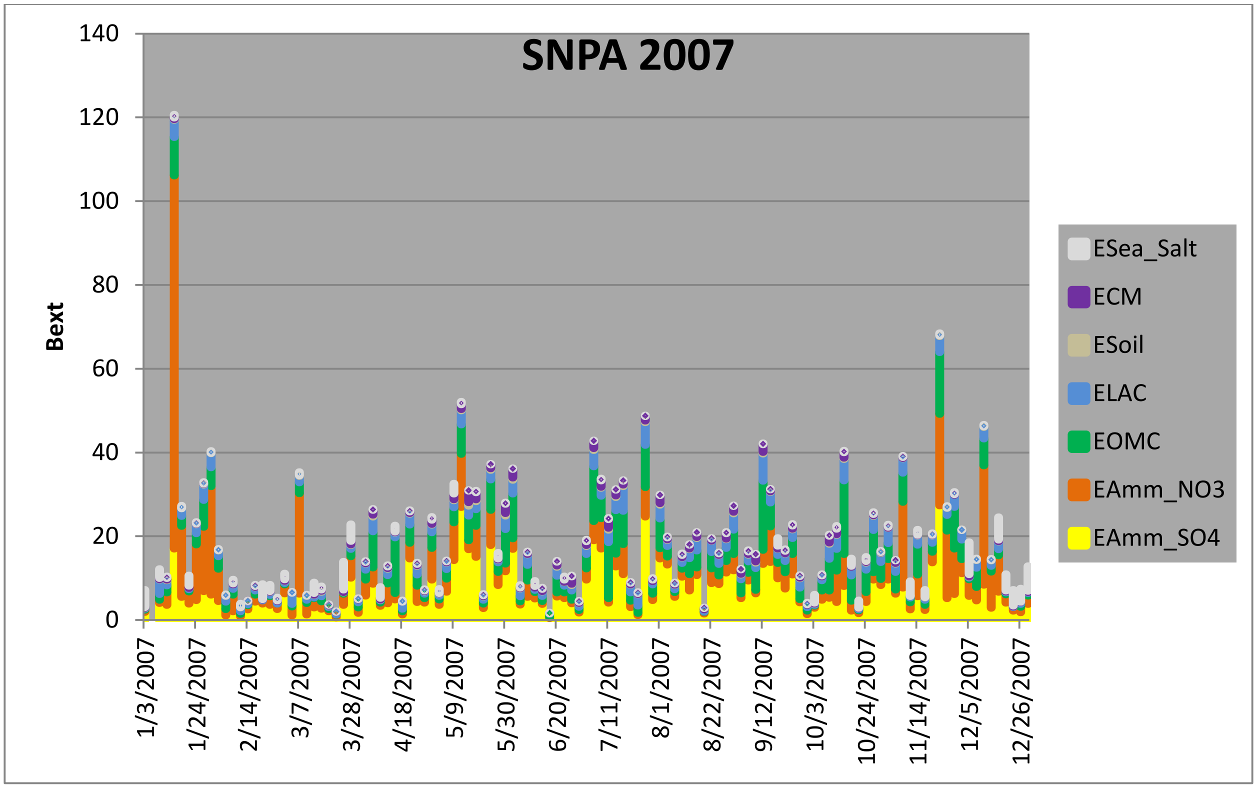
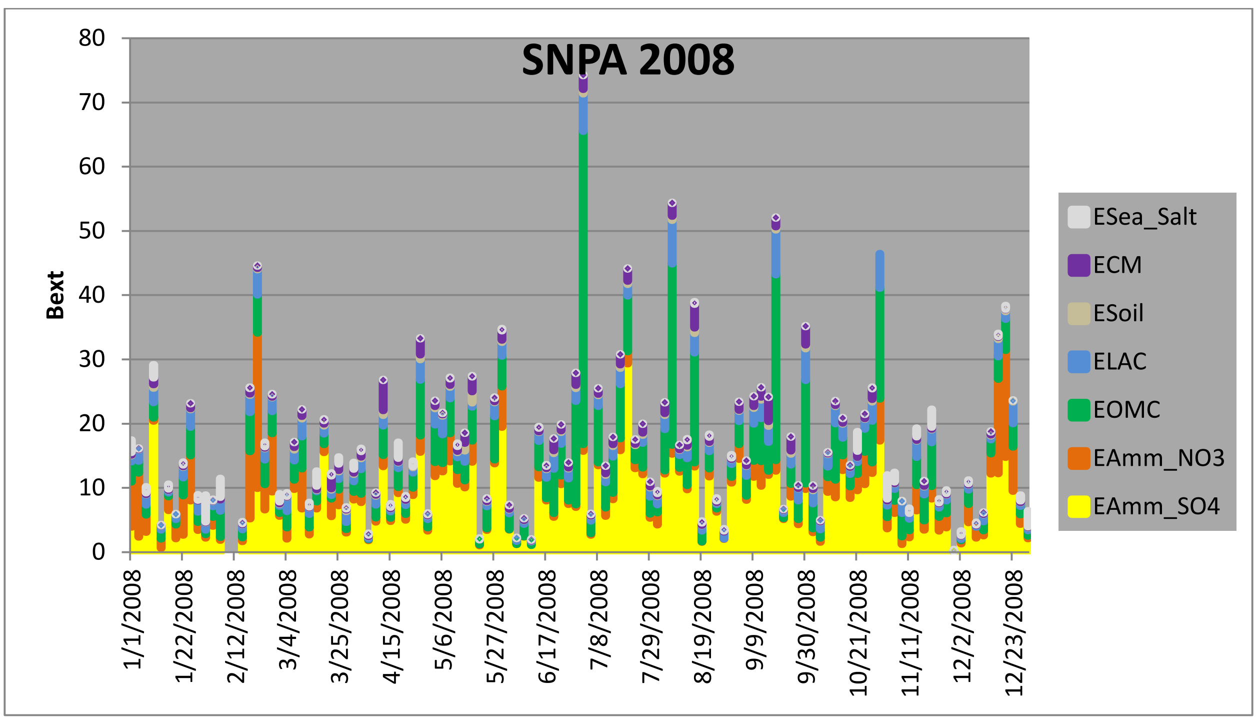
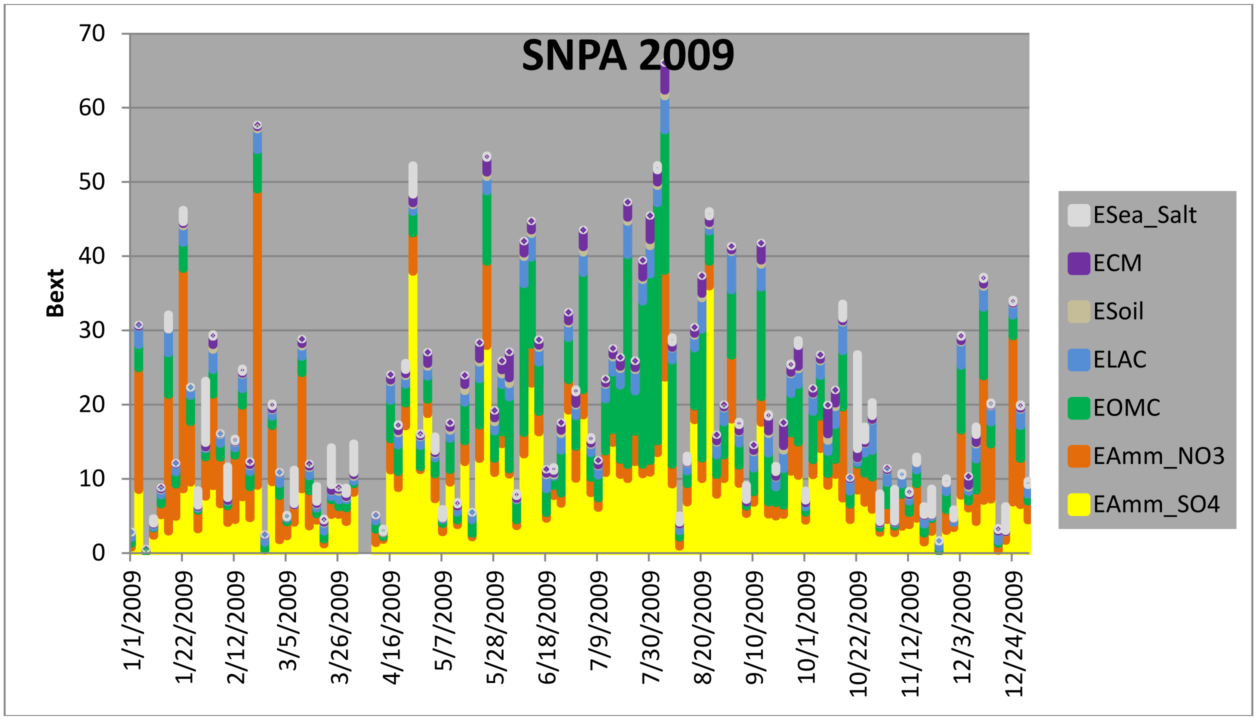
12/25/2006
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

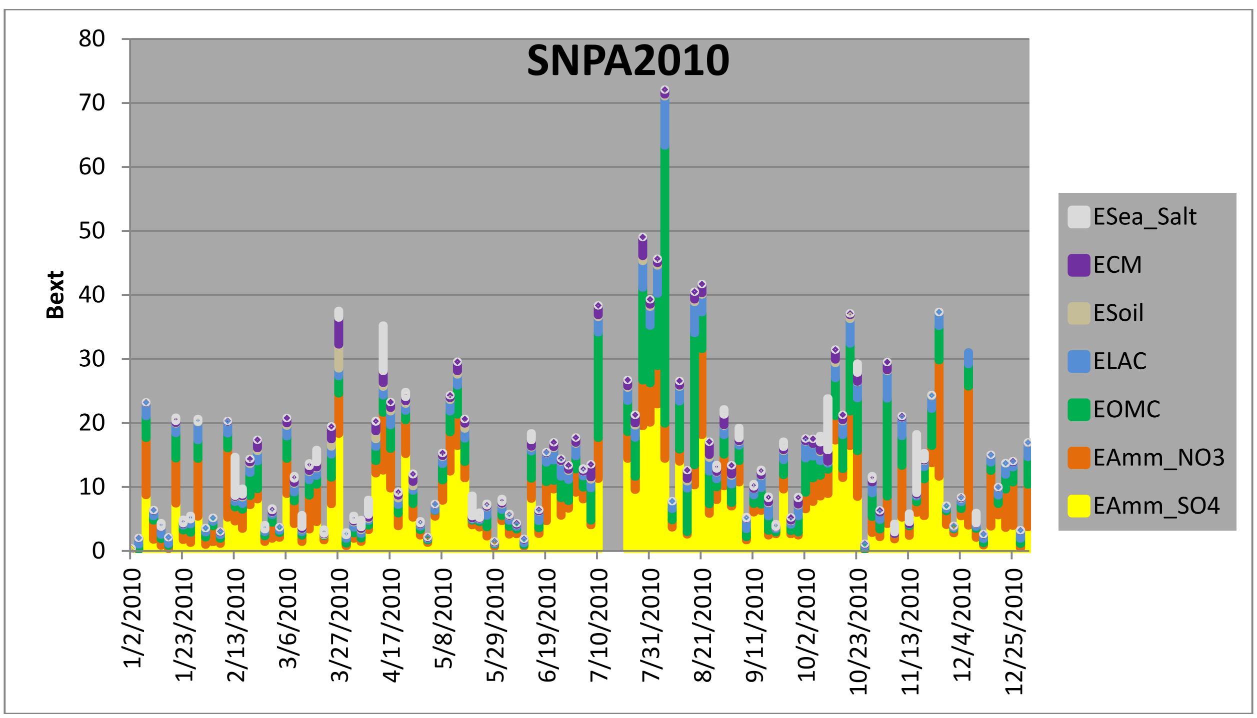



Unknown what generated the high ammonium nitrate values in January.





SNPA 2009
Bext
70
60
50
40
30
20
10
0
1/1/2009
1/22/2009
2/12/2009
3/5/2009
3/26/2009
4/16/2009
5/7/2009
5/28/2009
6/18/2009
7/9/2009
7/30/2009
8/20/2009
9/10/2009
10/1/2009
10/22/2009
11/12/2009
12/3/2009
12/24/2009
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

SNPA2010
Bext
80
70
60
50
40
30
20
10
0
1/2/2010
1/23/2010
2/13/2010
3/6/2010
3/27/2010
4/17/2010
5/8/2010
5/29/2010
6/19/2010
7/10/2010
7/31/2010
8/21/2010
9/11/2010
10/2/2010
10/23/2010
11/13/2010
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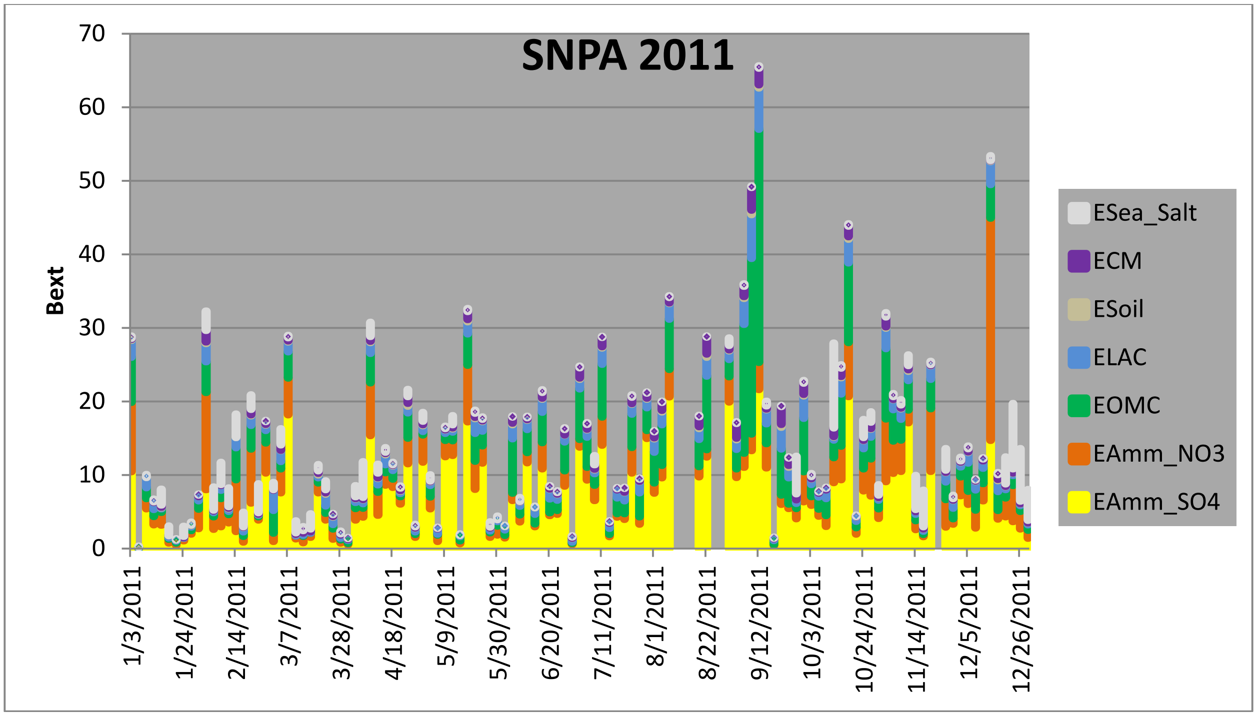
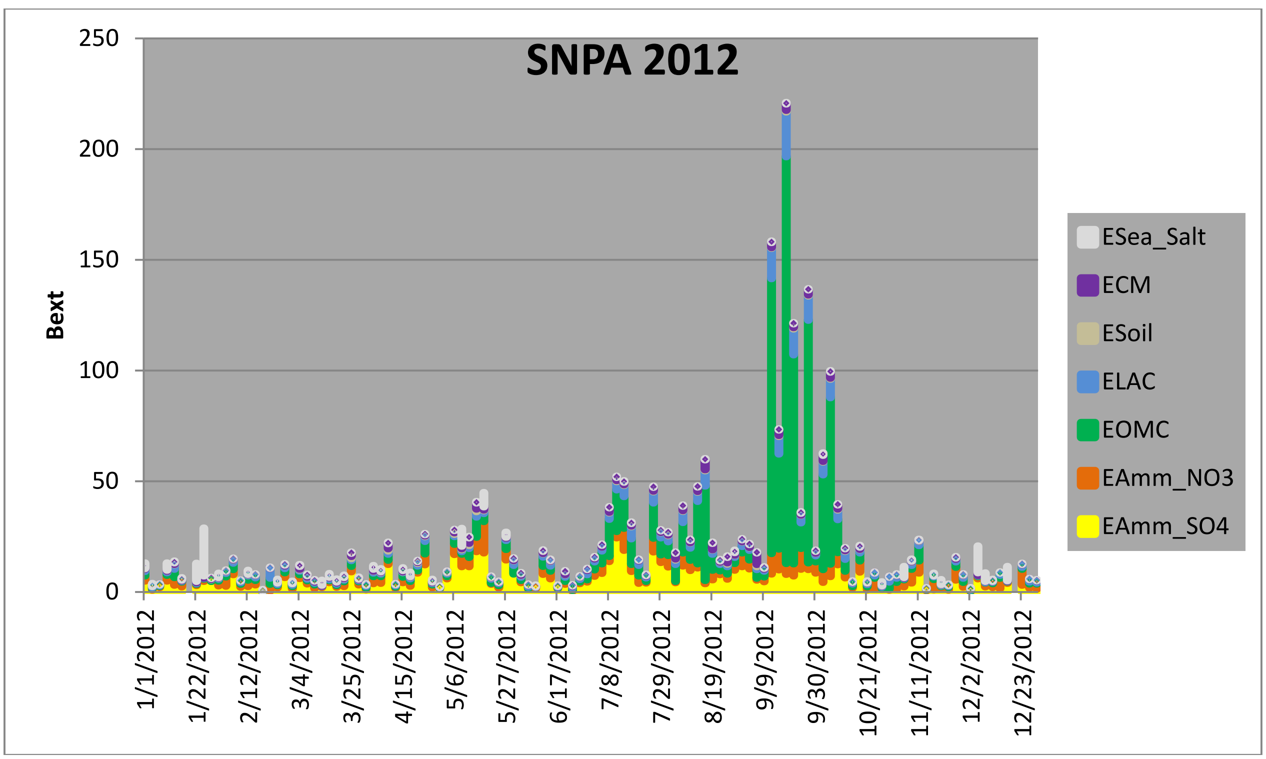
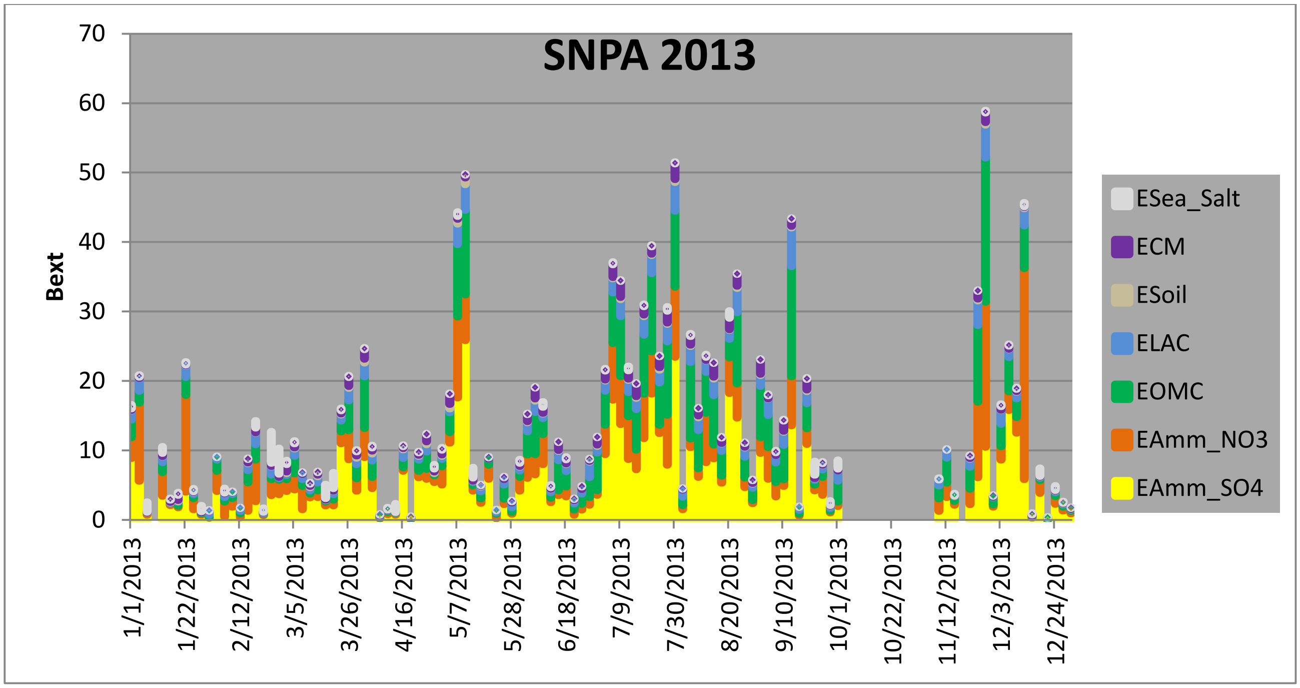
12/25/2010
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

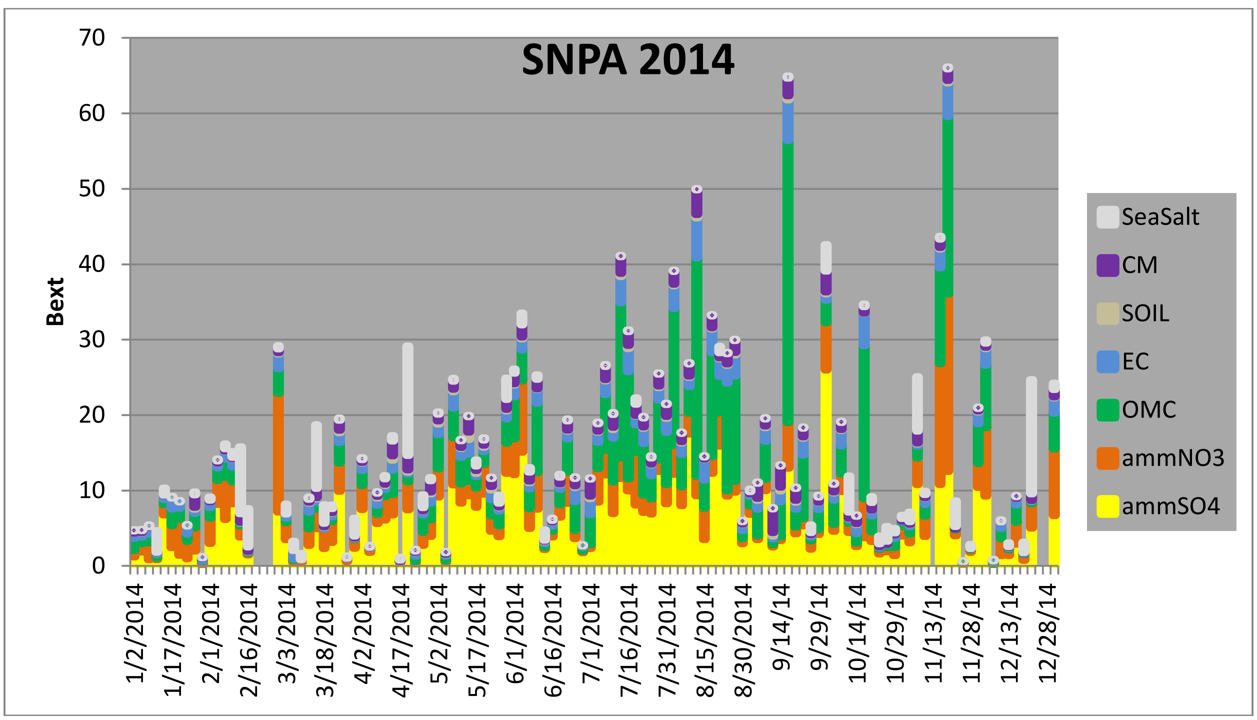



The worst day values this year were dominated by wild fires that occurred during the month of September. As discussed in Appendix D, these smoke impaired days were adversely affected by smoke from a large number of fires in Washington plus smoke plumes from fires in Eastern Oregon and southern British Columbia. All of the Washington fires were started by lightning strikes on September 8, 2012.

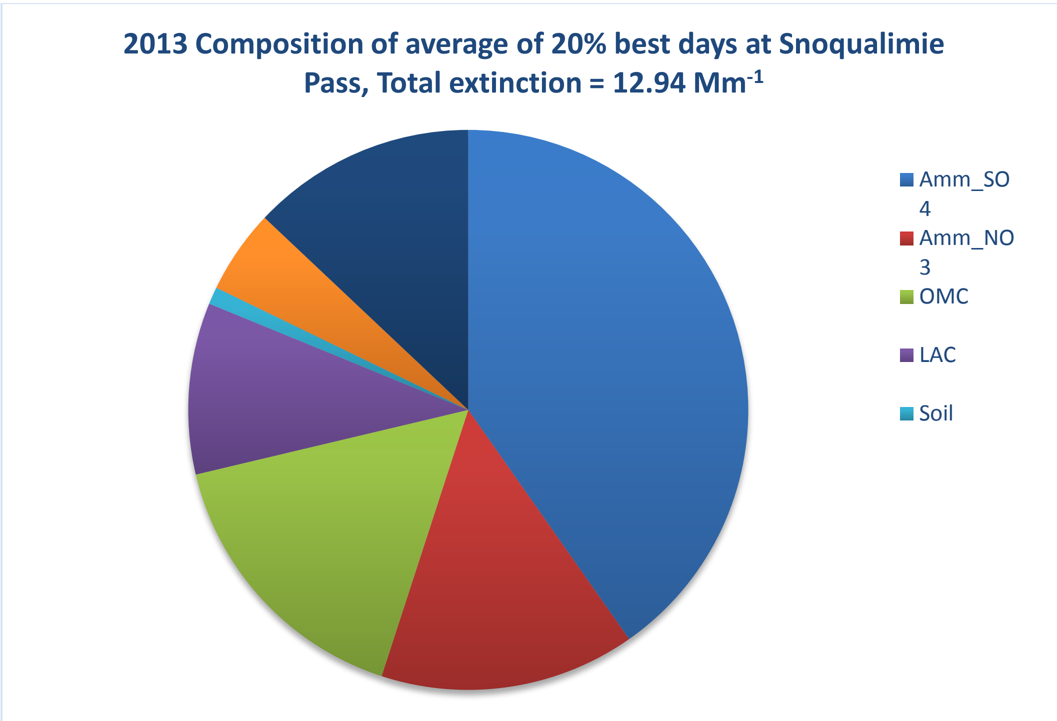


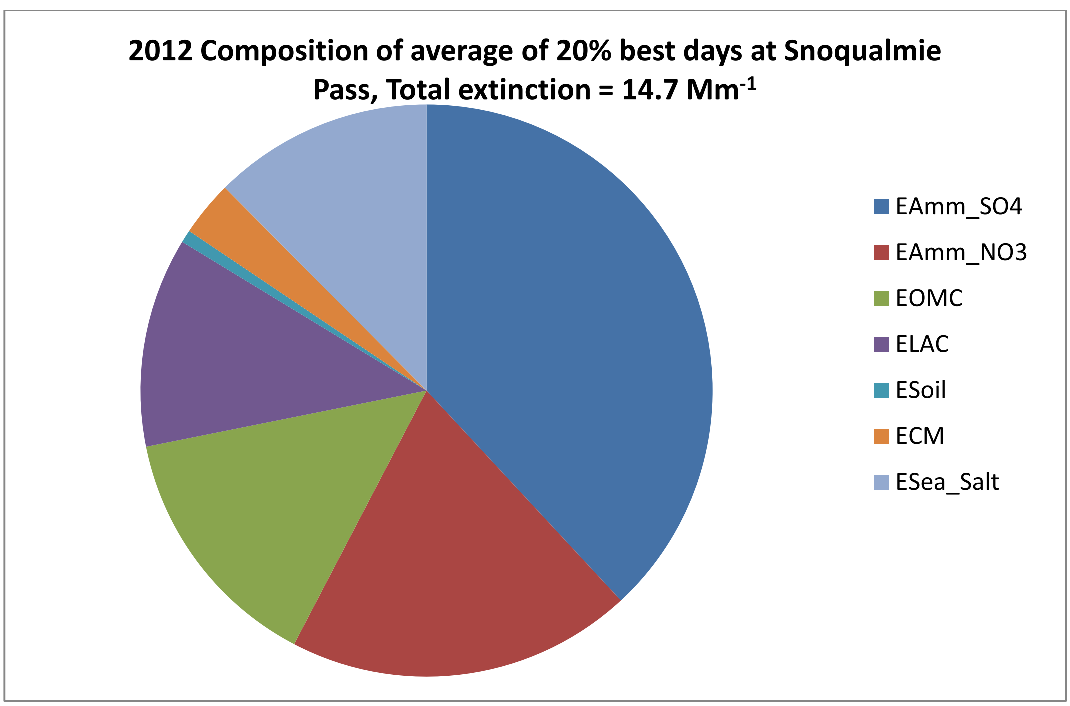

This is an incomplete year of data. As such the IMPROVE system has not produced statistics for 2013.

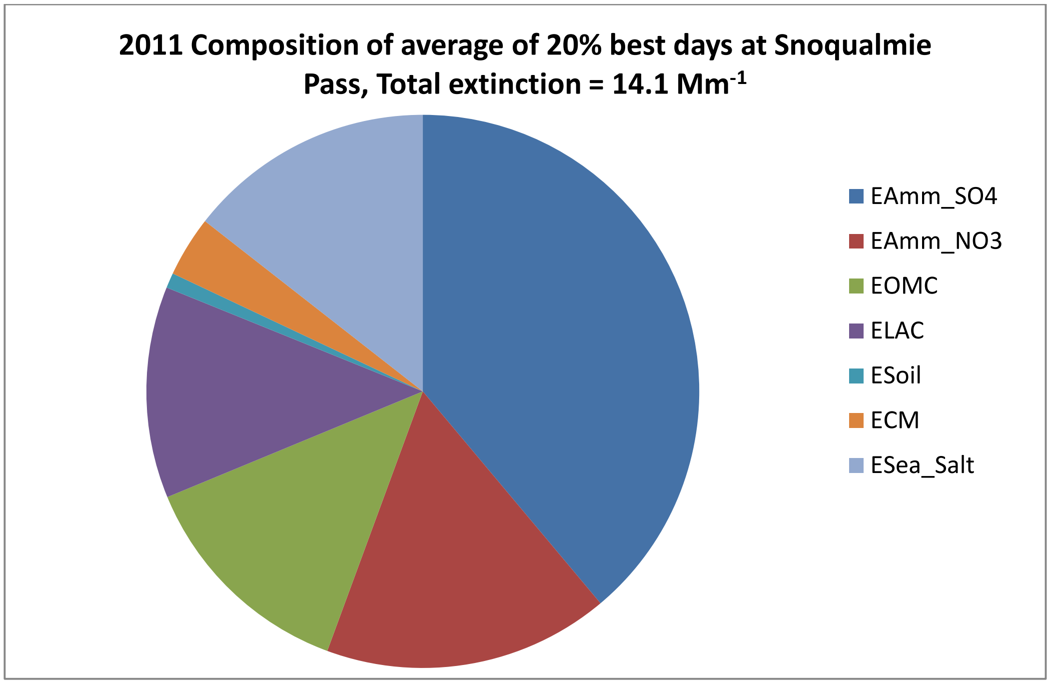


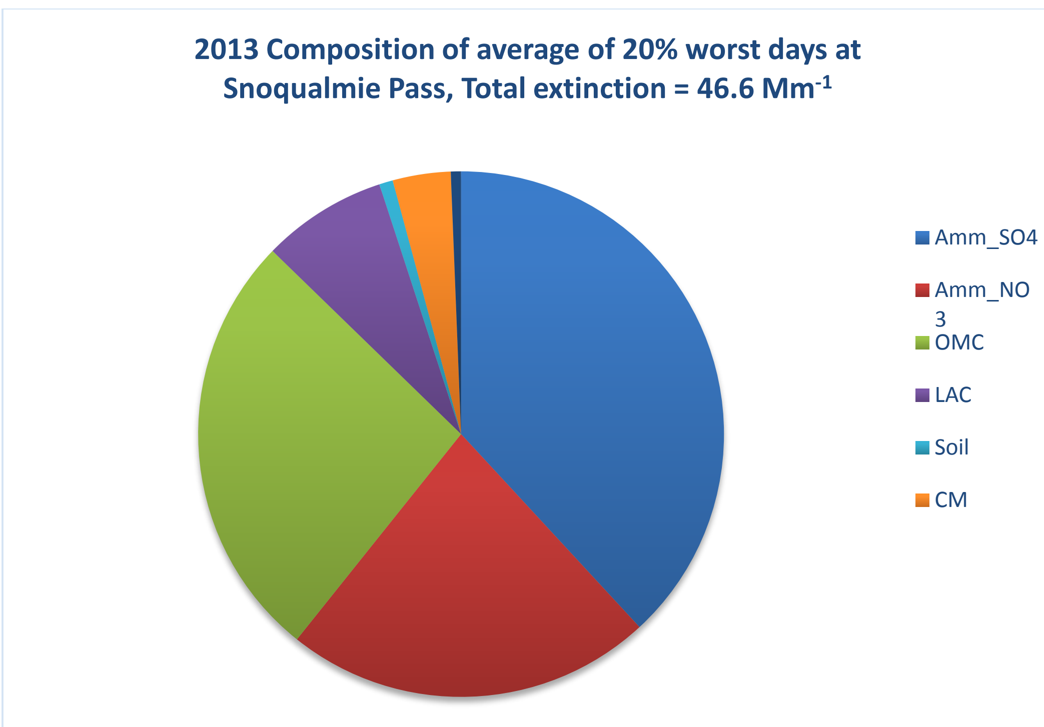

This is a fairly typical year including the relatively high nitrate signature during the winter months. In other years this winter high nitrate signature is accompanied by high organic carbon. This may be due to emissions generated local to the monitor from motor vehicles on Interstate 90 which passes below the monitor. Further investigations will need to be made to better ascertain the source of these emissions and determine the extent that they may be controllable.

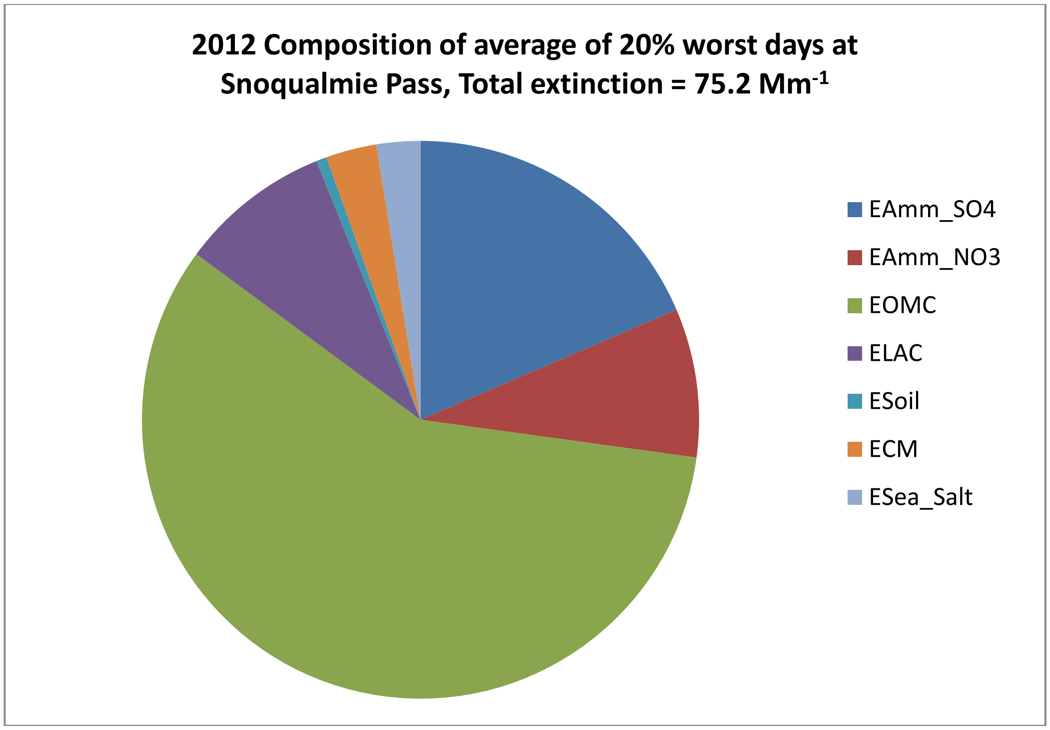
The following pie charts compare the average relative visibility impairment by the primary haze-causing pollutant species for years 2010 – 2012. The charts show the relative composition on the average of the 20% best and worst days for each of these years. The pie charts for the worst days show how much the monitor was affected by smoke from wildfires. (Compare worst day chart for 2012 to that for the more typical 2011 and 2013).

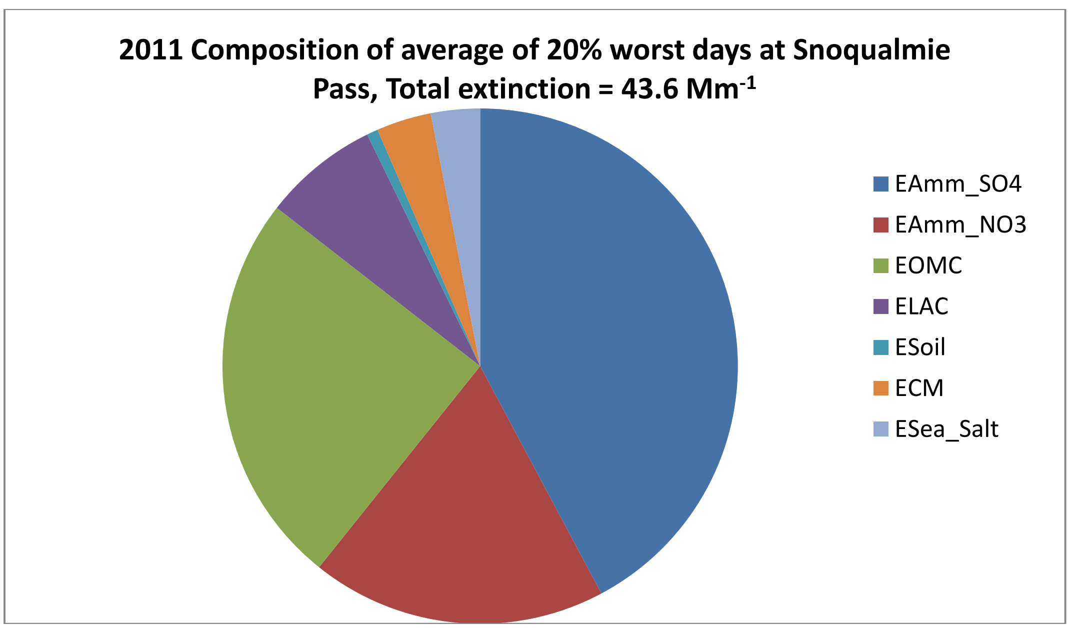


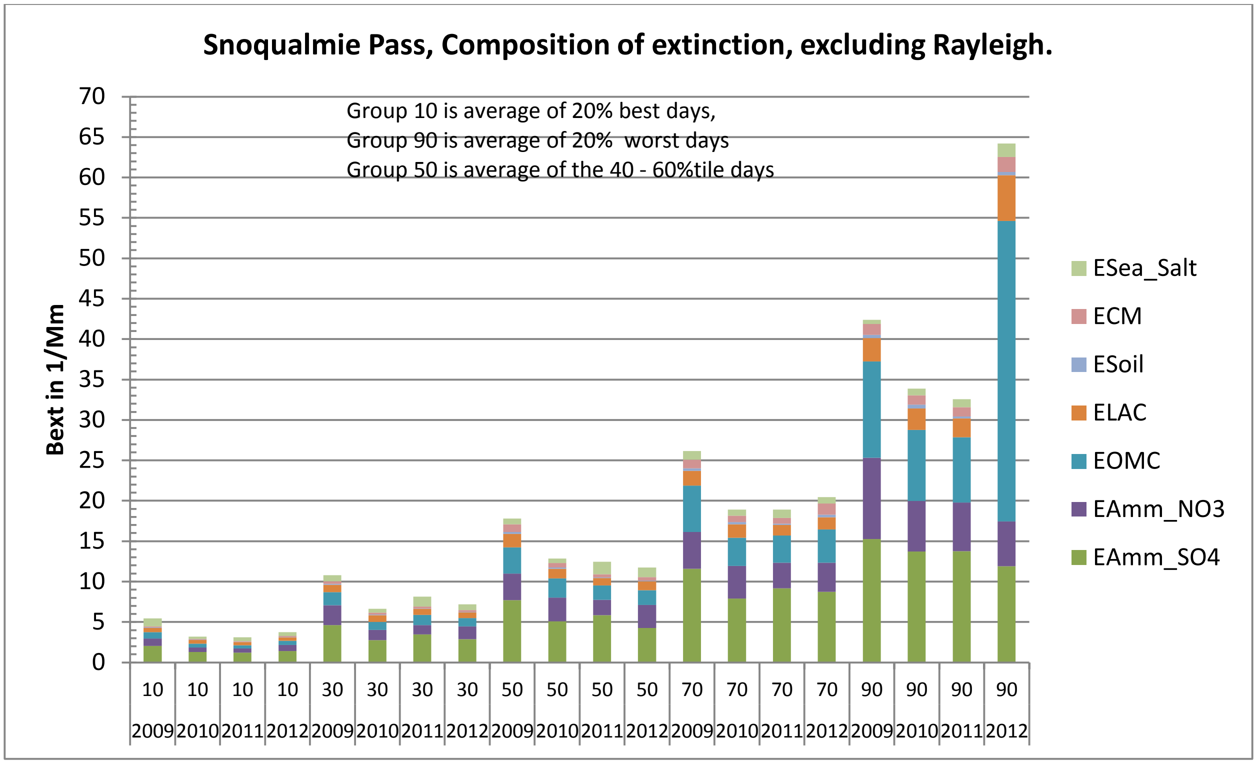

2011 Composition of average of 20% best days at Snoqualmie Pass, Total extinction = 14.1 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt


2013 Composition of average of 20% worst days at Snoqualmie Pass, Total extinction = 46.6 Mm-1
Amm_SO4
Amm_NO3
OMC
LAC
Soil
CM

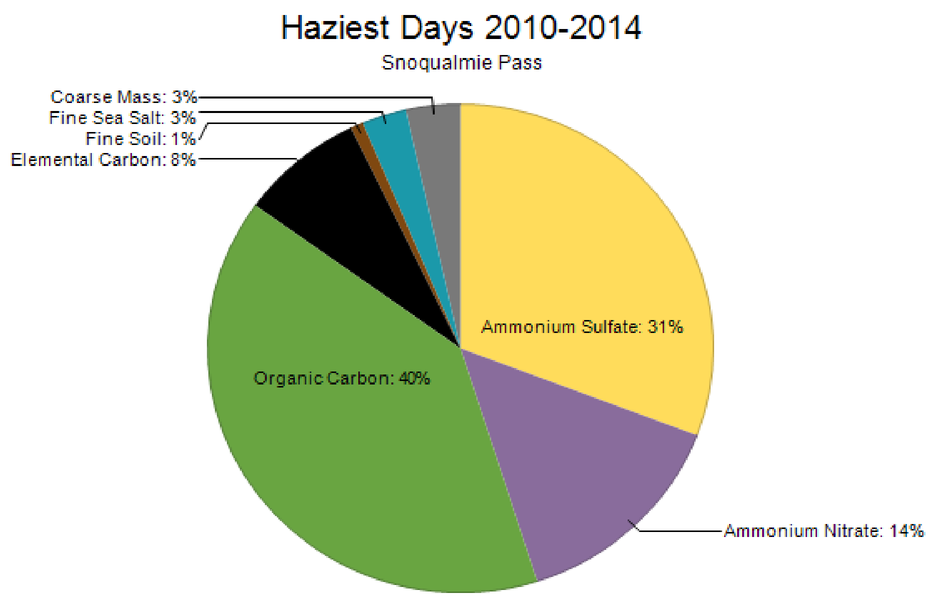

2012 Composition of average of 20% worst days at Snoqualmie Pass, Total extinction = 75.2 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt


2011 Composition of average of 20% worst days at Snoqualmie Pass, Total extinction = 43.6 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt

The following graph indicates the change in relative contribution to light extinction measured at the Snoqualmie Pass monitor. Note that nitrates and sulfates are both reducing over time at all statistical levels. Only the wildfire effects in 2012 affect the overall downward trend in visibility impairment.

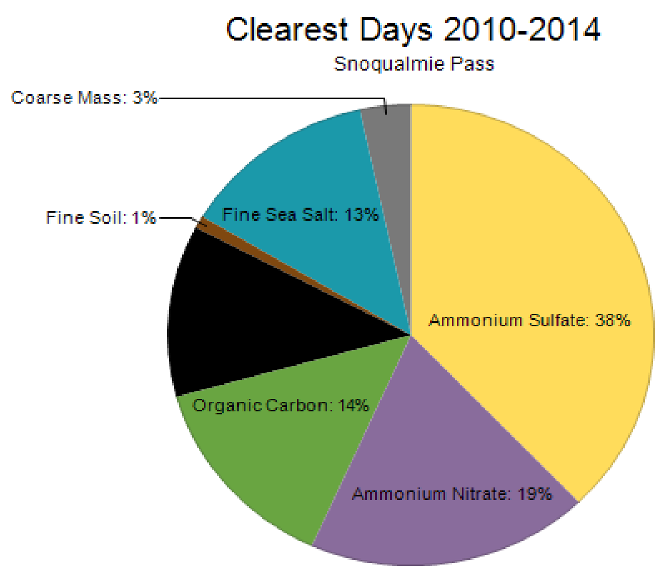


The following graphs produced by WRAP software show the 5 year average composition of the measured haze-causing pollutants on the worst 20% (haziest) and best 20% (clearest) days. Of note is the average composition of the aerosols producing visibility impairment on the worst days is dominated by organic carbon and ammonium sulfates, while on the best days, it is dominated by ammonium sulfate.




The chart above illustrates particle contribution to light extinction on haziest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: SNPA1, WA




The chart above illustrates particle contribution to light extinction on clearest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: SNPA1, WA

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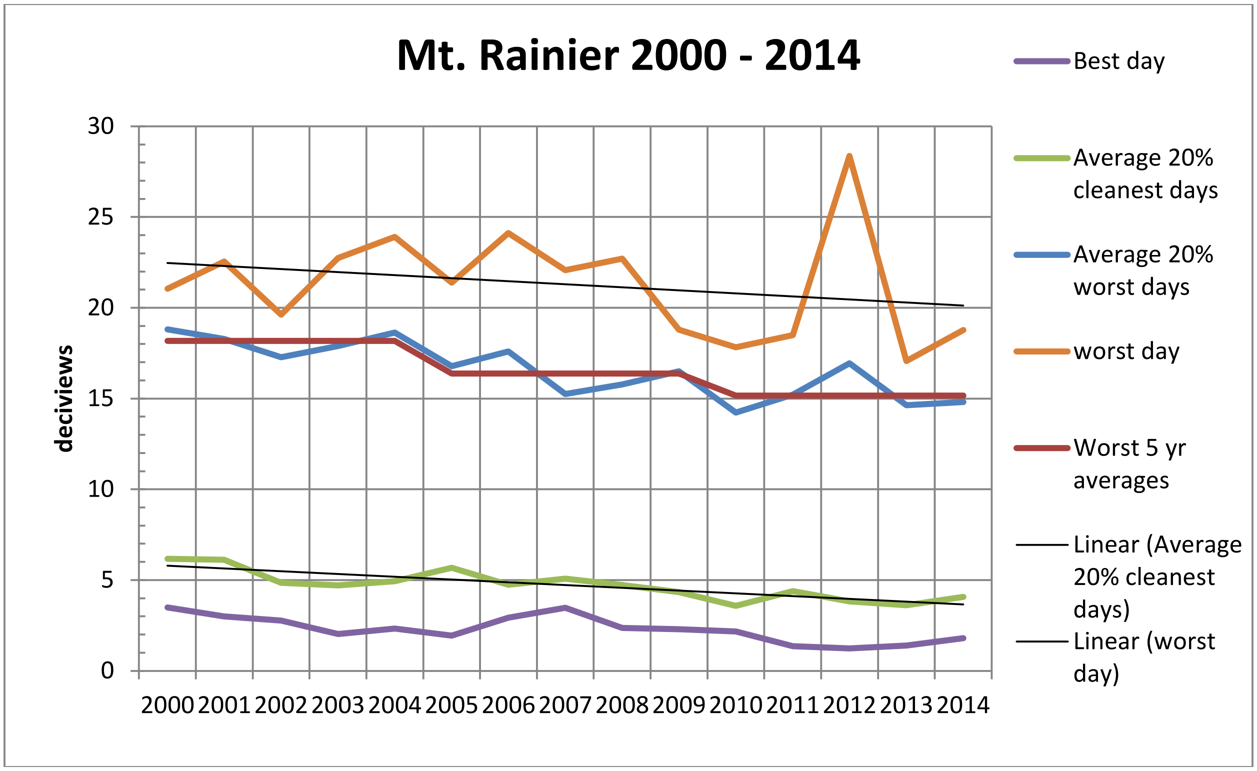
Mt Rainier National Park Annual Visibility Trend Graphs.




The Mt. Rainier National Park is represented by the MORA1 IMPROVE monitor site.

The projected 2018 reasonable progress goal for the 20% worst days is 16.66 dv and the uniform glide path[1] value for 2018 was 15.98 dv. The calculated 2064 natural condition value for the average of the 20% worst days for this monitor is 8.54 dv.

The average visibility on the 20% worst days for 2010 – 2014 period was 15.16 dv, which is better visibility than the reasonable progress goal and the uniform rate of progress values. The continued visibility improvement on the 20% worst days was in spite of the fire induced visibility impairment in 2012.

The average visibility during the best 20% days over the most recent 5 years is 3.90 dv.

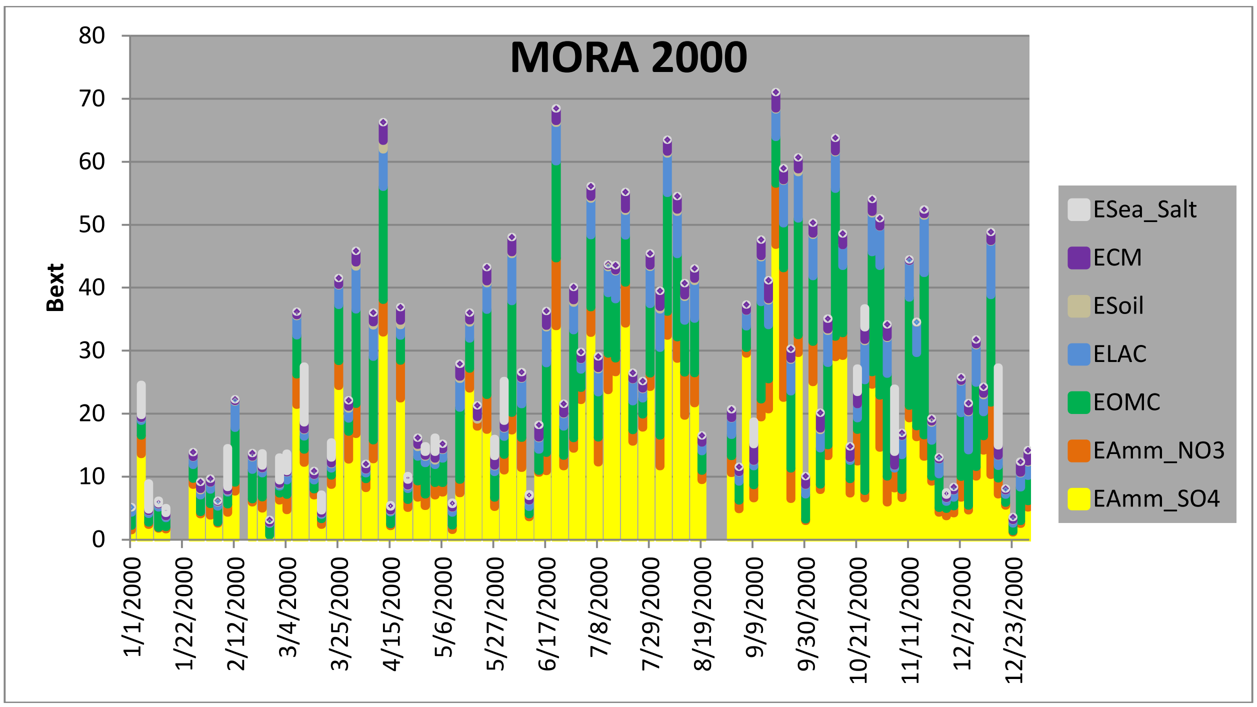
The graph at the top of this page depicts the visibility trends for this monitor since 2000. Even though the absolute worst day of each year shows year to year variability and the average of the worst 20% days each year varies between years, the 5 year average of the 20% worst days has continued a long term trend of visibility improvement. On the best days, the visibility trend shows steady improvement in visibility.

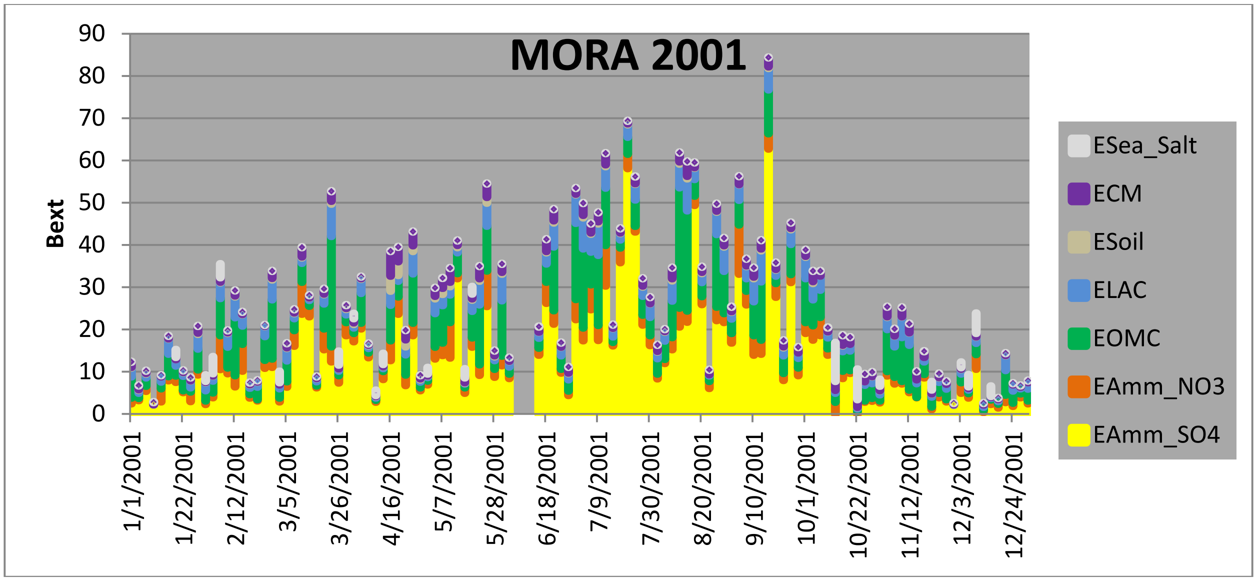
[1] The uniform glide path value is the starting place to develop a Reasonable Progress Goal. The uniform rate of progress represents the linear rate of visibility improvement required to meet the 2064 visibility goal in 2064.

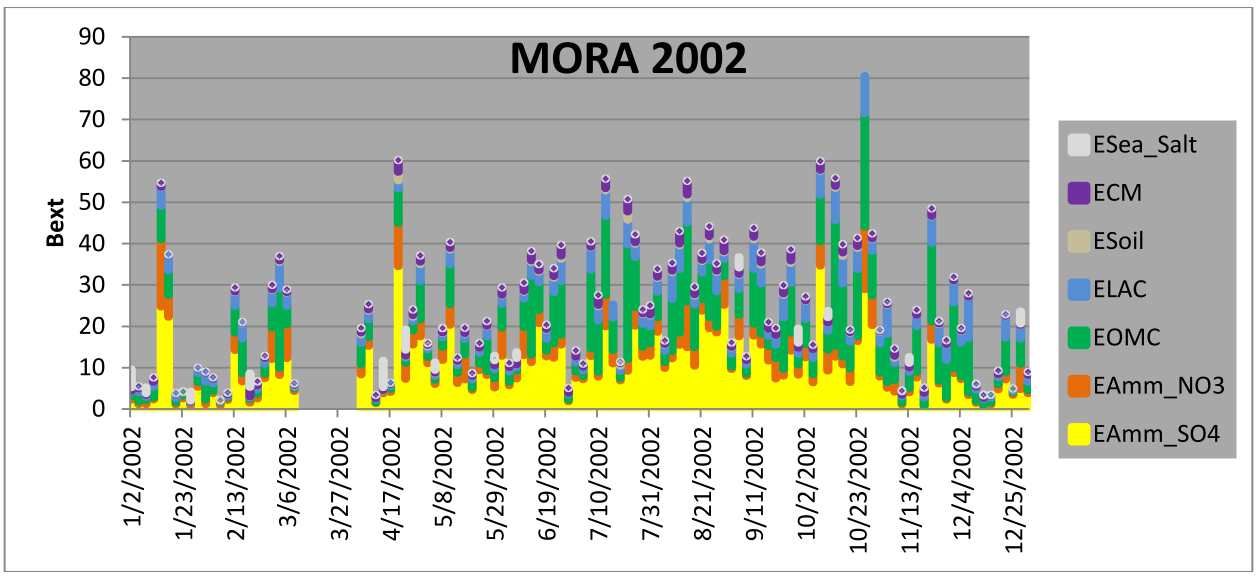
Similar to the monitor for Goat Rocks and Mt. Adams Wildernesses,, this monitor was adversely impacted in September of 2012 due to the same wildfire that impacted that monitor. The primary difference is the impact at the Mount Rainier National Park monitor occurred on one day rather than nearly 3 weeks at the At the Goat Rocks and Mt Adams Wildernesses monitoring site.

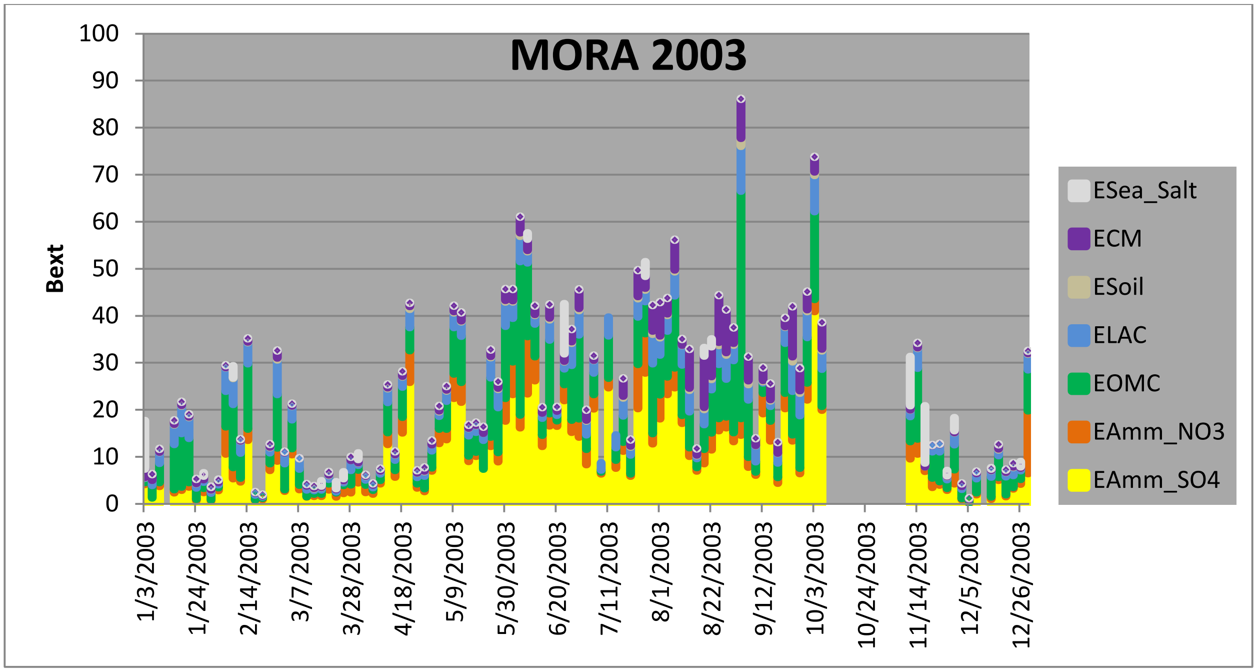
Due to this monitor being at a lower elevation and much closer to the TransAlta Centralia Generating power plant, this monitor's sulfate values show the influence of the power plant's operation better than any other Washington monitor. The power plant has continued to reduce its SO2 emissions since the 2002. In addition, operation of this plant has changed since the Regional Haze baseline period, resulting in the plant being off-line more months every year as other electric generating sources are operated instead. The effect of this reduced operation can be seen in the 'daily' graphs below. The effect is most obvious in the 2012 data as discussed below.

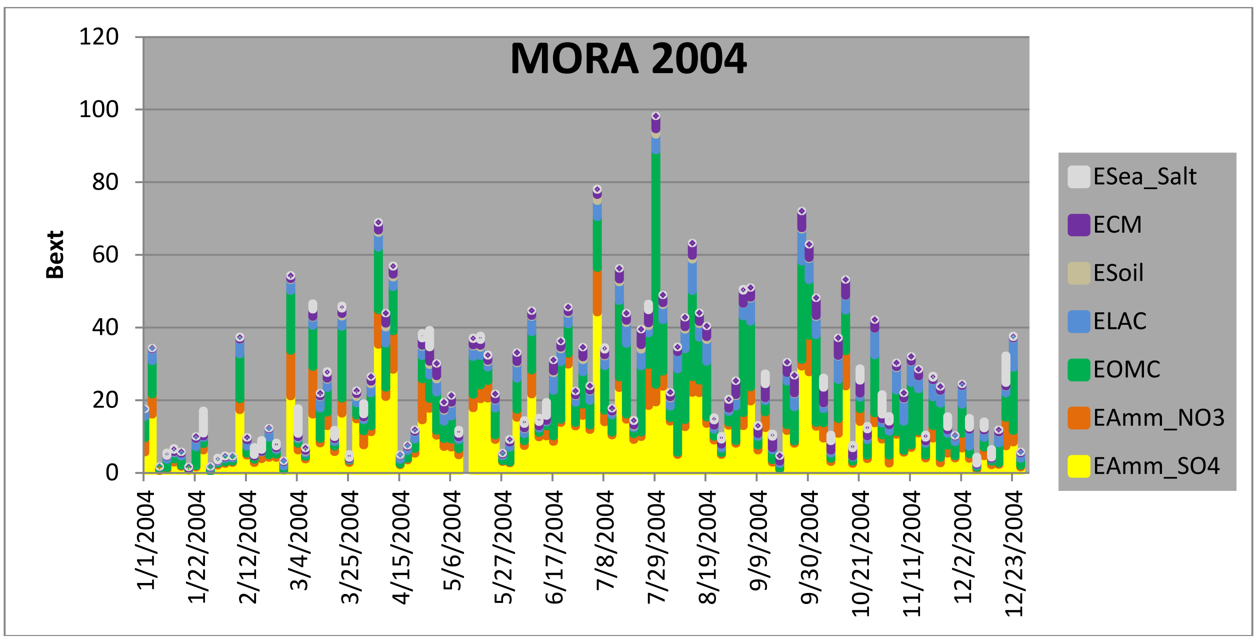
The following are graphs of the reconstructed light extinction ($B_{ext}$) for each year during the 2001 – 2014 period. The values show the relative contribution of the chemical types incorporated into the revised IMPROVE light extinction calculation. NOTE each graph has a different maximum value.

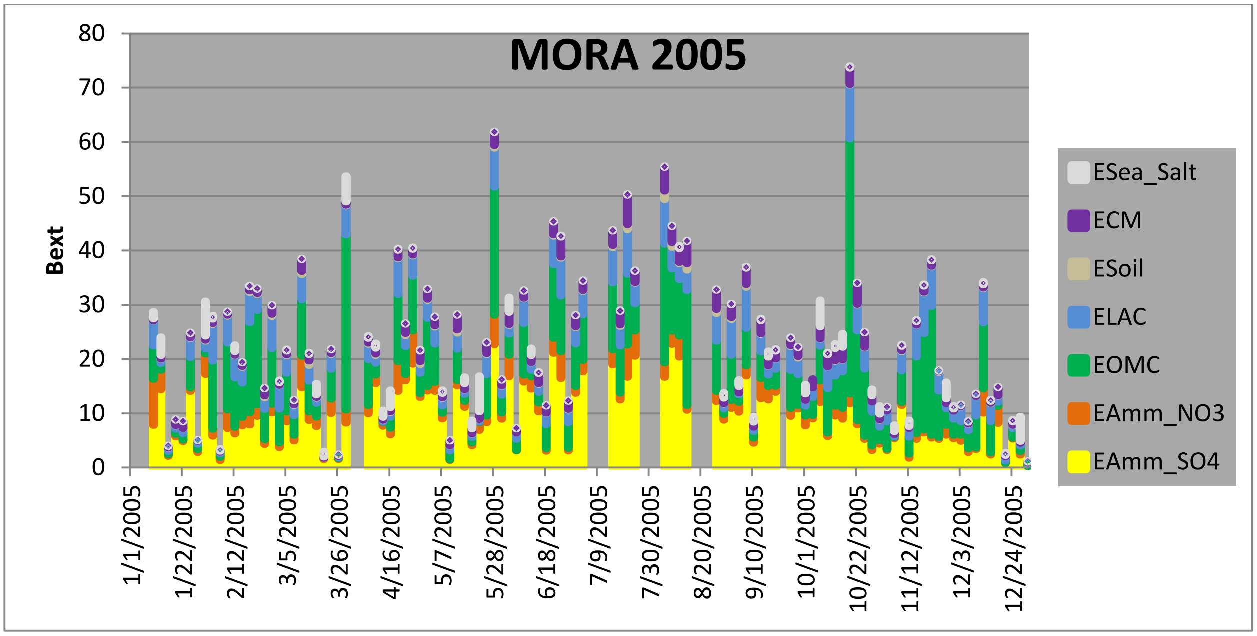


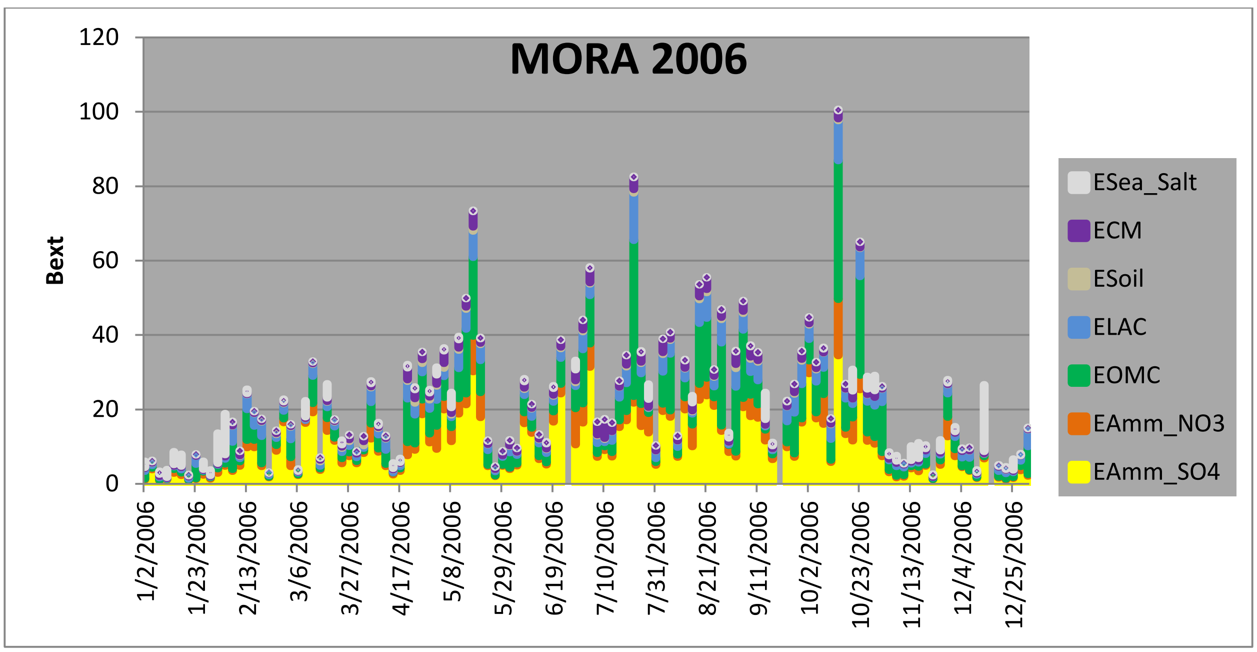

MORA 2001
Bext
90
80
70
60
50
40
30
20
10
0
1/1/2001
1/22/2001
2/12/2001
3/5/2001
3/26/2001
4/16/2001
5/7/2001
5/28/2001
6/18/2001
7/9/2001
7/30/2001
8/20/2001
9/10/2001
10/1/2001
10/22/2001
11/12/2001
12/3/2001
12/24/2001
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


MORA 2002
Bext
90
80
70
60
50
40
30
20
10
0
1/2/2002
1/23/2002
2/13/2002
3/6/2002
3/27/2002
4/17/2002
5/8/2002
5/29/2002
6/19/2002
7/10/2002
7/31/2002
8/21/2002
9/11/2002
10/2/2002
10/23/2002
11/13/2002
12/4/2002
12/25/2002
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

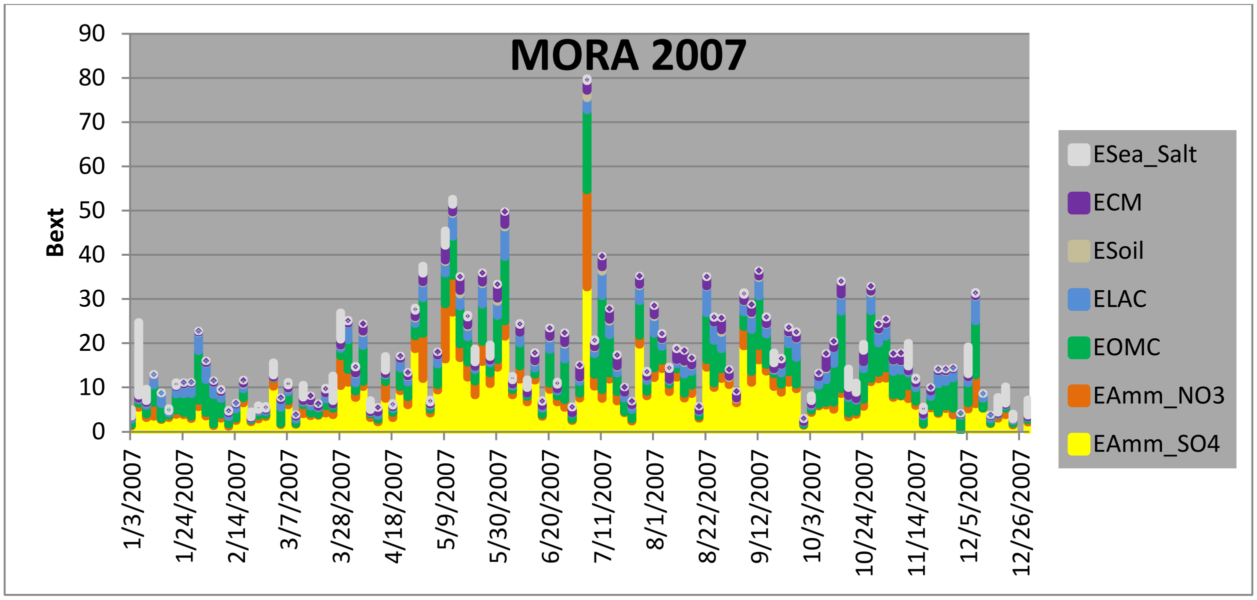

MORA 2003
Bext
100
90
80
70
60
50
40
30
20
10
0
1/3/2003
1/24/2003
2/14/2003
3/7/2003
3/28/2003
4/18/2003
5/9/2003
5/30/2003
6/20/2003
7/11/2003
8/1/2003
8/22/2003
9/12/2003
10/3/2003
10/24/2003
11/14/2003
12/5/2003
12/26/2003
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

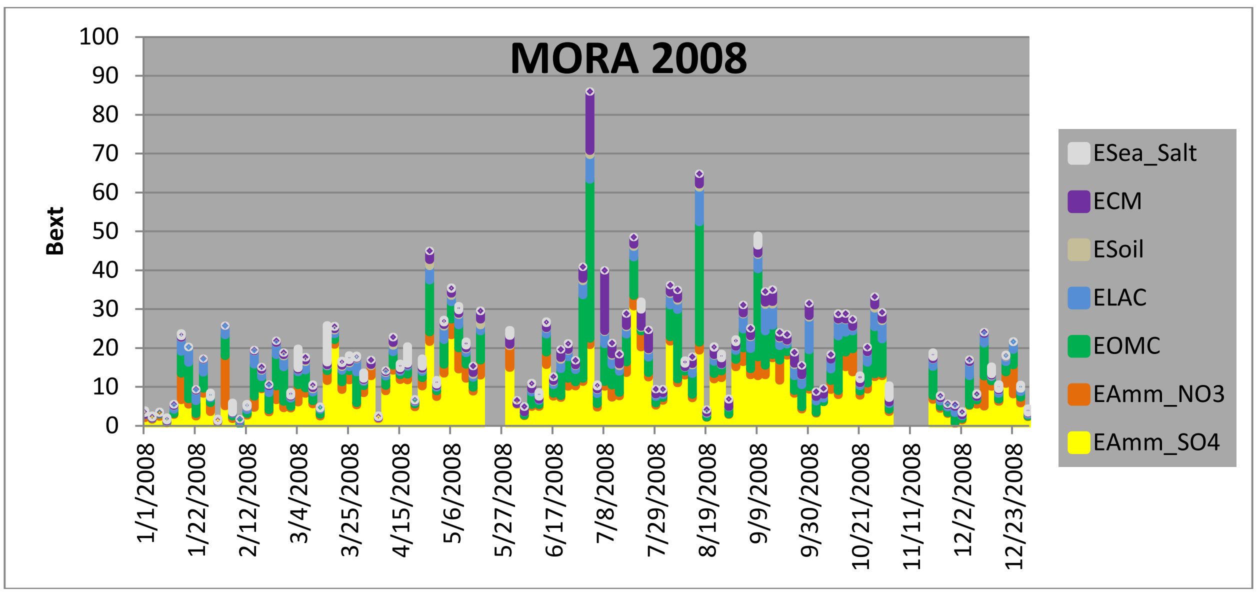

MORA 2004
Bext
120
100
80
60
40
20
0
1/1/2004
1/22/2004
2/12/2004
3/4/2004
3/25/2004
4/15/2004
5/6/2004
5/27/2004
6/17/2004
7/8/2004
7/29/2004
8/19/2004
9/9/2004
9/30/2004
10/21/2004
11/11/2004
12/2/2004
12/23/2004
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4



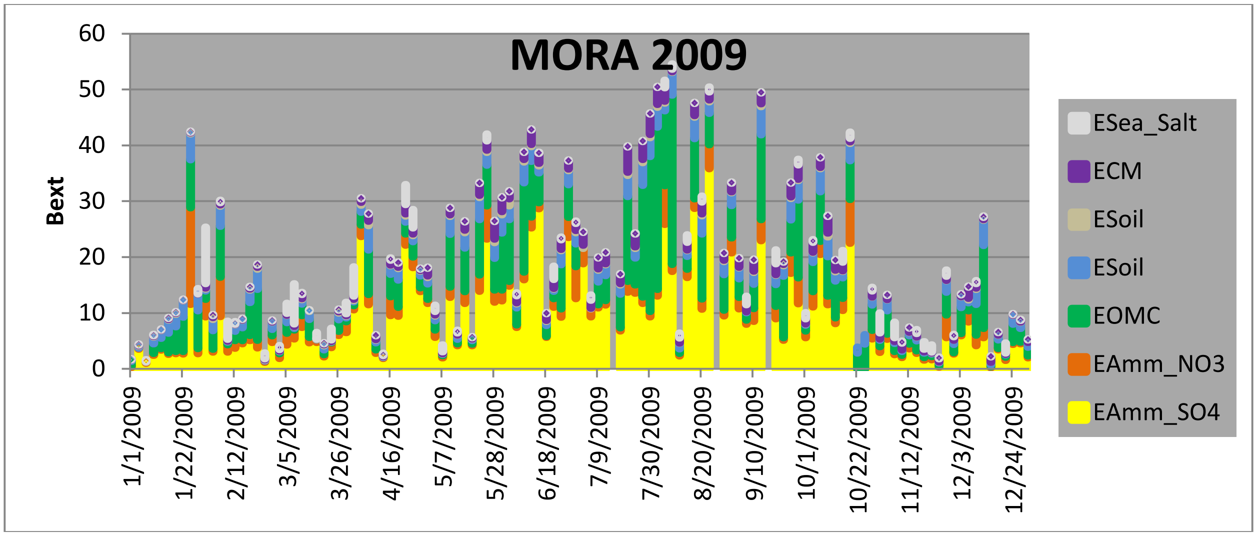

Centralia Power Plant unit BW11was off line March 6 - June 28. Unit BW22 was offline March 7 - July 1 2006



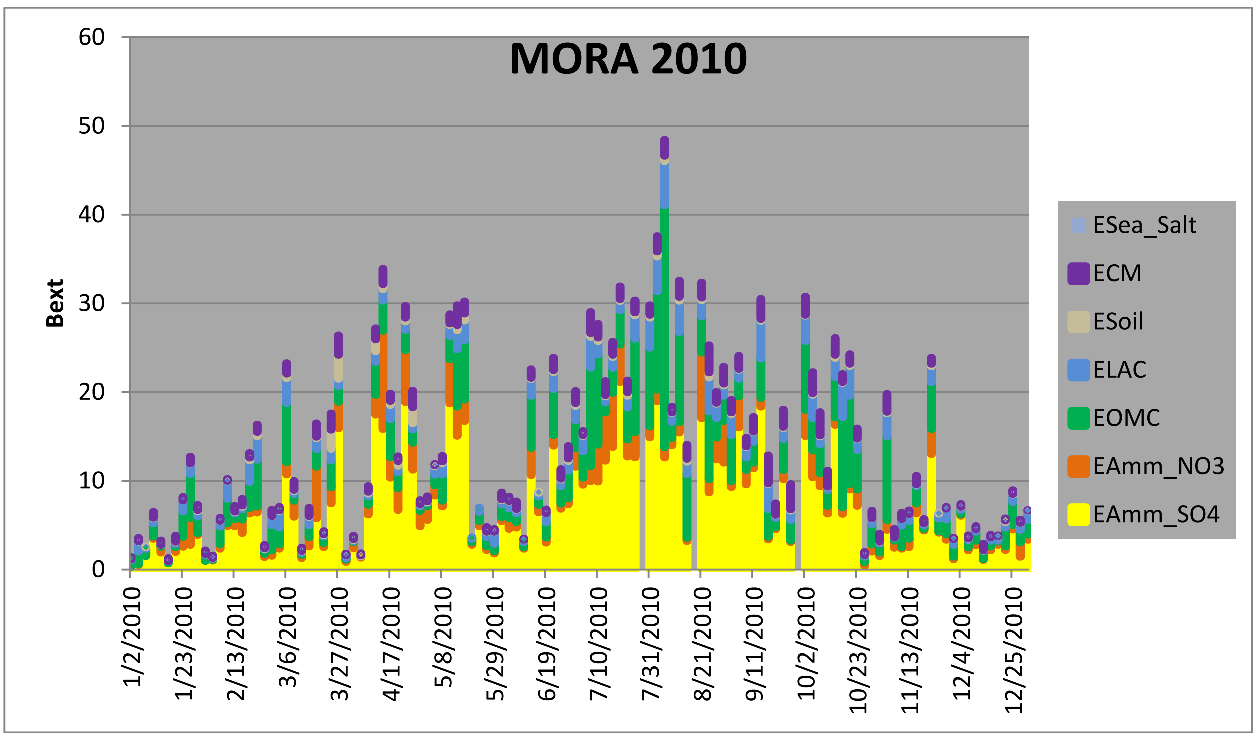




Centralia Power plant unit BW21was off line May 22 to June 18 and unit BW22 from March 3 to June 27 2008

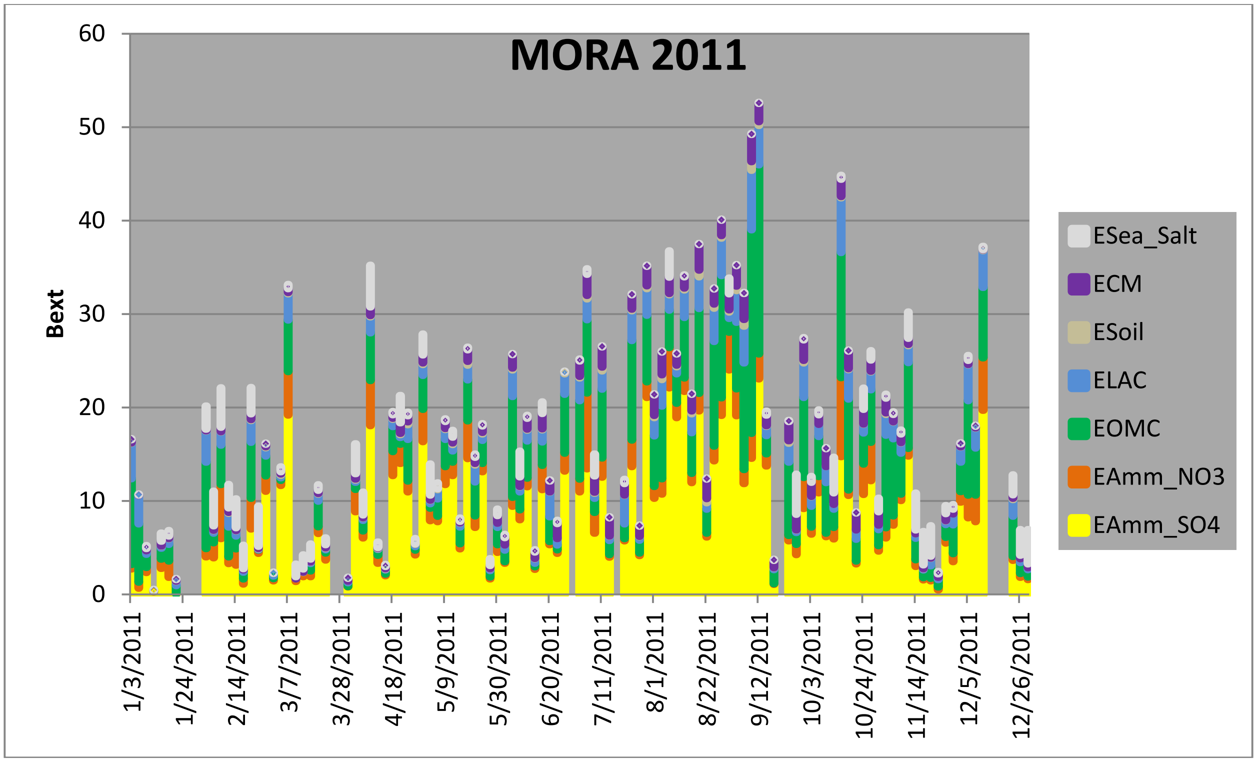
.



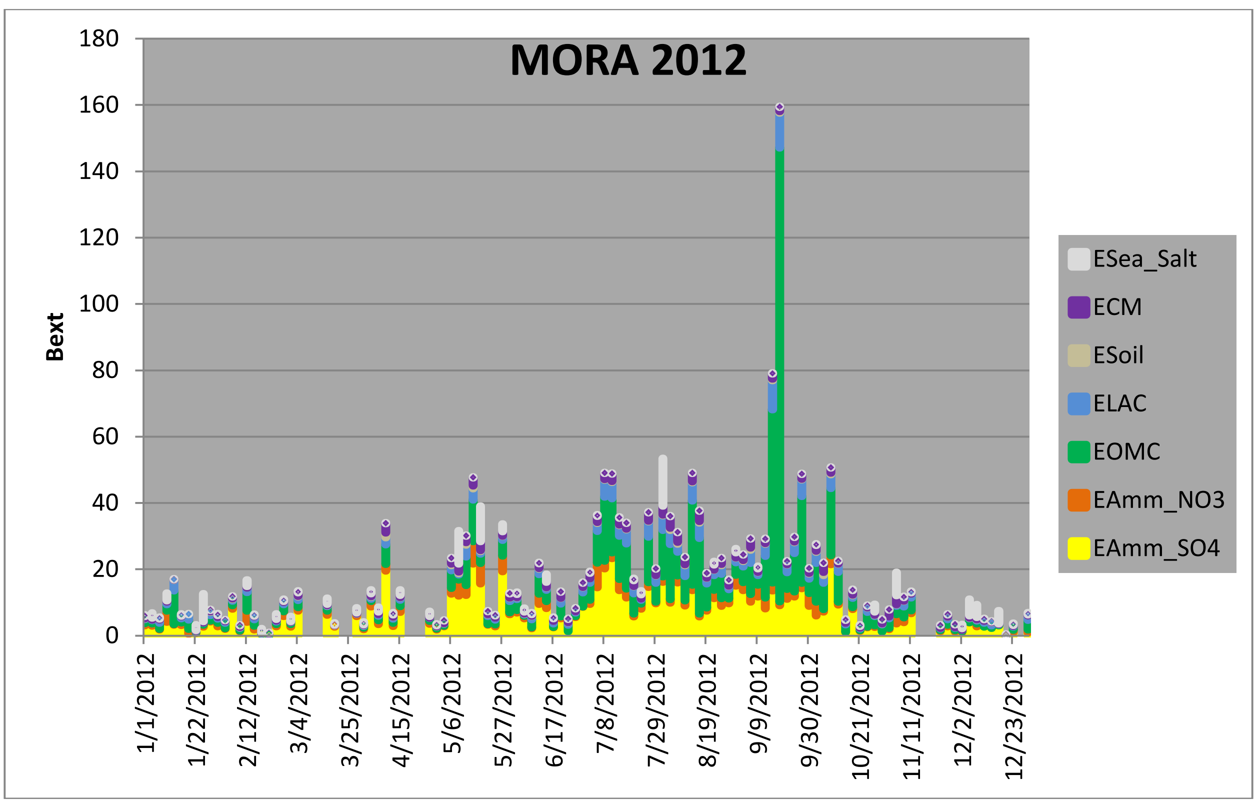

Centralia Power plant Unit BW21 was off line from April 14 to July 1 and unit BW22 was off line April 14 to June 28 2009.



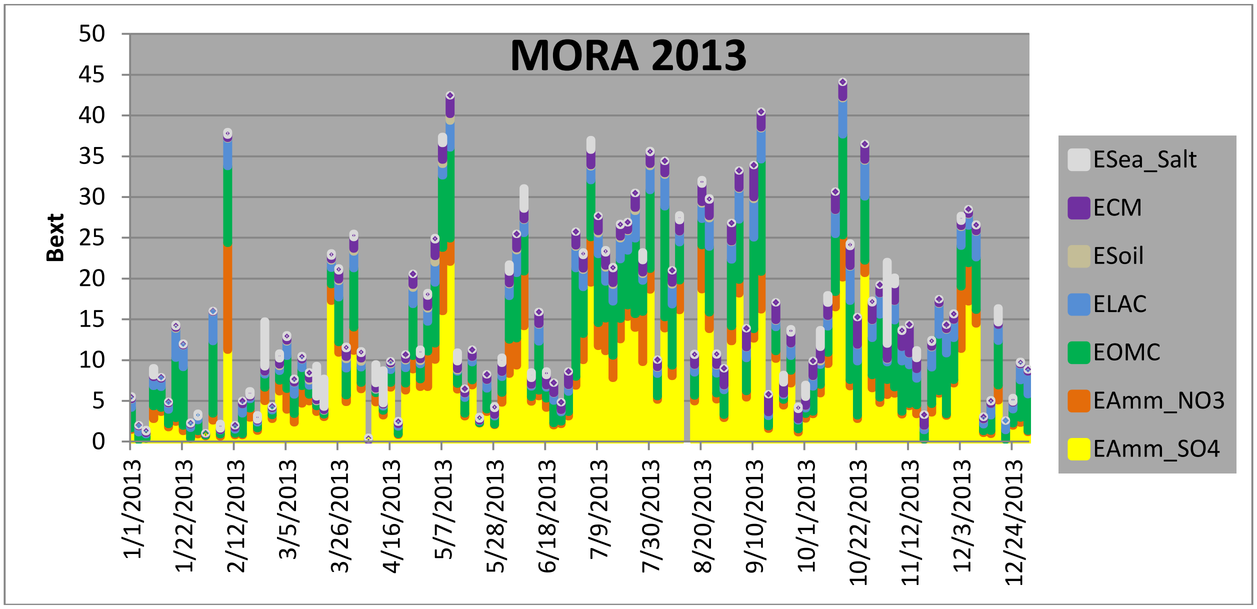

Centralia Power plant unit BW21 was off line June 8 – 28 and unit BW22 was off line April 27-July 3 2010



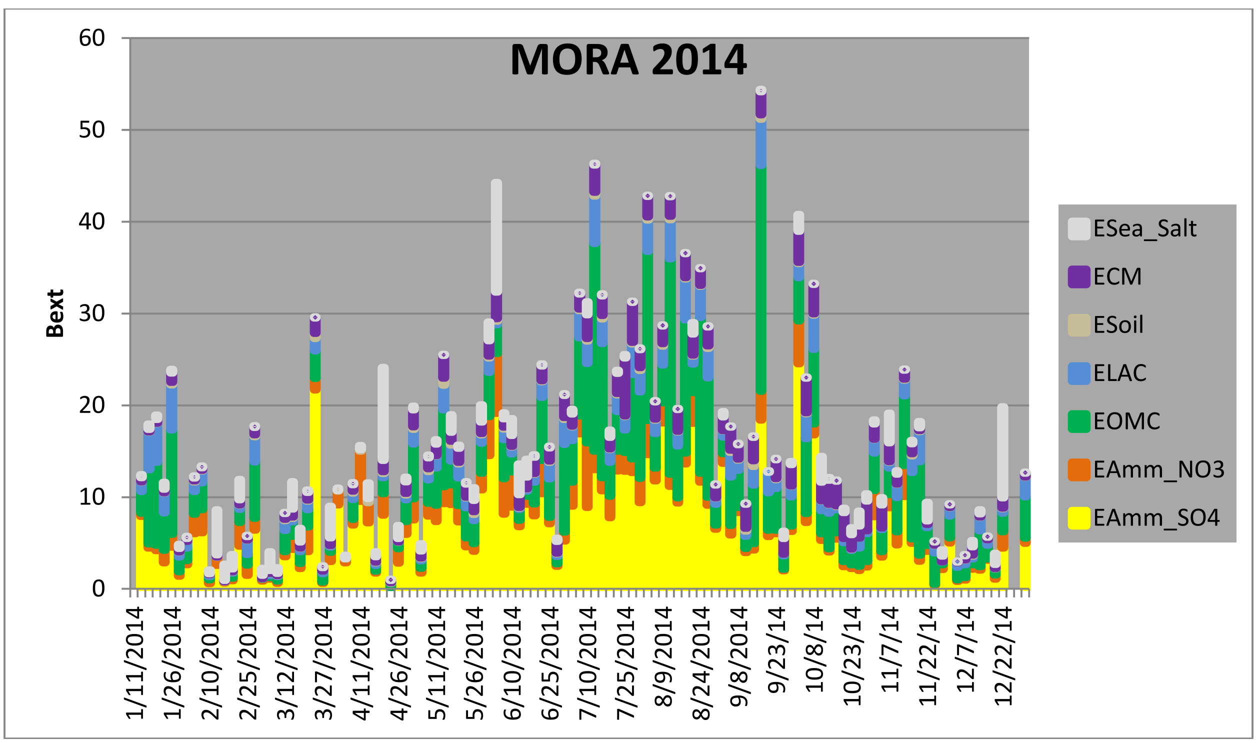

Centralia Power Plant units BW21 and 22 were offline February 4 to July 26 2011




Centralia Power Plant unit BW21 was off line January 26 to July 28 and unit BW22 was off line January 20 – August 5 2012. The extreme high values in September came from wildfires occurring east of the monitor in the Cascade Mountains. The high organic carbon value (EOMC) is indicative of wild fires. This wildfire effect can also be seen in comparing the pie charts of the composition of the visibility on the average worst day for 2011 – 2013.

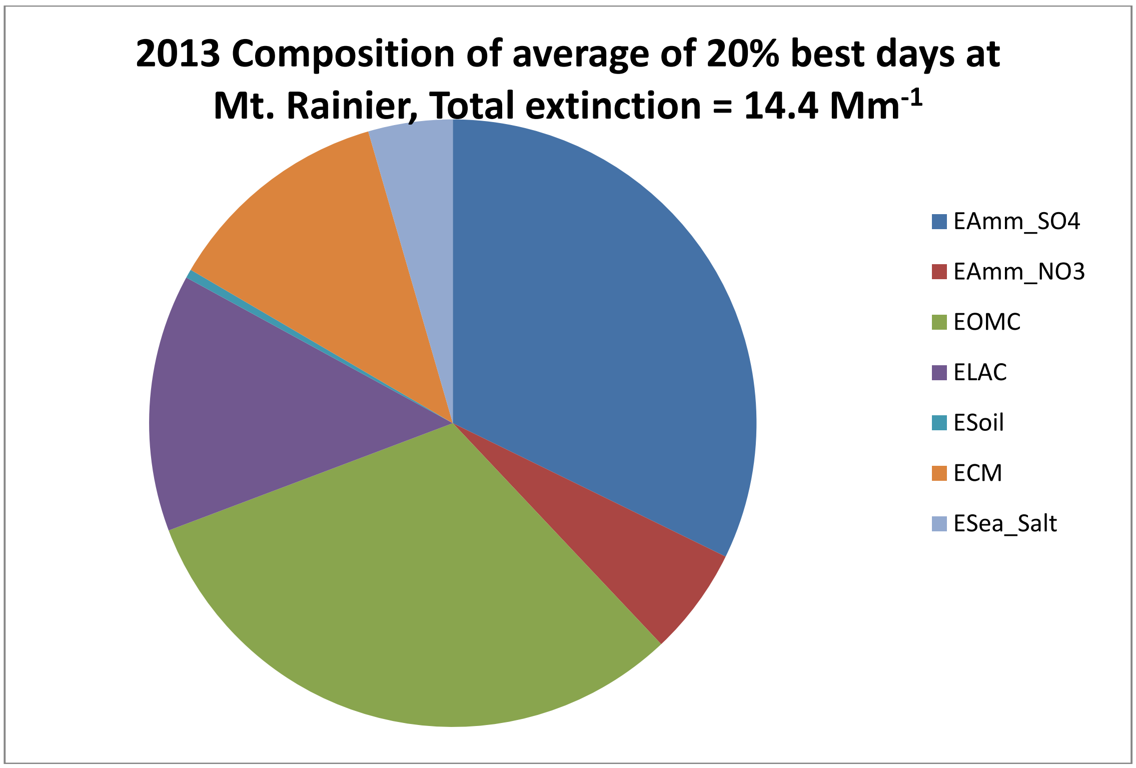


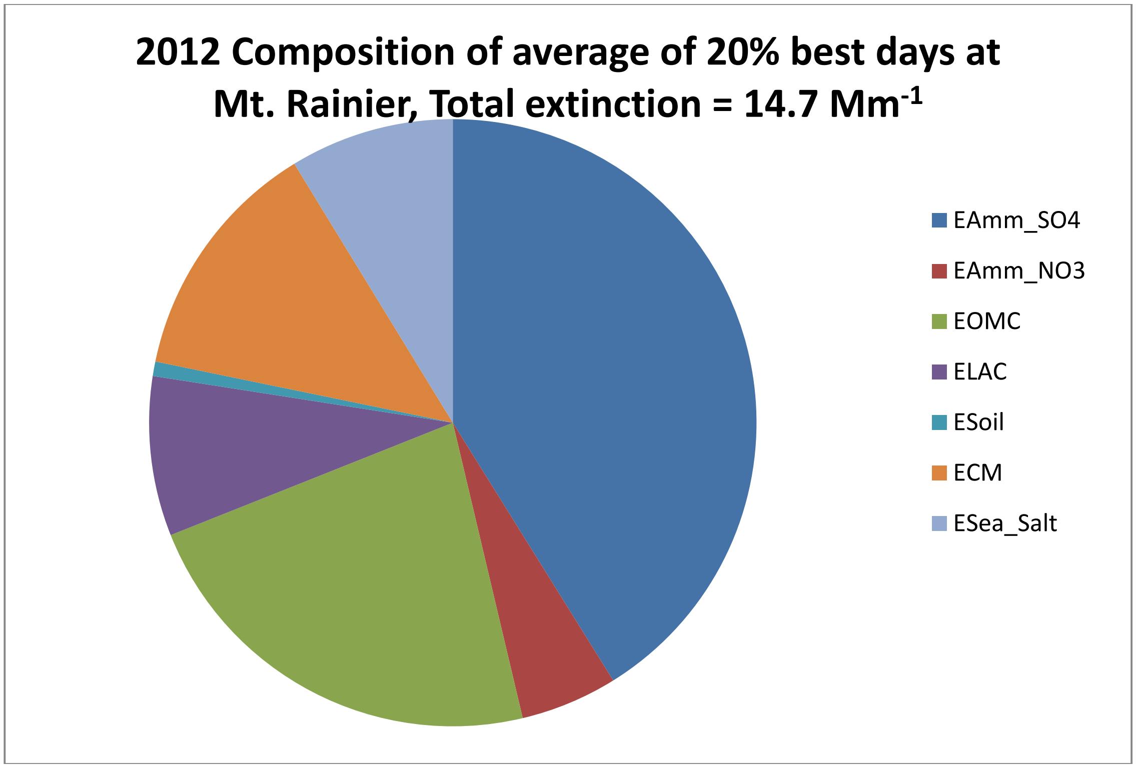

Centralia Power plant unit BW 21 was off line March 2 – June 21. Unit BW22 was off line January 28 – February 20 and March 30 to June 18 2013

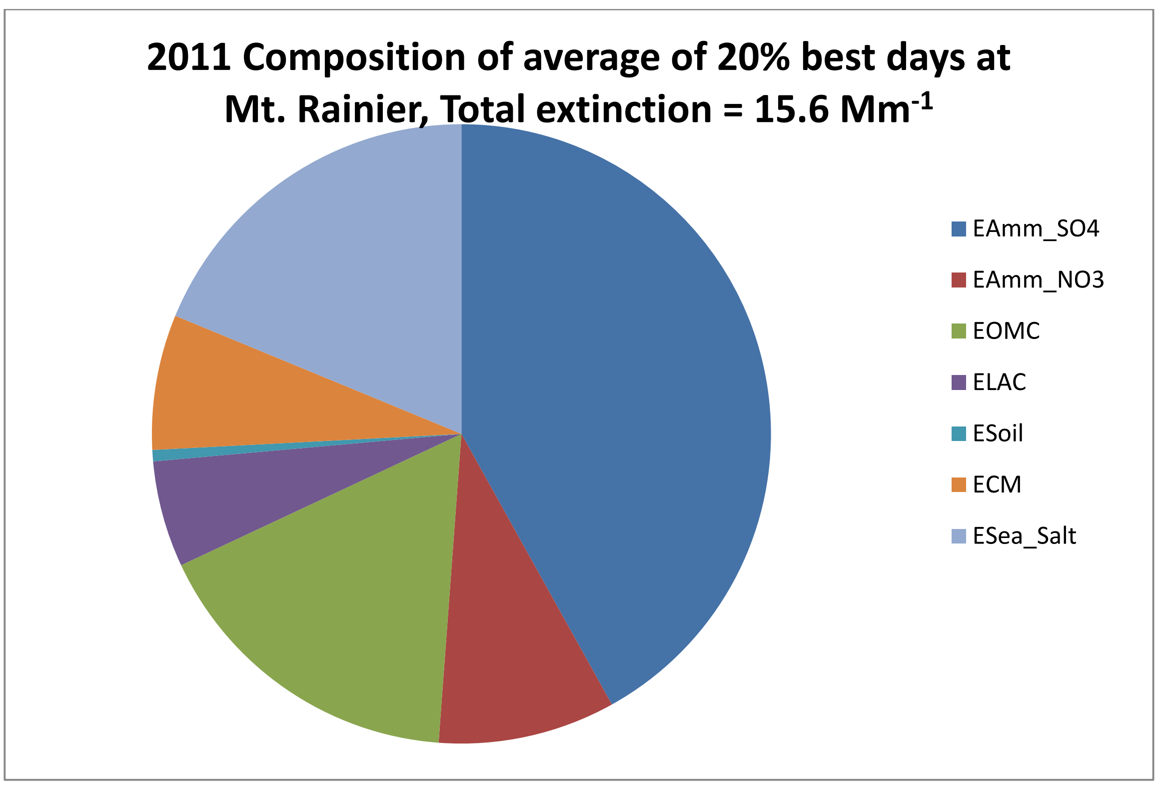


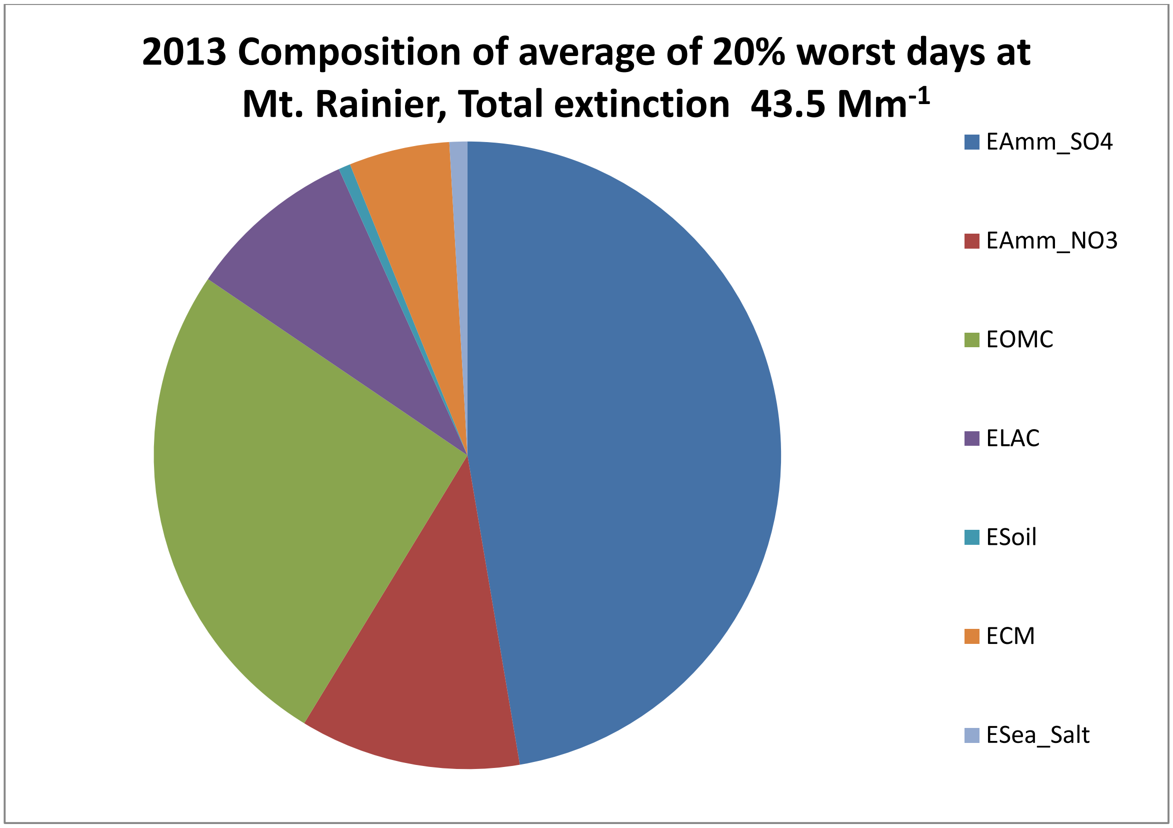

A review of monitoring over the past 10 years indicates that the high sulfate based visibility on March 24, 2014 and October 2, 2014 are not unusual. Since 2002 when wet scrubbers began operation on all of the Centralia Power plant emissions, there have been several worst days caused primarily by sulfate. While current emissions from the Centralia power plant are quite low, March 23 and 24, 2014 the plant operating emitted 5.5 tons of $SO_2$ and 1.3 tons$SO_2$/day, respectively. However, similar to most years, organic carbon from wild or prescribed fires cause most of the worst visibility days.

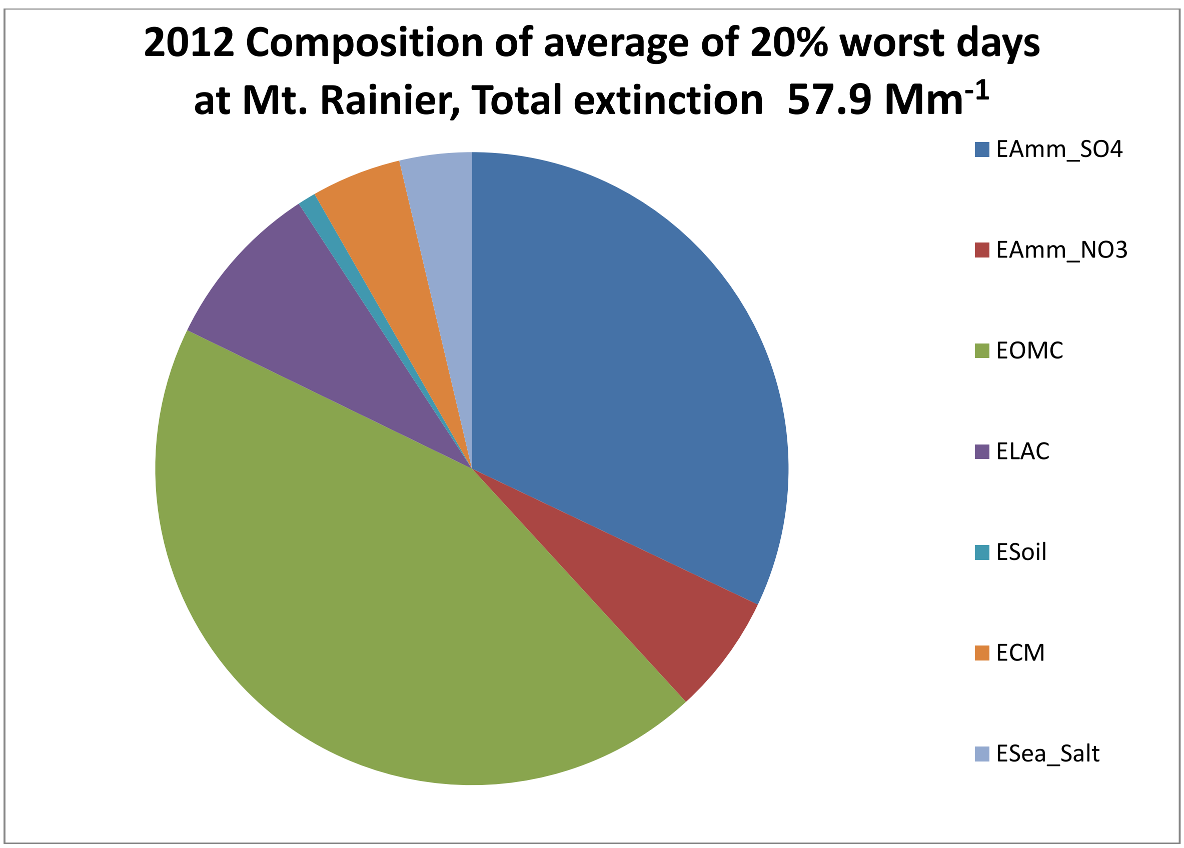
The following pie charts compare the average relative visibility impairment by the primary species in Calendar years 2011 – 2013. The charts show the relative composition on the average of the 20% best and worst days Note how the visibility impairment on both the best and worst days in 2011 and 2013 were dominated by sulfates. Meanwhile in 2012 the monitor was affected by wildfires in 2012.

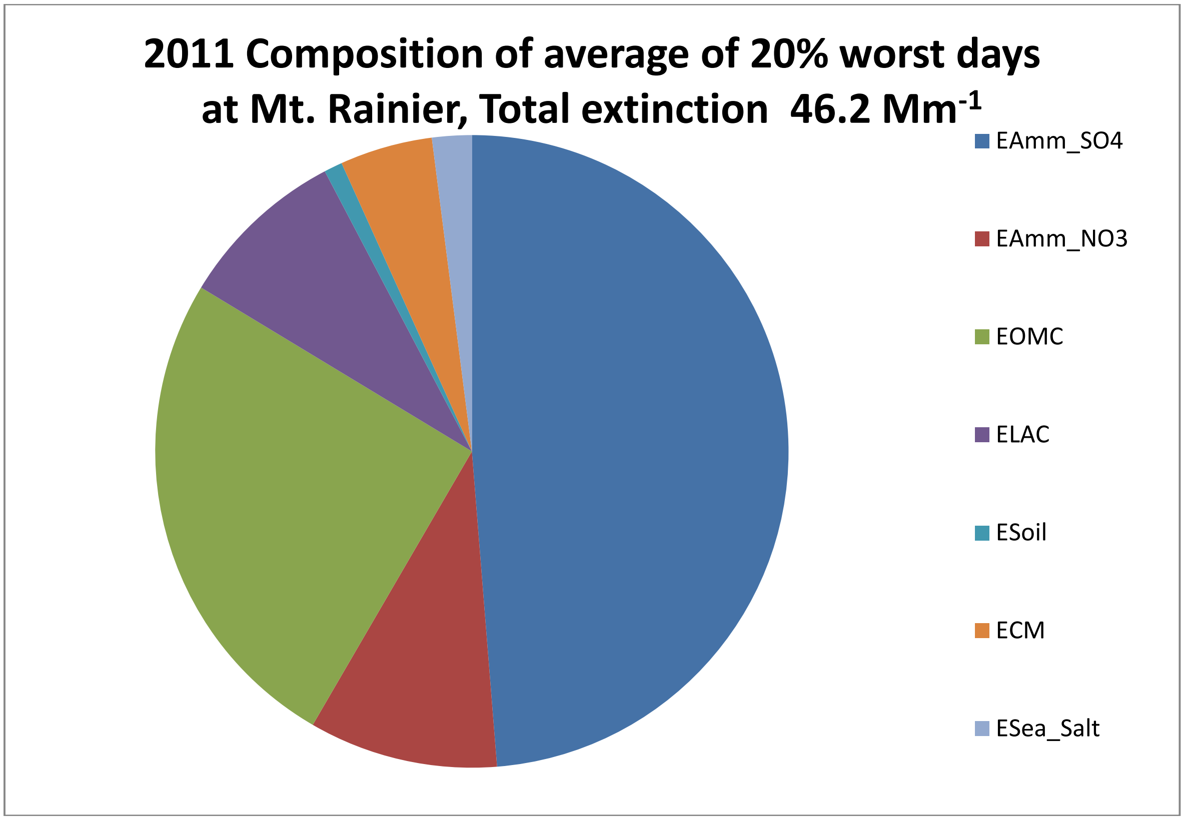



2012 Composition of average of 20% best days at Mt. Rainier, Total extinction = 14.7 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt

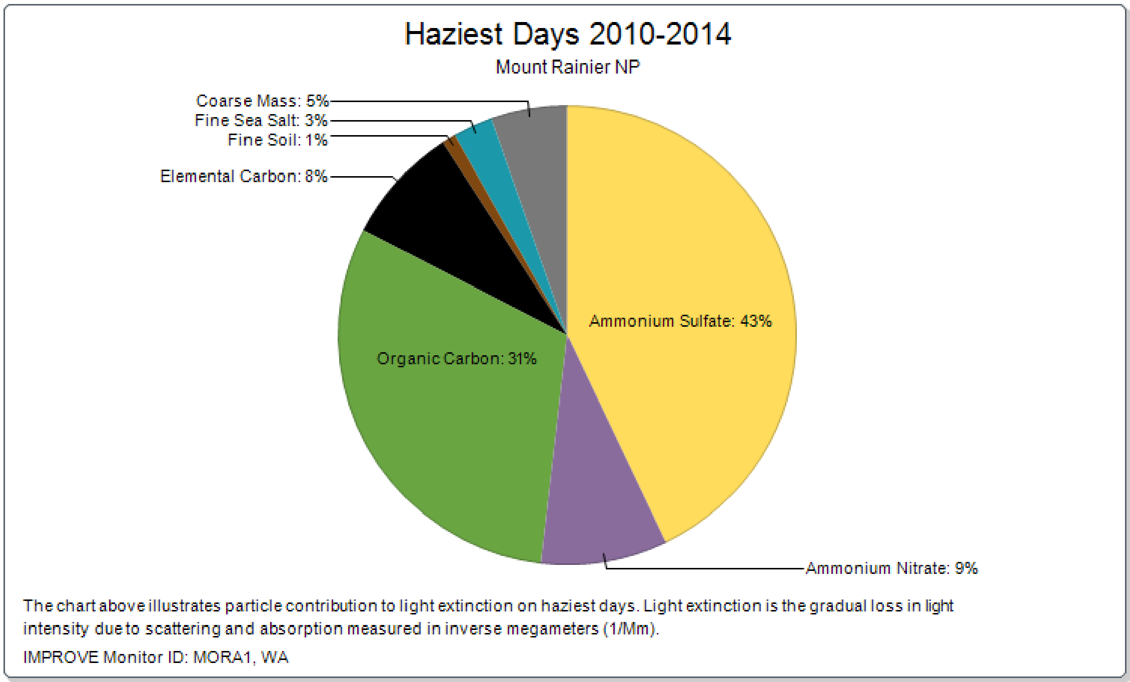

2011 Composition of average of 20% best days at Mt. Rainier, Total extinction = 15.6 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt

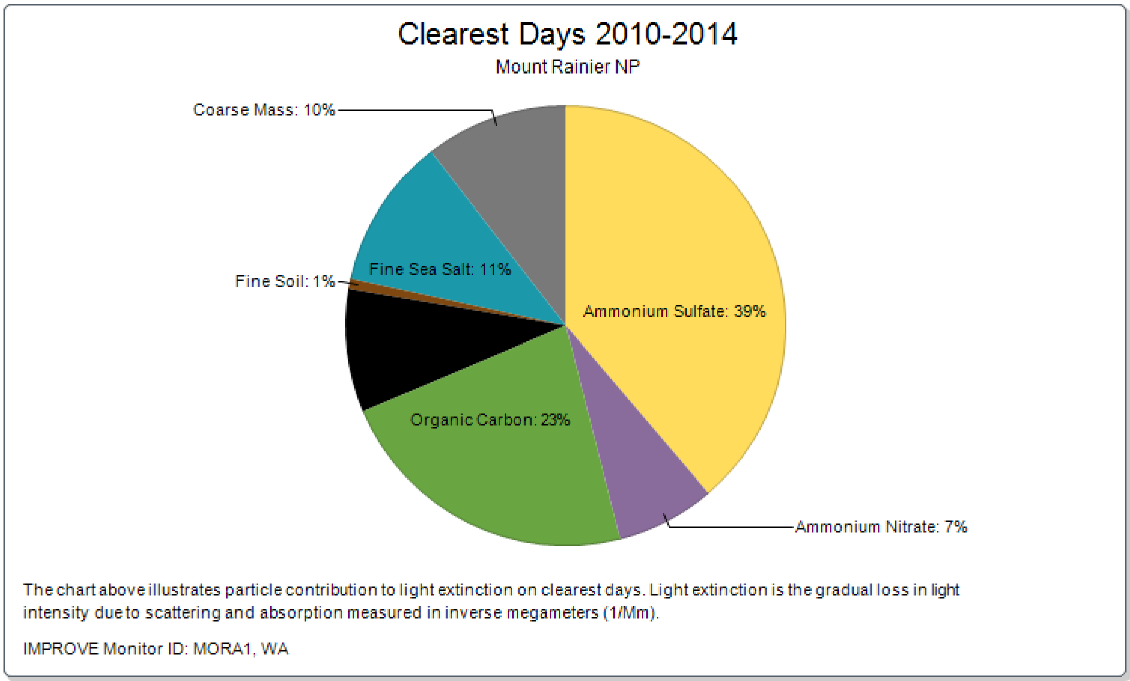

2013 Composition of average of 20% worst days at Mt. Rainier, Total extinction 43.5 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt


2012 Composition of average of 20% worst days at Mt. Rainier, Total extinction 57.9 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt


2011 Composition of average of 20% worst days
at Mt. Rainier, Total extinction 46.2 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt

The following graphs produced by WRAP software show the 5 year average composition of the measured haze-causing pollutants on the worst 20% (haziest) and best 20% (clearest) days.. For the 5 year period at this monitor, sulfate makes up the dominant portion of visibility impairment on both the best and worst days. While the annual average best and worst days composition of the haze –causing pollutants varies, the 5 year average shows that ammonium sulfate and organic carbon make up about 75% of the averaging worst days impairment. This contrasts to the best days where ammonium sulfate is the primary visibility impairing component.



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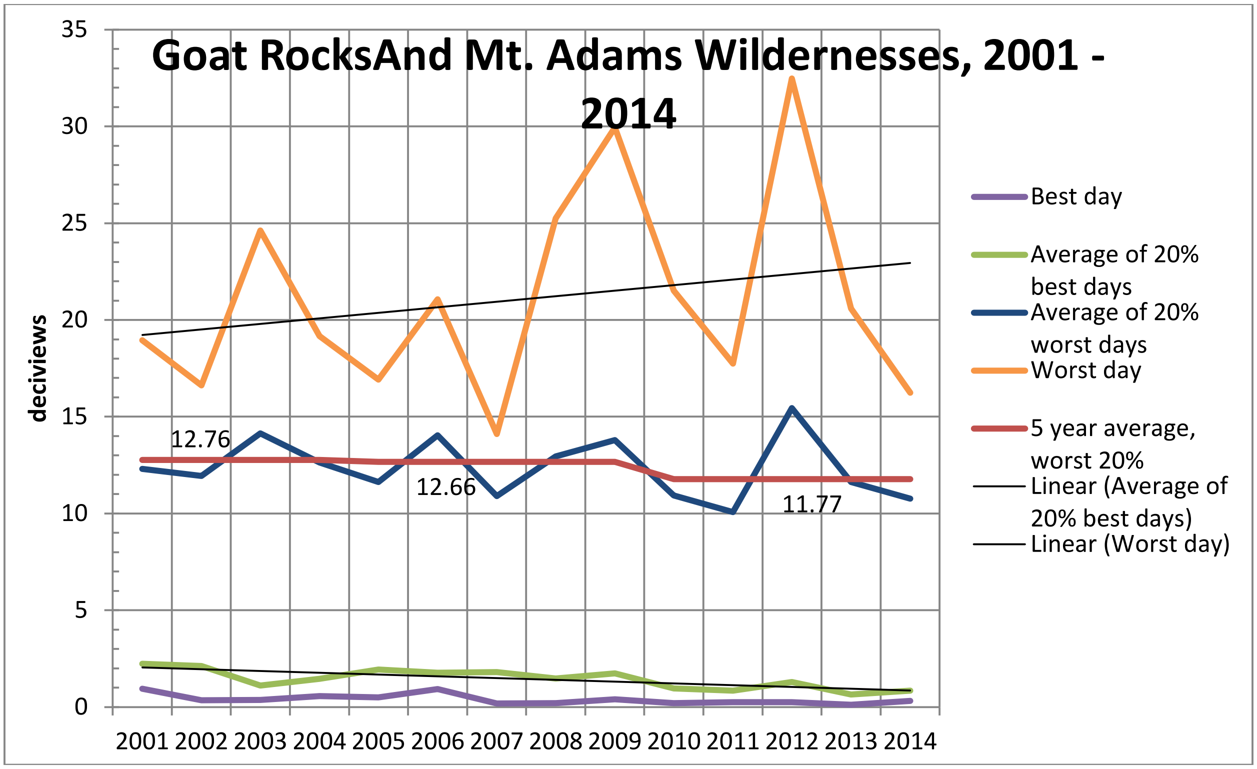
White Pass IMPROVE monitor visibility trends




The Goad Rocks Wilderness and Mt. Adams Wilderness is represented by the WHPA1 IMPROVE monitor site.

The projected 2018 reasonable progress goal for the 20% worst days is 11.79 dv and the uniform glide path[1] value for 2018 was 11.73 dv. The calculated 2064 natural condition value for the average of the 20% worst days for this monitor is 8.35 dv.

The average visibility on the 20% worst days for 2010 – 2014 period was 11.77 dv. This is better than the 2018 reasonable progress goal, however, due to wildfires in 2012, progress is less than expected from looking at anthropogenic source emissions alone. As discussed below, there was almost a month in 2012 that was impacted by wildfires. The organic carbon from the wildfires induced visibility impairment and is a major contributor to the low rate of visibility improvement on the 20% worst days and a trend of increasing visibility impairment on the maximum worst days at this site.

The average visibility during the best 20% days over the most recent 5 years is 0.92 dv.

The graph at the top of this page depicts the visibility trends for this monitor since 2001. Even though the absolute worst day of each year shows significant year to year variability and the

[1] The uniform glide path value is the starting place to develop a Reasonable Progress Goal. The uniform rate of progress represents the linear rate of visibility improvement required to meet the 2064 visibility goal in 2064.

average of the worst 20% days each year varies between years, the 5 year average of the 20% worst days has continued a long term trend of visibility improvement. On the best days, the visibility trend shows steady improvement in visibility.

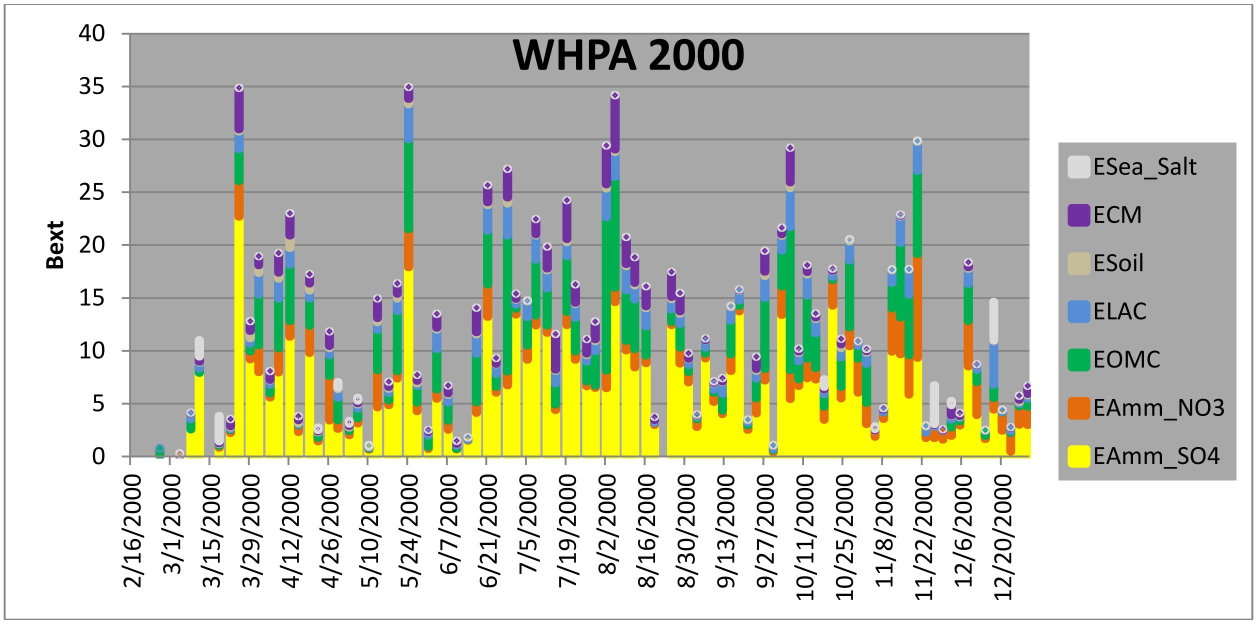
This monitor is the highest elevation of all IMPROVE monitors in Washington. While it is near to the Mt. Rainier monitor, the approximately 3,000 ft differences in elevation mean that they are sampling very different air. This is most easily seen when comparing the dv values for the very cleanest days.

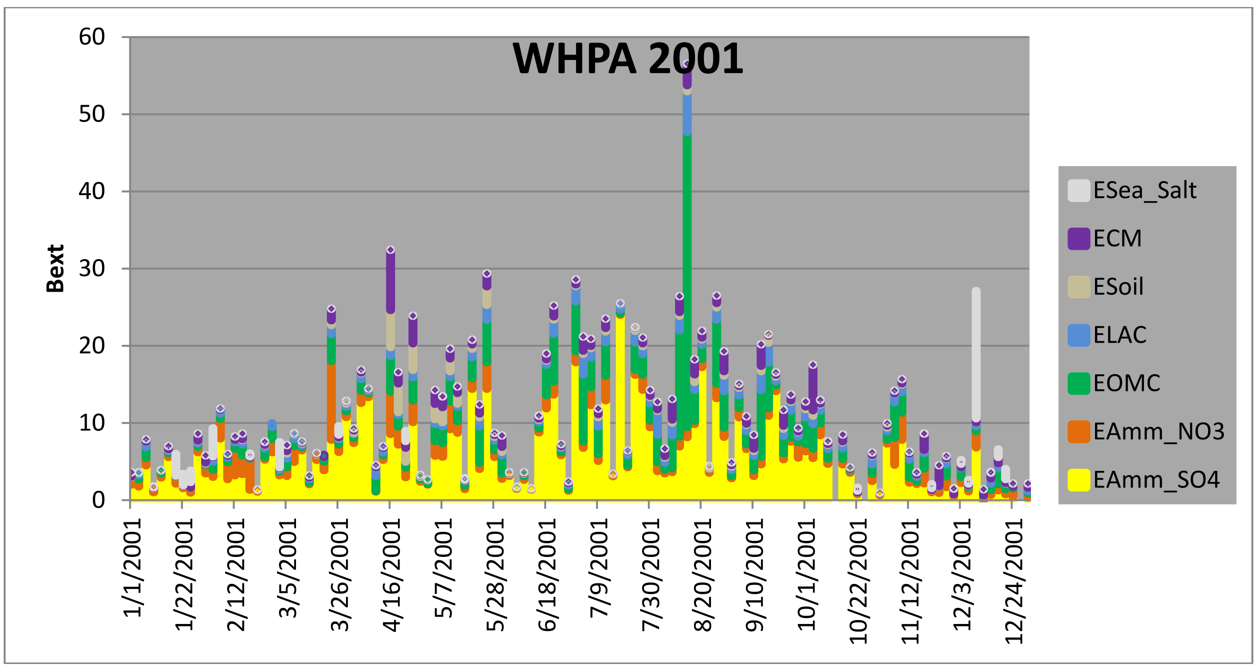
In spite of its elevation, this monitor is susceptible to impacts from wild and prescribed fires. The impacts from wildfires in 2012 have worked to adversely impact progress toward achieving the 2018 reasonable progress goal.

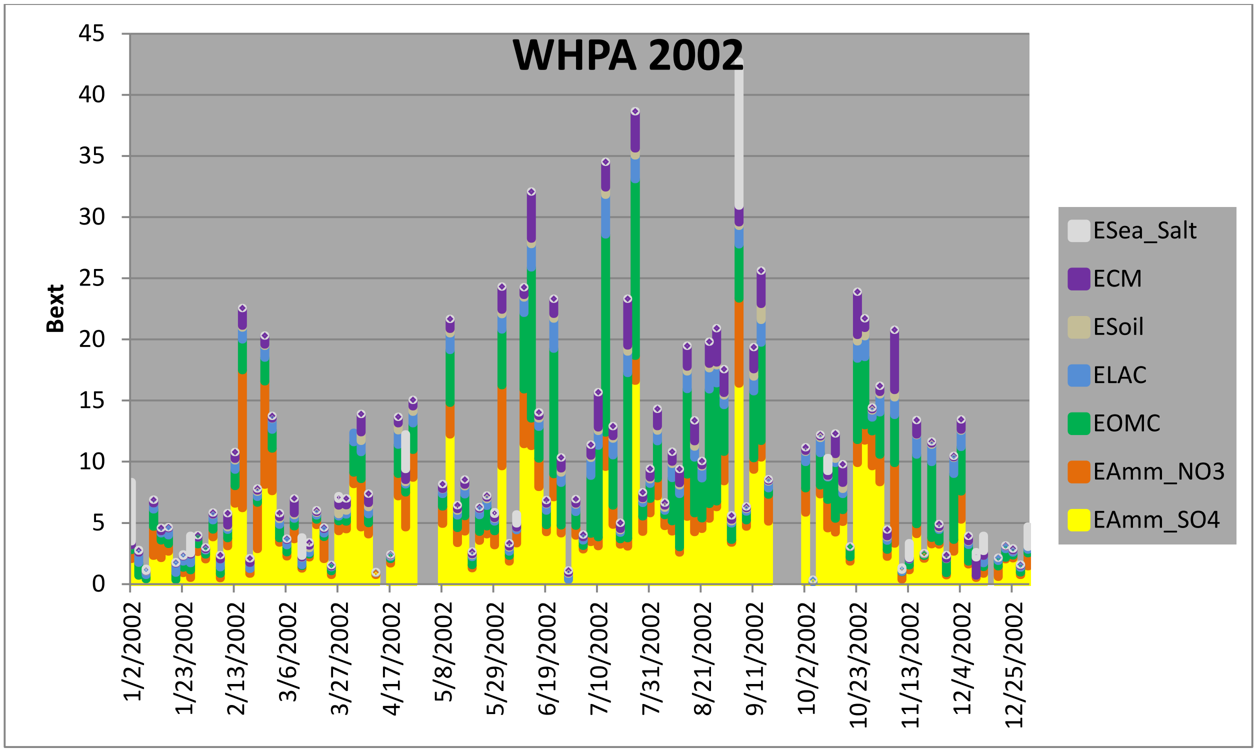
The wildfire event in September of 2012 resulted in 5 of 6 continuous monitored days (Sept, 12, 15, 18, 21, 24, and 27) with significant impairment caused by organic carbon. On 3 of these days of monitoring the organic carbon caused impairment to exceed 150 $Mm^{-1}$ (27.2 dv) of impairment, with the highest day at 257 $Mm^{-1}$ (32.5 dv) of impairment. On the highest 5 days of this period, the contribution from organic carbon was approximately 80%. All 6 days in this event are part of the worst 20% average for the year.

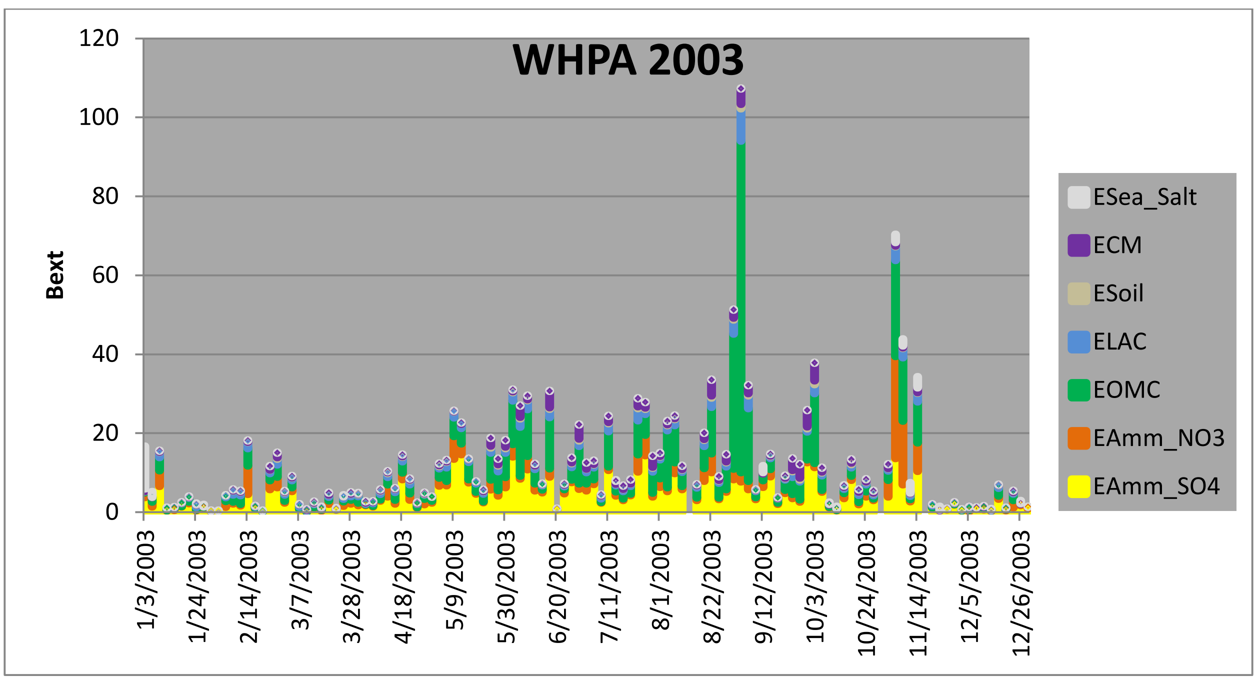
The other years that make up the 2010-20014 5 year average all have one or two days each year where organic carbon is the primary contributor to the 20% worst days average. For example September 9 and 12 of 2011 have organic carbon making up approximately two thirds of the total impairment on those days compared to one fifth on the 3rd worst day of the year. The total impairment on these days was respectively 35 $Mm^{-1}$ (15.0 dv) and 49 $Mm^{-1}$(17.7 dv). This same situation occurs on August 6, 2010 (worst day that year with 76 $Mm^{-1}$ (21.5 dv) of impairment) and July 30, 2013 (worst day that year with 38 $Mm^{-1}$ (20.6) of impairment.

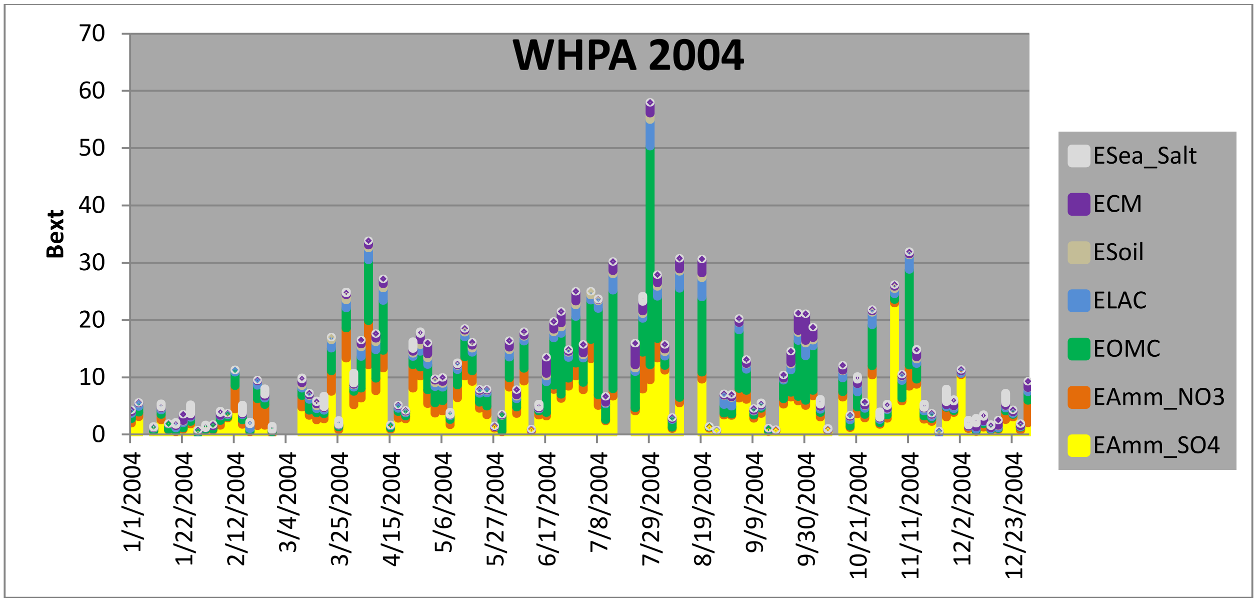
The following are graphs of the reconstructed light extinction ($B_{ext}$) for each year during the 2001 – 2014 period. The values show the relative contribution of the chemical types incorporated into the revised IMPROVE light extinction calculation. NOTE each graph has a different maximum value.


WHPA 2000
Bext
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


WHPA 2001
Bext
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


WHPA 2002
Bext
45
40
35
30
25
20
15
10
5
0
1/2/2002
1/23/2002
2/13/2002
3/6/2002
3/27/2002
4/17/2002
5/8/2002
5/29/2002
6/19/2002
7/10/2002
7/31/2002
8/21/2002
9/11/2002
10/2/2002
10/23/2002
11/13/2002
12/4/2002
12/25/2002
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


WHPA 2003
Bext
120
100
80
60
40
20
0
1/3/2003
1/24/2003
2/14/2003
3/7/2003
3/28/2003
4/18/2003
5/9/2003
5/30/2003
6/20/2003
7/11/2003
8/1/2003
8/22/2003
9/12/2003
10/3/2003
10/24/2003
11/14/2003
12/5/2003
12/26/2003
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


WHPA 2004
Bext
70
60
50
40
30
20
10
0
1/1/2004
1/22/2004
2/12/2004
3/4/2004
3/25/2004
4/15/2004
5/6/2004
5/27/2004
6/17/2004
7/8/2004
7/29/2004
8/19/2004
9/9/2004
9/30/2004
10/21/2004
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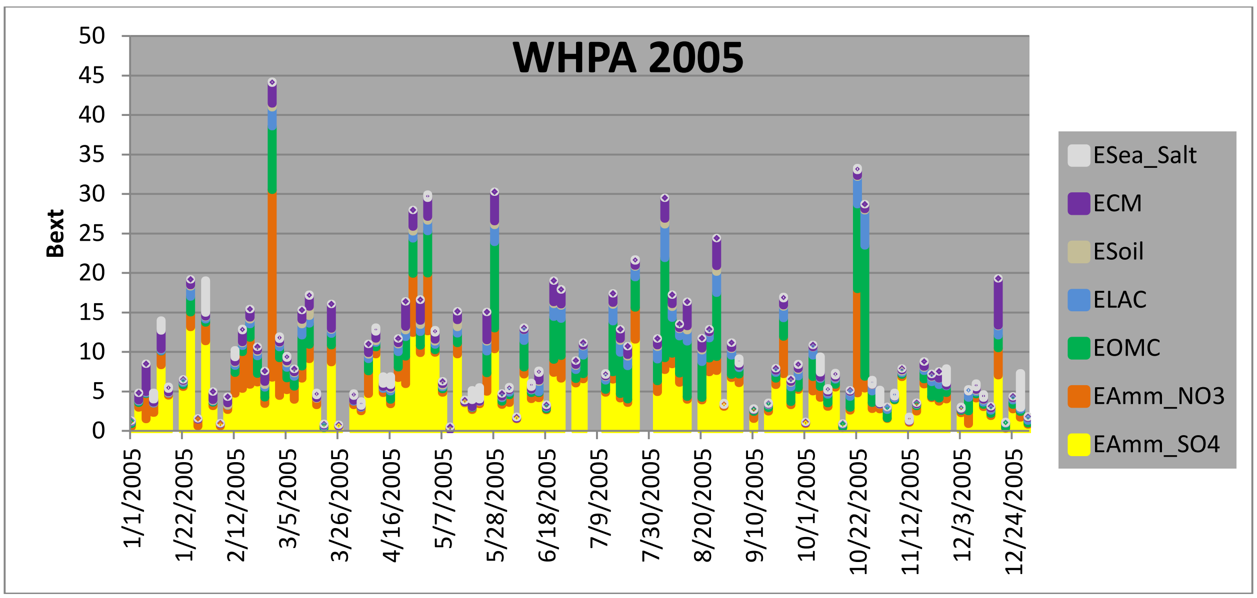
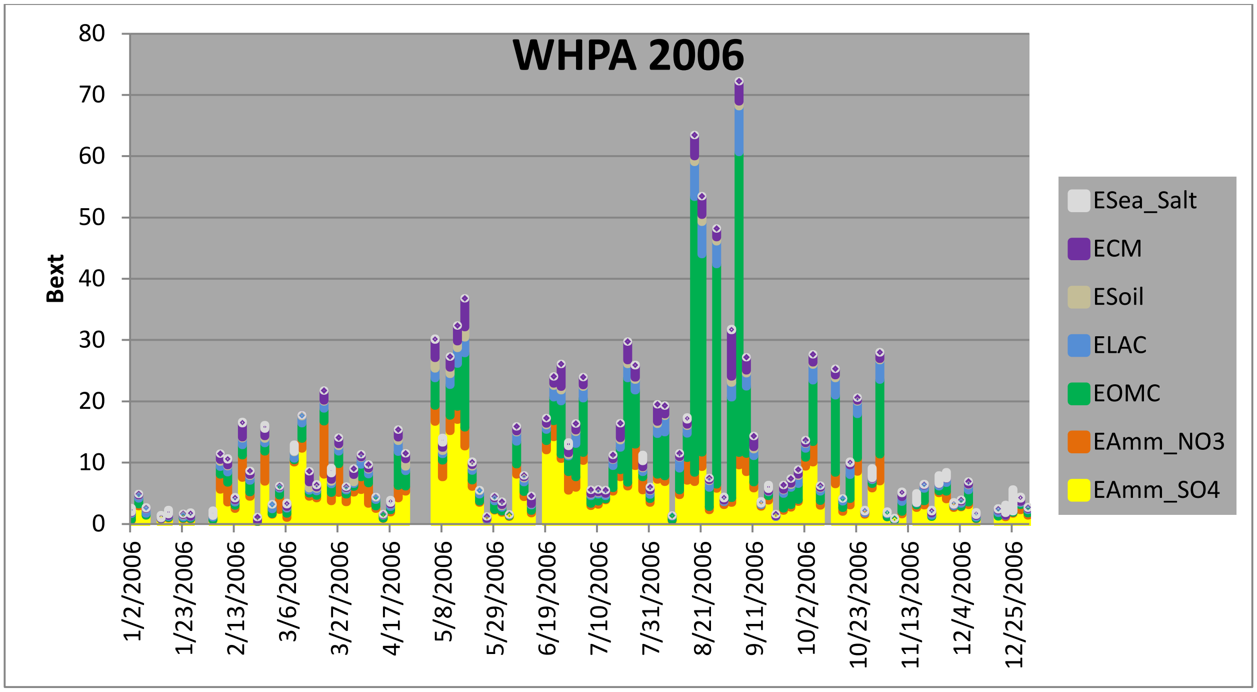
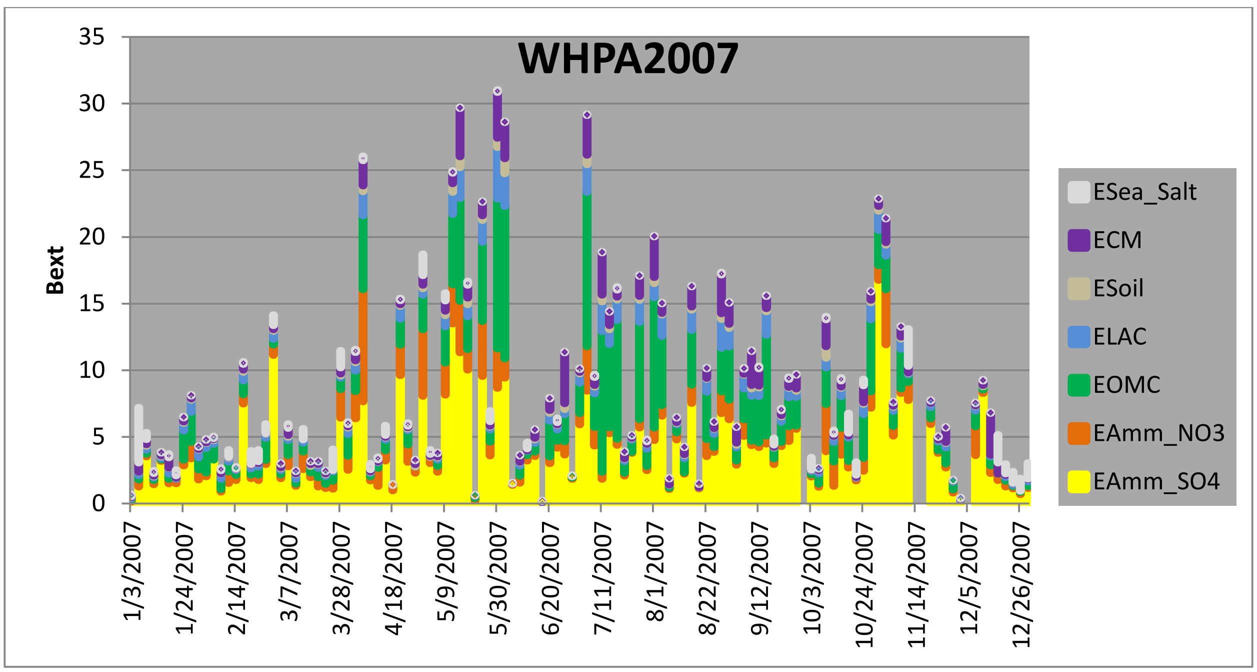
EAmm_NO3
EAmm_SO4


WHPA 2005
Bext
50
45
40
35
30
25
20
15
10
5
0
1/1/2005
1/22/2005
2/12/2005
3/5/2005
3/26/2005
4/16/2005
5/7/2005
5/28/2005
6/18/2005
7/9/2005
7/30/2005
8/20/2005
9/10/2005
10/1/2005
10/22/2005
11/12/2005
12/3/2005
12/24/2005
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


WHPA 2006
Bext
80
70
60
50
40
30
20
10
0
1/2/2006
1/23/2006
2/13/2006
3/6/2006
3/27/2006
4/17/2006
5/8/2006
5/29/2006
6/19/2006
7/10/2006
7/31/2006
8/21/2006
9/11/2006
10/2/2006
10/23/2006
11/13/2006
12/4/2006
12/25/2006
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4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Bext
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6/20/2007
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8/22/2007
9/12/2007
10/3/2007
10/24/2007
11/14/2007
12/5/2007
12/26/2007
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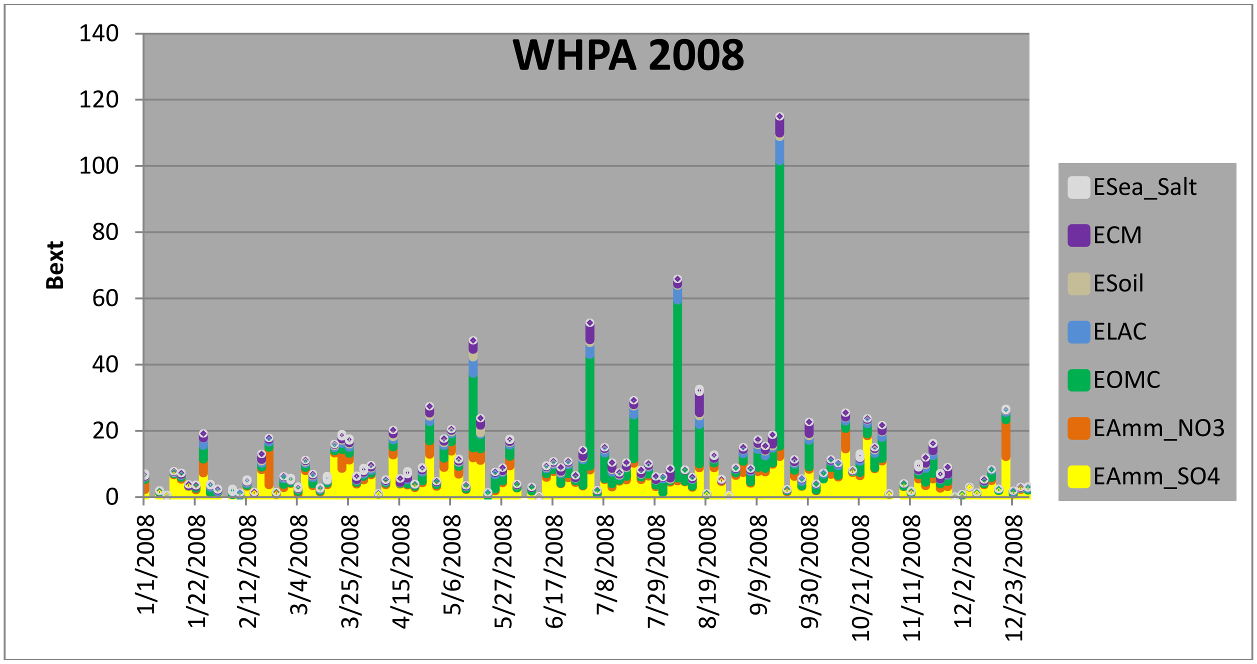
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4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5/27/2008
6/17/2008
7/8/2008
7/29/2008
8/19/2008
9/9/2008
9/30/2008
10/21/2008
11/11/2008
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12/23/2008
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ECM
ESoil
ELAC
EOMC
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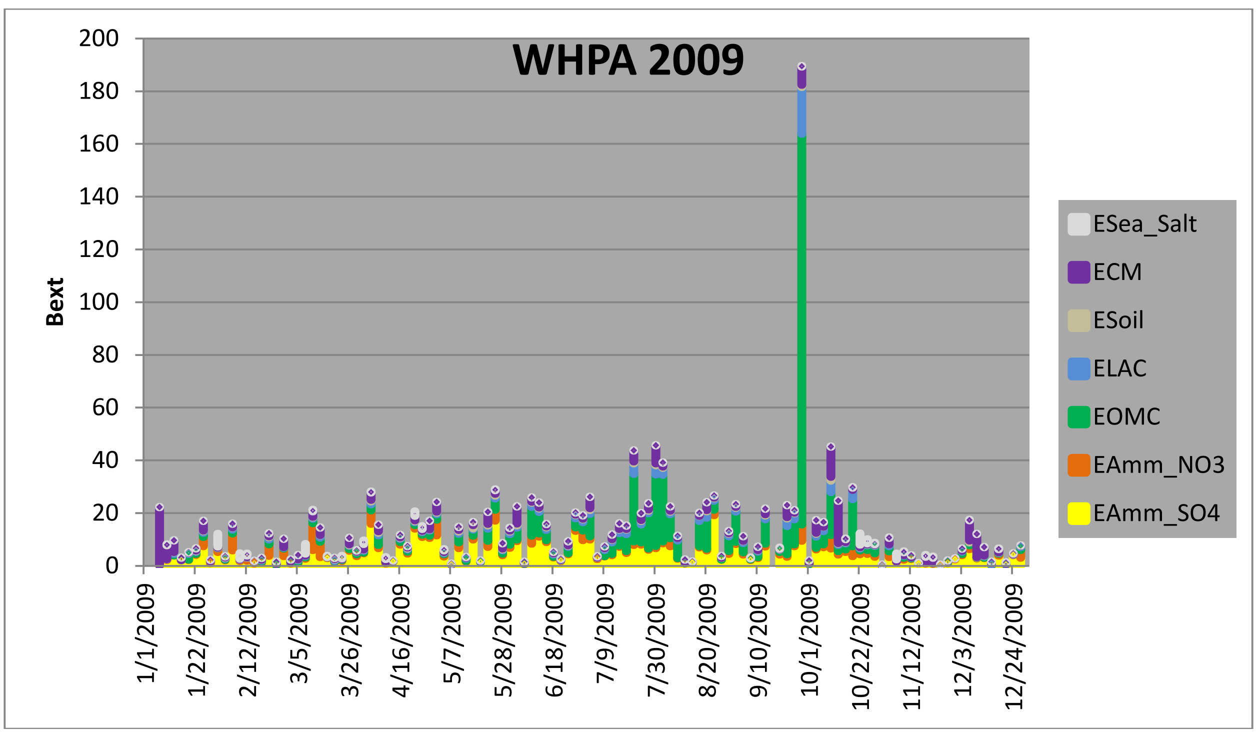
EAmm_SO4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9/10/2009
10/1/2009
10/22/2009
11/12/2009
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12/24/2009
ESea_Salt
ECM
ESoil
ELAC
EOMC
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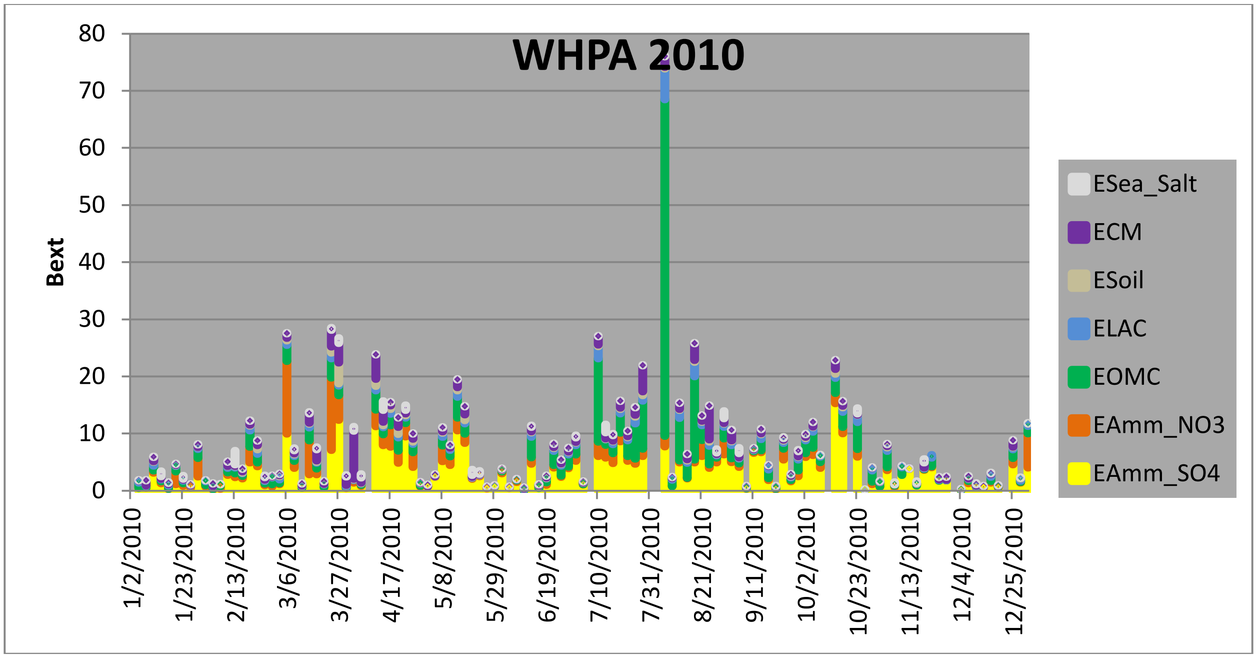
EAmm_SO4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10/2/2010
10/23/2010
11/13/2010
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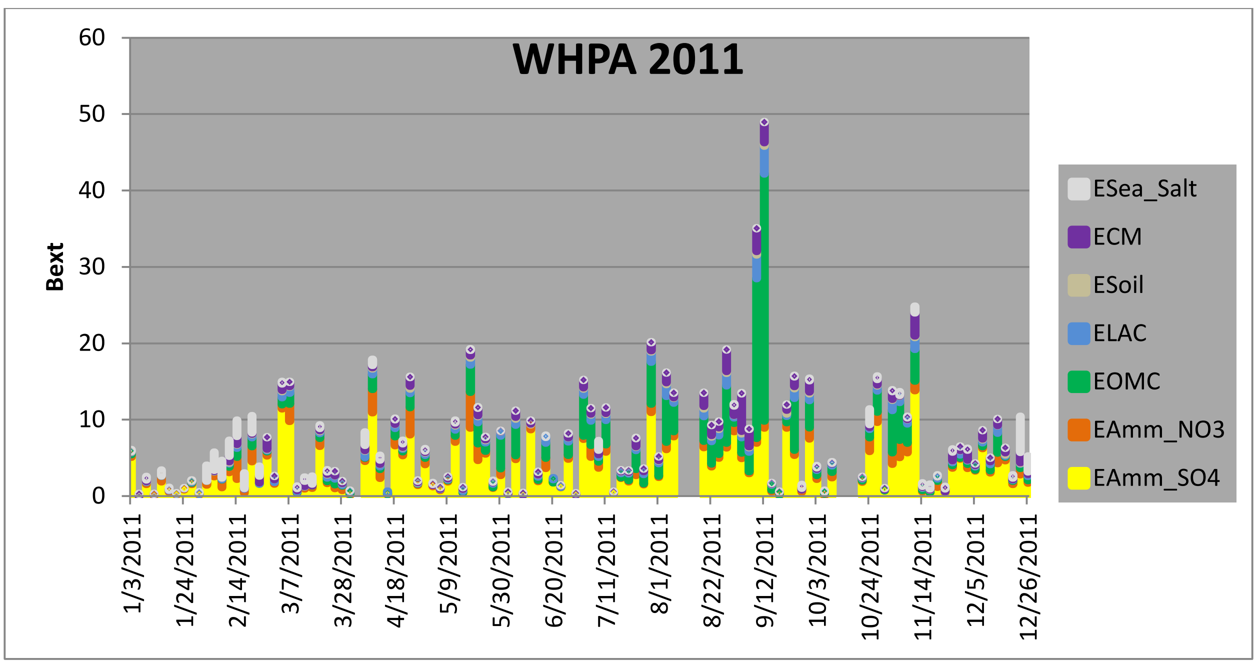
12/25/2010
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4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9/12/2011
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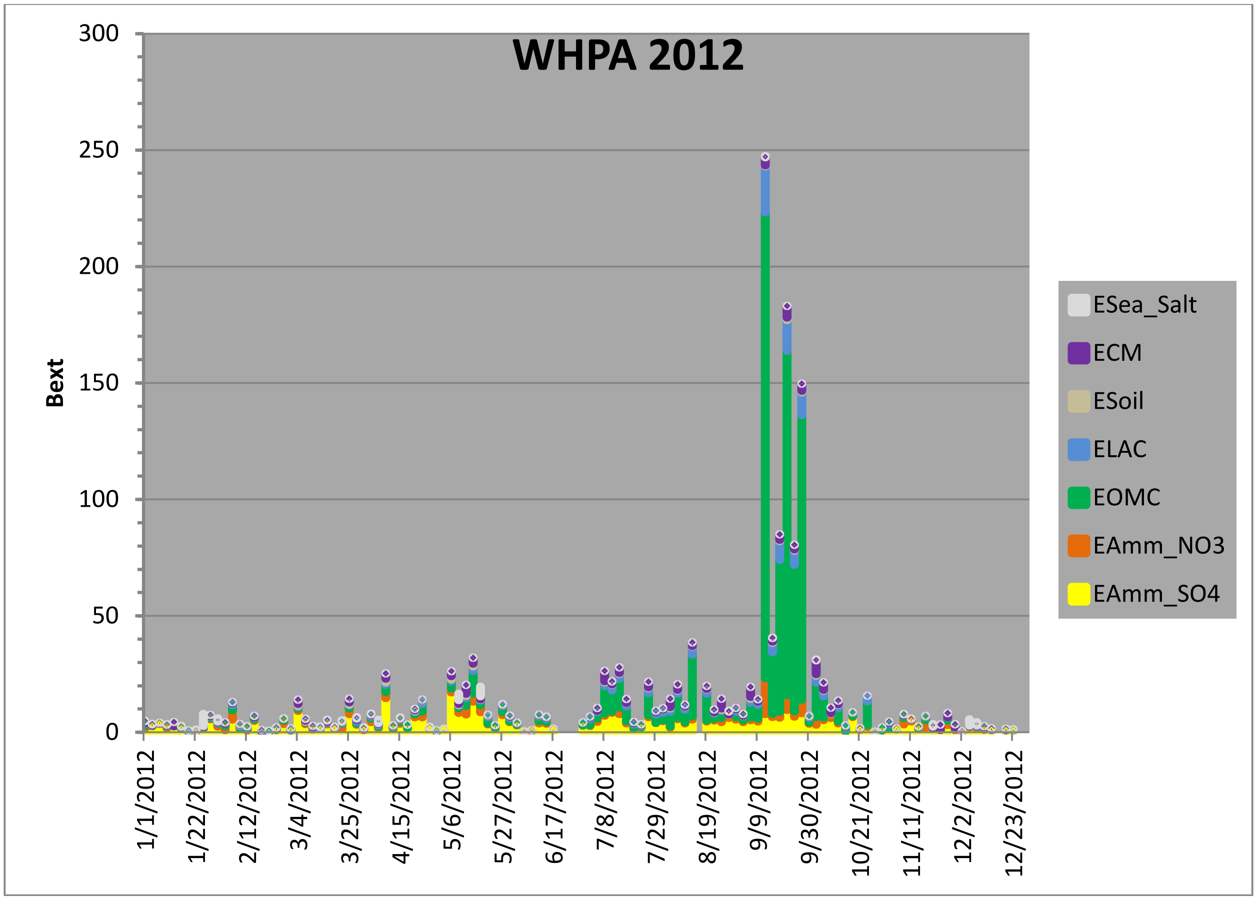
12/5/2011
12/26/2011
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4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6/17/2012
7/8/2012
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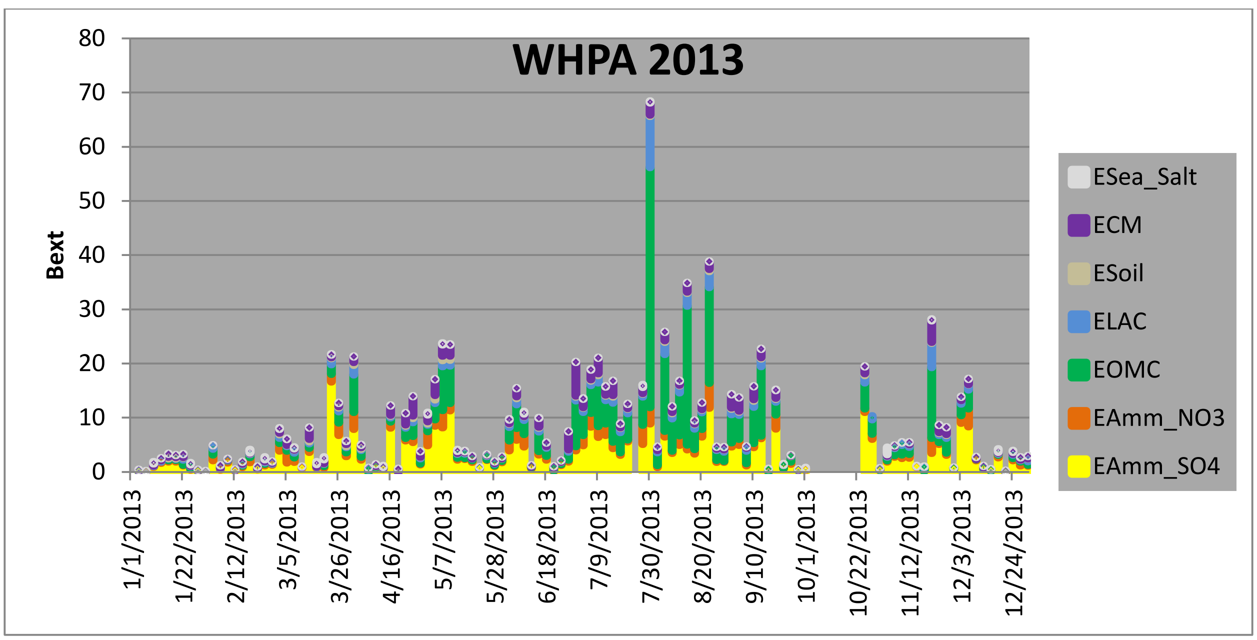
8/19/2012
9/9/2012
9/30/2012
10/21/2012
11/11/2012
12/2/2012
12/23/2012
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


WHPA 2013
Bext
80
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60
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40
30
20
10
0
1/1/2013
1/22/2013
2/12/2013
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3/26/2013
4/16/2013
5/7/2013
5/28/2013
6/18/2013
7/9/2013
7/30/2013
8/20/2013
9/10/2013
10/1/2013
10/22/2013
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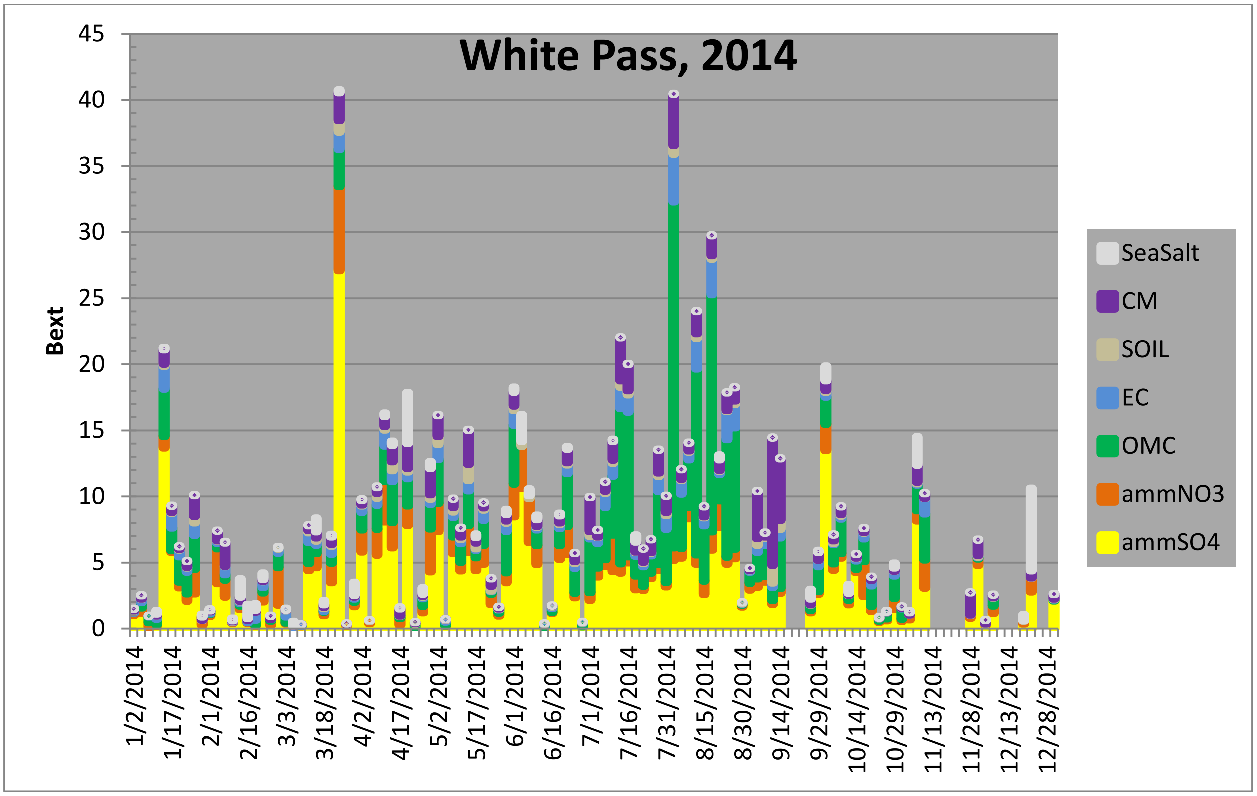
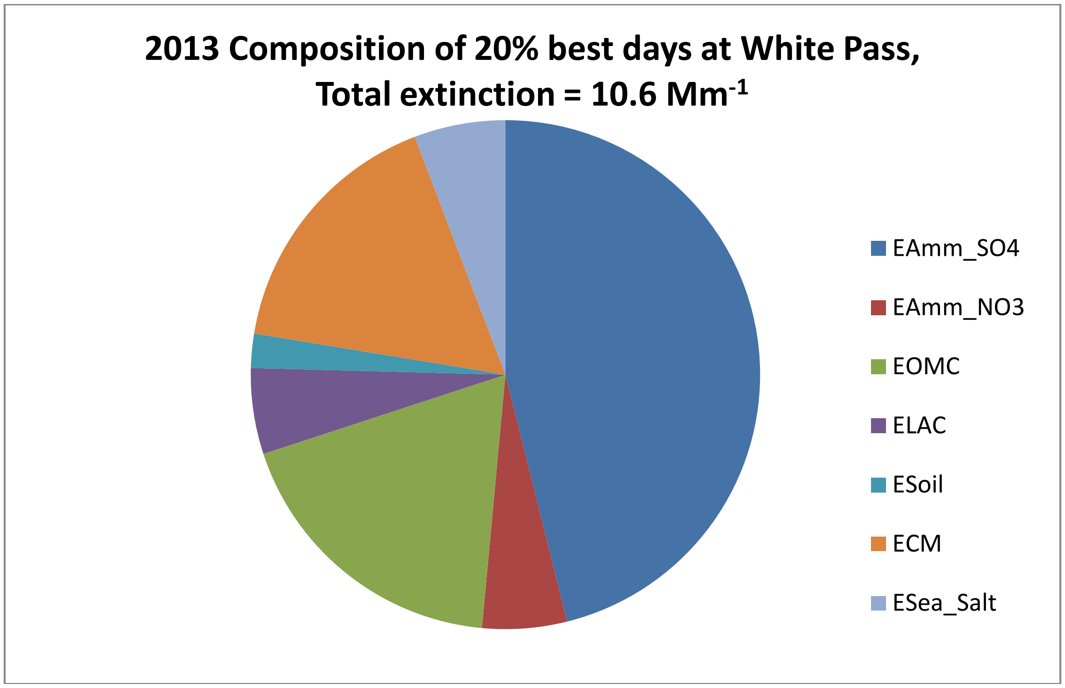
EAmm_NO3
EAmm_SO4

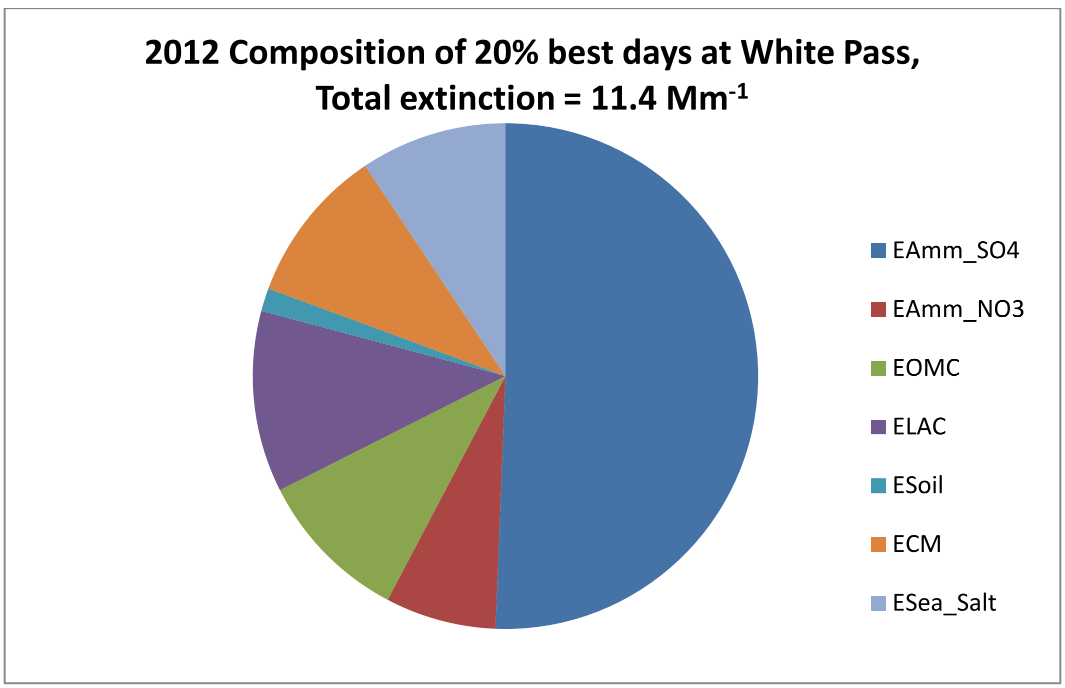


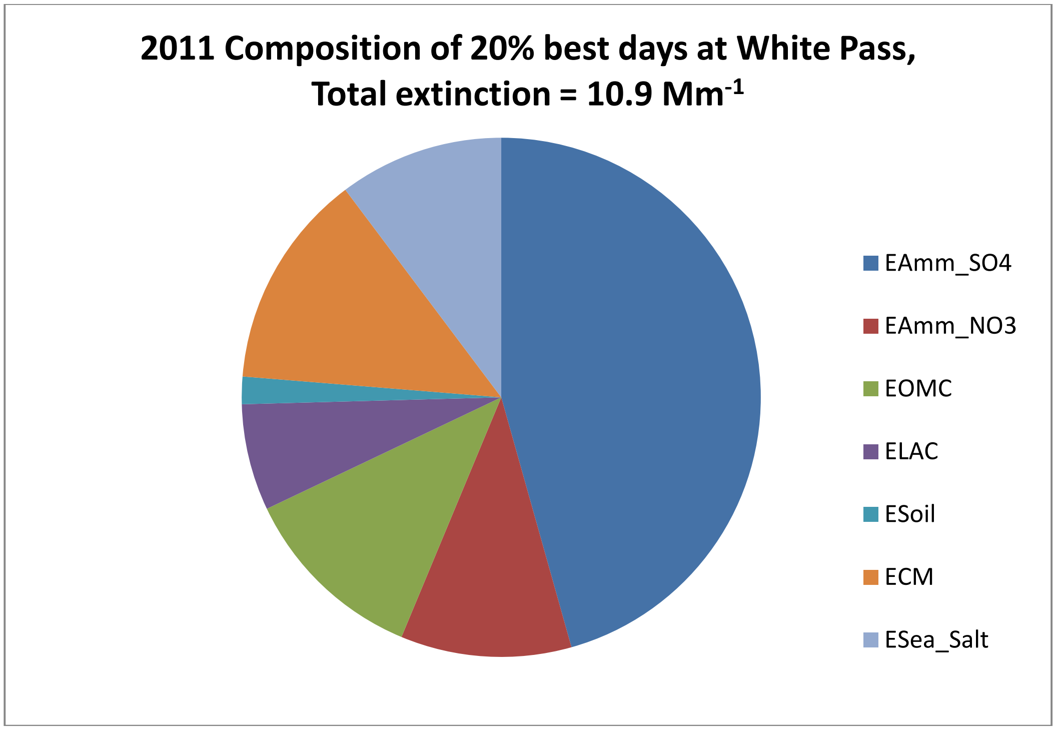

A review of monitoring over the past 10 years indicates that the high sulfate based visibility on March 24, 2014 resulted in one of the few worst days caused by sulfate. This was a day when the Centralia power plant was operating and emitted 1.3 tons $SO_2$. The previous day the plant emitted 5.5 tons of $SO_2$. There were four other days in 2014 that exhibited the same characteristic (January 14, October 2, November 7, June 10). Having the worst day or even one of the worst 20% of days in a year being so highly dominated by sulfate is at odds with all other worst days in the record. All other worst days in this period were caused by smoke from wildfires. This monitor is east of Mt. Rainier and NE of Mt. St. Helens. It is possible that some of the sulfate this monitor measures originates from one or both of these volcanoes.

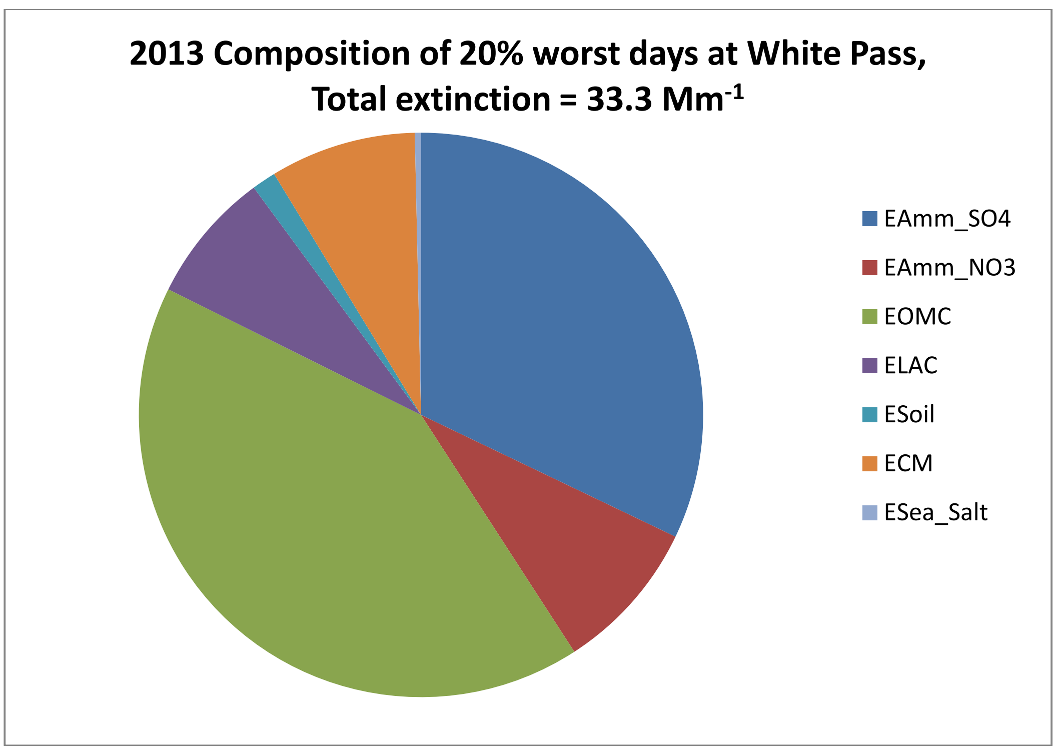
The following pie charts compare the average relative visibility impairment by the primary haze-causing pollutant species for the years 2011 – 2013. The charts show the relative composition on the average of the 20% best and worst days for each of these years. Note that on the best days, this monitor is heavily impacted by sulfates. However on the worst days, and indicated in the yearly graphs above, organic carbon from wildfires is the predominant source of visibility impairment.

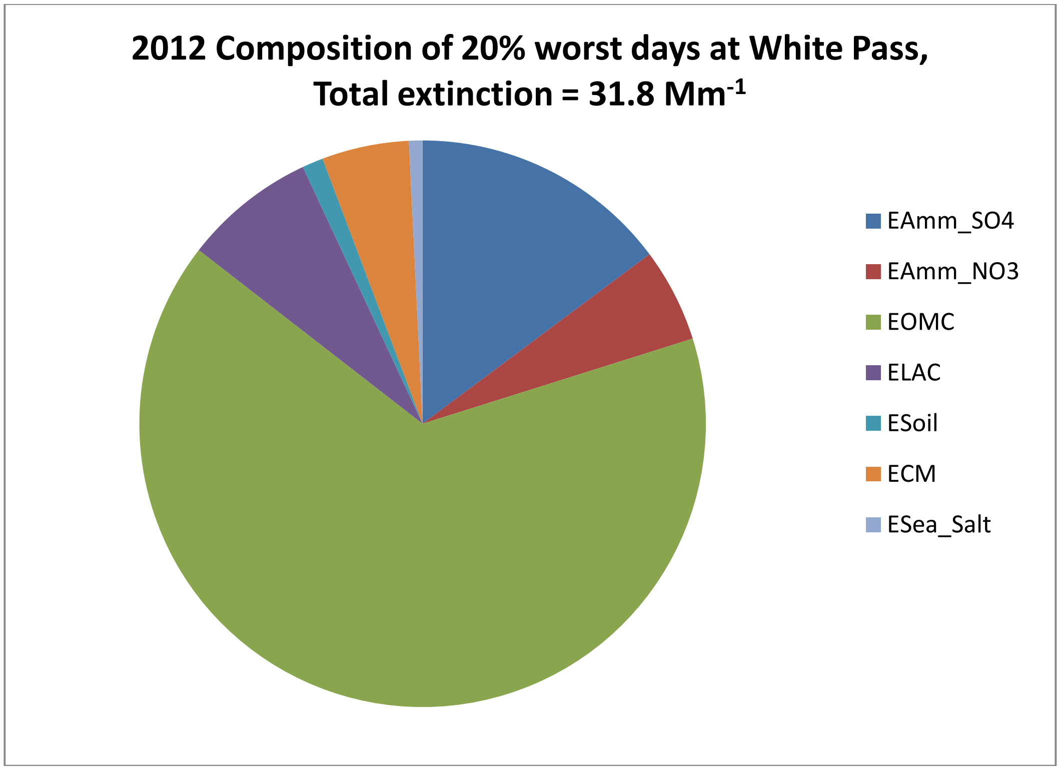
In 2012, a year with significant local wildfires, organic carbon made up almost 75% of the impairment measured on the worst days. Meanwhile on the other 2 years organic carbon made up almost 1/3 of the impairment on the worst days, and more on individual days. On the worst days of 2011, sulfate dominated the composition of haze causing pollutants, but reviewing the daily graphs for 2011 shows that the average and maximum day visibility impairment was low, compared to other years with high levels of fire impacts.

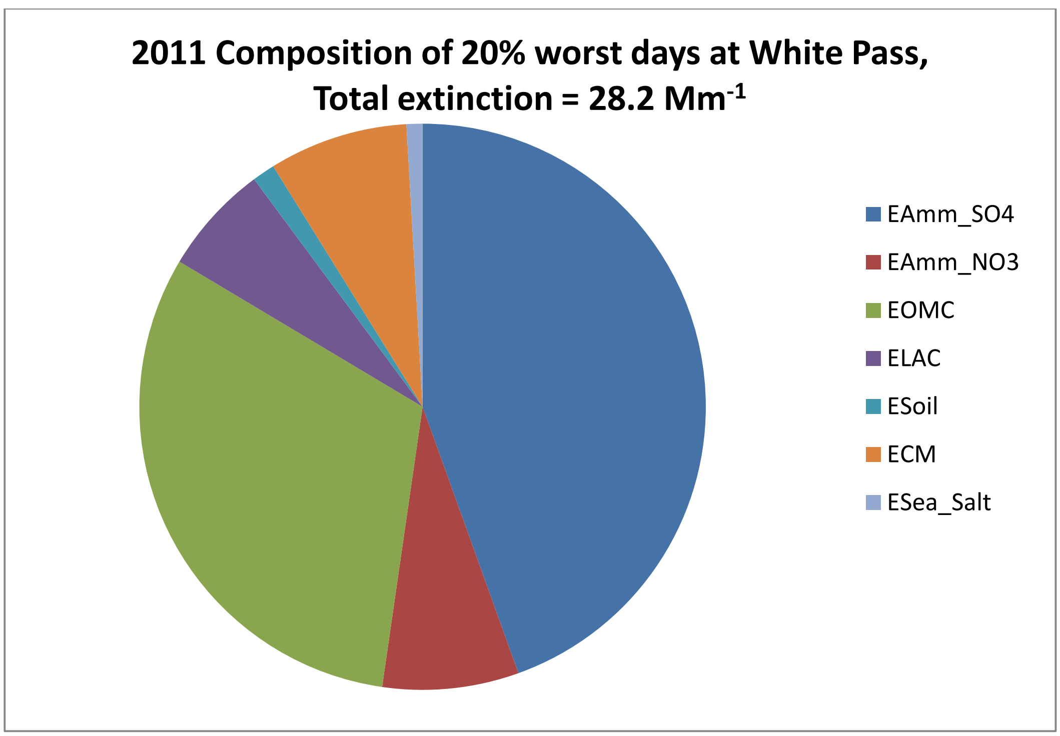


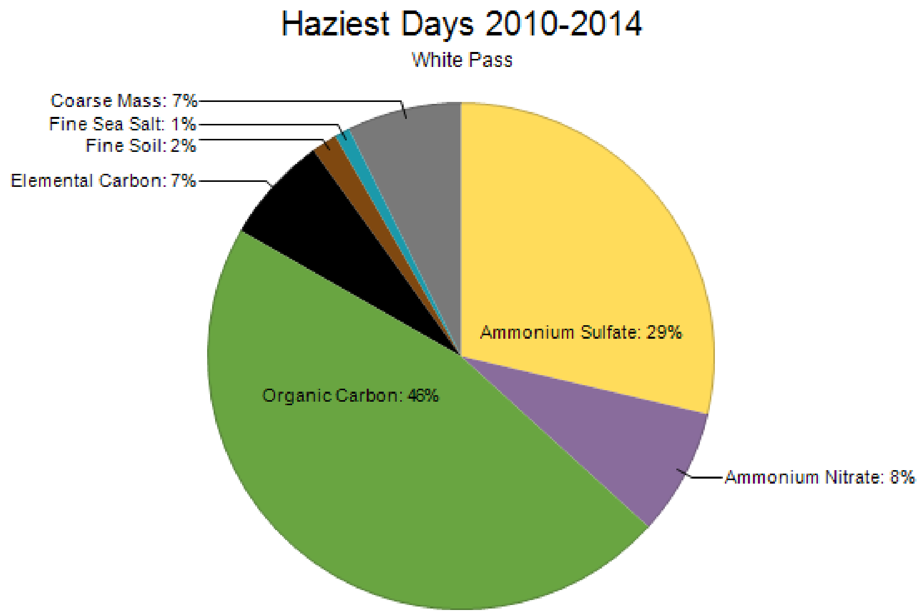

2011 Composition of 20% best days at White Pass,
Total extinction = 10.9 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt


2013 Composition of 20% worst days at White Pass,
Total extinction = 33.3 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt



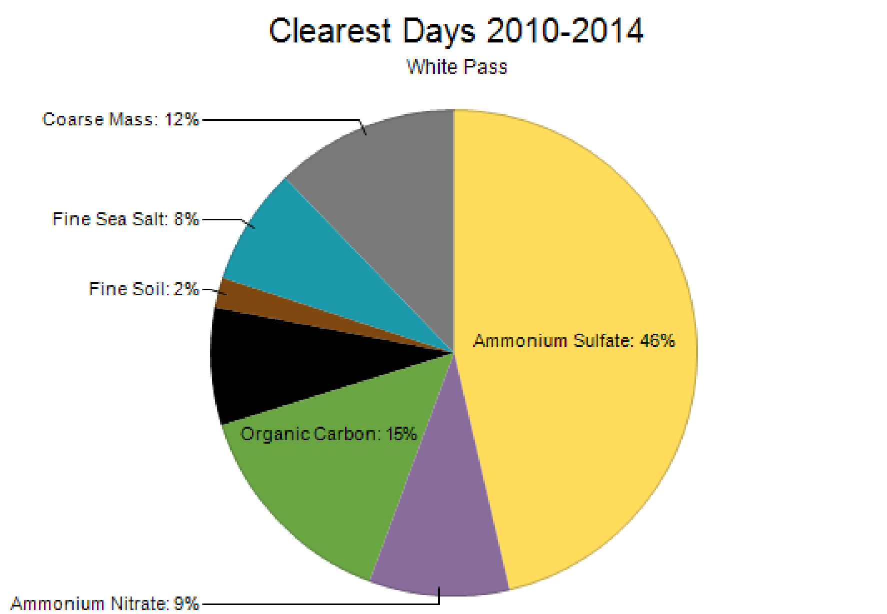




The following graphs produced by WRAP software shows the 5 year average composition of the measured haze-causing pollutants on the worst 20% (haziest) and best 20% (clearest) days. Of note is the average composition of the aerosols producing visibility impairment on the worst days is predominantly organic carbon with ammonium sulfate providing d, while on the best days, it is dominated by ammonium sulfate.




The chart above illustrates particle contribution to light extinction on haziest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: WHPA1, WA




The chart above illustrates particle contribution to light extinction on clearest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: WHPA1, WA

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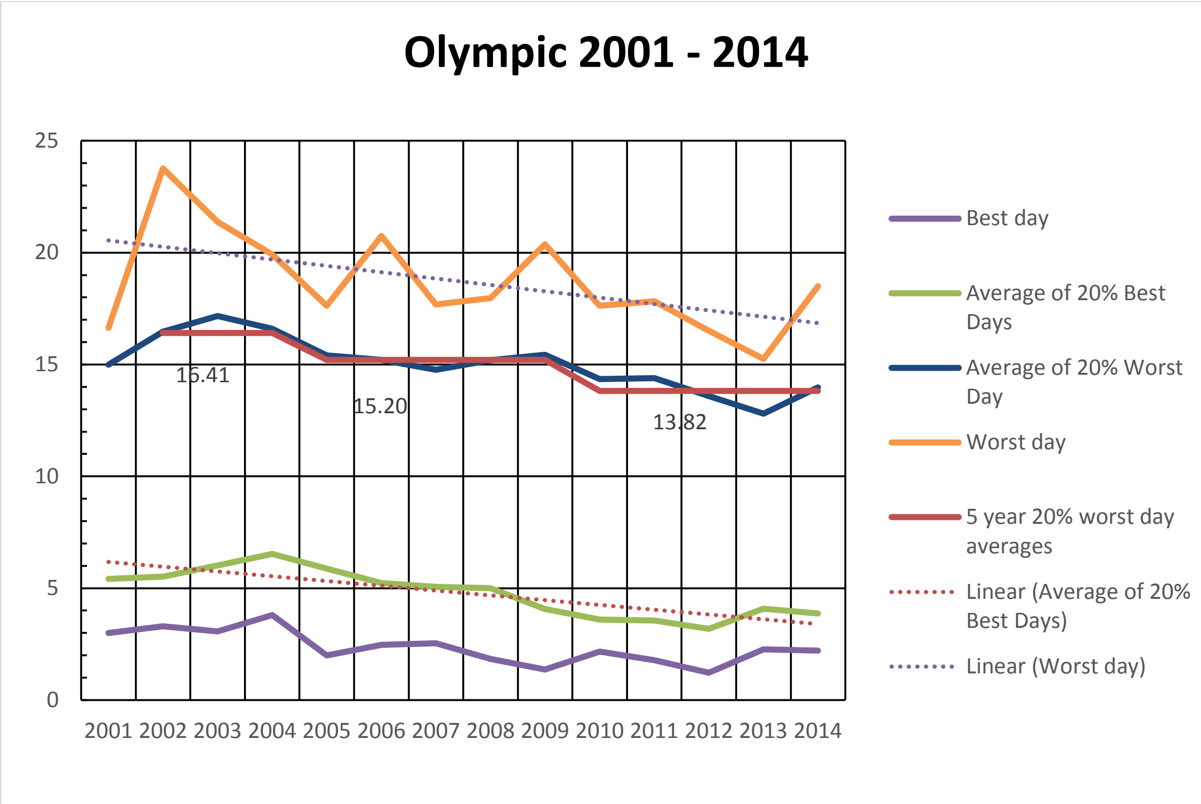
Olympic National Park IMPROVE Monitor Trend Graphs




The Olympic National Park is represented by the OLYM1 IMPROVE monitor site.

The projected 2018 reasonable progress goal for the 20% worst days is 16.38 dv and the uniform glide path[1] value for 2018 was 14.81 dv. The calculated 2064 natural condition value for the average of the 20% worst days for this monitor is 8.44 dv.

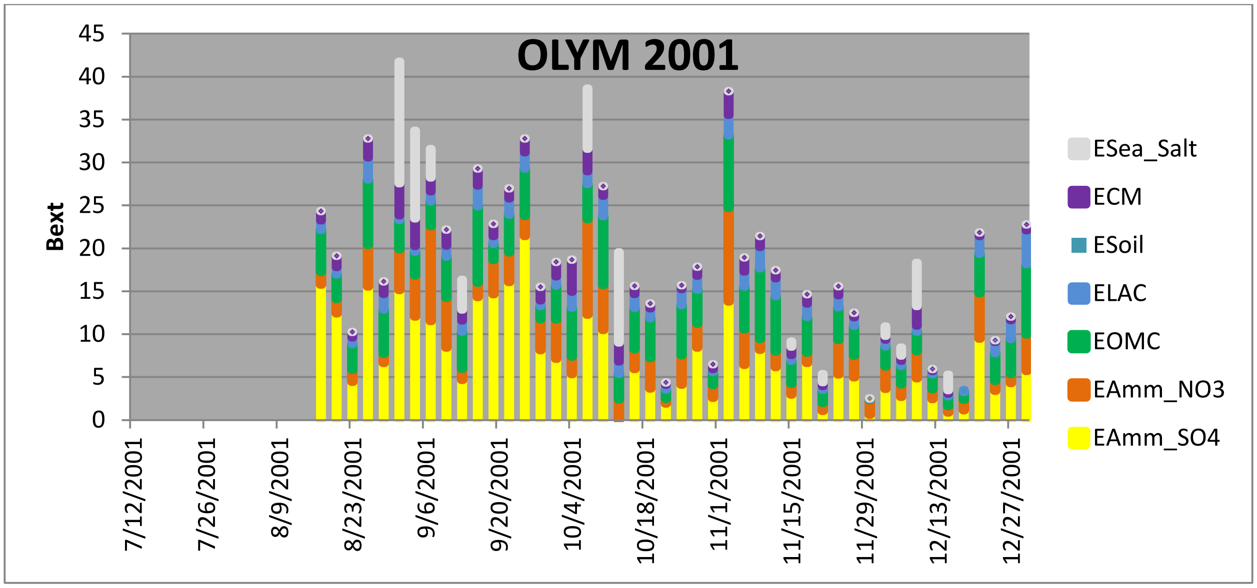
The average visibility on the 20% worst days for 2010 – 2014 period was 13.82 dv, which is better visibility than the reasonable progress goal and the uniform rate of progress values. This monitoring site shows continued visibility improvement on the 20% worst days.

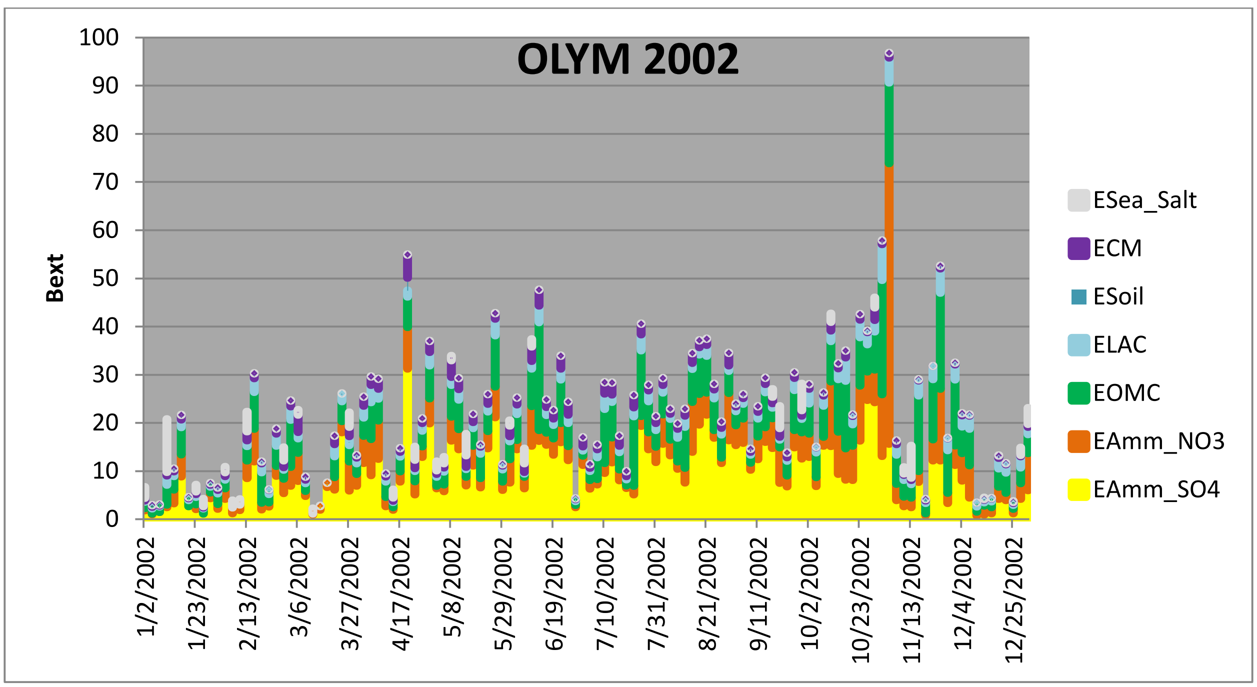
The average visibility during the best 20% days over the most recent 5 years is 3.66 dv.

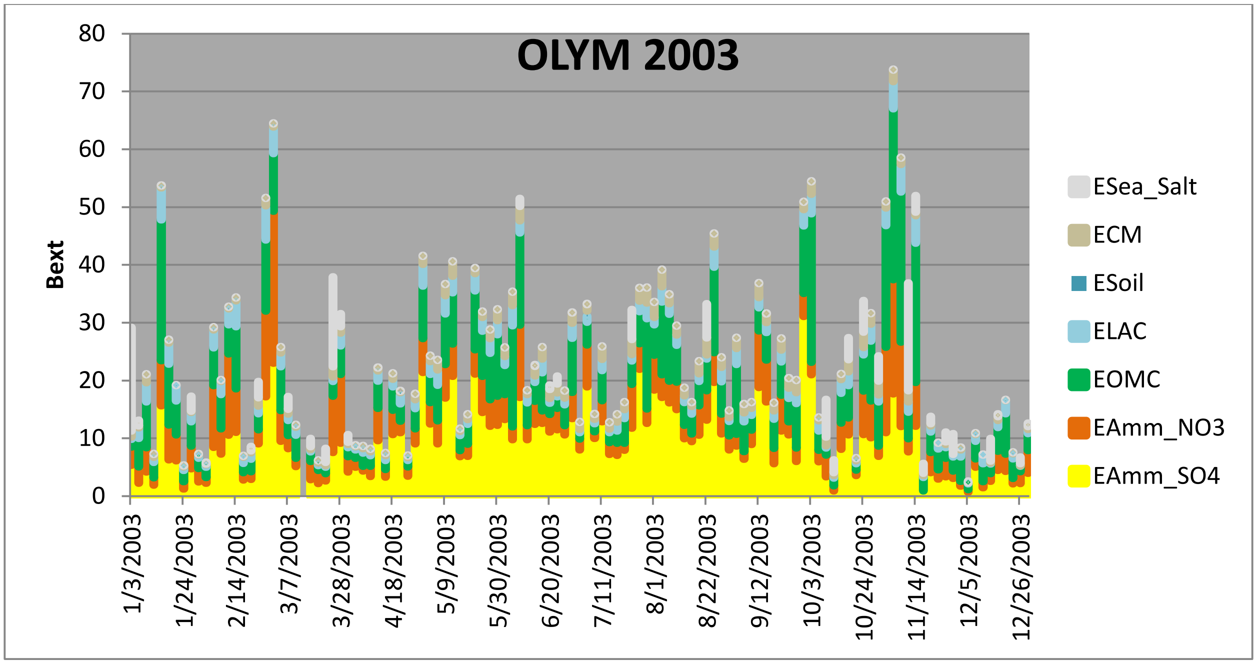
The graph at the top of this page depicts the visibility trends for this monitor since 2001. Even though the absolute worst day of each year shows significant year to year variability and the average of the worst 20% days each year varies between years, the 5 year average of the 20% worst days has continued a long term trend of visibility improvement. On the best days, the visibility trend shows steady improvement in visibility.

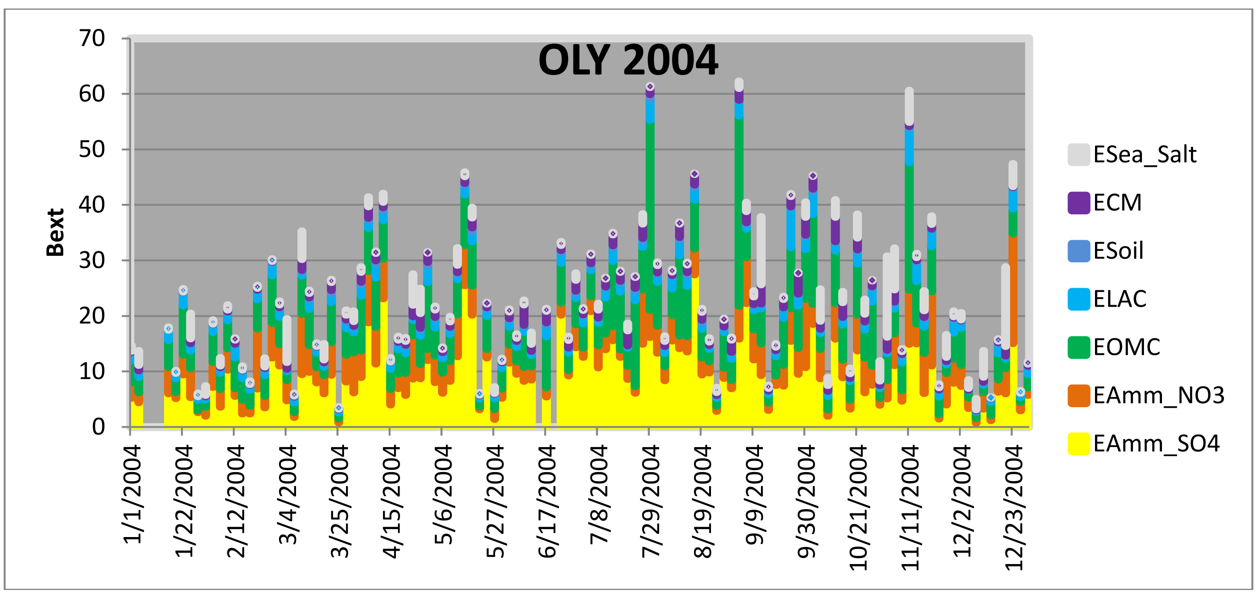
[1] The uniform glide path value is the starting place to develop a Reasonable Progress Goal. The uniform rate of progress represents the linear rate of visibility improvement required to meet the 2064 visibility goal in 2064.

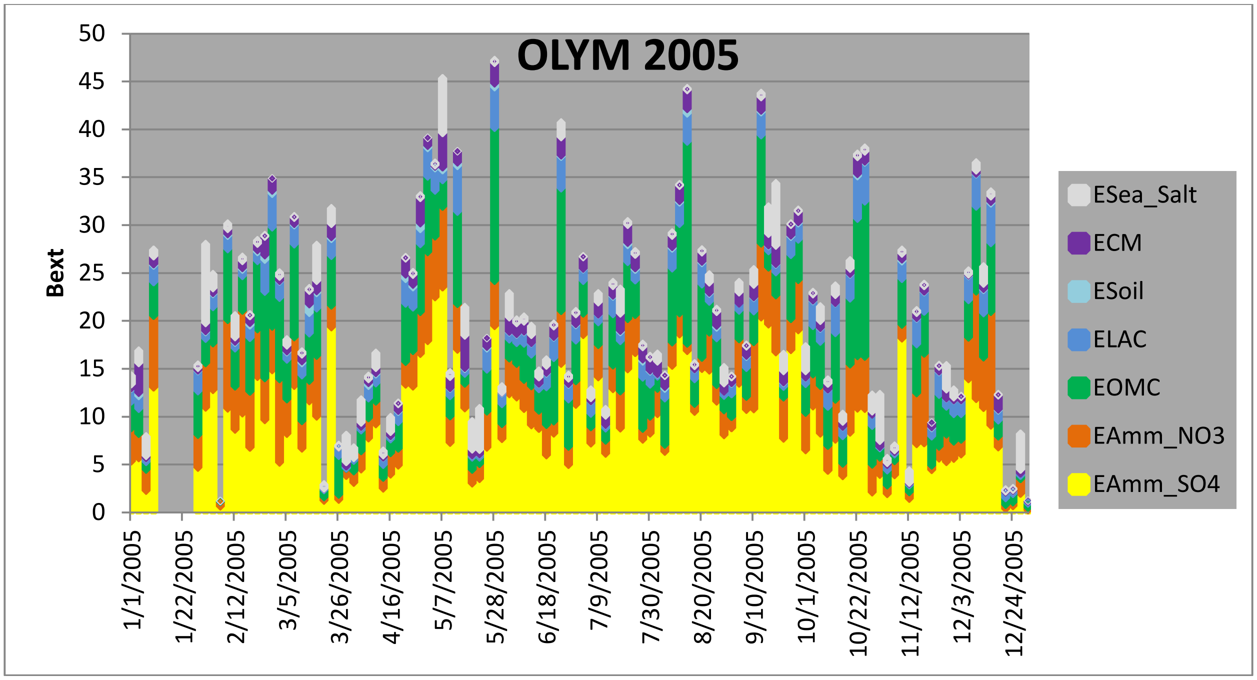
The following are graphs of the reconstructed light extinction ($B_{ext}$) for each year during the 2001 – 2014 period. This monitoring site is near sea level and shows impacts from marine vessels and on-road transportation. The values show the relative contribution of the chemical types incorporated into the revised IMPROVE light extinction calculation. NOTE each graph has a different maximum value.




OLYM 2003
Bext
0
10
20
30
40
50
60
70
80
1/3/2003
1/24/2003
2/14/2003
3/7/2003
3/28/2003
4/18/2003
5/9/2003
5/30/2003
6/20/2003
7/11/2003
8/1/2003
8/22/2003
9/12/2003
10/3/2003
10/24/2003
11/14/2003
12/5/2003
12/26/2003
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


OLY 2004
Bext
0
10
20
30
40
50
60
70
1/1/2004
1/22/2004
2/12/2004
3/4/2004
3/25/2004
4/15/2004
5/6/2004
5/27/2004
6/17/2004
7/8/2004
7/29/2004
8/19/2004
9/9/2004
9/30/2004
10/21/2004
11/11/2004
12/2/2004
12/23/2004
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


OLYM 2005
Bext
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45
40
35
30
25
20
15
10
5
0
1/1/2005
1/22/2005
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3/5/2005
3/26/2005
4/16/2005
5/7/2005
5/28/2005
6/18/2005
7/9/2005
7/30/2005
8/20/2005
9/10/2005
10/1/2005
10/22/2005
11/12/2005
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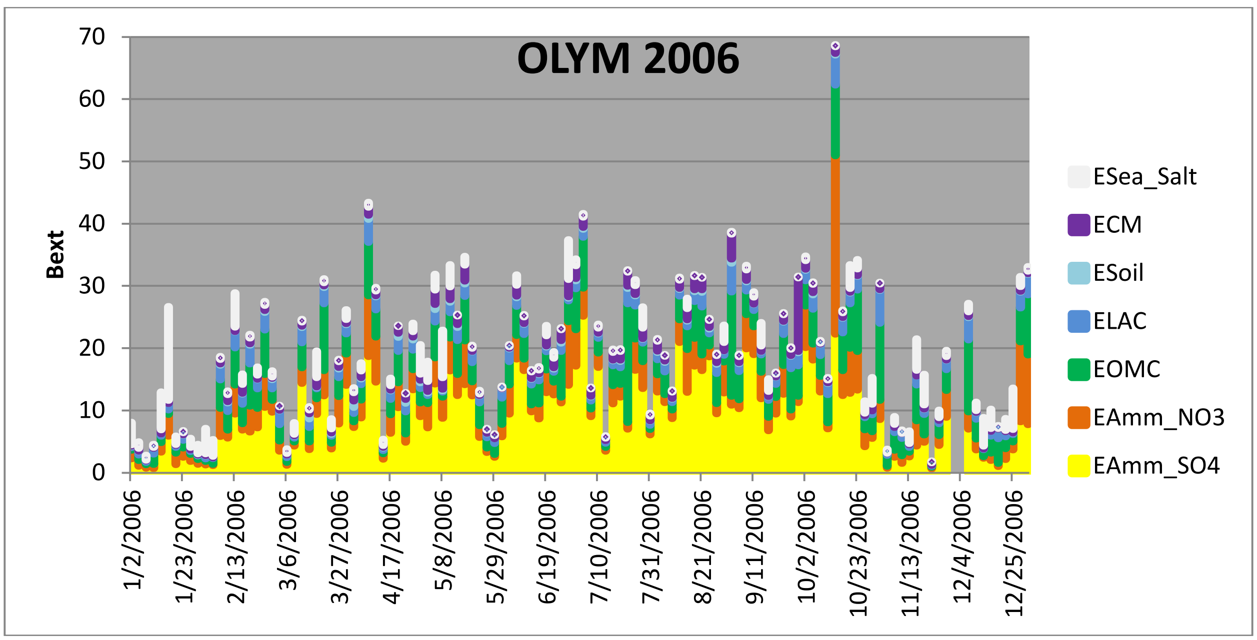
12/24/2005
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


OLYM 2006
Bext
70
60
50
40
30
20
10
0
1/2/2006
1/23/2006
2/13/2006
3/6/2006
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6/19/2006
7/10/2006
7/31/2006
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9/11/2006
10/2/2006
10/23/2006
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12/25/2006
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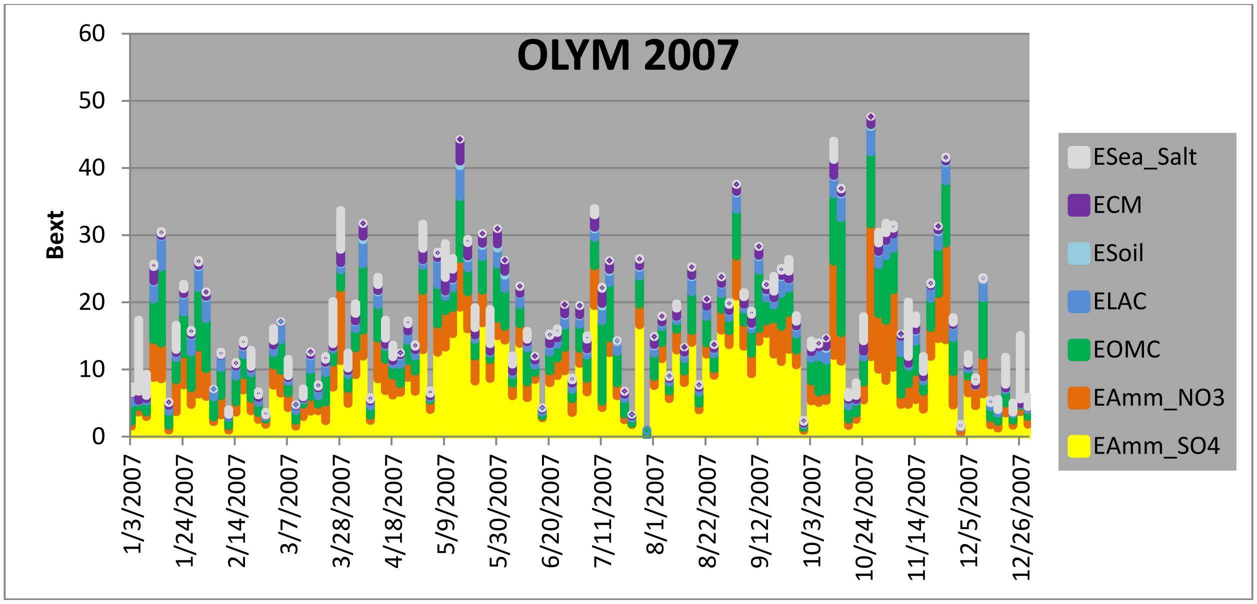
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


OLYM 2007
Bext
0
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30
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50
60
1/3/2007
1/24/2007
2/14/2007
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10/3/2007
10/24/2007
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12/26/2007
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ECM
ESoil
ELAC
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EAmm_NO3
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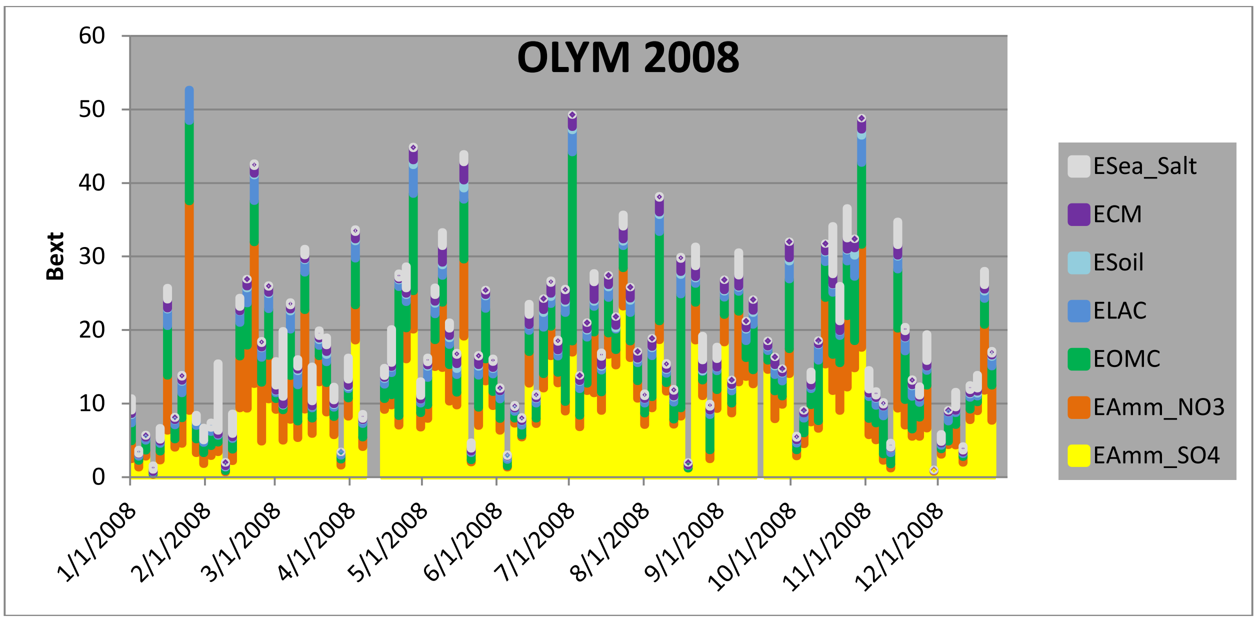
OLYM 2008
Bext
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60
1/1/2008
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12/1/2008
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ECM
ESoil
ELAC
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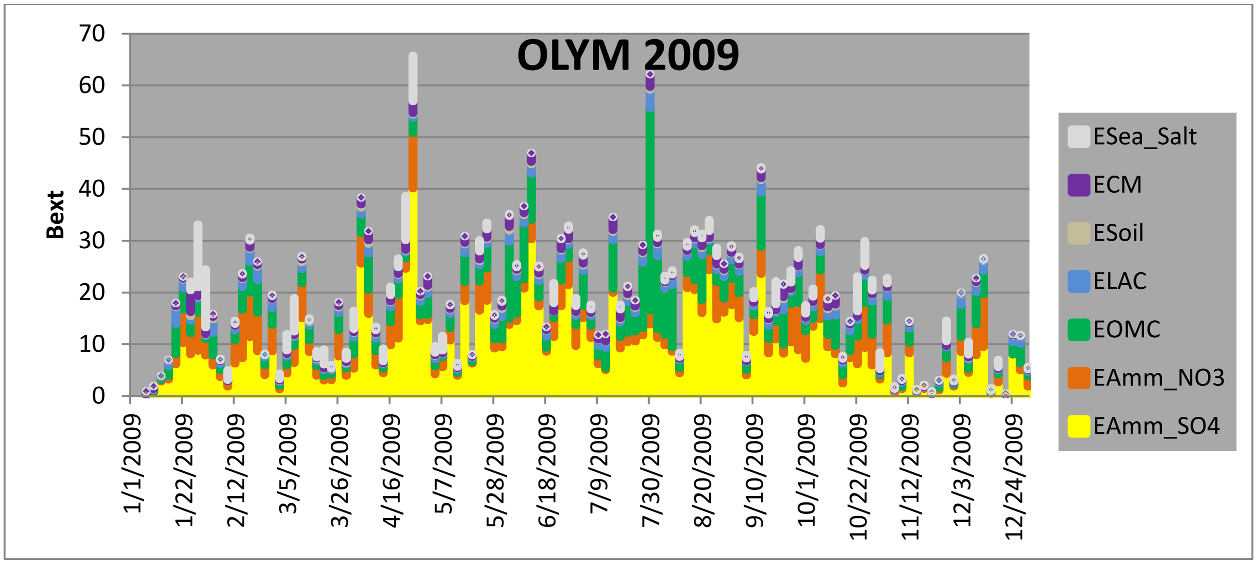

OLYM 2009
Bext
70
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40
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9/10/2009
10/1/2009
10/22/2009
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12/24/2009
ESea_Salt
ECM
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ELAC
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EAmm_NO3
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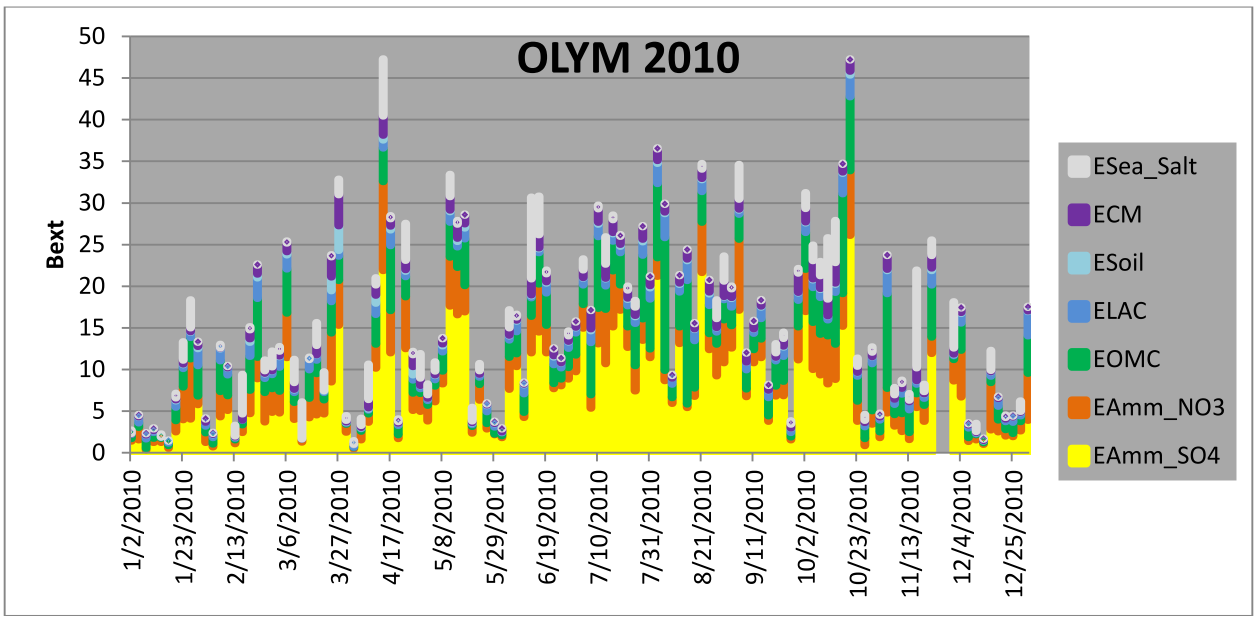

OLYM 2010
Bext
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35
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20
15
10
5
0
1/2/2010
1/23/2010
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3/6/2010
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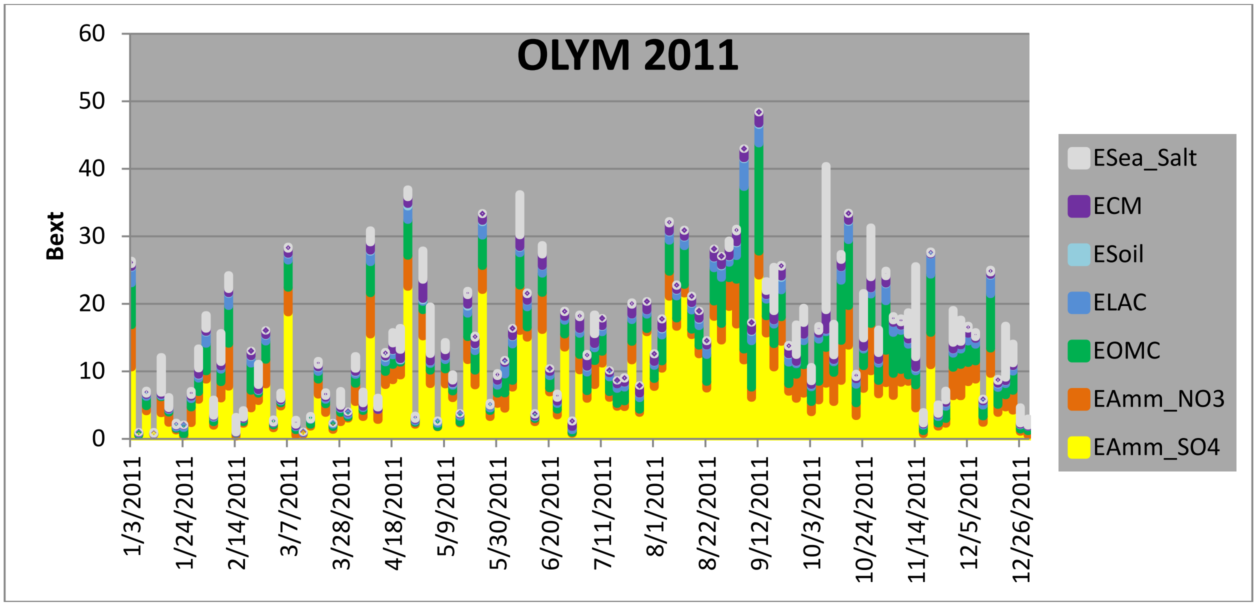
OLYM 2011
Bext
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0
1/3/2011
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12/26/2011
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ELAC
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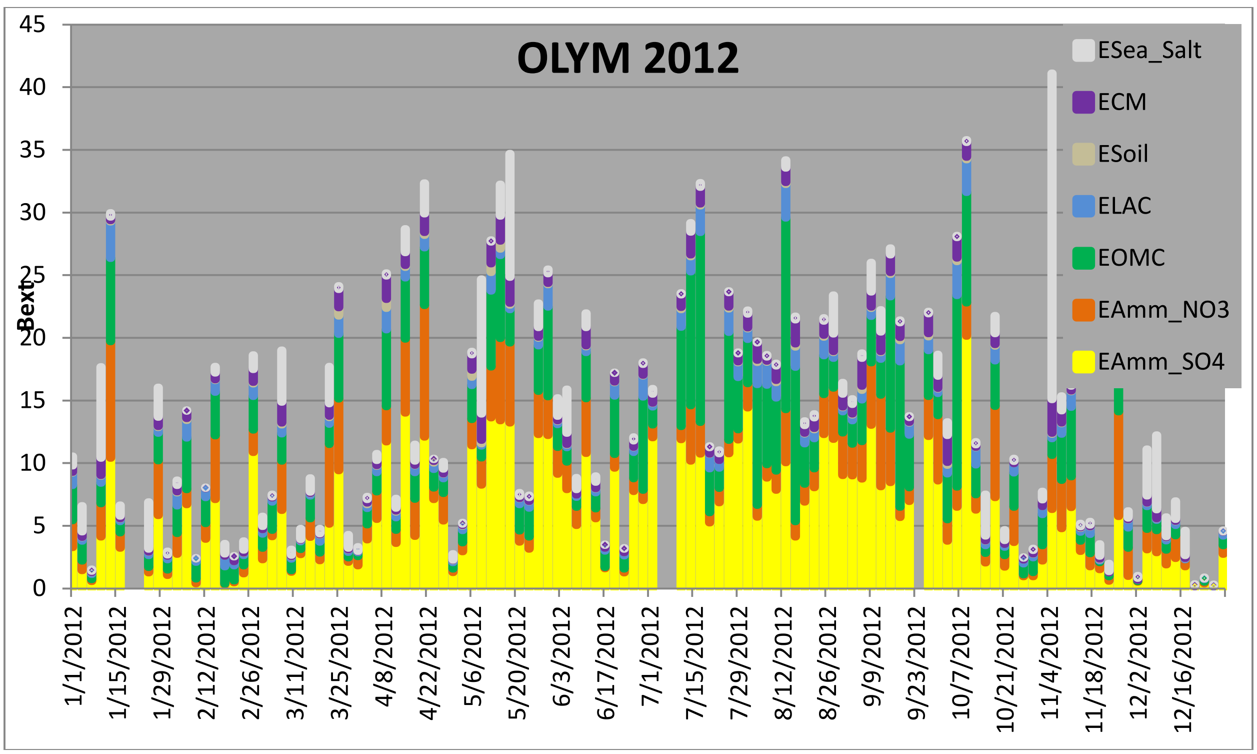
OLYM 2012
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12/16/2012
ESea_Salt
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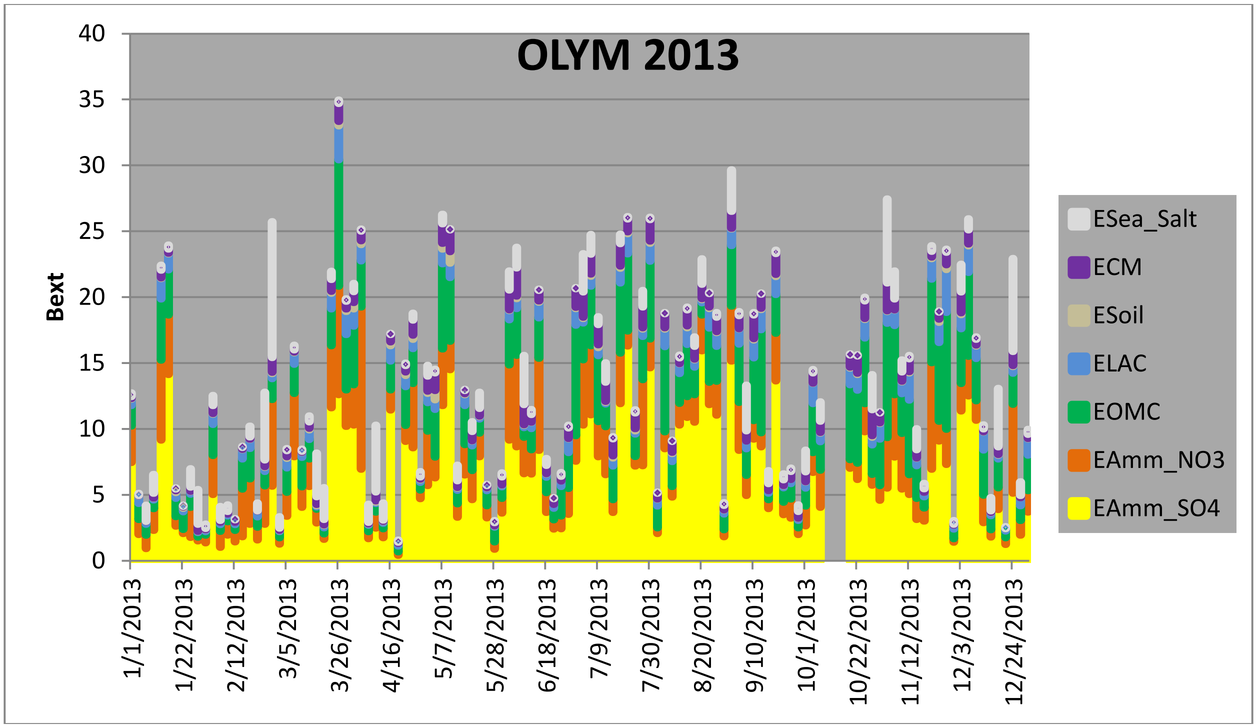
ELAC
EOMC
EAmm_NO3
EAmm_SO4



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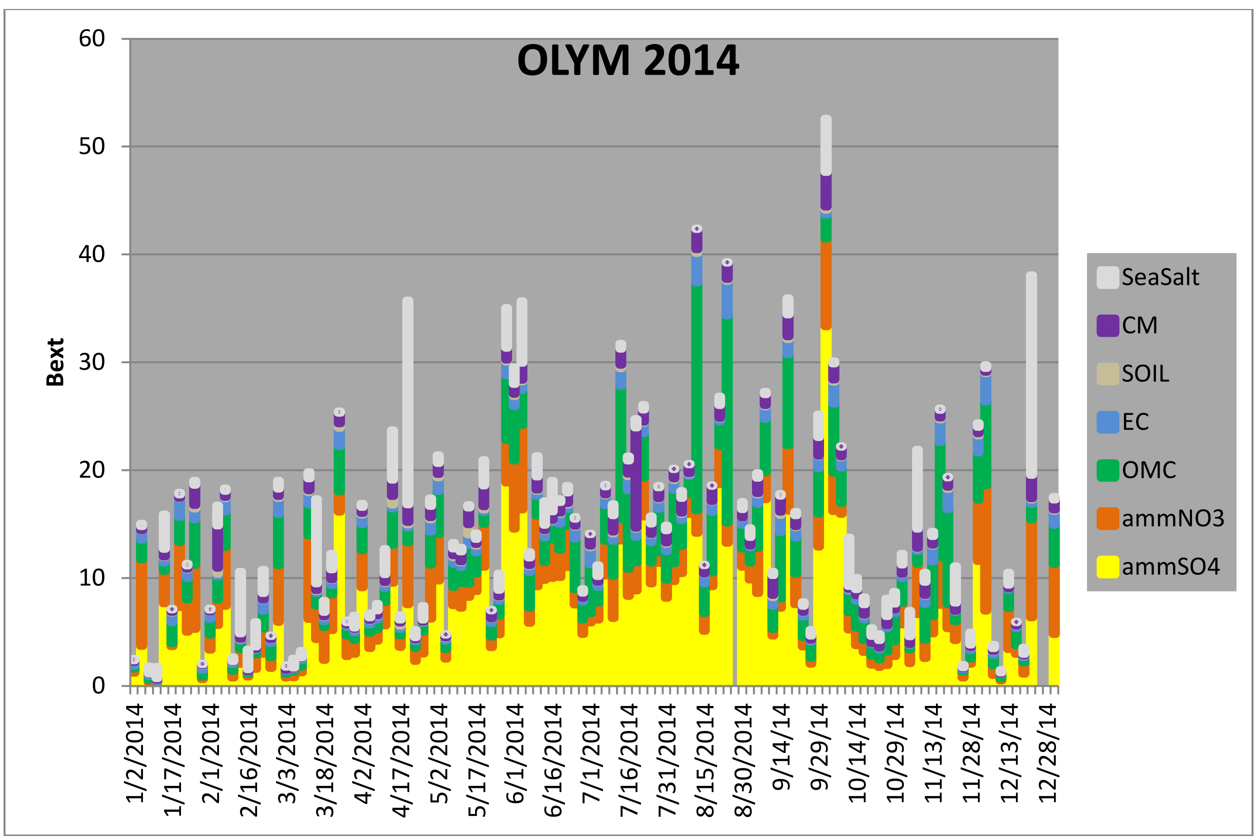
EAmm_SO4

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Bext
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1/2/2014
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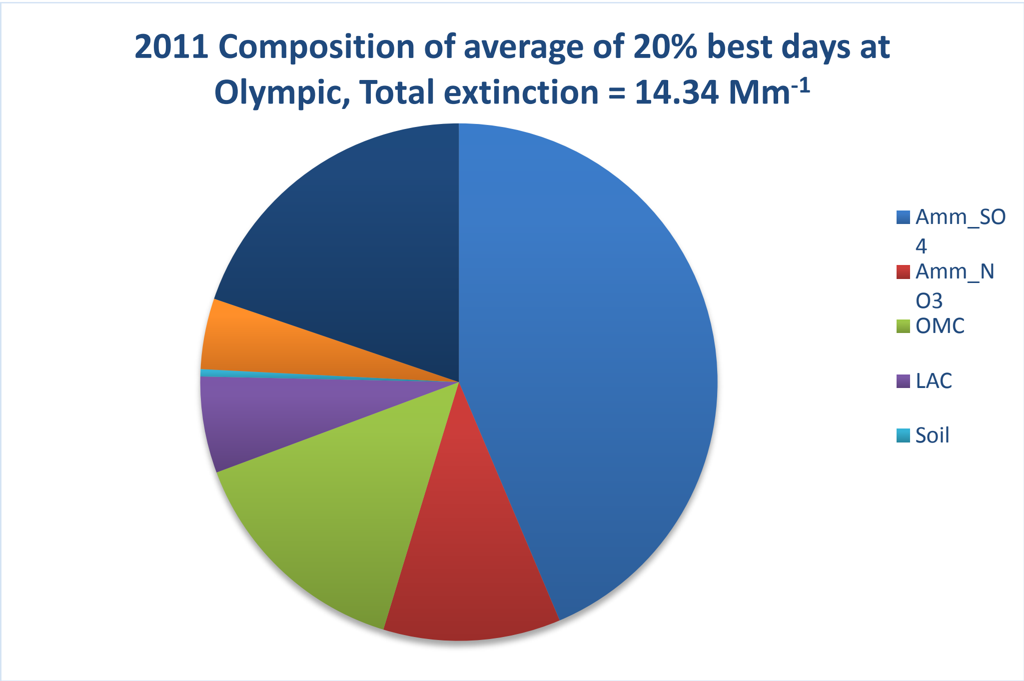
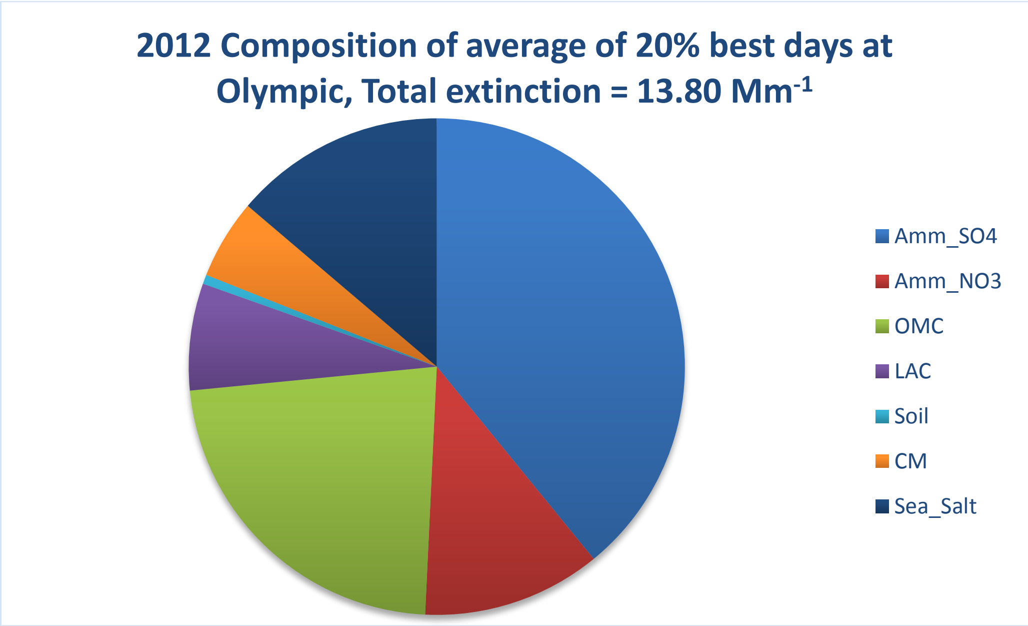
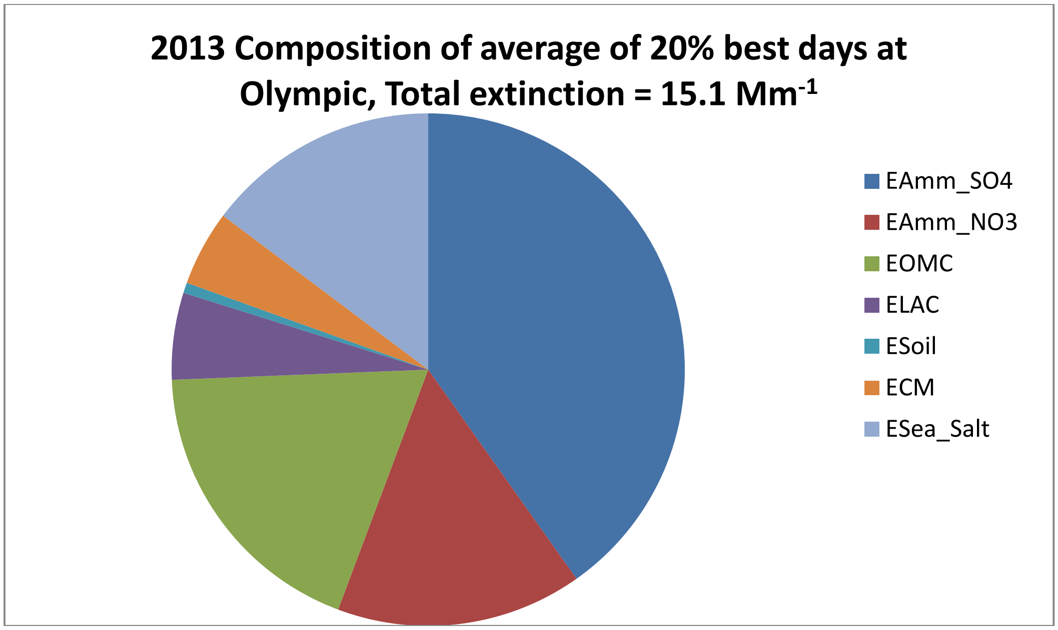
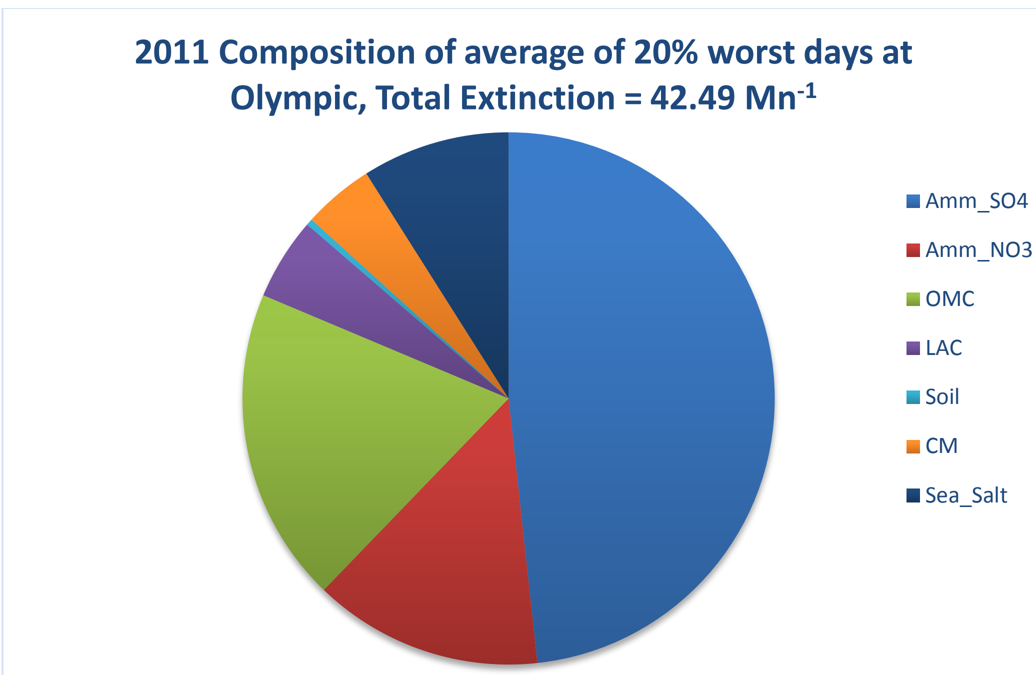
10/29/14
11/13/14
11/28/14
12/13/14
12/28/14
SeaSalt
CM
SOIL
EC
OMC
ammNO3
ammSO4

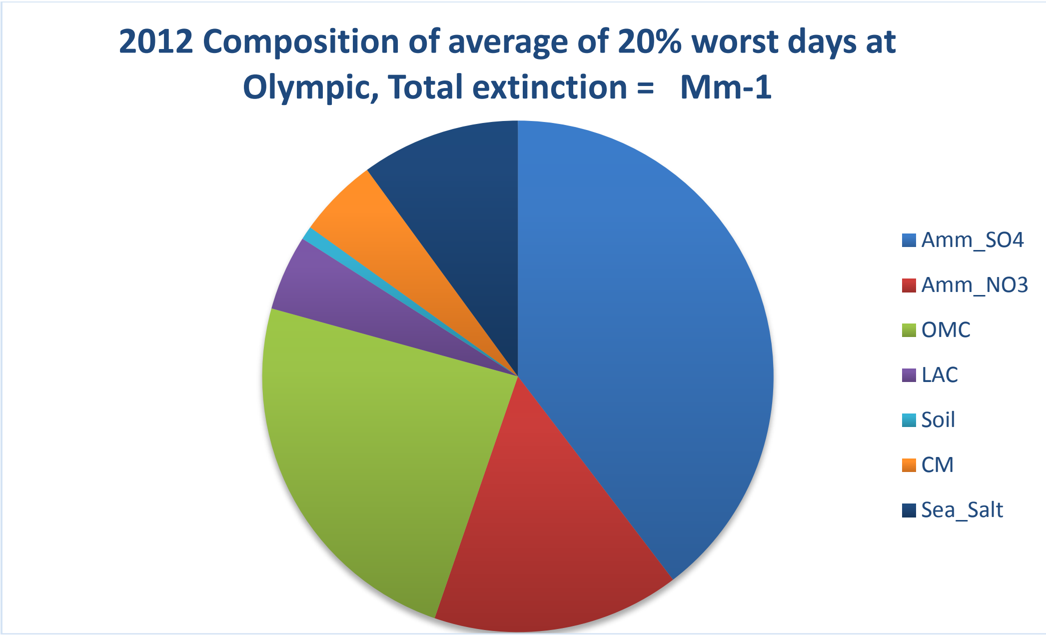
The following pie charts compare the average relative visibility impairment by the primary haze-causing pollutant species for the years 2011 - 2013. The charts show the relative composition on the average of the 20% best and worst days for each of these years. As a comparison to the other IMPROVE sites representing Class I areas in Washington, this site is both the closest to sea level and the only site where sulfate is the primary source of visibility impairment. As discussed in the 2010 RH-SIP, this monitor is affected by emissions from marine vessels visiting the mostly ports of Seattle and Tacoma, and the petroleum Refineries in Whatcom and Skagit Counties.

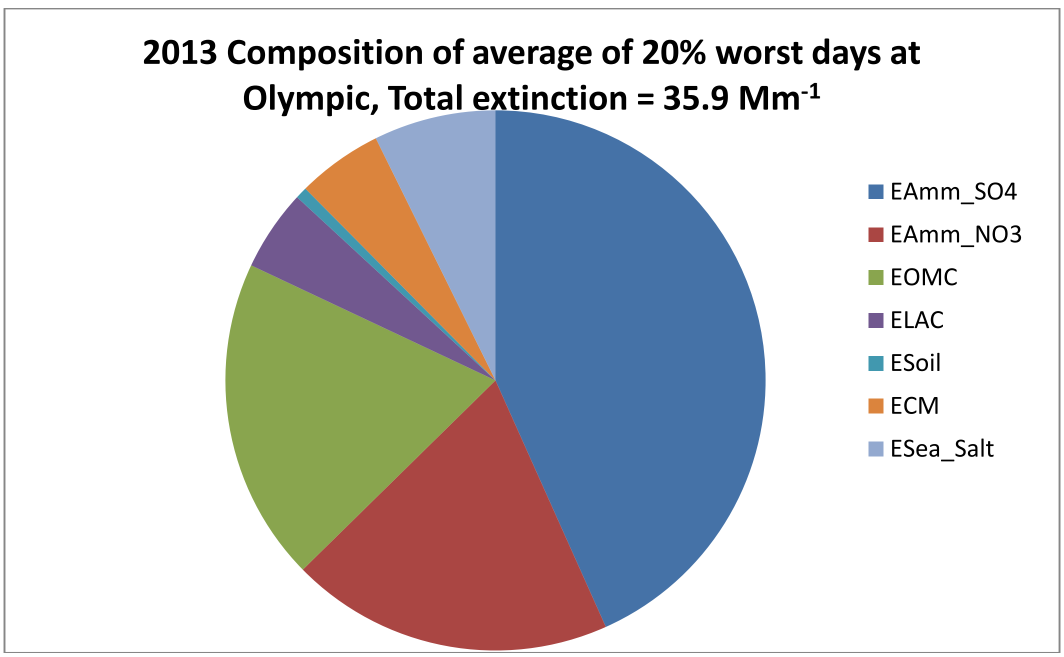


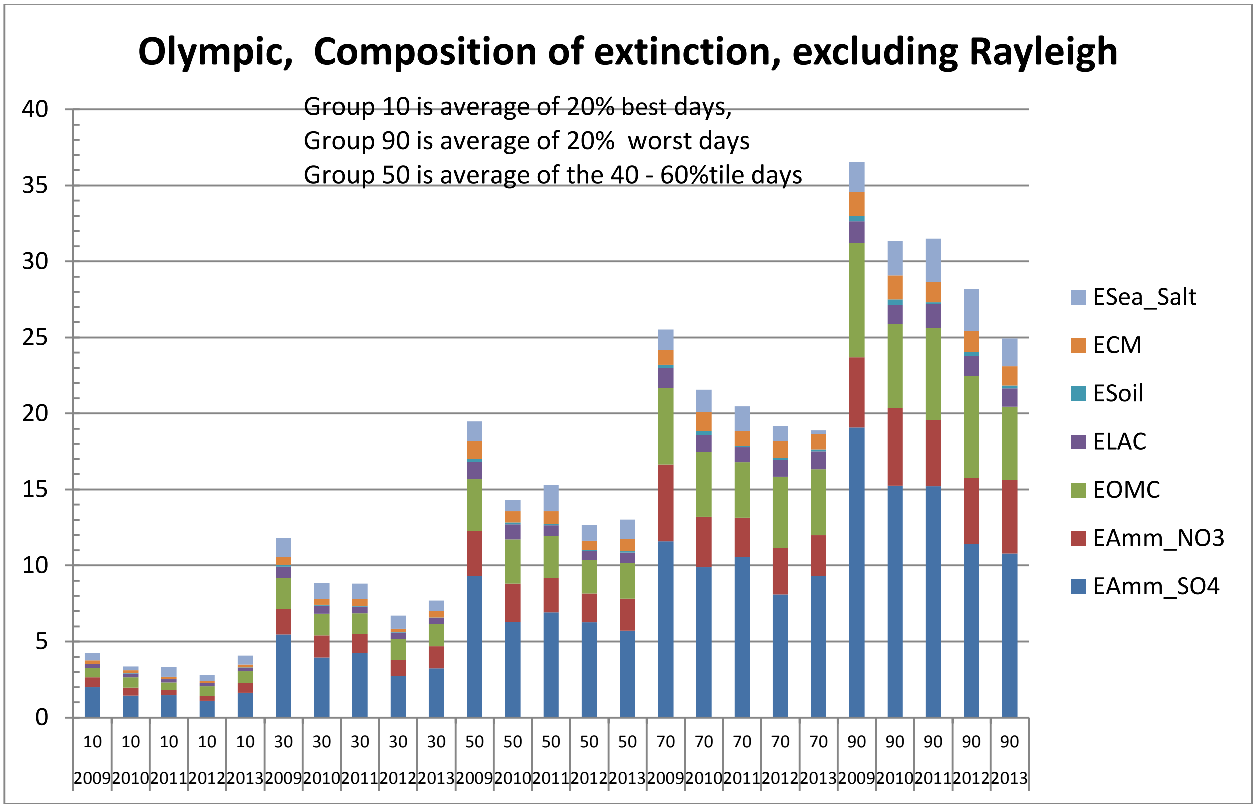

2013 Composition of average of 20% best days at Olympic, Total extinction = 15.1 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt


2011 Composition of average of 20% worst days at Olympic, Total Extinction = 42.49 Mn-1
Amm_SO4
Amm_NO3
OMC
LAC
Soil
CM
Sea_Salt

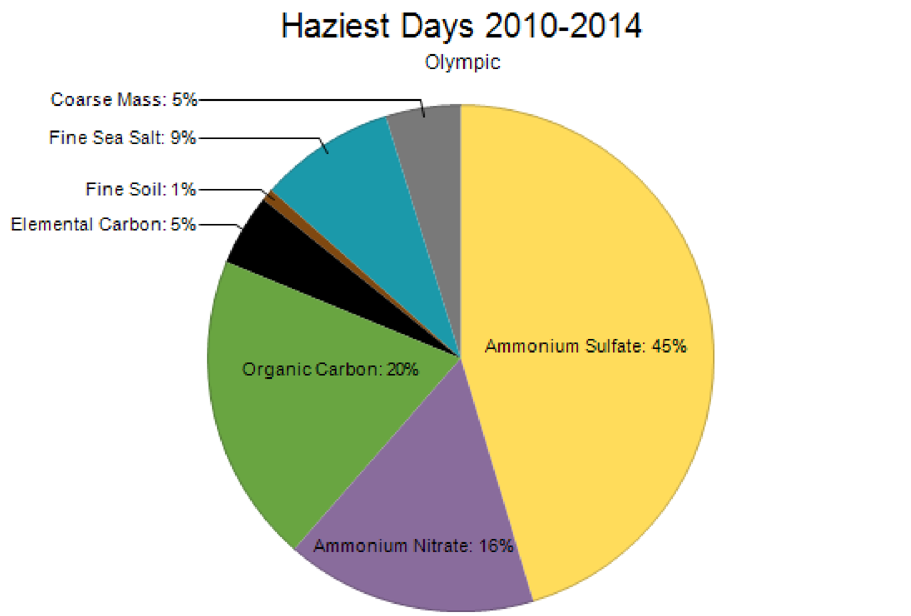

2012 Composition of average of 20% worst days at Olympic, Total extinction = Mm-1
Amm_SO4
Amm_NO3
OMC
LAC
Soil
CM
Sea_Salt


2013 Composition of average of 20% worst days at Olympic, Total extinction = 35.9 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt

The following graph of the average of the 20% best, 20% worst and median visibility impairment for 2010 – 2014. The graph shows that the ammonium sulfate contribution to impairment at this monitor is decreasing over time, though on the worst days, sulfate is still the dominant visibility impairing component.

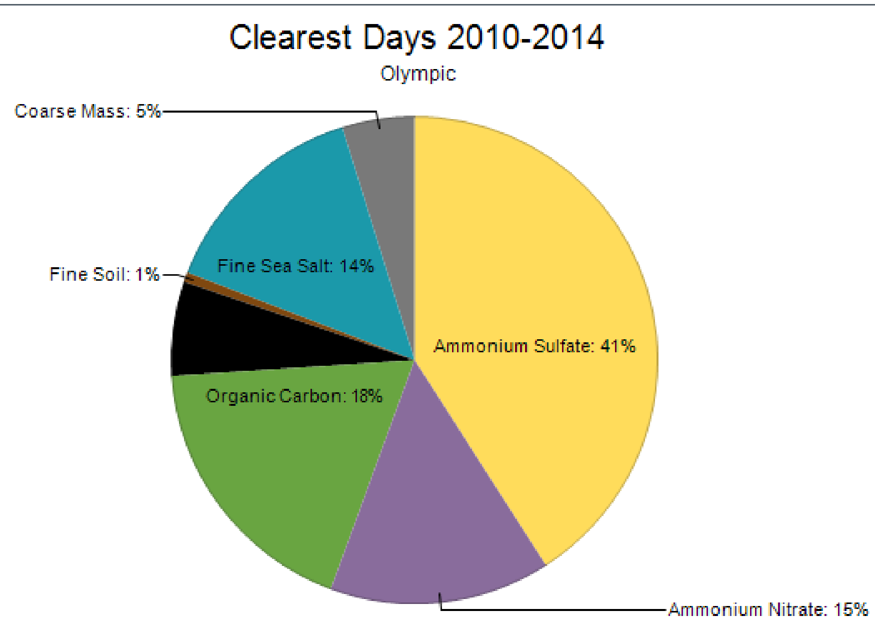


The following graphs produced by WRAP software shows the 5 year average composition of the measured haze-causing pollutants on the worst 20% (haziest) and best 20% (clearest) days. Of note is the average composition of the aerosols producing visibility impairment on the worst days and the best days is dominated by ammonium sulfate.




The chart above illustrates particle contribution to light extinction on haziest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: OLYM1, WA




The chart above illustrates particle contribution to light extinction on clearest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: OLYM1, WA

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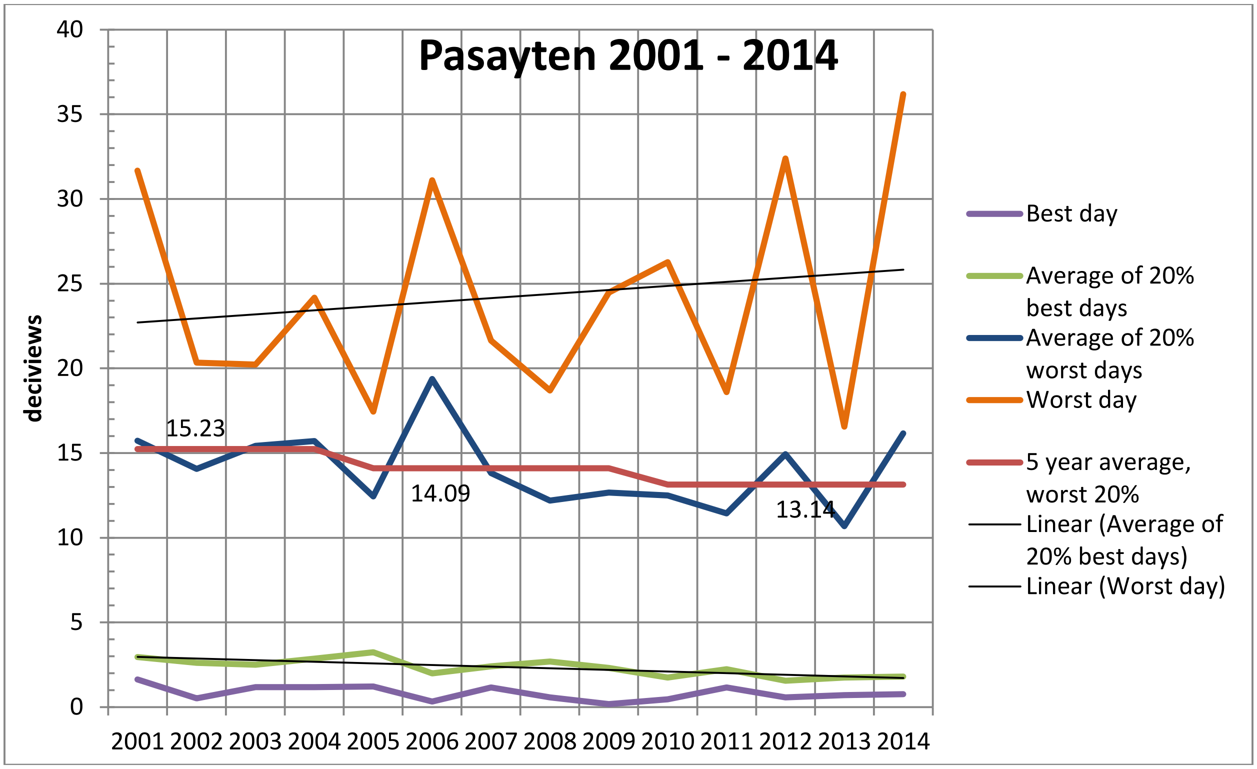
Pasayten Wilderness IMPROVE Monitor Visibility Trend Graphs




The Pasayten Wilderness is represented by the PASA1 IMPROVE monitor site.

The projected 2018 reasonable progress goal for the 20% worst days is 15.09 dv and the uniform glide path[1] value for 2018 was 13.60 dv. The calculated 2064 natural condition value for the average of the 20% worst days for this monitor is 8.25 dv.

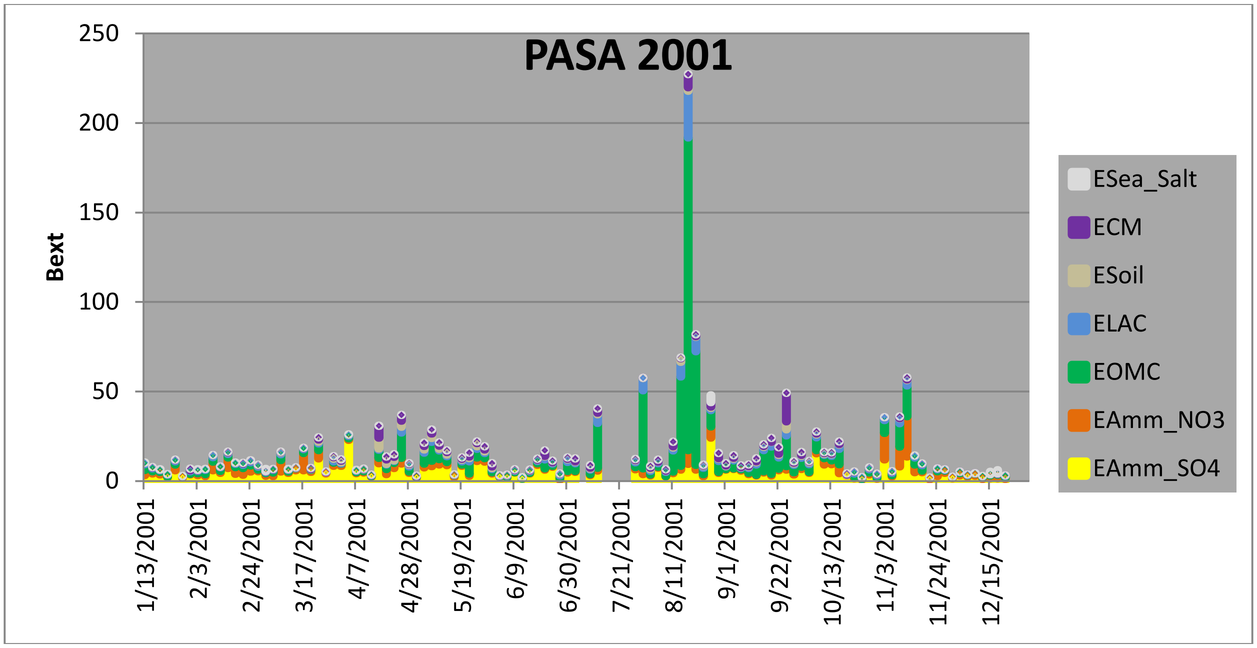
The average visibility on the 20% worst days for 2010 – 2014 period was 13.14 dv, which is better visibility than the reasonable progress goal but not the uniform rate of progress values. The continued visibility improvement on the 20% worst days was in spite of the high quantity of fire induced visibility impairment in 2012 and 2014.

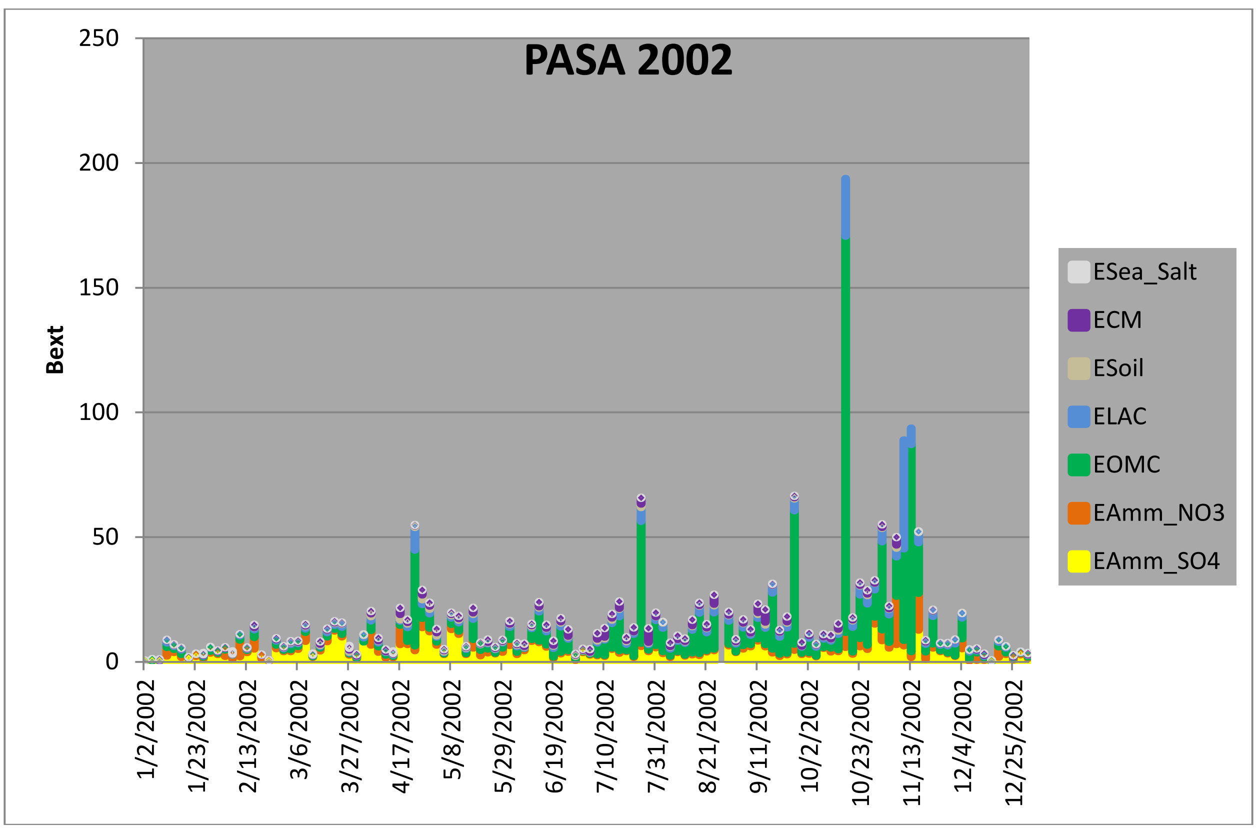
The average visibility during the best 20% days over the most recent 5 years is 1.82 dv.

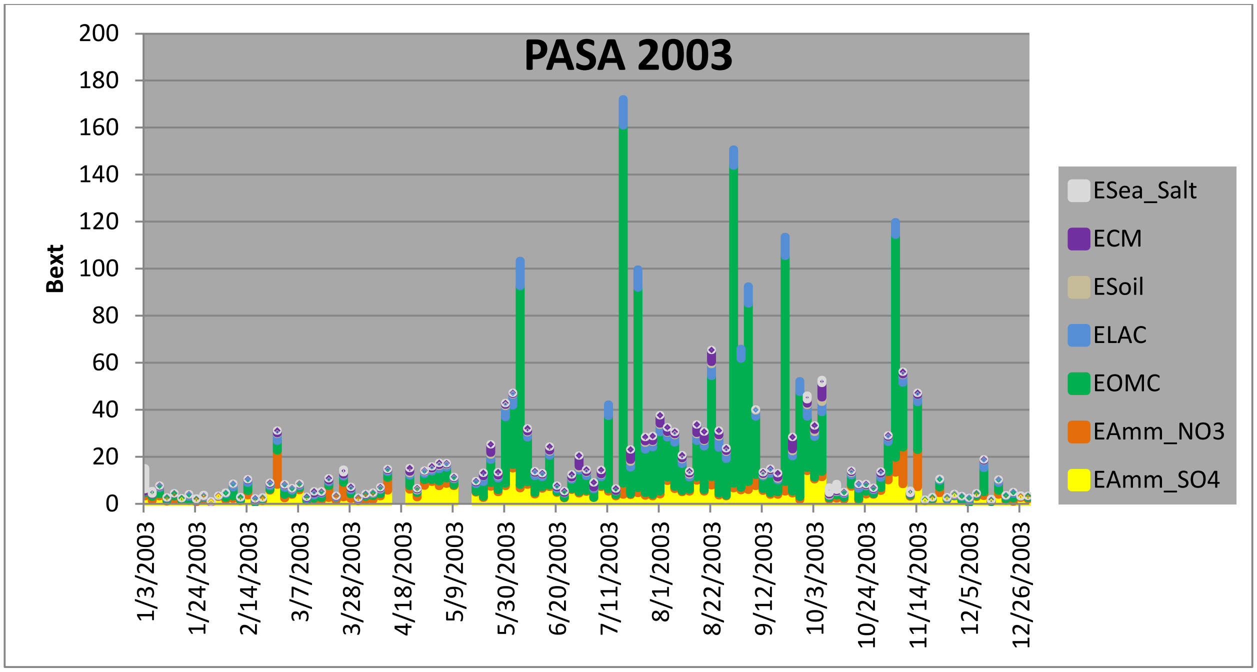
The graph at the top of this page depicts the visibility trends for this monitor since 2001. Even though the absolute worst day of each year shows significant year to year variability and the average of the worst 20% days each year varies between years, the 5 year average of the 20% worst days has continued a long term trend of visibility improvement. On the best days, the visibility trend shows steady improvement in visibility.

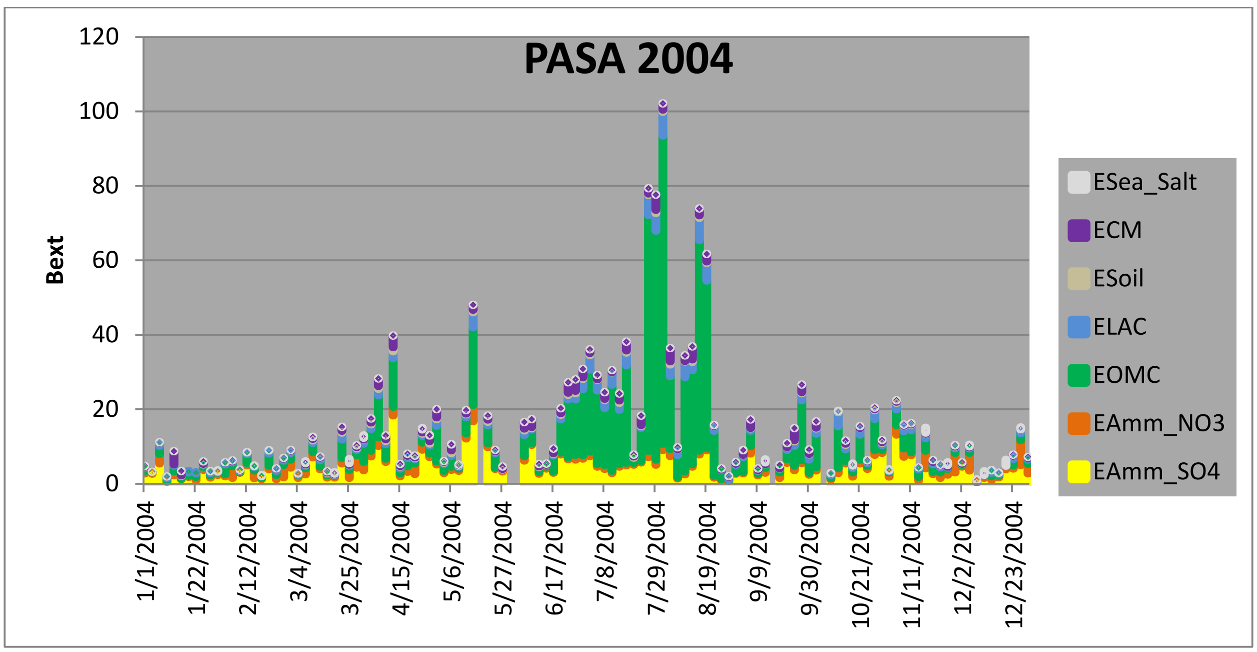
[1] The uniform glide path value is the starting place to develop a Reasonable Progress Goal. The uniform rate of progress represents the linear rate of visibility improvement required to meet the 2064 visibility goal in 2064.

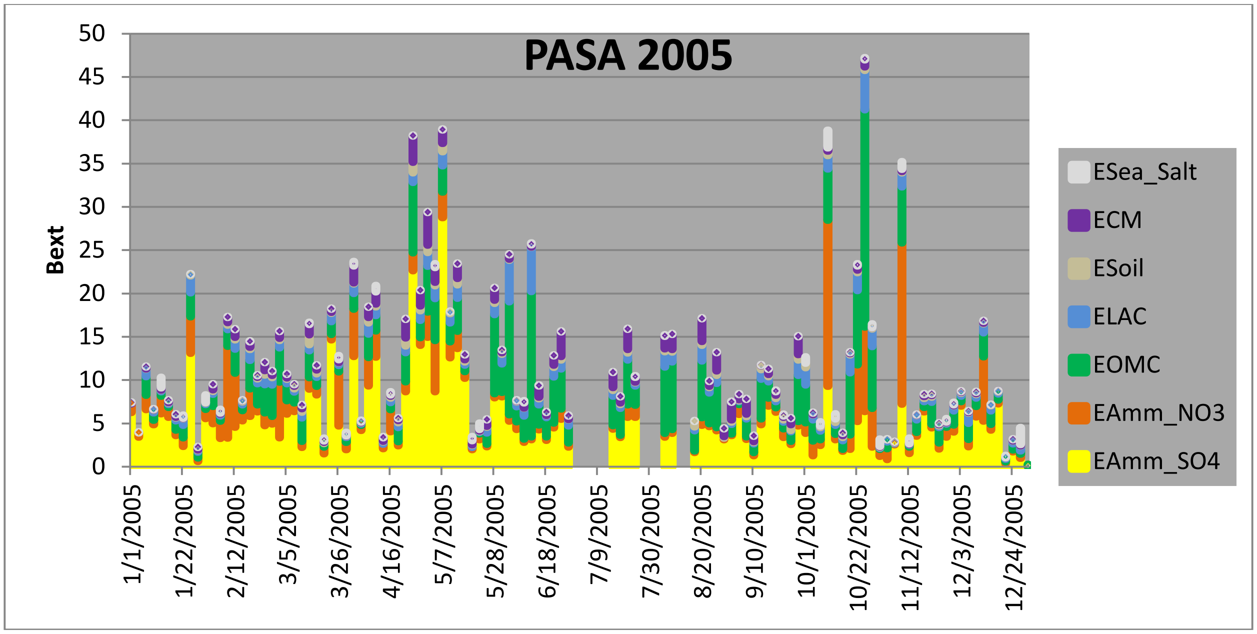
The following are graphs of the reconstructed light extinction ($B_{ext}$) for each year during the 2001 – 2014 period. The values show the relative contribution of the chemical types incorporated into the revised IMPROVE light extinction calculation. NOTE each graph has a different maximum value.

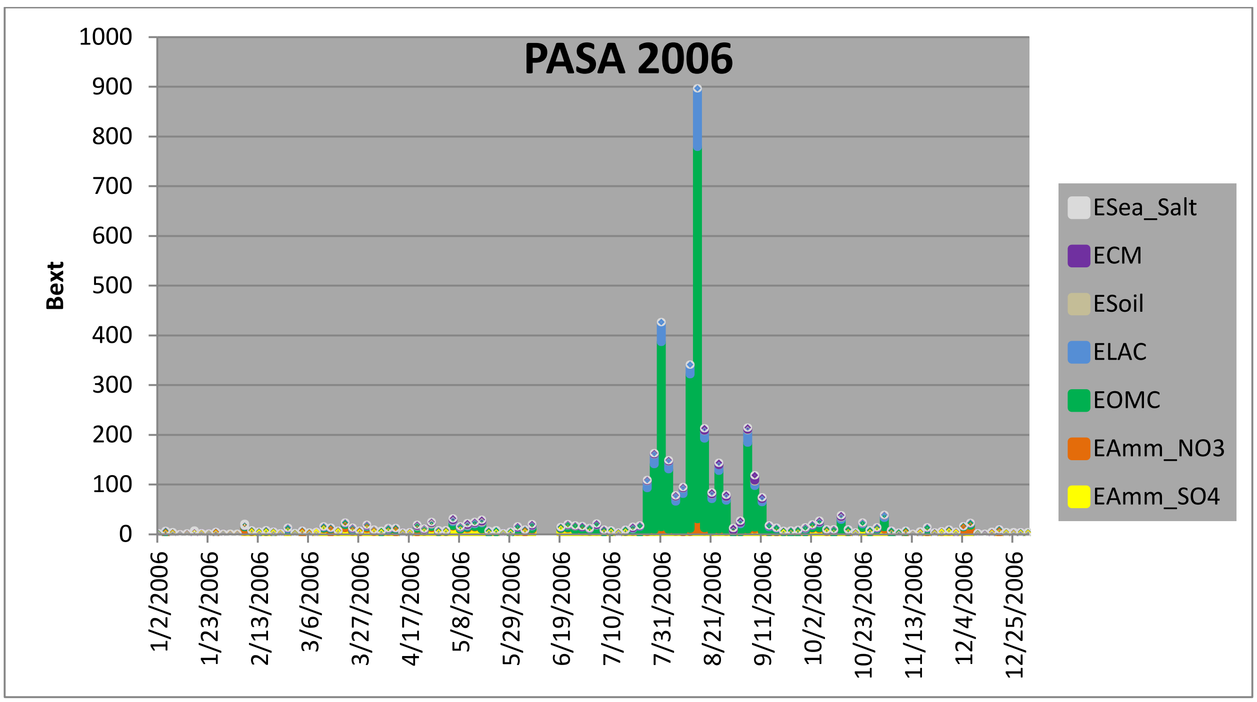


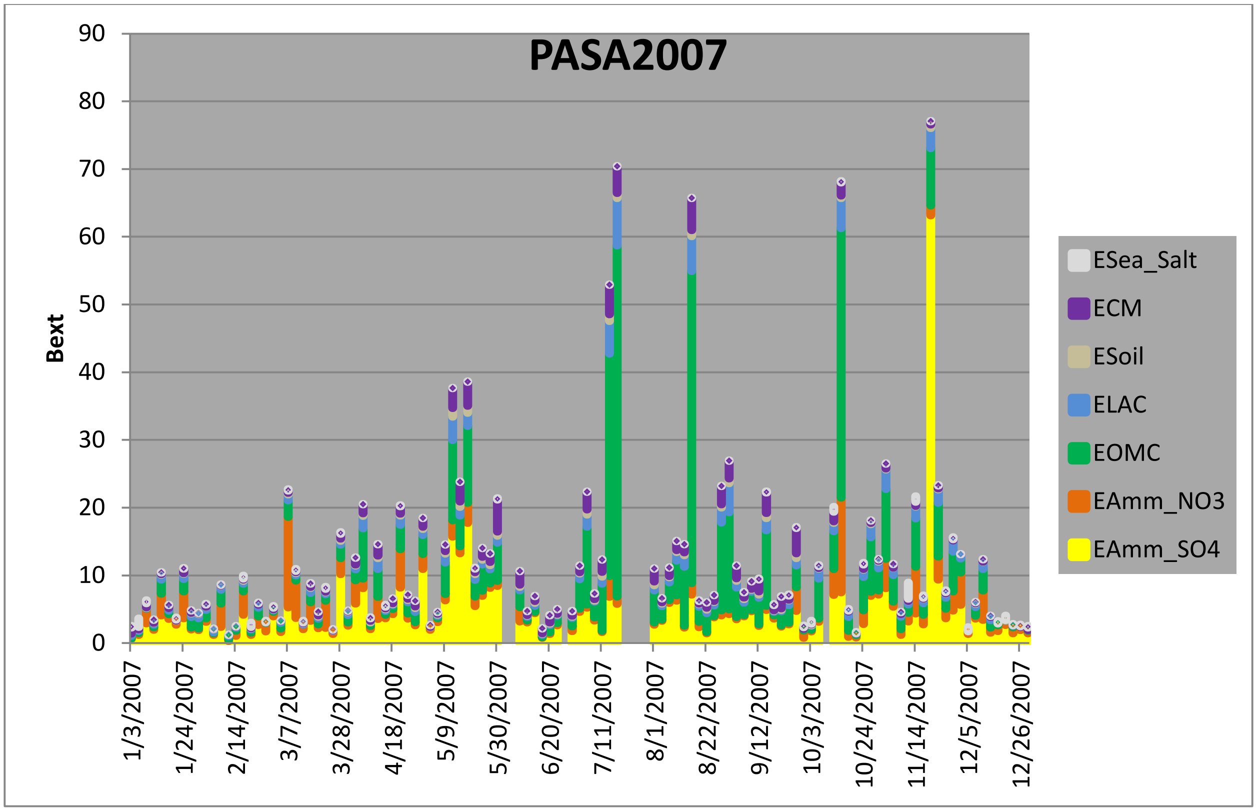

PASA 2003
Bext
200
180
160
140
120
100
80
60
40
20
0
1/3/2003
1/24/2003
2/14/2003
3/7/2003
3/28/2003
4/18/2003
5/9/2003
5/30/2003
6/20/2003
7/11/2003
8/1/2003
8/22/2003
9/12/2003
10/3/2003
10/24/2003
11/14/2003
12/5/2003
12/26/2003
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

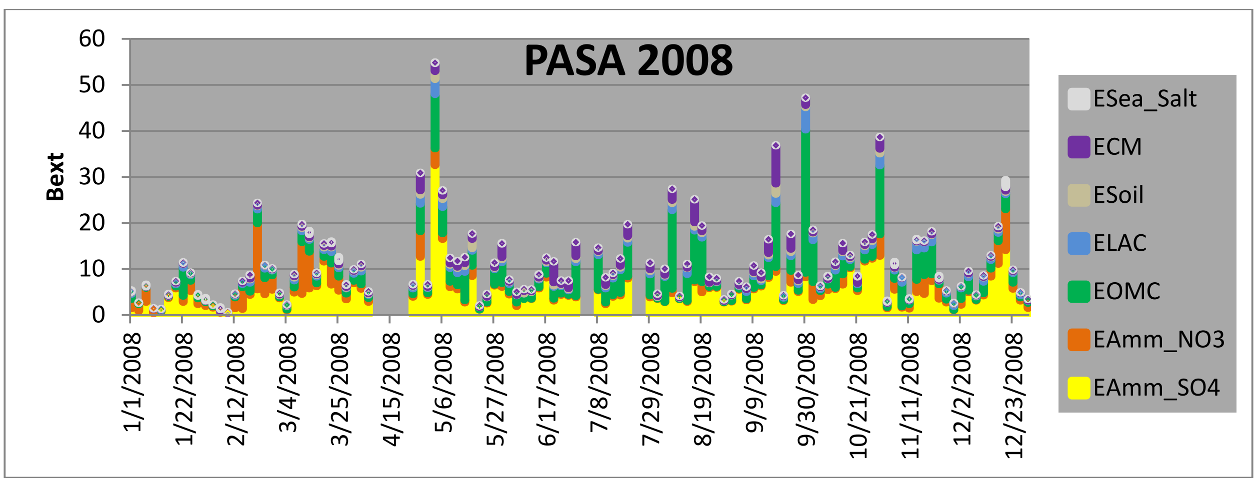

PASA 2004
Bext
120
100
80
60
40
20
0
1/1/2004
1/22/2004
2/12/2004
3/4/2004
3/25/2004
4/15/2004
5/6/2004
5/27/2004
6/17/2004
7/8/2004
7/29/2004
8/19/2004
9/9/2004
9/30/2004
10/21/2004
11/11/2004
12/2/2004
12/23/2004
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

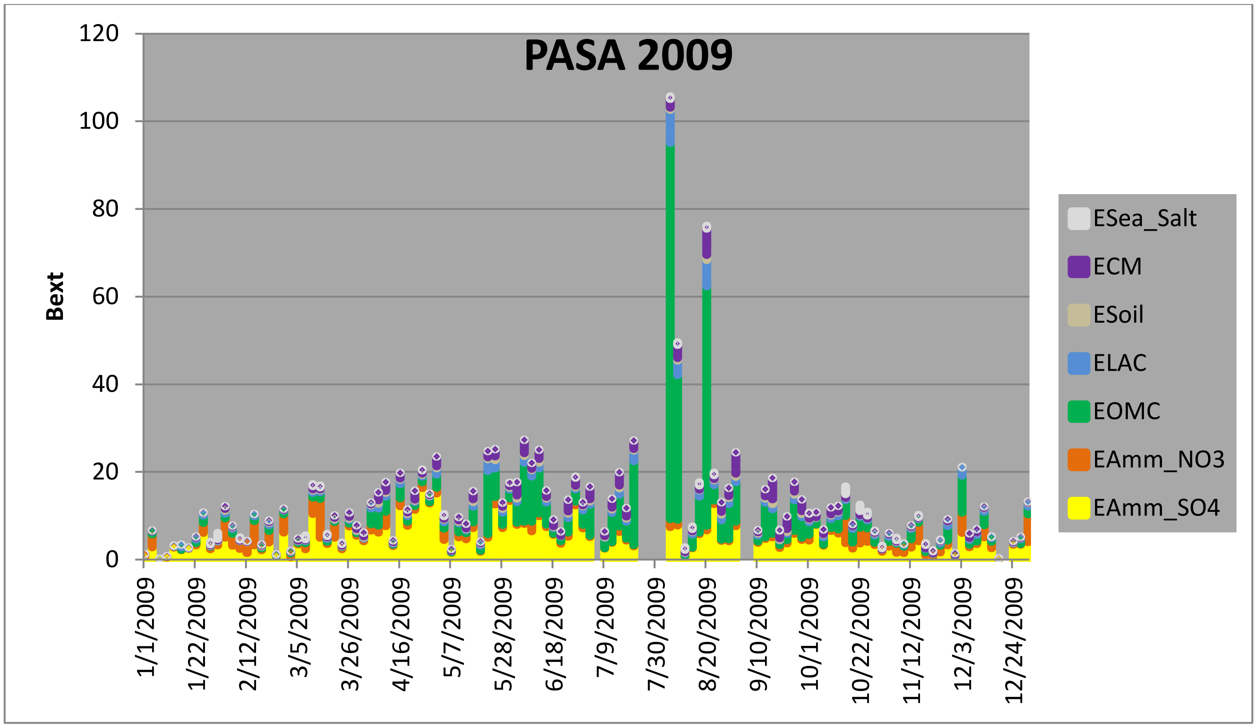


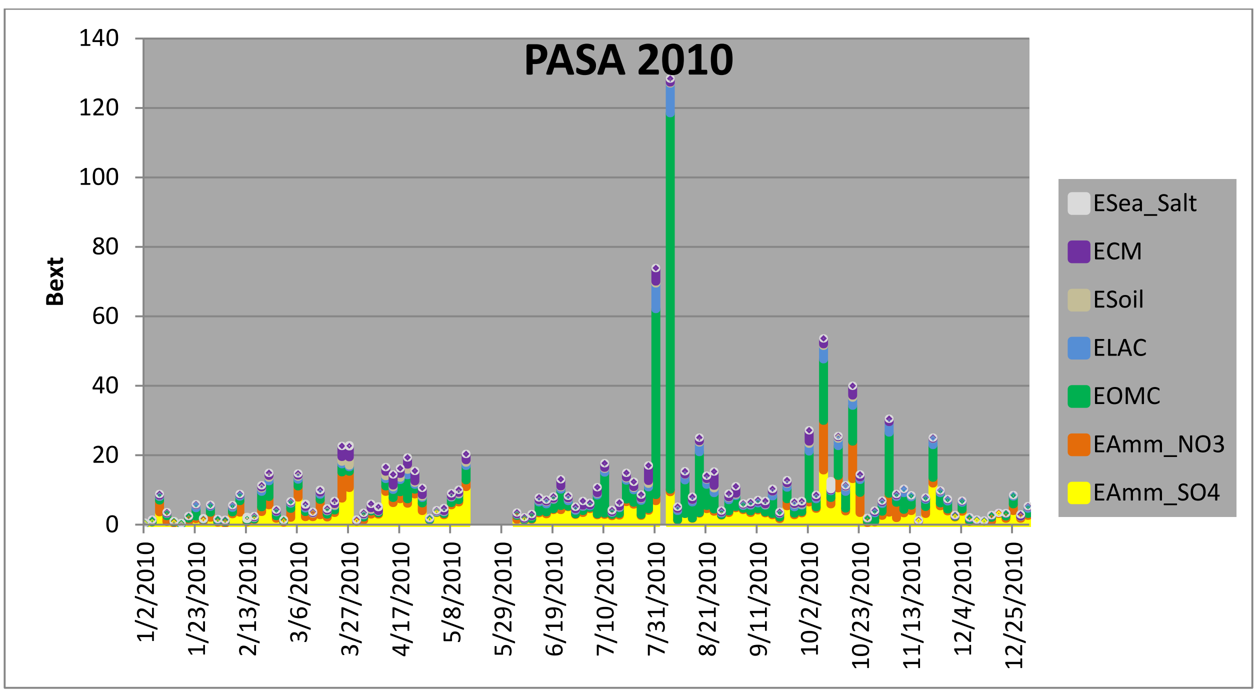




As can be seen, this year was heavily dominated by wildfire in the nearby Loomis State forest. This fire took several weeks to control and caused visibility impairment from its smoke plume in adjoining states and British Columbia. When changing the scale of the graph to evaluate the non-wildfire days, the remaining days are similar in magnitude to other years.


PASA2007
Bext
90
80
70
60
50
40
30
20
10
0
1/3/2007
1/24/2007
2/14/2007
3/7/2007
3/28/2007
4/18/2007
5/9/2007
5/30/2007
6/20/2007
7/11/2007
8/1/2007
8/22/2007
9/12/2007
10/3/2007
10/24/2007
11/14/2007
12/5/2007
12/26/2007
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


PASA 2008
Bext
60
50
40
30
20
10
0
1/1/2008
1/22/2008
2/12/2008
3/4/2008
3/25/2008
4/15/2008
5/6/2008
5/27/2008
6/17/2008
7/8/2008
7/29/2008
8/19/2008
9/9/2008
9/30/2008
10/21/2008
11/11/2008
12/2/2008
12/23/2008
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


PASA 2009
Bext
120
100
80
60
40
20
0
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4
1/1/2009
1/22/2009
2/12/2009
3/5/2009
3/26/2009
4/16/2009
5/7/2009
5/28/2009
6/18/2009
7/9/2009
7/30/2009
8/20/2009
9/10/2009
10/1/2009
10/22/2009
11/12/2009
12/3/2009
12/24/2009


PASA 2010
Bext
140
120
100
80
60
40
20
0
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4
1/2/2010
1/23/2010
2/13/2010
3/6/2010
3/27/2010
4/17/2010
5/8/2010
5/29/2010
6/19/2010
7/10/2010
7/31/2010
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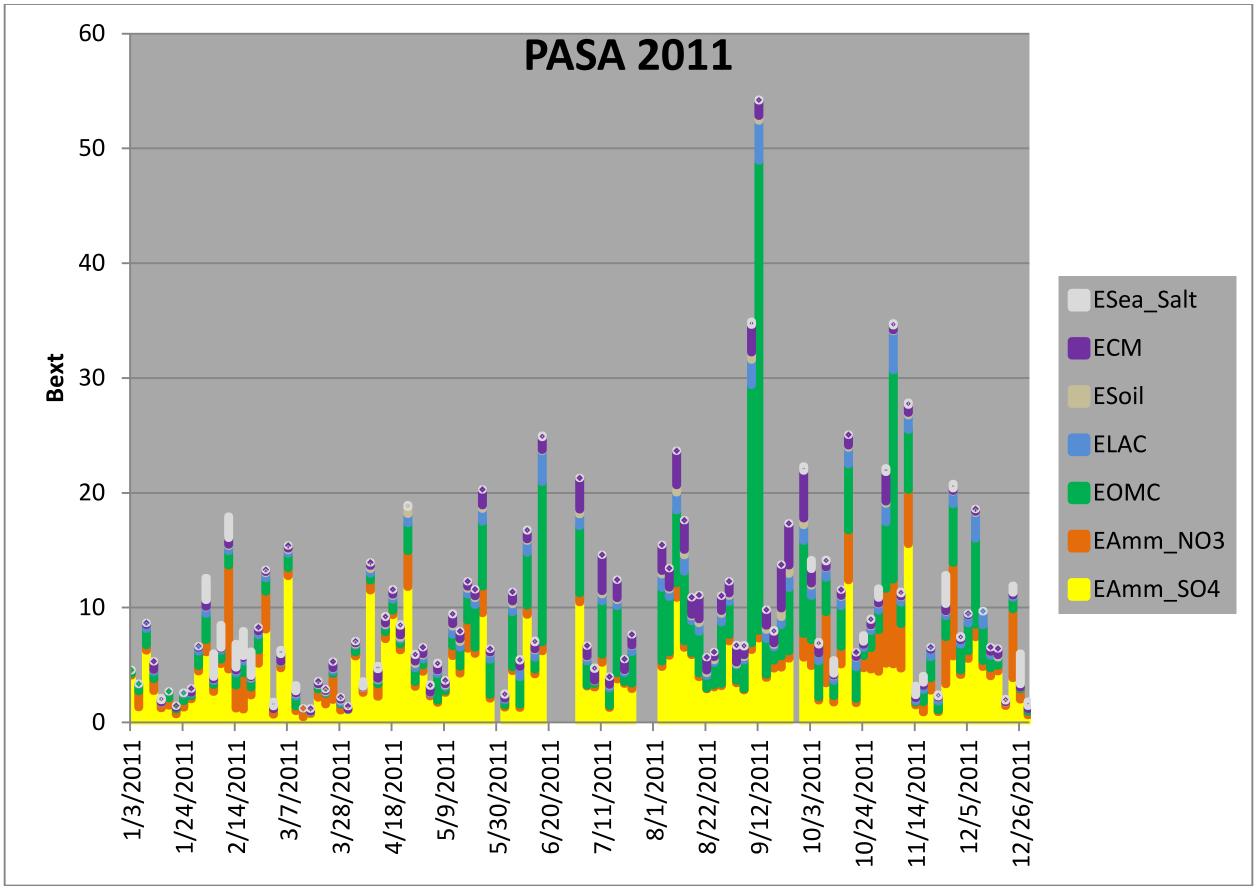
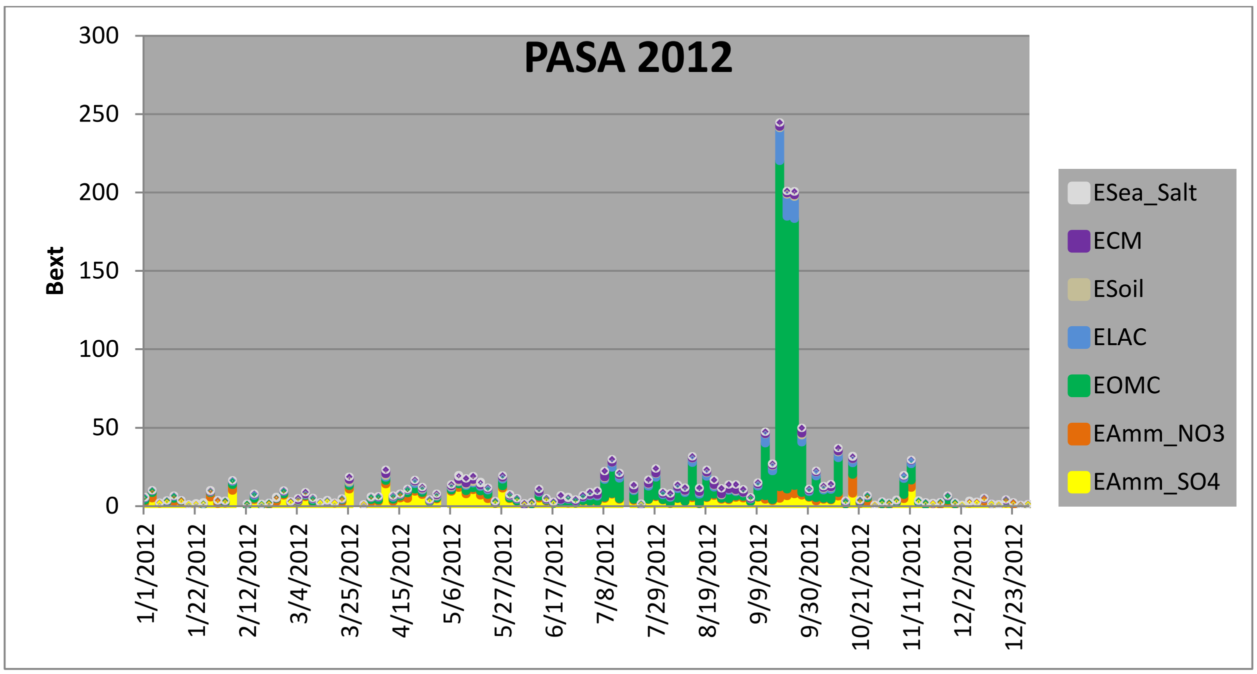
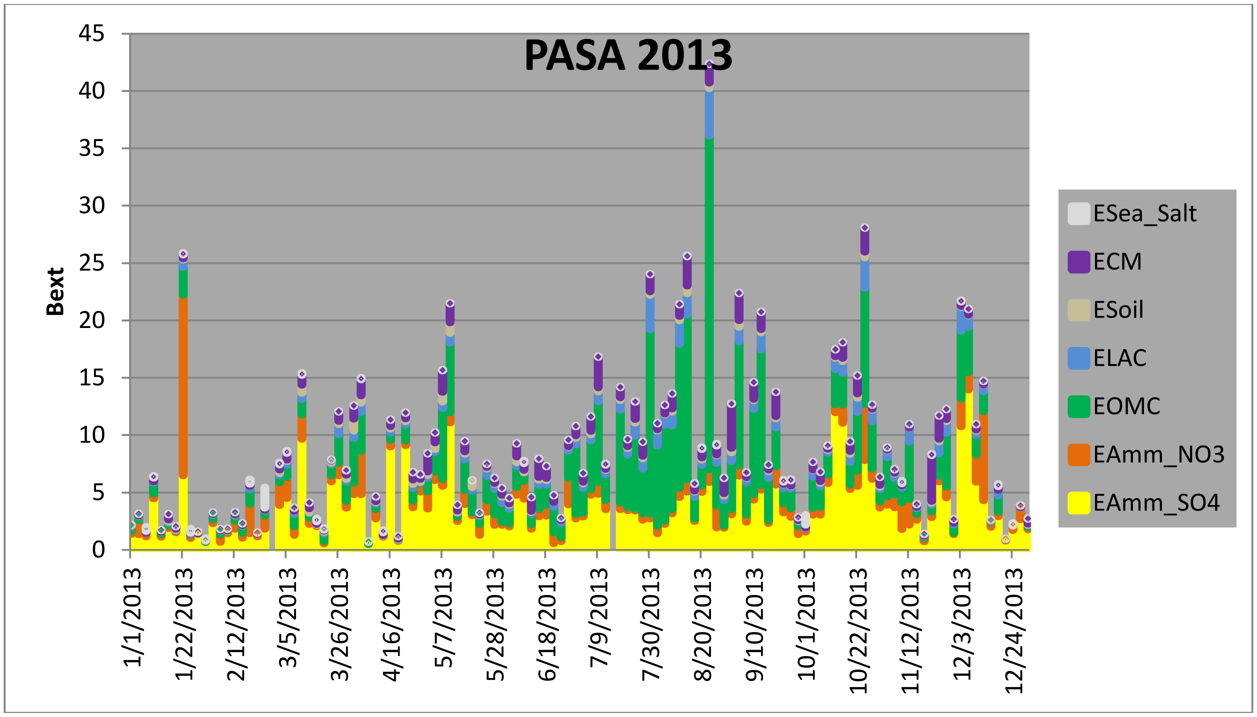
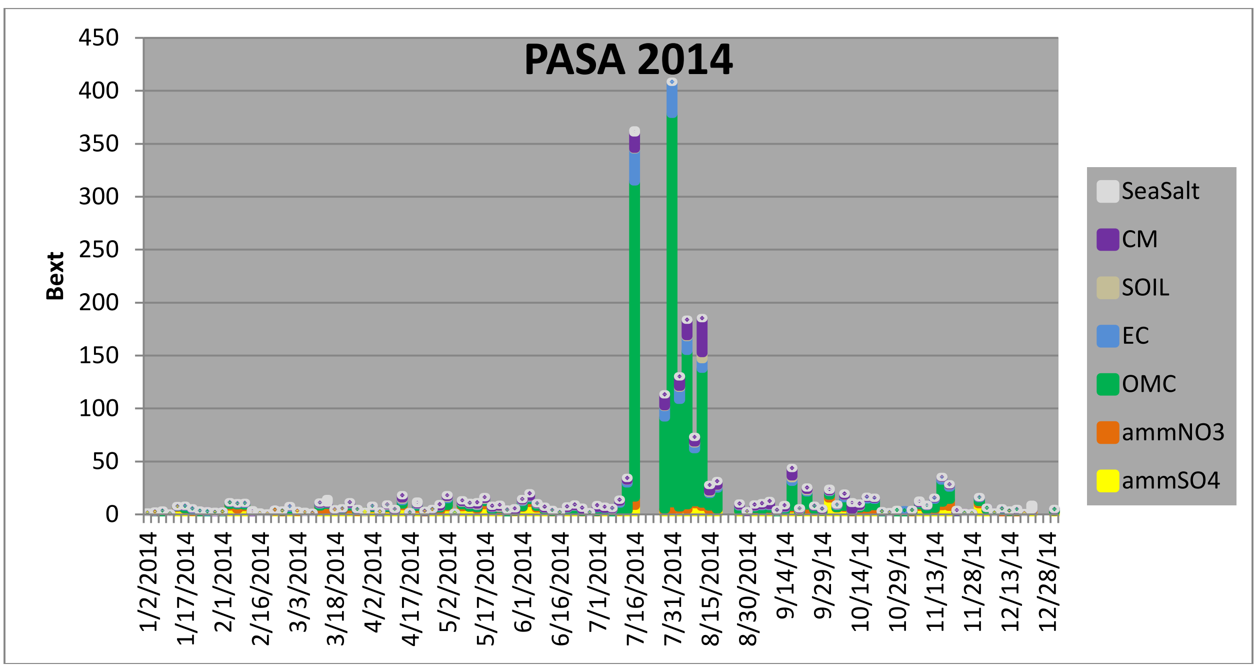
9/11/2010
10/2/2010
10/23/2010
11/13/2010
12/4/2010
12/25/2010


PASA 2011
Bext
0
10
20
30
40
50
60
1/3/2011
1/24/2011
2/14/2011
3/7/2011
3/28/2011
4/18/2011
5/9/2011
5/30/2011
6/20/2011
7/11/2011
8/1/2011
8/22/2011
9/12/2011
10/3/2011
10/24/2011
11/14/2011
12/5/2011
12/26/2011
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4


PASA 2012
Bext
0
50
100
150
200
250
300
1/1/2012
1/22/2012
2/12/2012
3/4/2012
3/25/2012
4/15/2012
5/6/2012
5/27/2012
6/17/2012
7/8/2012
7/29/2012
8/19/2012
9/9/2012
9/30/2012
10/21/2012
11/11/2012
12/2/2012
12/23/2012
ESea_Salt
ECM
ESoil
ELAC
EOMC
EAmm_NO3
EAmm_SO4

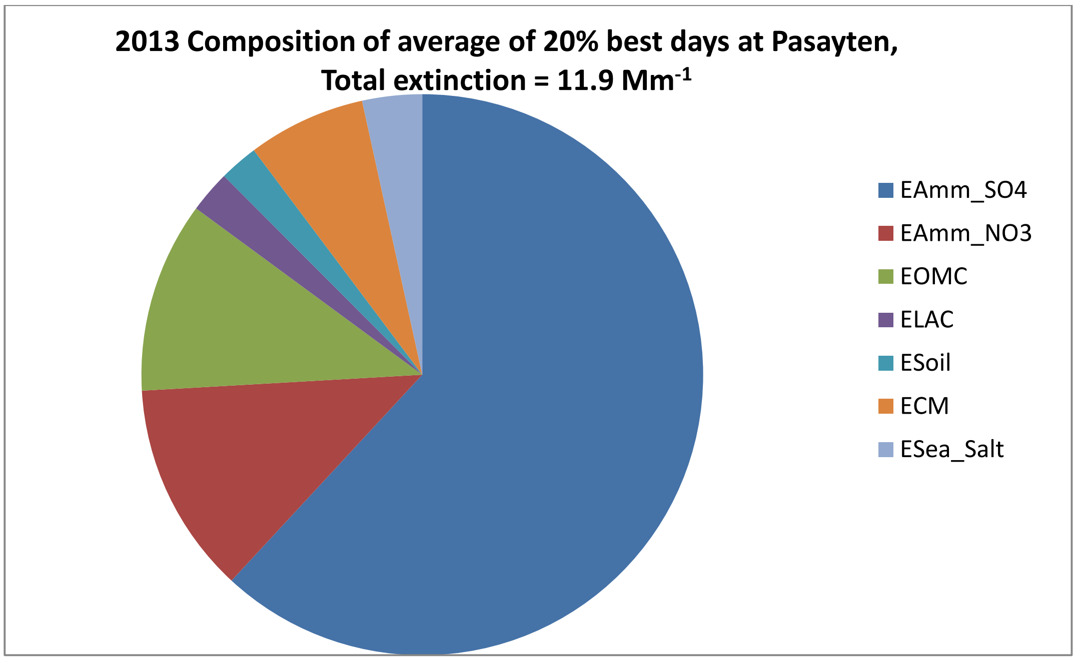


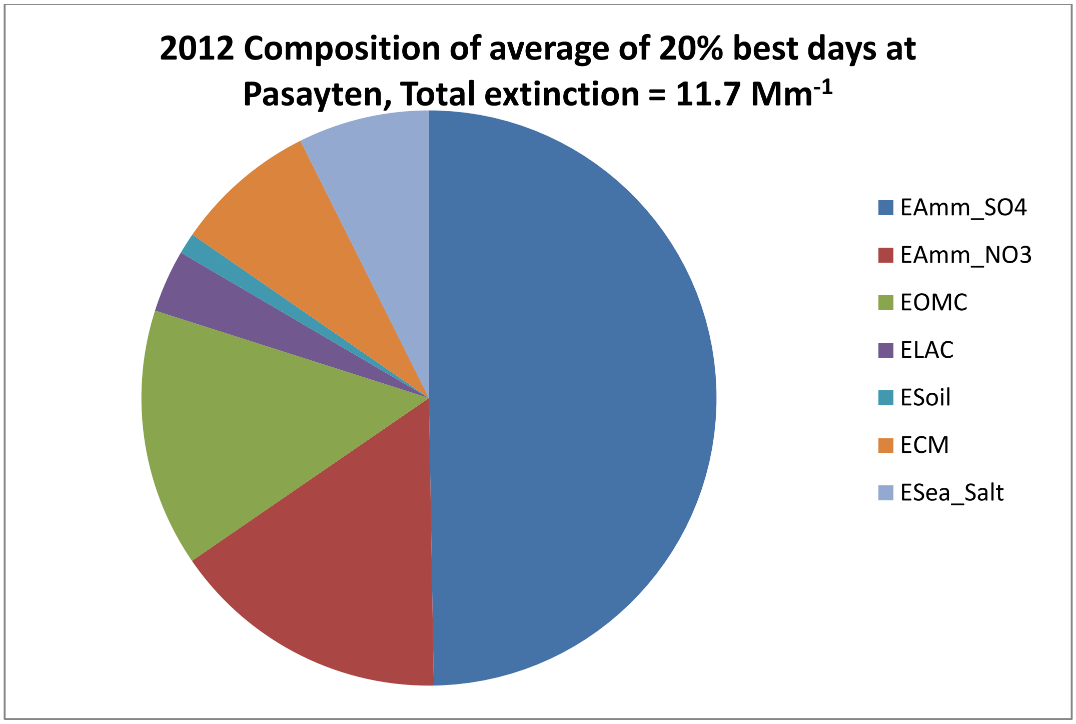



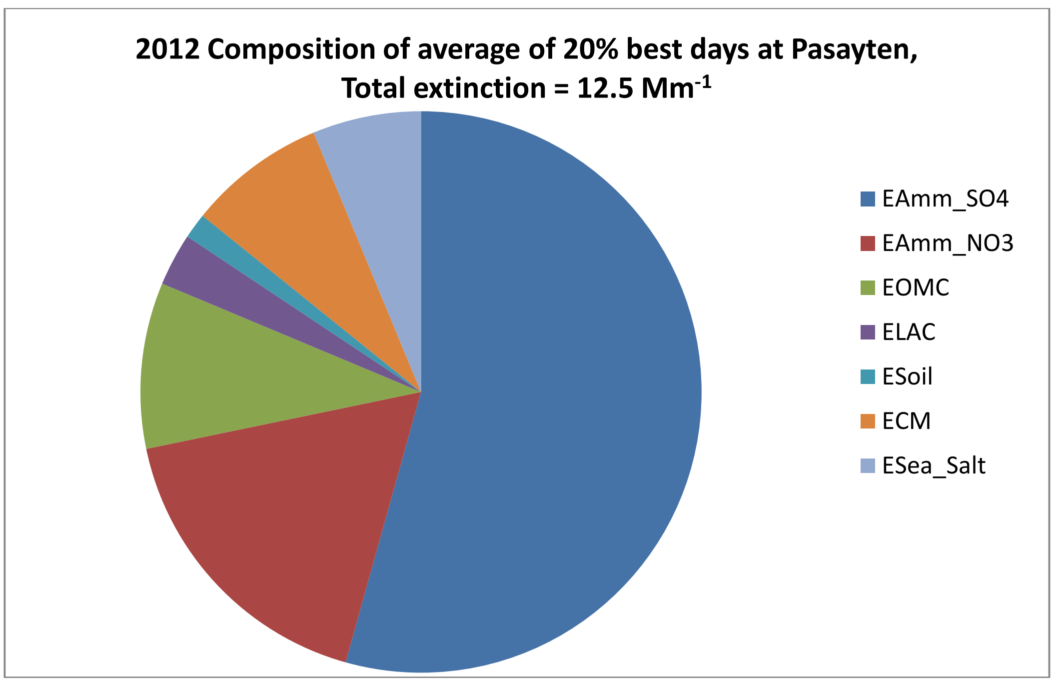

As can be observed, this site was significantly impacted by smoke from wildfires mid-July and mid-August 2014. On the worst days in this period the aerosol extinction was over 350 $Mm^{-1}$ on 2 days and above 100 $Mm^{-1}$ on 6 days. The worst day, July 31, is not part of the calculation of worst days due to missing data from the monitor (no samples for elemental carbon and coarse soil). The 409 $Mm^{-1}$ value that day is 90% due to organic matter. For comparison the average of the 20% worst days with complete data was only 73 $Mm^{-1}$. On one day in in this period, the IMPROVE database indicates the operators log noting “fire on opposite ridge”.

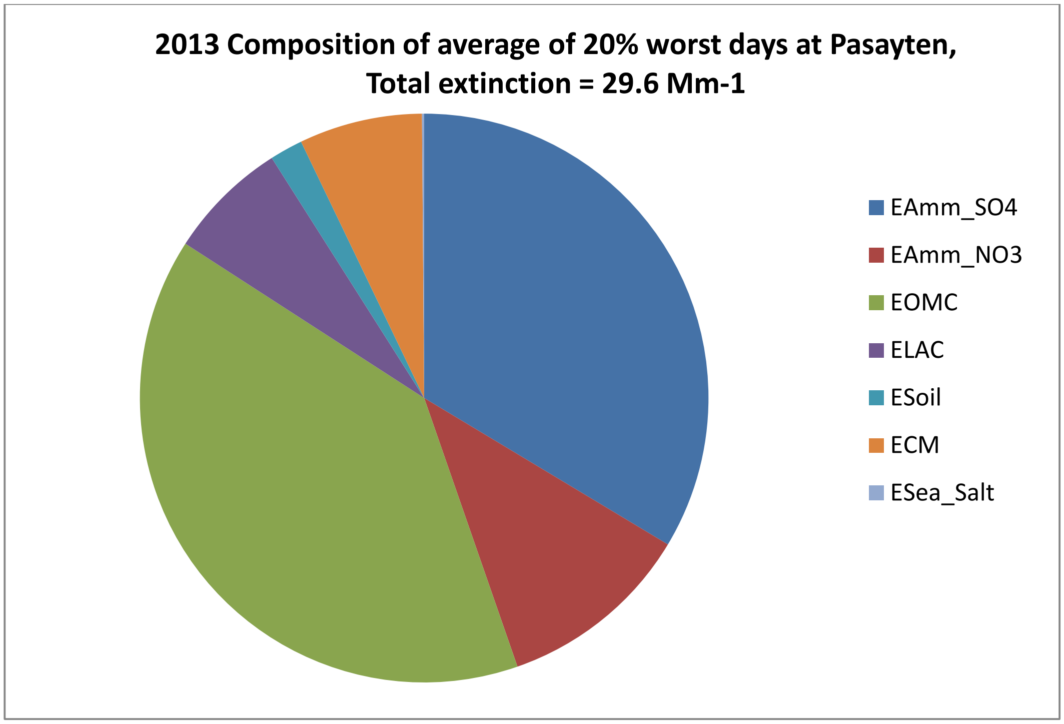
The following pie charts compare the average relative visibility impairment by the primary haze-causing pollutant species for the years 2011 – 2013. The charts show the relative composition on the average of the 20% best and worst days for each of these years. Note that on the best days, this monitor is heavily impacted by sulfates. However on the worst days, and indicated in the yearly graphs above, organic carbon from wildfires is the predominant source of visibility impairment.

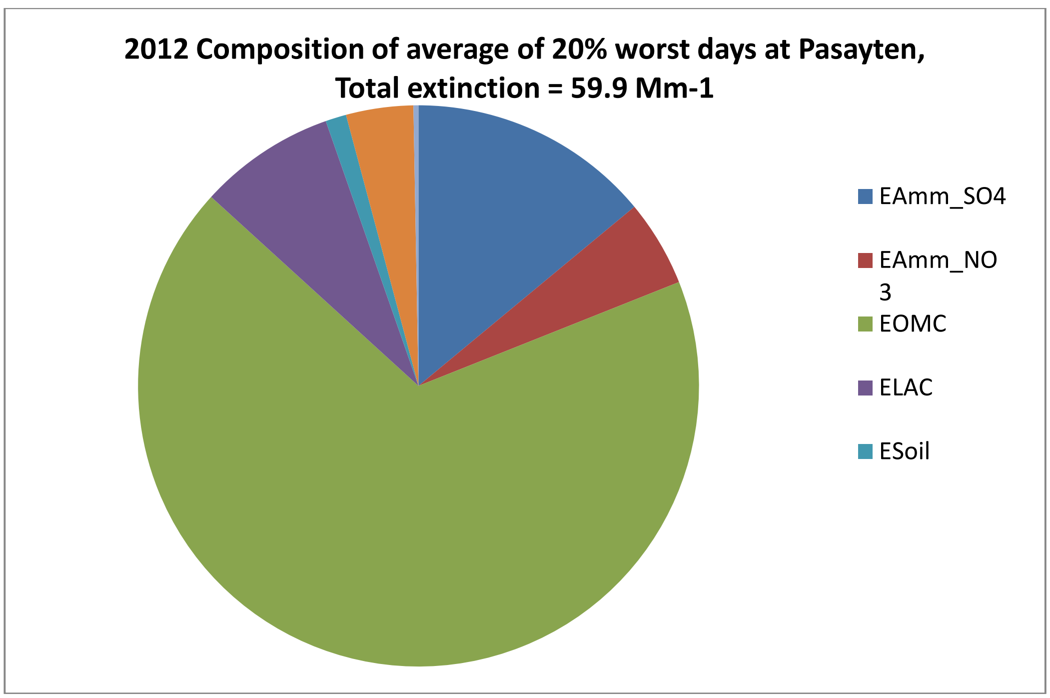
In 2012, a year with significant local wildfires, organic carbon made up almost 75% of the impairment measured on the worst days. Meanwhile on the other 2 years organic carbon made up almost 1/3 of the impairment on the worst days, and more on individual days.

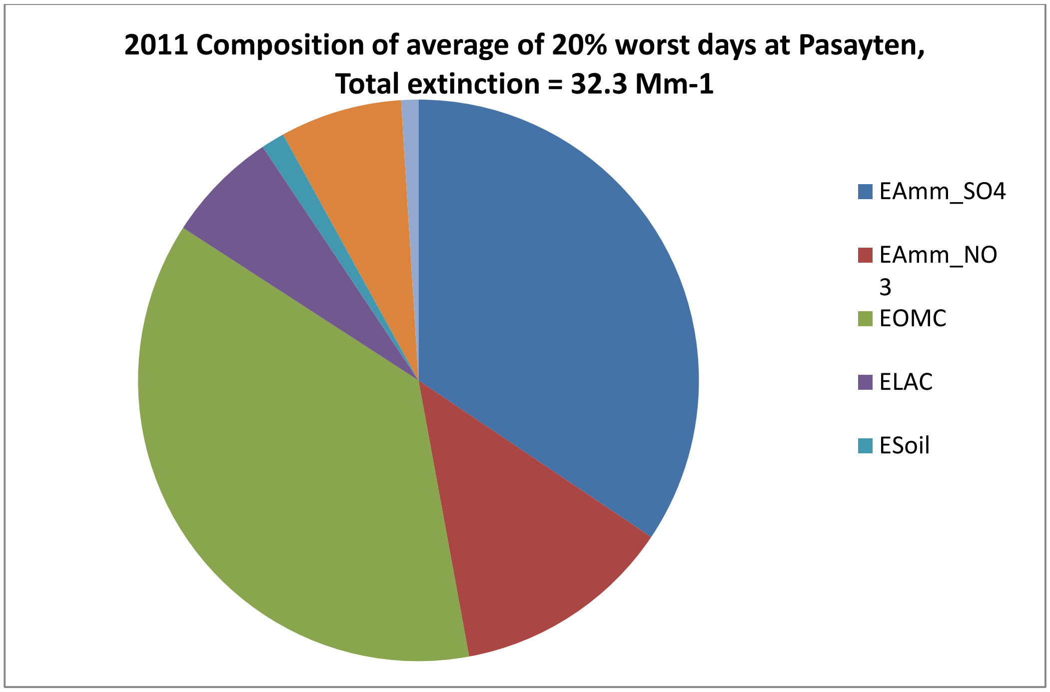



2012 Composition of average of 20% best days at Pasayten, Total extinction = 11.7 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt

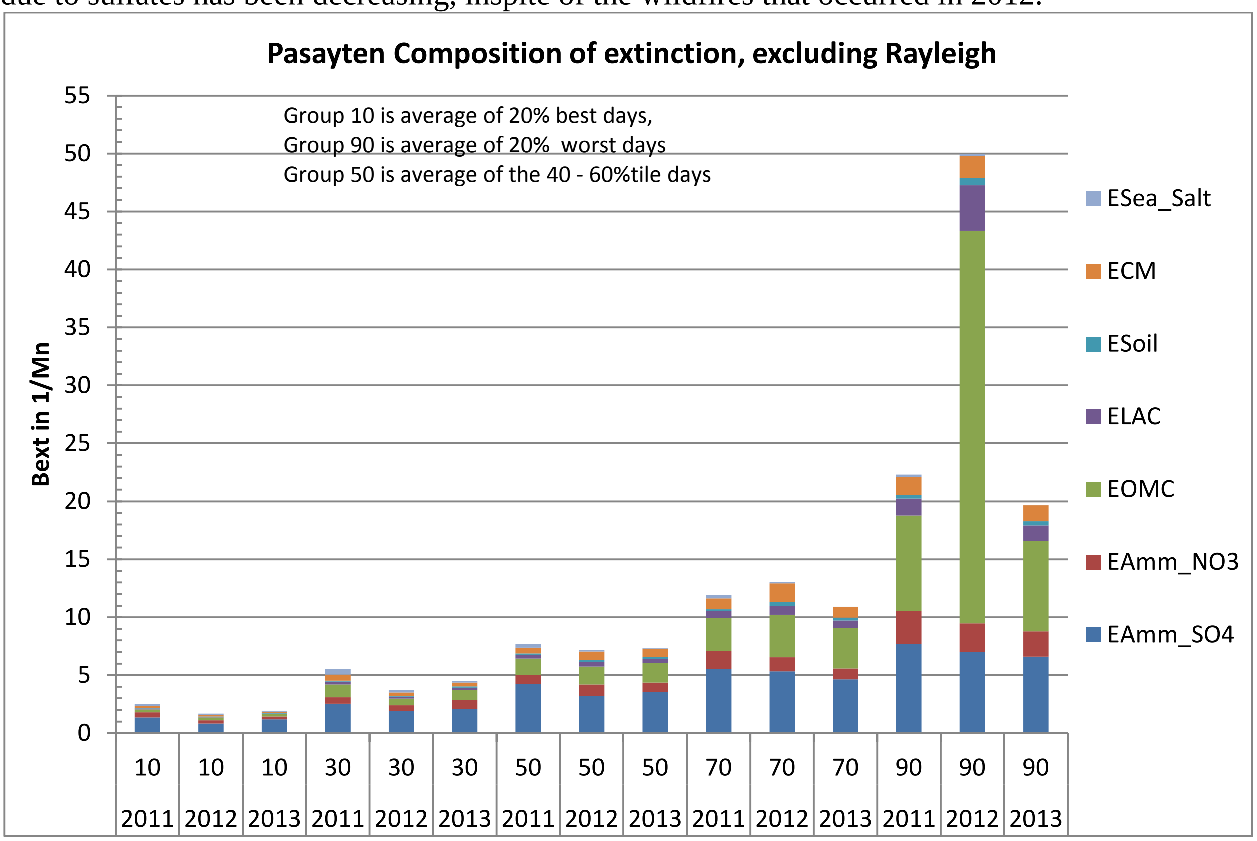

2012 Composition of average of 20% best days at Pasayten, Total extinction = 12.5 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt


2013 Composition of average of 20% worst days at Pasayten,
Total extinction = 29.6 Mm-1
EAmm_SO4
EAmm_NO3
EOMC
ELAC
ESoil
ECM
ESea_Salt

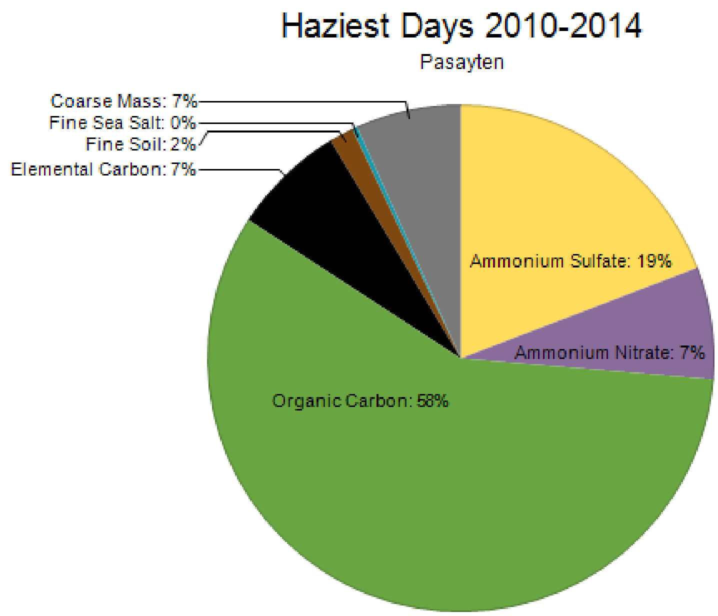

2012 Composition of average of 20% worst days at Pasayten,
Total extinction = 59.9 Mm-1
EAmm_SO4
EAmm_NO
3
EOMC
ELAC
ESoil




The following graph indicates that on all days, the relative percentage of visibility impairment due to sulfates has been decreasing, inspite of the wildfires that occurred in 2012.

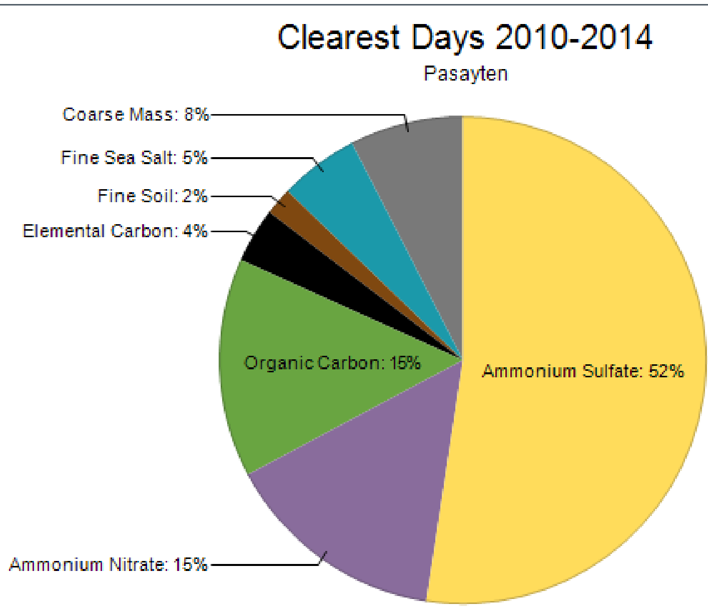


The following graphs produced by WRAP software show the 5 year average composition of the measured haze-causing pollutants on the worst 20% (haziest) and best 20% (clearest) days. Of note is the average composition of the aerosols producing visibility impairment on the worst days is dominated by organic carbon, while on the best days, it is dominated by ammonium sulfate.




The chart above illustrates particle contribution to light extinction on haziest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: PASA1, WA




The chart above illustrates particle contribution to light extinction on clearest days. Light extinction is the gradual loss in light intensity due to scattering and absorption measured in inverse megameters (1/Mm).

IMPROVE Monitor ID: PASA1, WA

# Appendix D. Technical Analysis of Factors Impeding Progress

## Appendix D: Technical Analysis of Factors Impeding Progress

The emission inventories discussed in Appendix B show significant decreases in the emissions of visibility impairing air pollutants and precursor pollutants over the past decade. However, there are still some specific source types and locations where possible further progress remains to be achieved. Some of these specific source types and locations can be controlled by actions of the Washington Department of Ecology, others are out of the control of the Department.

In general the most significant uncontrollable impediment to achieving the national visibility goal of 'natural conditions' comes from wildfires which are projected to grow in severity and frequency as climate change continues. The effect of wildfires on progress is discussed below.

The Department has control over stationary sources of air pollution located in Washington and has limited control over emissions resulting from mobile sources and residential activities such as home heating and open burning. With few exceptions, the stationary sources do not dominate the days with the worst visibility impairment at Washington's mandatory federal Class I areas. Other sources of anthropogenic generated visibility impairing emissions are not subject to control by the Department. This is evaluated in the following section.

### Impediments to progress resulting from Anthropogenic sources

#### Mobile source emissions

As was demonstrated in the 2010 Regional Haze Plan and substantiated in the emissions inventory in Appendix B, mobile sources are the dominant source of anthropogenic NOx and VOC emissions in Washington. With the reduction in motor vehicle fuel sulfur content over the past 15 years, the contribution of sulfur oxides from this source category to visibility impairment in the Class I areas has been reduced. Emission limitations on NOx and VOC emissions from motor vehicles along with requirements for increased fuel economy over the next decade will continue to reduce total emissions of NOx and VOCs from motor vehicles. Similarly programs in the State of Washington providing incentives and charging stations for electric vehicles will tend to reduce motor vehicle emissions.

Further progress in Washington in reducing emissions from mobile sources is dependent on actions of the federal government. Unlike California, the federal Clean Air Act limits the ability of states like Washington to limit motor vehicle emissions beyond the federal levels. The federal law only allows us to adopt California requirements that have been approved by EPA. Similarly the state is restricted in its ability to limit emissions from other mobile sources such as off-road (construction) vehicles, locomotives, and marine vessels. The state legislature can influence emissions from those marine vessels (ferries) that the state owns or contracts with, but these are a very small part of the total marine vessel emissions.

The Department is also limited in its ability to influence design choices in the state's transportation network. These decisions are made by intergovernmental transportation planning agencies and the state legislature. At this time, those decisions are only required to meet the general conformity requirements of EPA.

The marine vessel NOx and SOx reductions resulting from the SOx and NOx emission standards for ocean-going marine vessels resulting from the MARPOL VI NOx and fuel sulfur requirements, the more stringent Emission Control Area requirements for the US and Canadian West Coasts, and federal marine engine fuel sulfur content regulation for in-shore vessels all serve to reduce the impact of marine vessel emissions on visibility in Class I areas. In spite of the reductions the increase in ocean–going vessel entering and leaving Washington and southern British Columbia (BC) ports will eventually reduce the effects of these requirements.

International air pollutant transport

Class I areas in Washington, especially Olympic National Park, North Cascades National Park and the Pasayten Wilderness can be adversely impacted by emissions from Canada and marine vessels entering and leaving the Canadian ports of Victoria and Greater Vancouver. The modeling done by WRAP for the 2010 Regional Haze plan indicates that on some days, Canadian emissions are a significant portion of the total visibility impairment at these monitors. Anthropogenic emissions from the lower Fraser River delta area and Vancouver Island can be important portions of the visibility impairment at the Olympic and North Cascade National Parks. As shown in the discussion on wildfires, wildfires in eastern BC can adversely impact air quality throughout much of the state. The WRAP modeling indicates that wildfires and NOx sources in BC can be important contributors to poor visibly days at the Pasayten Wilderness.

While an important source of visibility impairing emissions, these Canadian emissions are not the primary source of visibility impairment at these Class I Areas. This may change in the future as additional reductions in controllable Washington emissions occur.

Transpacific transport of visibility impairing pollutants from Asia were demonstrated by the WRAP modeling to be an important component of the visibility at most Class I Areas in the West. The Goat Rocks, Mt. Adams, and Alpine Lakes Wildernesses and North Cascades National Park are the Class I Areas that can be impacted by these transpacific pollutants. The Class I Areas with IMPROVE monitors at lower elevation such as the Olympic and Mt. Rainier National Parks are primarily influenced by more local, Washington sources.

Additional studies by researchers indicate that transpacific transport of air pollutants continues to be an important source of air pollutants in the western US[1].

Specific industrial operations

While most industries are well controlled and have limited opportunities for additional emission reductions, there are a specific industries whose emissions will continue to challenge our ability to continue to make progress to the 2064 visibility goal.

The Mt. Rainier National Park and the Goat Rocks IMPROVE monitors are both directly influenced by emissions from the Centralia Power Plant. This plant is scheduled to have one of its 2 emission units cease operation in 2020, reducing the remaining impacts by half. Closure of the other unit in 2025 will remove remaining emissions and impacts. The IMPROVE monitoring indicates that closure of this power plant should result in a detectable improvement in visibility on the average and worst days. While visibility improvements and reductions in the portions of the visibility impairment due to sulfates and nitrates at these 2 Class I Areas has resulted from process improvements at the power plant, remaining reduction in impairment caused by sulfates and nitrates will await closure of this plant. As discussed and shown in Appendix C, the monitoring data shows visibility benefits when the power plant is not operating.

Visibility improvements measured by the Olympic National Park monitor is influenced by emissions from the Port Townsend Paper Co. mill and marine vessels. Marine vessel emission are discussed above, and are scheduled to go down. Port Townsend Paper was subject to BART and BART was determined to be the existing emission controls installed at the plant. Further reductions from this facility beyond those required by BART will occur via a future 4-factor analysis.

Affecting primarily the North Cascades and Olympic National Park's monitors, the emissions of NOx from petroleum refineries located in Whatcom and Skagit counties will continue to affect visibility at these

[1] Roklin J. Park et al, 2006, Regional visibility Statistics in the United States: Natural and transboundary pollution influences , and the implications for the Regional Haze Rule, J. Atmospheric Environment, 40 5405-5423

monitors.  Great progress has been made in reductions in SOx from these refineries since the baseline inventory.  This can be seen in the emission inventory information presented in Appendix B.

A challenge to additional visibility improvement at these Class I Areas comes from the $SO_2$ emissions from the Intalco Aluminum smelter in Whatcom County and to a much lesser extent the Alcoa smelter in Chelan County.  At both of these smelters, The BART process determined that there were no economically viable $SO_2$ controls that could be implemented by the smelters beyond controlling the sulfur content of petroleum coke used to make anodes.  Additional $SO_2$ control may result from ongoing work related to attainment designations for the 2010 SOx ambient air quality standard.

A review of the emission inventory data shows a dearth of individual sources with significant emissions of visibility impairing precursors beyond those discussed above.  In Appendix E, we present the results of an evaluation of chemical pulp mill chemical recovery operations, which is an important source of SOx, NOx, and PM emissions.  This evaluation indicates that even if emission levels were reduced to the rates associated with the use of best available control technology, the visibility benefits are extremely small.

Impediments to progress resulting from Wildfires

As has been shown by WRAP in its analyses of regional Haze for all Western States use in their original Regional Haze Plans and 5 year reviews, smoke from wildfires is the single most significant impediment to meeting natural conditions in 2064. Washington's IMPROVE monitors show that wildfires in Washington and British Columbia can mask progress in reductions of controllable anthropogenic emissions. While not part of this review period, wildfires in British Columbia in July and August 2015 caused poor air quality throughout the Puget Sound Basin and in Eastern Washington.

As we show in Appendix C, organic carbon from wildfires has caused significant impediments to attaining the 2018 goals for the several monitors, especially from wildfires in 2010 and 2012. The following discussion indicates the potential size of the problem of wildfires on attaining both the interim goals and the ultimate visibility goal.

The IMPROVE monitoring date graphed in Appendix C indicate smoke events in 2010 and 2012 were severe enough to require further inspection.

In late July and early August 2010, there were numerous fires in British Columbia and some in north-Central Washington that adversely impacted visibility in Washington and many other states. The graphs for 2010 in Appendix C indicate that these fires impacted the highest day values for all of Washington's Class I areas except for Olympic National Park, which was isolated from the smoke by the Cascade Mountains. The following is an excerpt from the U. S. Air Quality Smog Blog archived at the UMBC[2]. This archive also contains entries from the entire month of August 2010 including the days leading up August 6. Reports and photos of the Pacific Northwest for July 31 and August 1 indicate the presence of smoke in Washington which is also shown in the IMPROVE monitoring data.

August 6, 2010
CODE ORANGE PM2.5 AND HIGH AOD[3] FROM SMOKE IN NORTHWEST;
NOAA's Hazard Mapping System (HMS, top) shows smoke covering much of Canada and parts of the United States. In the northwest, smoke from the wildfires in Canada, Oregon, and Washington covers Washington, Oregon, and California. MODIS TERRA[4] true color image (middle left) shows the smoke covering these states. The MODIS Terra AOD map (IDEA, middle right[5]) shows high AOD values over Washington and Oregon as a result of the smoke. PM2.5 levels (top bottom, courtesy AIRNow) in Oregon reached Code Yellow[6] (Moderate). Code Orange (Unhealthy for Sensitive Groups) PM2.5 levels were reported in Washington.

HMS also reports smoke from the Canadian fires extending into the U.S covering the states of Montana, North Dakota, South Dakota, Minnesota, Iowa, Illinois, Michigan, Indiana, Kentucky, Ohio, West Virgina, Pennslyvania, New York, and Vermont. The MODIS Terra AOD map shows moderate AOD levels in North Dakota, Iowa, Illinois, and Indiana. Code Yellow PM2.5 levels were reported across many of these states, with Code Orange PM2.5 levels reported in Minnesota.

Elsewhere, the MODIS Terra AOD map reports moderate to high AOD values in Nevada, Mississippi, Georgia, and

[2] Archive located at http://alg.umbc.edu/usaq/archives/2010_08.html last accessed on Oct. 2, 2015.
[3] AOD = Aerosol Optical Depth
[4] MODIS Terra is a satellite that produces high resolution images of the earth's surface.
[5] Not reproduced here. Refer to the web page in foot note 1.
[6] The color coding references the EPA Air Quality Index.

South Carolina. PM2.5 levels (bottom left, courtesy AIRNow) in the South and Mid-Atlantic region were mainly Code Yellow. In southern California, Code Orange PM2.5 levels were reported. Ozone levels (bottom right, courtesy AIRNow) were mostly good across the country. However, in southern California, Georgia, and Florida Code Orange ozone levels were reported.

Figures 1 and 2 accompanied the above entry showing the extent of the smoke and effects on PM2.5 monitors.

**Figure 1**, MODIS Terra image showing Northwest fires/smoke August 6, 2010. The fires are primarily in southern British Columbia, but smoke affects visibility and air quality throughout eastern Washington, including the Pasayten IMPROVE monitor. [7]

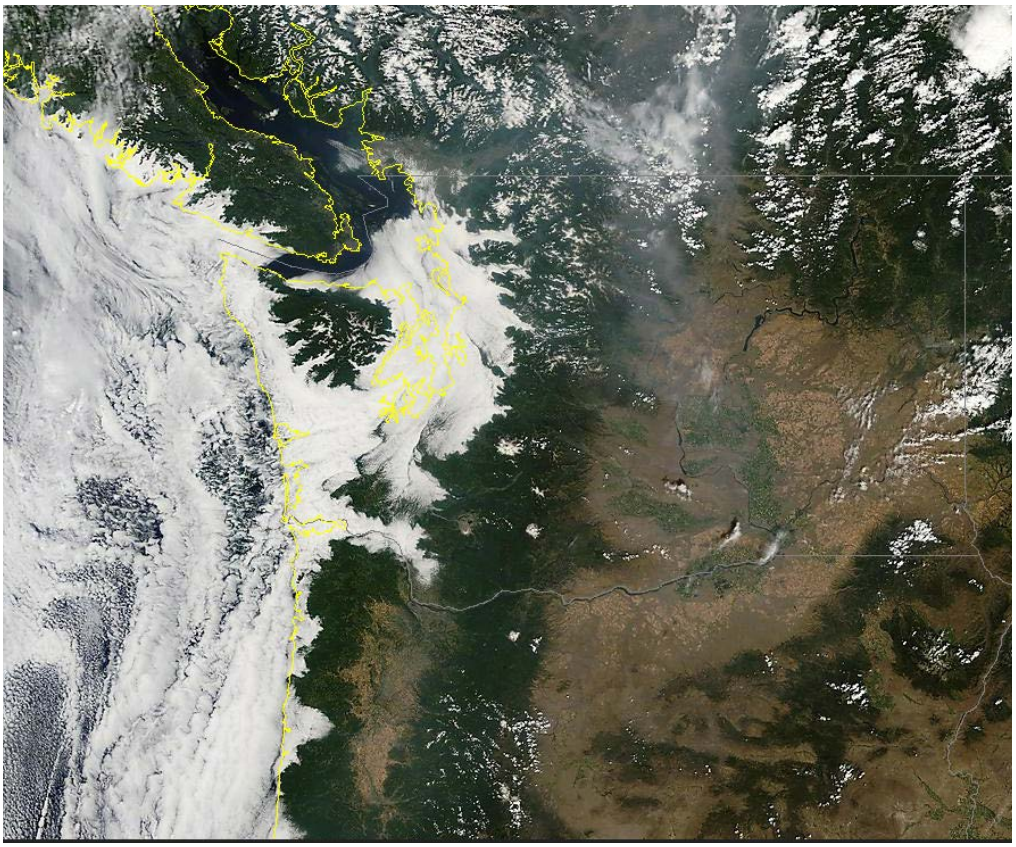
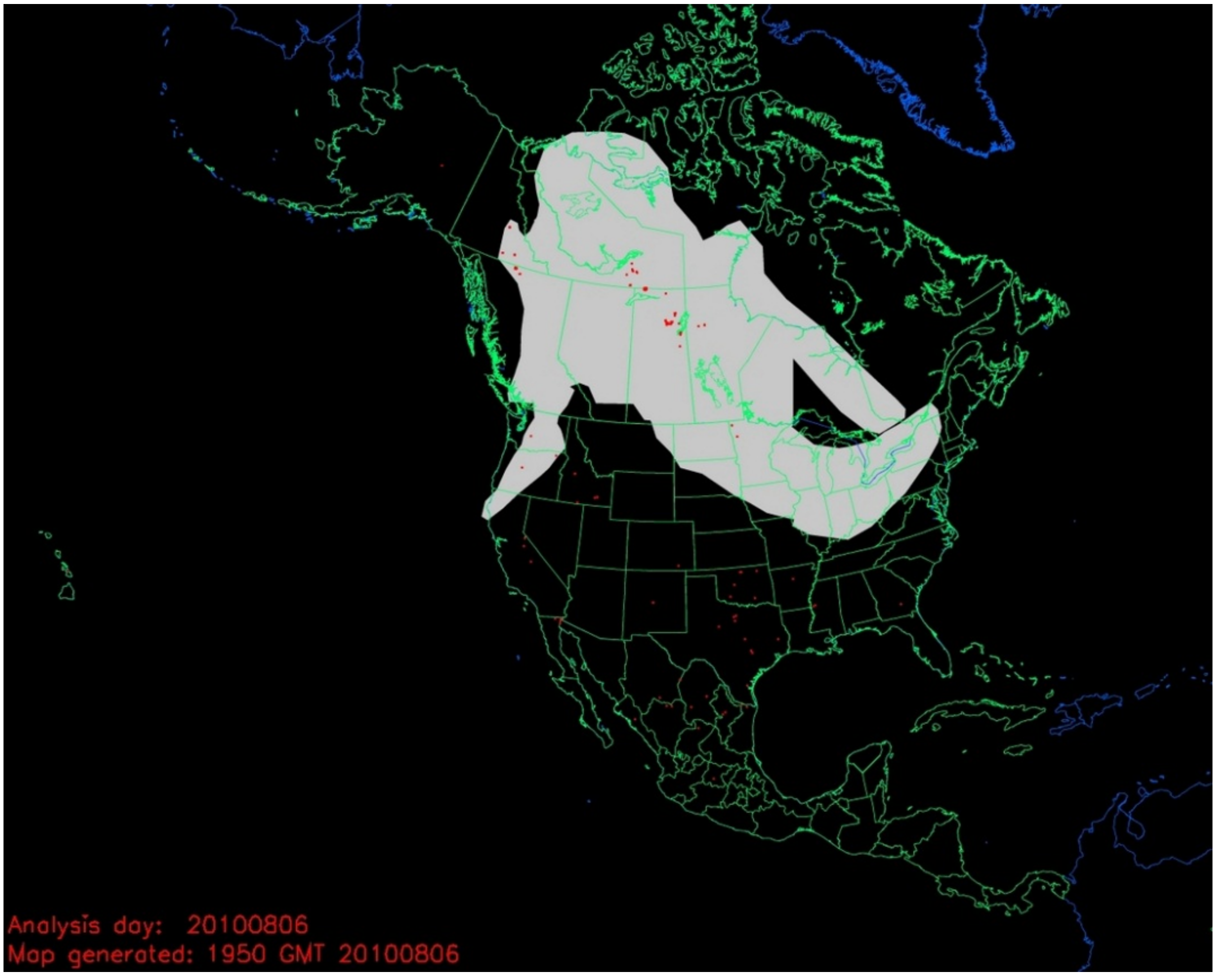


Figure 2 HMS 20100806.jpg image showing interpolated smoke plumes (gray) and locations of significant fires (red dots)

[7] This and other Images or graphics were obtained from the U.S. Air Quality Smog Blog (**http://alg.umbc.edu/usaq**).




In September 2012, again wildfires adversely affected most IMPROVE monitors in Washington. As occurred in 2010, the Cascade Mountains, protected the Olympic National Park monitor from the affects of these fires. The U. S. Air Quality Smog Blog archived at the UMBC for the month of Sept. 2012[8] discusses the dense smoke from wildfires in Washington and Canada adversely impact the air quality in Washington and other places in the US and Canada.

The posting from the Air Quality Smoke Blog for Sept. 20, 2012 says:

September 20, 2012

VERY UNHEALTHY PM2.5 LEVELS IN NORTHWEST; SMOKE MOVING SOUTHWARD TO THE PLAINS

Very unhealthy Air Quality was reached today in Idaho and Oregon where a very thick and large plume was emitted due to the fires in these regions (top left). PM2.5 concentrations were extremely high in Idaho reaching purple levels as reported by AirNow Tech (top right). According to the situation in Northwest, HMS reported an impressive swath of moderate-to-thick density smoke visible stretching across Vancouver Island, Washington, eastern Oregon, and Idaho this morning. The thickest area of smoke expanded mainly southward from east-central Washington. Remnant light smoke from the ongoing wildfires in the Pacific Northwest region expanded across the central and southern plains and into the western portions of the Tennessee Valley ahead of the surface cold front (middle left). Meanwhile,

[8] At http://alg.umbc.edu/usaq/archives/2012_09.html, Last accessed Oct. 2, 2015.

MODIS aerosol optical depth product also detected high AOD values over the Northwest region due to the fires reported (middle right). MODIS true color image also shows the very thick smoke plume over Oregon and Idaho (bottom).

Figure 3 shows the MODIS true color image from Sept. 21 showing the dense smoke plumes from the Washington fires blanketing the eastern half of the state, including the Cascade Mountains.

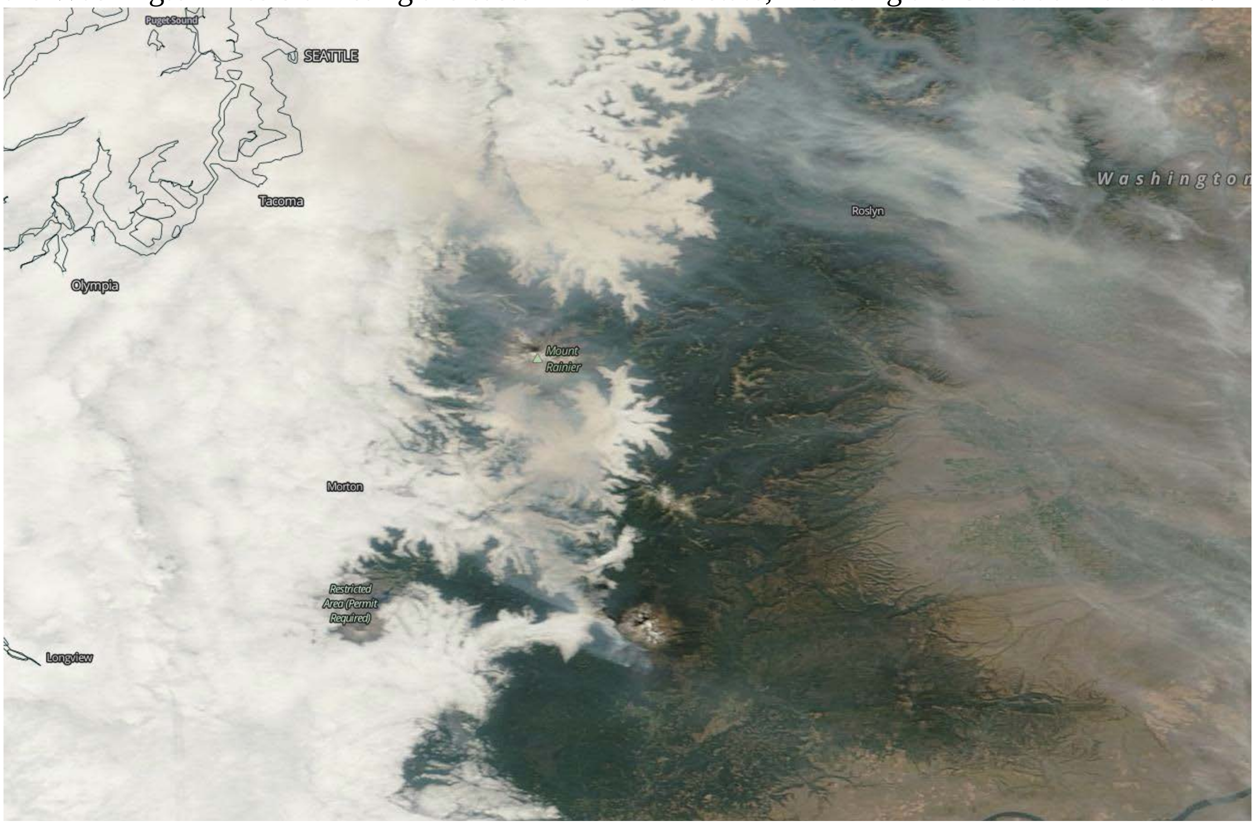
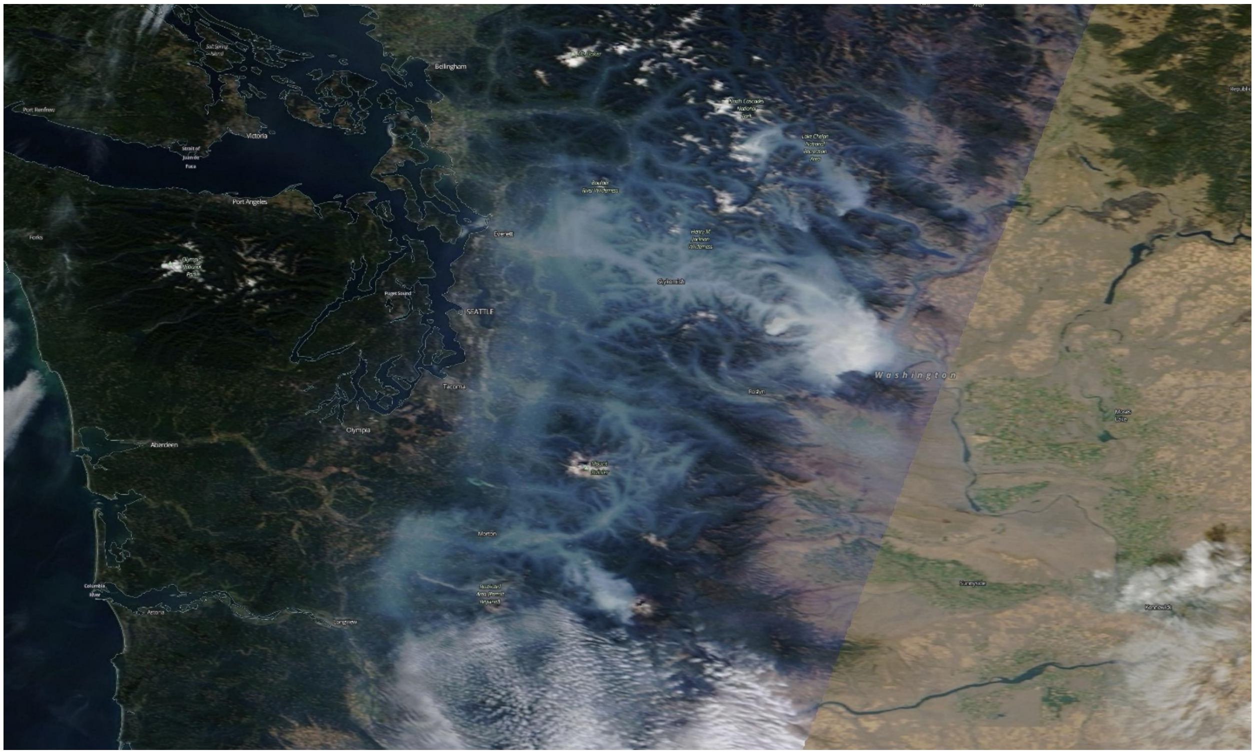



Figure 4 shows individual fires on Sept. 27, 2012. Note how the fires are inundating the Cascade Mountains, especially the mountain passes where the White Pass and Snoqualmie pass monitors are located.



The following Wikipedia article (https://en.wikipedia.org/wiki/2012_Washington_wildfires) summarizes the quantity of wildfires that occurred in September of 2012. These wildfires affected all of the Class I area IMPROVE monitors, but as was shown in Appendix C, most severely impacted the SNPA monitor. Of note the WHPA monitor was even more severely impacted by wildfires, near to the monitor in the William O. Douglas Wilderness located east of the monitor and one fire, the Hell Creek fire, located within the Goat Rocks Wilderness. These fires started September 10, 2012 and were not considered fully contained till October 31[9].

The Wikipedia article states:

"The 2012 Washington wildfires were are series of 1,342 wildfires that burned 259,526 acres (1,050 km2) over the course of 2012.[1] The fires primarily occurred in the Okanogan and Wenatchee National Forests during September and October 2012.[citation needed] A severe lightning storm on September 8 caused hundreds of fires across the east side of Cascade Range. Smoke caused hazardous air quality conditions in the cities of Ellensburg and Wenatchee,[2] and was noticeable in Seattle. The cost of fighting the largest four fires was estimated to be $67.5 million.

Taylor Bridge Fire

The first major wildfire in Washington during the 2012 season started on August 13 east of Cle Elum between Interstate 90 and U.S. Route 97 in Kittitas County. The fire was fully contained on August 28 after burning 23,500 acres (36.7 sq. mi; 95.1 km2) acres and destroying 61 homes. The cause of the fire is under investigation, but is suspected to be construction work.

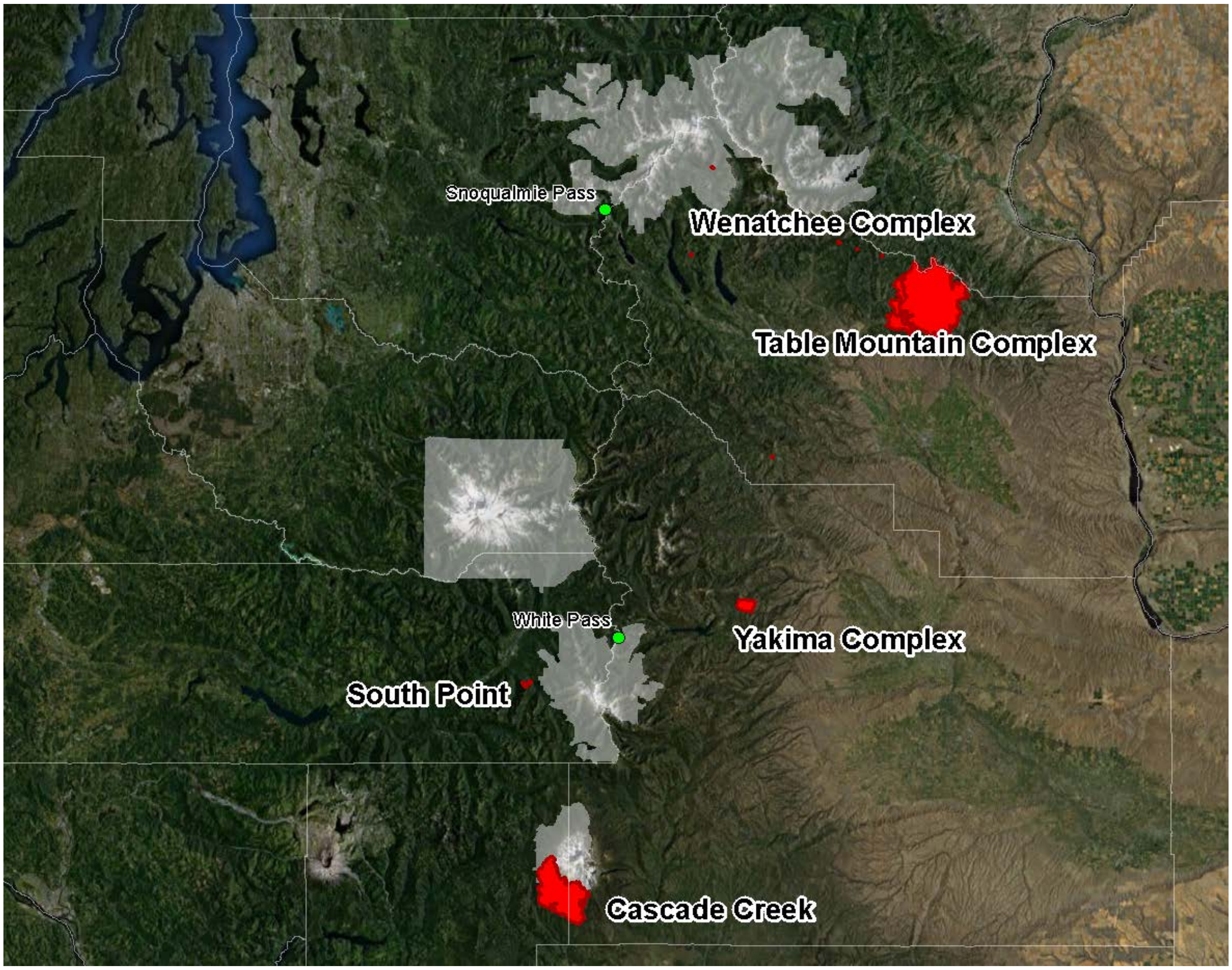
9 The Incident Status Summary indicates that the fires in the William O. Douglas and Goat Rocks Wildernesses were still burning on Oct. 31. The form can be viewed at http://fam.nwcg.gov/fam-web/hist_209/hist_r_print_209_head_2012?v_number=WA-OWF-000583&v_report_date=10/31/2012&v_hour=1559&v_gaid=NW

September 8 lighting-strike fires

- Okanogan Complex – 6,169 acres (9.639 sq. mi; 24.97 km2). Three fires in the lower Methow River valley, on either side of State Route 153 in Okanogan County.
- Wenatchee Complex – 56,291 acres (87.95 sq. mi; 227.8 km2). The largest fires were south of U.S. Route 2 near the city of Wenatchee mainly in Chelan County. Other fires in the complex were in the upper Entiat and Wenatchee River drainages.
- Byrd Fire – 14,119 acres (22.06 sq. mi; 57.14 km2)
- Canyon Fire – 7,557 acres (11.81 sq. mi; 30.58 km2). Located less than a mile west of the city of Wenatchee in Number 1 and Number 2 canyons.
- Cashmere Fire – 2,651 acres (4.142 sq. mi; 10.73 km2). Located south of Icicle Creek extending into the Alpine Lakes Wilderness.
- Peavine Canyon Fire – 19,467 acres (30.42 sq. mi; 78.78 km2). The Peavine Canyon Fire grew to become contiguous with the Table Mountain Fire to the south.
- Poison Canyon Fire – 5,910 acres (9.234 sq. mi; 23.92 km2)
- Table Mountain Fire – 42,312 acres (66.11 sq. mi; 171.2 km2). Located east of U.S. Route 97 near Blewett Pass in Kittitas County, the Table Mountain Fire threatened homes and historic structures near Liberty, Washington. The fire grew to become contiguous with the Peavine Canyon Fire to the north.
- Yakima Complex – 2,300 acres (3.6 sq. mi; 9.3 km2). Approximately 75 small fires in Kittitas and Yakima counties. The Wild Rose Fire was the largest and is located north of U.S. Route 12 and east of Rimrock Lake.
- Cascade Creek Fire – 20,038 acres (31.31 sq. mi; 81.09 km2). Located on the south and west slopes of Mount Adams in the Gifford Pinchot National Forest, including part of the Mount Adams Wilderness. Skamania and Yakima counties.

Figure 5 shows the locations of fires on September 2012 that affected the Goat Rocks and Alpine Lakes Wilderness's monitors[10].

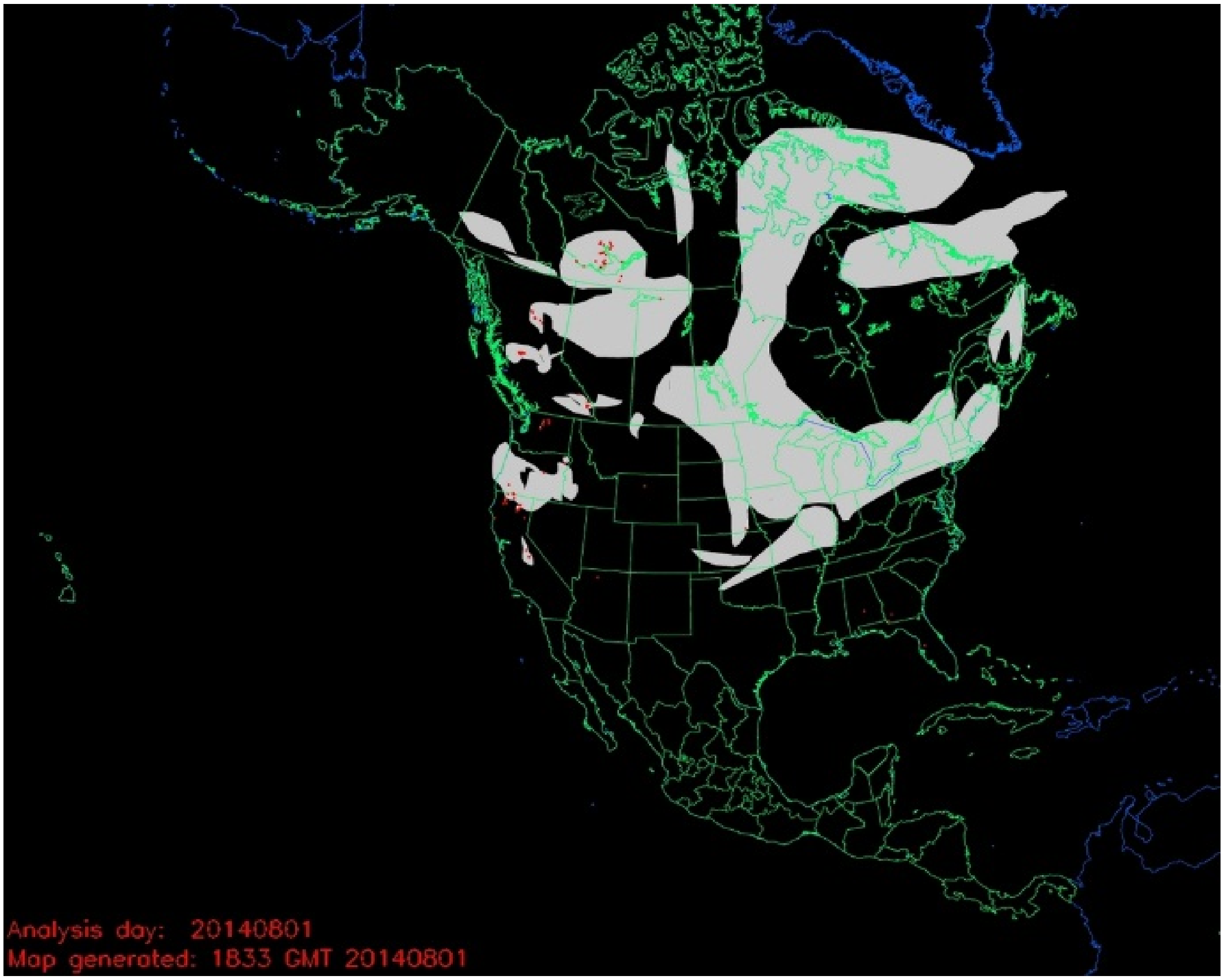
[10] Copied from https://en.wikipedia.org/wiki/2012_Washington_wildfires




In 2014, there were severe fires in Okanogan County, referred to as the Carlton Complex, that adversely impacted the Pasayten Wilderness monitor from mid-July to mid-August. There are several days in July during the fire where there is no data from this IMPROVE monitor. The following is a satellite photo from that day. The Fire Incident Report is attached.

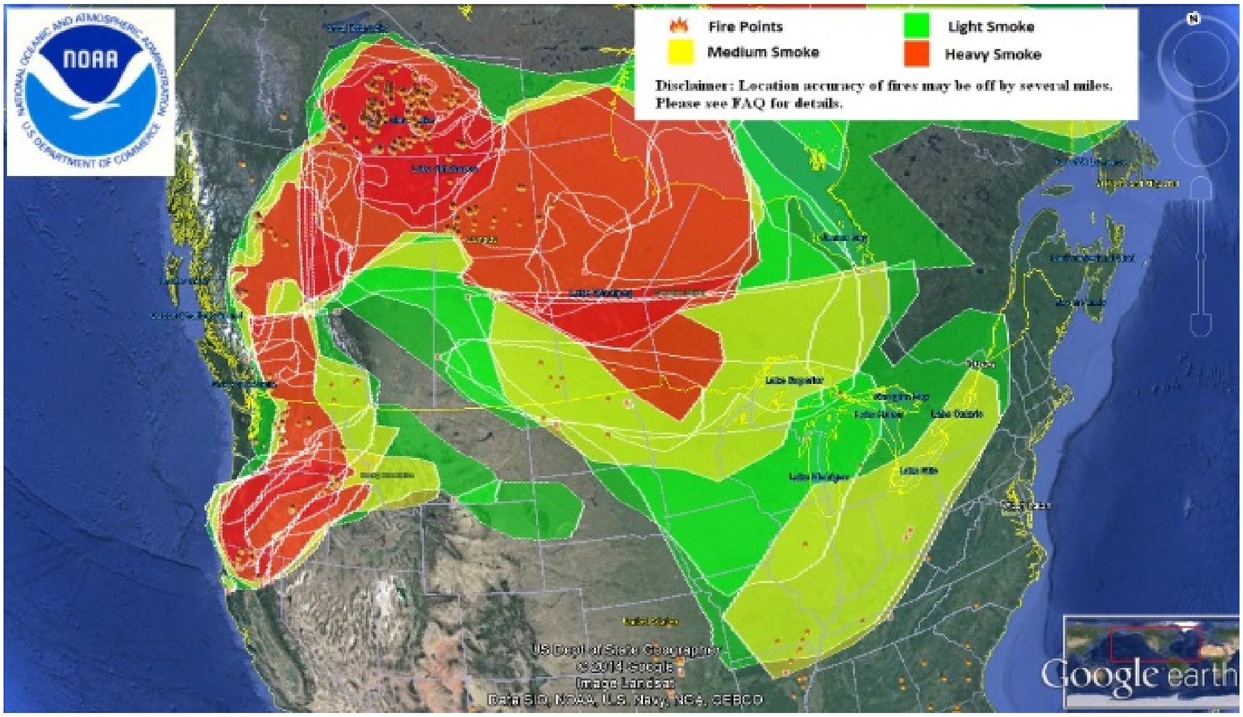
The Air Quality Smog Blog for several dates in August and July said:

August 1, 2014
NORTHWEST TERRITORIES WILDFIRES PERSIST; CARLTON COMPLEX FIRE IN WASHINGTON LEADS TO UNHEALTHY AQIS
Looking at the NOAA HMS Smoke and Fire Product (below), the clumps of small red dots indicate masses of currently burning fires, with smoke plumes being indicated by the grey patches. The Northwest Territories wildfires have created smoke ranging from light to heavy density from western Canada to the northeast United States. The MODIS Terra image (top right (*not included here*)) illustrates highly elevated AODs in the Great Lakes region because of this smoke. In addition, the HMS picked up two plumes of Asian smoke that have migrated into the Yukon. Furthermore, one in the Pacific Northwest was seen as a result of wildfires in this region, particularly the Carlton Complex fire, which has burnt 252,761 acres so far in Washington.

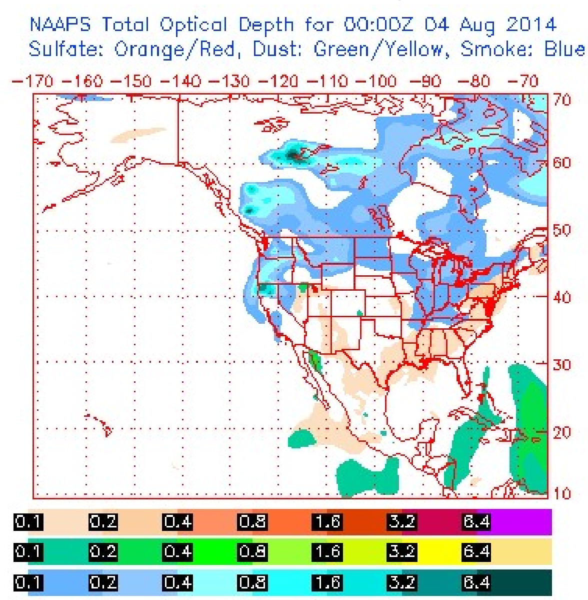


Analysis day: 20140801
Map generated: 1833 GMT 20140801

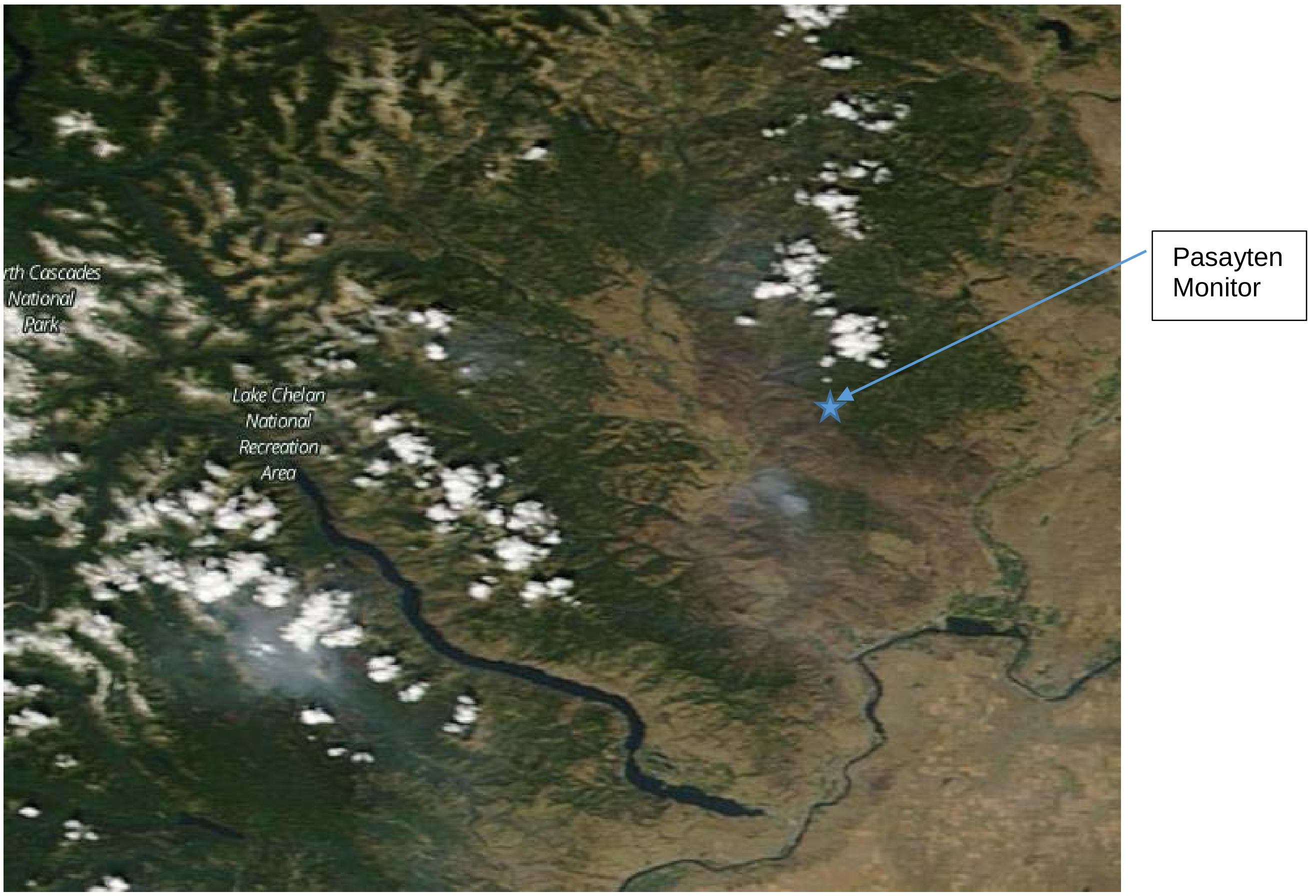
**August 4, 2014**
**PACIFIC NORTHWEST ABLAZE; CANADIAN SMOKE OVER GREAT LAKES REGION**




Moderate PM2.5 AQIs plague the West Coast as well as much of the Eastern US, seemingly parallel to the coast line (EPA AirNow, top left (*not included here*)). USG conditions appear around 4PM EDT in Washington State. The plentiful wildfires producing thick plumes of smoke over Washington, Northern California, and British Columbia are mixing with the smoke from the still burning wildfires in the NW Territories--the main cause of air pollution in the region (NOAA HMS Google Earth, top right (*included above*)). The NAAPS Aerosol Model (bottom left) predicts the smoke surface concentration over the wildfire sites to exceed 128 ug/m^3. The combined mass of the thickest smoke is seen making its way Northeasterly into Idaho and Montana, which explains high AOD levels seen over the Pacific Northwest, Northern Rocky Mountain States and British Columbia (MODIS Terra, bottom right).

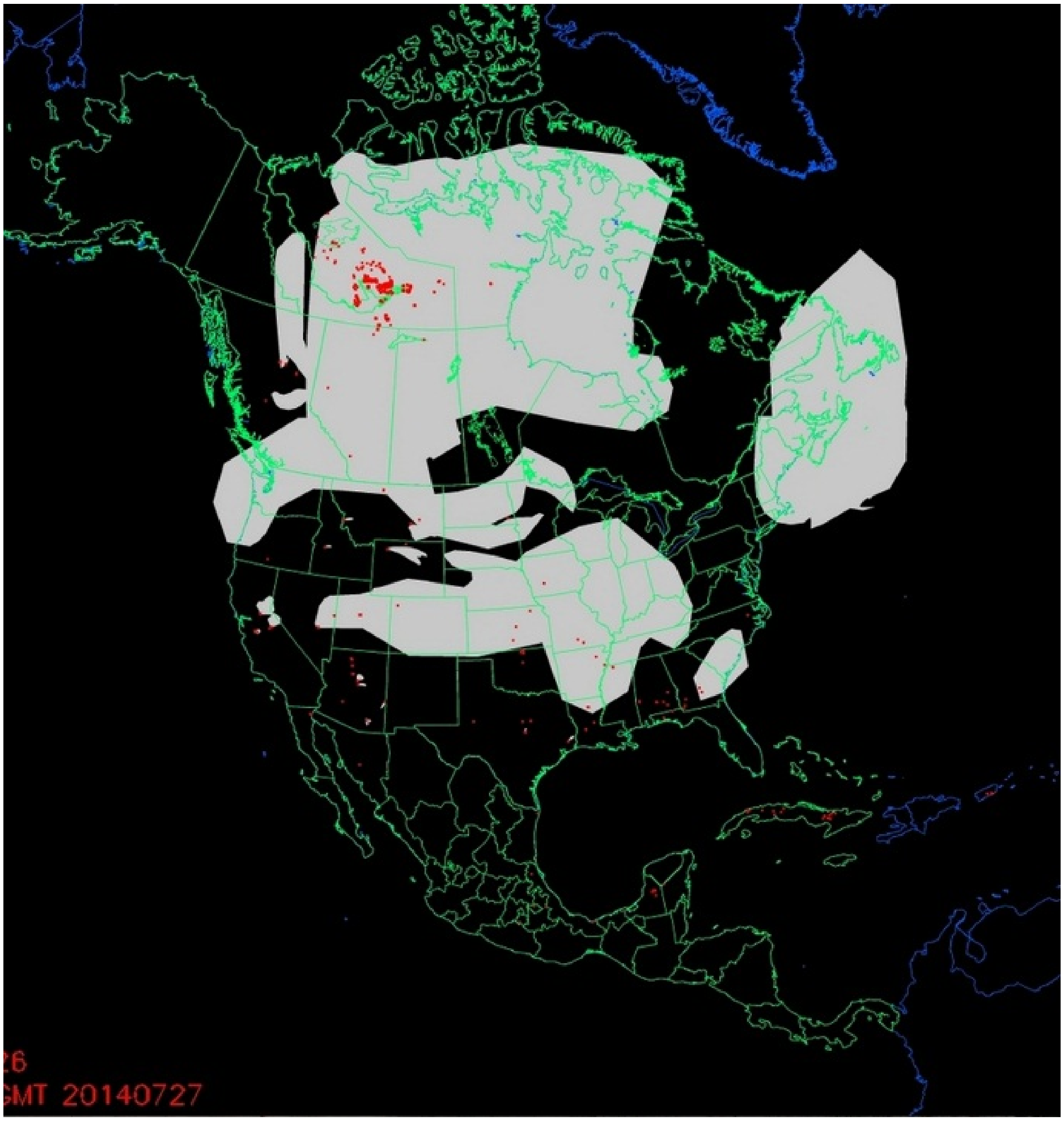


An August 3 MODIS Terra image showing the Carlton Complex fires and the proximity to the Pasayten IMPROVE monitor.

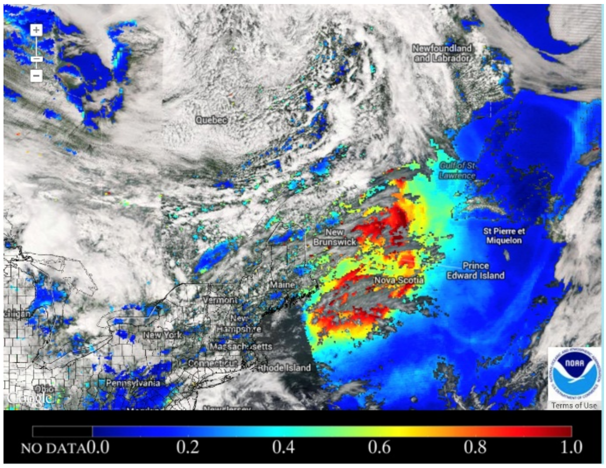


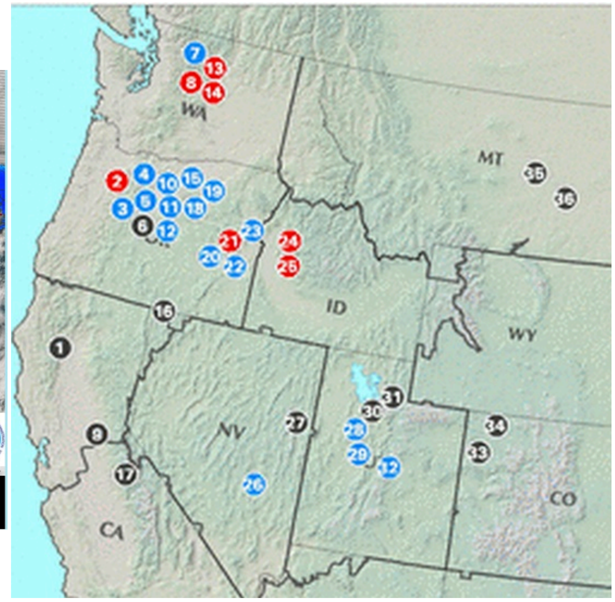

This is the Air Quality blog for July 26, 2014. The bottom notes the number of wildfires in Oregon and Washington states.

July 26, 2014
WEEKEND EDITION: SMOKE CONTINUES TO DOMINATE NORTH AMERICA
The US and Canada continue to be covered by smoke. The HMS map shows most of North American impacted by the plumes from the West and the Northwest Territories. In Utah today, code Red or unhealthy conditions were seen overnight (below right).




In the east high AOD's were seen off Nova Scotia from transported smoke. The number of currently active fires in the Pacific Northwest is impressive. 36 fires are named on the National Forest Service fire page.






To conclude, as one of the adverse effects of climate change wildfires are projected to increase in number and severity in the future. The number and severity of wildfires can only be marginally affected by actions of the state. The most significant options are to remove excess underbrush, dead limbs and trees, and to thin overly dense tree stands.

Underbrush, dead limbs and trees are commonly removed by controlled burning of small areas of the forest. This has been shown to reduce the impact of wildfires on the treated areas. These controlled fires require good smoke dispersion conditions and crews of fire fighters to keep the fires spreading beyond their intended area and becoming a wildfire.

Thinning of overly dense stands of trees removes small trees that contribute to the spread of wildfires in the forest. Thinning is a manual task performed by crews of workers. The trees removed currently have limited commercial value and are often burned to reduce fire risk.

These treatments are limited in size due to the cost to do the work. The work is commonly performed under direction of the U.S. Forest Service or by the Washington Department of Natural Resources. These agencies have limited budgets to carry-out this work, with the budget often eliminated to pay for fighting wildfires instead.

<u>Additional documentation attached to this appendix</u>

The following spreadsheet contains links to useful information about the fires in 2010 and 2012 that impacted the IMPROVE monitors in August 2010 and September 2012. Note: in the column for "Smoke Blog" you will link to a web site containing pictures and a discussion of visibility impacts. The "Smoke Reports" are short text descriptions from NOAA based on satellite imagery and describe the smoke conditions in the U. S, as a whole. The ICS-209 links are for the individual fire reports.

| Improve Monitor | Dates impacted | Site Code | State | Latitude | Longitude | Elevation (m) | Comments | Smoke Blog | Smoke reports (Not affiliated with Incident reports) |
|---|---|---|---|---|---|---|---|---|---|
| White Pass | Sept. 28, 2009 | WHPA1 | WA | 46.624 | -121.388 | 1827 | WF <10 mi E of monitor | | |
| | | | | | | | | | |
| White Pass | August 6, 2010 | WHPA1 | WA | 46.624 | -121.388 | 1827 | Many WF in BC (Cariboo) | http://alg.umbc.edu/usaq/archives/2010_08.html | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2010/2010H070319.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2010/2010H060522.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2010/2010H061646.html |
| | | | | | | | | | |
| White Pass | Sept 12 – 27, 2012 | WHPA1 | WA | 46.624 | -121.388 | 1827 | Many WF in WA and ID | http://alg.umbc.edu/usaq/archives/2012_09.html | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I121552.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I130114.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I140119.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I150348.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I161913.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I171813.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I190711.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I200332.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I201831.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I211834.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I230410.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I240353.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I250711.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I260402.html |
| | | | | | | | | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I280338.html |
| | | | | | | | | | |
| Snoqualmie Pass | Sept. 12, 2012. | SNPA1 | WA | 47.422 | -121.426 | 1049 | See White Pass Info | http://alg.umbc.edu/usaq/archives/2012_09.html | See White Pass Info |
| | Sept. 15,2012. | SNPA1 | WA | 47.422 | -121.426 | 1049 | See White Pass Info | | See White Pass Info |
| | Sept. 18, 2012. | SNPA1 | WA | 47.422 | -121.426 | 1049 | See White Pass Info | | See White Pass Info |
| | Sept. 21, 2012. | SNPA1 | WA | 47.422 | -121.426 | 1049 | See White Pass Info | | See White Pass Info |
| | Sept. 28, 2012. | SNPA1 | WA | 47.422 | -121.426 | 1049 | See White Pass Info | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2012/2012I281843.html |
| | | | | | | | | | |
| Snoqualmie Pass | Oct 6, 2012. | SNPA1 | WA | 47.422 | -121.426 | 1049 | Exact Fire Unconfirmed (see image) | | |
| | | | | | | | | | |
| | | | | | | | | | |
| Pasayten | July 31, 2014 | | | | | | Carlton Complex | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2014/2014H010426.html |
| | August 3, 2014 | | | | | | Carlton Complex | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2014/2014H030246.html |
| | August 9, 2014 | | | | | | Carlton Complex | | http://www.ssd.noaa.gov/PS/FIRE/DATA/SMOKE/2014/2014H091759.html |

| Incident Number | Incident Name | Lat | Long | ICS-209 report link |
|---|---|---|---|---|
| WA-OWF-1000 | TWIN PEAKS | 46° 37´ 45" | 121° 20´ 12" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2009?v_gaid=NW&v_209_number=WA-OWF-1000&button= |
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| WA-GPF-000563 | CASCADE CREEK | 46° 8´ 16" | 121° 34´ 59" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-GPF-000563&button= |
| WA-OWF-000559 | WENATCHEE COMPLEX | 47° 22´ 19" | 120° 26´ 59" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-OWF-000559&button= |
| WA-OWF-000583 | YAKIMA COMPLEX | 47° 10´ 55" | 120° 45´ 43" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-OWF-000583&button= |
| WA-OWF-000642 | Table Mountain Fire | 47° 14´ 55" | 120° 34´ 59" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-OWF-000642&button= |
| WA-OWF-424 | ICY CREEK | 48° 21´ 27" | 120° 59´ 0" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-OWF-424&button= |
| WA-GPF-000628 | SOUTH POINT | 46° 32´ 6" | 121° 38´ 39" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-GPF-000628&button= |
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| | YAKIMA COMPLEX | 47° 10´ 55" | 120° 45´ 43" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-OWF-000583&button= |
| | Table Mountain Complex | 47° 14´ 55" | 120° 34´ 59" | http://fam.nwcg.gov/fam-web/hist_209/hist_r_list_209s_2012?v_gaid=NW&v_209_number=WA-OWF-000642&button= |
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# Appendix E.  FLMs Review and Washington Response

## Appendix E. Comments from the Federal Land Mangers and Ecology's Responses

The e-mail message with the comments from the U.S. Forest Service and the PDF document with the National Park Service comments are found at the end of this appendix.

**United States Forest Service:**

I have reviewed the Washington State 5-year progress report and am satisfied with its characterization of visibility trends and challenges within the state and broader region. The report clearly demonstrates that Washington has made significant progress in reducing visibility impairing emissions as evidenced by already meeting or exceeding the established 2018 Reasonable Progress Goals (RPG).

I was especially impressed with the depth of analysis provided in the appendices. Additionally, both myself and the R6 air program manager, Rick Graw agree with Ecology's finding that wildfire smoke "is the single most significant impediment to meeting natural conditions in 2064." Likewise, we share an interest in expanding the IMPROVE network. Specifically, a monitor near Lake Chelan to assess atmospheric conditions in/around the Glacier Peak Wilderness would be a fantastic addition to the IMPROVE network, though we acknowledge there are funding obstacles at this time.

In close, I'd like to thank everyone at Ecology who helped produce this clear and thorough progress report. I look forward to working with Ecology and others in the region to continue our mutual efforts to improve air quality in the Pacific Northwest. If you have any questions or comments, feel free to contact me either via email or phone.

**Response:**

Thank you for the review and compliments.

**National Park Service (NPS):**

**Section 1.3 Source Impacts on Visibility**
In addition to the general background, we recommend that Section 1.3 describe that ammonium sulfate, organic carbon, and ammonium nitrate are the most important pollutant contributions on the 20% worst visibility days at Class I areas in Washington State in 2010-2014. The information in Appendix C is detailed and well written. In Section 1.3 please add a summary graphic that illustrates the five year (2010-2014) average pollutant contributions on the 20% worst days for the six IMPROVE monitors.

**Response:**

Changes along the lines of the suggestion have been made to this section.

**Section 2 Control Strategies and Emissions**

Sources that contribute to ammonium sulfate, ammonium nitrate, and organic carbon are both anthropogenic and natural. The first sentence at the beginning of Section 2 is inconsistent with data in Appendix C, incorrectly identifying ammonium nitrate as more important than ammonium sulfate. Please review and correct.

Ecology's summary of source categories and emissions changes through federal actions and the Regional Haze SIP is too general and abbreviated to demonstrate that Washington is meeting the SIP commitments. Please include better documentation of emission control requirements.

**Response:**

1. Revisions have been made to this section. Textual errors have been corrected.

2. We believe what was provided was consistent with other 5-year review reports we have reviewed, but have supplemented Section 2.1 with additional information from the 2010 RH SIP.

**Section 2.2 Best Available Retrofit Technology (BART)**

The regulatory actions and operational changes for the BART facilities need to be better documented. The requested information could be updated from Section 11.5 of the 2010 SIP to include regulatory actions since 2010 and could be summarized in tables. This section on BART sources needs to include the regulatory basis for emissions limits implemented since 2004, including specific controls, installation dates, operational requirements, and emissions reductions for the BART units and the facility as a whole. These actions include the State of Washington's requirements for Centralia Generating Station, the EPA consent decrees for oil refineries and cement plants, operational constraints for Alcoa Intalco, and alternative controls in lieu of BART at Tesoro. We reviewed 10 year emissions trends for each BART facility and request this data be included in this section or an appendix as further evidence of emissions progress.

**Response:**

1. We have made minor edits to this section to add clarity. We are not including any of the supplemental information suggested. The technical support documents and additional supporting information for each Ecology BART determination are included in Appendix L of the 2010 Regional Haze SIP. All of the Ecology determined BART supporting documentation is included in the 2010 Regional Haze SIP. All of the supporting analyses for the EPA FIPs are contained in the dockets for those actions. Ecology was not privy to the bases for EPA's FIP determinations.

2. Documenting all emission reduction and other projects at each BART facility that occurred since 2004 is not being provided. In our opinion, the requested information is outside of the scope of the elements to be covered in this review report as outlined in EPA's guidance.

3. We have added information on the emission trends at the BART facilities over the past 10 years to this section.

**Section 2.3 New Control Strategies**
In Table 2 Ecology briefly identifies regulatory programs that have been implemented since the WRAP air quality modeling that was used to set reasonable progress goals for 2018. Ecology did not include the Mercury and Air Toxic Standards, the 1-hour national ambient air quality standard for sulfur dioxide ($SO_2$), the revised national standard for fine particulate matter, or the revised standard for ozone. Do any of these regulations affect emissions from electric generating units or industrial sources in Washington?

**Response:**

1. The Mercury and Air toxics rule only affects one facility in Washington. The effect is that start-up on coal is no longer allowed, reducing some short-term, uncontrolled $SO_2$ and PM emissions. Due to current operations of the plant, the effect of this rule on the plant is small on an annual basis, though could be large during the few hours during boiler start-up that now cannot use coal for fuel. The plant utilizes ultralow sulfur diesel as its "clean fuel" for start-up.

2. This review was drafted prior to EPA issuing the Data Reporting Requirements for the 2010 $SO_2$ rule. Only in the time that the FLMs were reviewing the report has it become clear whether there is any affect from the 2010 $SO_2$ standard on the emissions from sources in the state. We proposed to EPA in July 2016 that we would do dispersion modeling on the Centralia Power Plant to determine compliance status and utilize ambient monitoring for the two aluminum smelters in the state. EPA Region 10 has accepted this approach.

   We are now in negotiations with the power plant ownership and local regulatory agency about how to address the results of the modeling. Our approach will be included in the required January 2017 attainment status designation submittal to EPA.

   No other sources in the state are affected by the 2010 $SO_2$ standard.

3. The ambient standards for fine particulate matter, $NO_X$, and ozone do not affect emissions from any stationary sources. Ambient monitoring continues to indicate all of Washington either attains these ambient standards or qualifies to be classified as "unclassifiable."

**Section 2.4 Emission Inventory Trends**
More detail is needed specific to emission inventory assumptions and contributing source categories. Most states have discussed the implications of changing emission inventory assumptions between 2005 and 2011. In particular, changes in the on-road and non-road emissions models make it difficult to compare mobile emissions across inventory years. Ecology should also discuss these implications.

Mobile source emissions of nitrogen oxides (NOx) in 2002 differ by an order of magnitude between Table 3 of Section 2.4 and the table in Appendix B; please reconcile the two tables and explain the correct data. For area sources, please clarify that in addition to the fire categories listed, area sources also include agricultural sources and many smaller emissions categories such as construction, waste treatment, etc. Also clarify whether the wildfire estimates for WRAP 2002 represent a 5-year average for 2000-2004 or are specific to the year 2002. Because the discussion in Appendix B is short, it would be more informative for the reader if it is included in this section rather than an appendix.

Please include in Table 3 the WRAP 2018 emission projections for the major source categories. By comparing the 2011 emissions to the 2018 projections, Ecology can better demonstrate whether emissions are already below, or on track by 2018 to be below, the emissions levels that were used in the WRAP 2018 regional air quality modeling and that were the basis for Ecology's 2018 reasonable progress goals.

**Response:**

1. The text has been expanded along the lines suggested.

2. Mobile source emissions are all estimates that have been adversely affected by the change in models imposed by EPA. Also complicating the estimates are the changes in vehicle emissions over the time period being evaluated, all of which is outside of the control of the state. Both sets of mobile source emissions data are the correct data, within the assumptions of the models that produced them. The text will be edited to indicate the difficulties of comparing the results of the two different mobile source emissions models.

   The Iowa 5-year review has this to say about the mobile source models: "A meaningful comparison between the CENRAP 2002/2018 and the 2008 NEI on road emissions is complicated by the significantly different methods used to estimate onroad emissions. The 2002/2018 data are based upon use of the MOBILE6 model while the 2008 NEI are derived from EPA's application of the new Motor Vehicle Emissions Simulator (MOVES) mobile source model. The extent to which the different methodologies influence the change in emissions is not readily quantifiable but could be significant. However, this discrepancy does not influence other source sector emissions and does not alter any substantive conclusions."

   Also from their Appendix C: "The NEI OnRoad and NonRoad data categories contain mobile sources which are estimated for the 2008 NEI v2 via the MOVES and NONROAD models, respectively. NONROAD was run within the National Mobile Inventory Model (NMIM). Note that emissions data for aircraft, locomotives, and commercial marine vessels are NOT included in the NonRoad data category starting with the 2008 NEI. Aircraft engine emissions occurring during Landing and Takeoff operations and the Ground Support Equipment and Auxiliary Power Units associated with the aircraft are now included in the point data category at individual airports in the 2008 NEI. Emissions from locomotives that occur at rail yards are also included in the point data category. In-flight aircraft emissions, locomotive emissions outside of the rail yards, and commercial marine vessel emissions (both underway and port emissions) are included in the nonpoint data category."

Ecology follows this NEI guidance in developing its periodic NEI emissions inventories.

3. The extent of what emissions are included in area sources has been further explained in Appendix B.

4. As discussed in the WRAP inventory method documents,[1] the wildfire estimates modeled for 2002 are a 5-year average. WRAP utilized the average wildfires in both the inventory and in the dispersion modeling that was done.

5. Table 3 did not include the 2018 WRAP emission projections by intent. Such projections seemed to be of dubious value in this review. However, based on this comment, a column with that information has been added.

**Section 3 Visibility Progress**
For 2010-2014, visibility on the 20% worst days at all six IMPROVE monitors is better than the 2018 reasonable progress goals and, as well, better than the 2018 uniform rate of progress toward no man-made visibility impairment at four of the six IMPROVE monitors. This latter information is discussed in Appendix C and should be added to Table 4 and discussed in this Section as further evidence that the existing SIP is sufficient.

Please discuss if and how Washington differentiates the contributions to measured organic carbon due to wildfire, prescribed fire, agricultural burning, commercial biomass burning, or residential wood combustion.

Please better characterize the percentage reductions in $SO_2$ and $NO_x$ emissions from marine vessels that are expected from reducing sulfur in marine fuel under the North America Emissions Control Area treaty.

Should the last sentence on page 13 refer to Appendix C instead of Appendix D?

**Response:**

1. We are choosing to leave the more detailed demonstration of rate of progress and RPG goals in Appendix C. An overview discussion of those demonstrations/evaluations has been added to this section.

2. Washington is unable to differentiate organic carbon sources based on the IMPROVE data and has not attempted to do a source attribution analysis. We rely on the emission inventory to characterize the annual emissions from wildfires, agricultural burning, commercial/industrial biomass burning, and residential wood combustion.

[1] http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx

3. We have attempted to characterize the effects of marine vessel $SO_2$ and $NO_X$ reduction from the North America ECA in Section 2.3.

4. Thank you for catching the reference on page 13. We have confirmed and corrected the reference.

**Section 5 Assessment of Current Control Strategy**
Adding WRAP 2018 emission projections to Table 3 in Section 2.4 would strengthen the conclusion in Section 5 that emissions from Washington will not impair the ability of neighboring states to meet their reasonable progress goals for 2018.

**Response:**
We have added the WRAP 2018 emission projections to the table.

**Appendix E Reasonably Achievable Control Technology**
We appreciate that Ecology committed in the 2010 Regional Haze SIP to evaluate Reasonable Available Control Technology (RACT) for one or more source categories. However, a RACT analysis is not an appropriate precedent or substitute for a four factor reasonable progress analysis under the Regional Haze Rule. This RACT analysis considers the "impact of additional controls on air quality," i.e. visibility improvement. The Clean Air Act does not include visibility improvement as a factor in the analysis to demonstrate reasonable progress in improving visibility. Therefore, RACT cannot be substituted for a RP analysis for Washington's next Regional Haze SIP. Our comments below are on the RACT analysis independent of Regional Haze.

**Response:**

While the four factors given in the federal Clean Air Act do not include a factor on air quality impacts, our analyses must also conform to requirements in the Washington State Clean Air Act, and those requirements include an evaluation of the impact of those emissions on air quality (see RCW 70.94.154). As a result, this evaluation utilized visibility as the ambient air quality indicator in the evaluation of the impact of the additional controls on air quality.

**Comment:**
We agree that the pulp and paper industry is a major contributor to statewide emissions. However, by limiting this analysis to the recovery furnaces and lime kilns, Ecology considered only 53% of the visibility-impairing pollutants (PM, SO2, NOx) emitted by these facilities based upon the 2011 National Emissions Inventory. Power boilers at these facilities are typically the largest emission units, and we recommend that controls for the power boilers also be evaluated.

**Response:**

This evaluation focused on the chemical recovery processes of kraft and sulfite pulp mills in Washington. In this state, these are the dominant sources of $SO_2$ emissions from the pulp mills. The analysis intentionally did not look at the power boilers. With one exception, power boilers at these facilities are almost entirely fueled by wood waste or natural gas. Only one power boiler is even permitted to utilize coal as part of its fuel input (Weyerhaeuser-Longview, #10 boiler). The one exception to wood and natural gas at the other mills is one boiler and the lime kiln at the Port Townsend Paper mill currently utilize reprocessed fuel oil, and that facility is in the process of converting all fuel oil combustion to liquefied natural gas received by barge.

The list of source categories or types for the next RACT review includes all boilers, with the option to segregate out boilers by fuel, size, or age.

**Comment:**

Ecology dismissed low sulfur fuel as a control option even though the Longview Fiber Operating Permit contains limits on fuel sulfur content as low as 0.5%. Limiting fuel sulfur content is an established strategy for reducing $SO_2$ emissions from most fossil fuel burning emission units, including those at pulp mills, and should have been evaluated.

For visibility benefits, Ecology modeled 2007 baseline actual emission rates and the potential RACT emission rates using the CMAQ regional photochemical modeling. By excluding all $NO_X$ reductions and all lime kiln emission reductions, Ecology further reduced the potential controls evaluated. As a consequence, the emission reductions modeled by Ecology represent only 13% of visibility-impairing 2011 emissions from these facilities. It is unclear why Ecology did not use more recent emissions. Ecology appeared to have set 0.05 dv (98th percentile) as its criterion for what constitutes a significant improvement in visibility, although Ecology did not explain its criterion. Ecology concluded the visibility benefits were too small to warrant controls even for Class I areas with benefits greater than 0.10 dv. For comparison, EPA used 0.3% change in extinction, which is approximately equal to 0.03 dv, as its significance criterion in its TX FIP[1].

In Section 6 Estimated Costs, Ecology concluded that mill-specific costs of controls are not necessary to implement RACT limits. Considering the magnitude of the emissions from these facilities and the differences among them, we recommend that future evaluations be conducted on a facility-by-facility basis.

**Response:**

1. The use of low sulfur fuel was not dismissed out of hand. However, the emission reduction possible from a limit is much smaller than the reductions from the technologies that were evaluated.

2. Yes, we considered the visibility benefits that could result from installation of the controls evaluated to be small. The controls evaluated included updated retrofit controls and the imposition of BACT level controls on these chemical recovery units. This evaluation also considered the cost on the facilities to install those controls and in all cases, the extent of reconstruction required to install them. As shown, for the one mill that exhibited a greater than 0.1 dv visibility improvement was predicated on installation of a complete new recovery furnace technology, a major capital expense very much outside of the cost considerations of either RACT or the 4-factor analysis processes.

3. The 2011 emissions utilized reflect the available emissions data at the start of the evaluation process and available for use in the CMAQ modeling performed. In our view, using a newer year of emissions would not change the results of the RACT evaluation.

4. Developing cost estimates on a mill-by-mill basis is not a trivial task, and with the approach that we utilized, would have unlikely resulted in a different conclusion. As noted above, Washington must do these evaluations in conformance with the requirements of Washington State law, not the less inclusive federal requirements. The law puts severe limits on when we can do these RACT evaluations on a source-by-source basis. The primary bases to do single source evaluations are to mitigate a specific air quality impact caused by only one source, or that there be less than three sources in a source category.

   If the results of the RACT evaluation on a source category indicate the need for lower emission limitations, state law requires those limits must be set by rule and be applicable to all sources in Washington State.

# Appendix F.  Public Involvement and Outreach

# Air Quality





## Regional Haze

Ecology works to improve visibility in national parks and wilderness areas. We monitor air quality and develop strategies for returning visibility to natural conditions by 2064. Our initial strategies focus mainly on large industrial sources of air pollution and how forestry debris is burned.

**Progress report**
The Regional Haze 5-Year Progress Report describes our progress to improve visibility since 2010. The report determined that visibility has improved at all Washington's mandatory federal Class I areas. All areas improved at least as much as required by the 2018 visibility goals established in the 2010 Regional Haze State Implementation Plan. However, continued improvement may be difficult due to smoke from wildfires.

Comment on the 5-year progress report and appendices A, B, C, D, E, F.

**Public Comment Period:**
June 20 - August 1, 2017

Comment on the report:
- Online comment form
- Email
- Mail Anya Caudill
  Air Quality Program
  Washington State Dept. of Ecology
  P.O. Box 47600
  Olympia, WA 98504-7600

**Public Hearing**, if requested by July 19, 2017 *
Thursday, July 27, 2017 at 6 p.m.
Ecology, 300 Desmond Drive SE - Lacey
* We will update public hearing information after July 19. If a public hearing is not requested, we will post a cancellation notice on this web page and on the public involvement calendar.

Request a public hearing:
- Email Anya Caudill
- Call (360) 407-6630

### Speak up!

Comment on Washington's 5-year progress report and appendices A, B, C, D, E, F.

**Public Comment Period:**
June 20 - August 1, 2017

**Public Hearing:**
*if requested by July 19, 2017 **
July 27, 2017 at 6 p.m.
Ecology, 300 Desmond Drive - Lacey
* We will update hearing information after July 19.

### Información en español!
Para información en español, manda un correo electrónico al equipo de español de Ecología a preguntas@ecy.wa.gov.

**Regional haze ruins our view**
Have you ever looked out expecting to see a breathtaking view of Mount Rainier or the North Cascades, and been disappointed to see an ugly brown or white haze ruining the view? It's called "regional haze" and it's air pollution. Regional haze has reduced scenic views in national parks and wilderness areas from an average of 140 miles down to 35-90 miles in the western United States. In the eastern United States, visibility has decreased from an average of 90 miles down to 15-25 miles.

Haze is caused when tiny particles in the air absorb and scatter sunlight between the object we are looking at — such as Mount Rainier — and our eyes. More particles means more light is either absorbed or scattered, reducing the clarity and color of what we see.

**Measuring visibility**
We measure visibility by collecting and analyzing particles in the air as part of the Interagency Monitoring of Protected Visual Environments (IMPROVE) monitoring network. We do this in partnership

with the National Park Service and U.S. Forest Service. In Washington, there are 9 IMPROVE monitoring sites. One 24-hour air sample is collected at each site every three days, providing up to 121 samples every year from each site.

Once the samples are collected, we analyze them for substances such as sulfate, nitrate, carbon-containing particles, sea salt, and dirt and sand — all of which affect visibility. We calculate visibility based on the types and amounts of substances in the particles.

**We show visibility in one of three ways:**

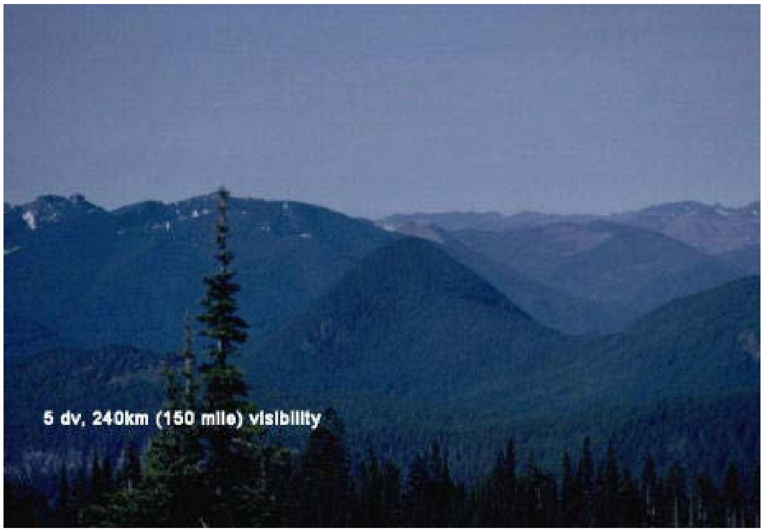
- Visual range (the number of miles or kilometers the naked eye can see).
- Deciviews (the number on a visibility index where the higher the number, the worse the visibility). The human eye can see a change in visibility of even one deciview.
- Light scatter measurement, using an instrument such as a nephelometer.

Long-term monitoring trends suggest that visibility is improving somewhat at Washington's national parks and wilderness areas.

**Sources of fine particles**
The particles that cause haze come from both natural and human-caused sources. Natural sources include windblown dust and soot from wildfires or other burning. Human-caused sources include motor vehicles, electric utility and industrial fuel burning, and manufacturing operations. Fine particles can come from as far away as Asia. Some of the particles that cause haze are emitted directly to the air. Others are formed from gases such as sulfur dioxide and nitrogen dioxide that can be carried far from their source. This is why we often see haze in areas that don't have any major sources of air pollution.

Fine particles have also been linked to serious health problems and environmental damage. Learn more about fine particle pollution.

The photos below show the same view, looking west from the slopes of Mount Rainier, with and without regional haze.


**Improving visibility**
The federal Clean Air Act requires states to protect and improve visibility in national parks and wilderness areas. The Clean Air Act has set a goal of returning visibility in these areas to natural

conditions by the year 2064. Congress designated 156 national parks and wilderness areas as "mandatory federal Class 1 areas" where visibility is especially important. All states must submit a plan to EPA to reduce air pollutants that affect visibility in their mandatory Class 1 areas.

Washington has 8 mandatory federal Class 1 areas, totaling more than 3.3 million acres. They are:

- Alpine Lakes Wilderness Area
- Glacier Peak Wilderness Area
- Goat Rocks Wilderness Area
- Mount Adams Wilderness Area
- Mount Rainier National Park
- North Cascades National Park
- Olympic National Park
- Pasayten Wilderness Area

In 2010, Ecology wrote a Regional Haze State Implementation Plan (SIP) to define a strategy for improving visibility in our Class 1 areas. Through the Western Regional Air Partnership, we worked closely with other states and organizations to write this plan. It documented existing conditions and identified key sources of air pollution. The plan noted that retrofitting emission technology at large industrial sources, and existing federal and state controls are important for making reasonable progress by 2018. Updates to this strategy will occur periodically.

**Regional haze reduction results**

In 2011, as a result of the 2010 law (Chapter 80.80 RCW), a significant step was achieved in reducing regional haze when the TransAlta power plant in Centralia agreed to install nitrogen oxide reducing technology on two coal boilers.

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Contact us

# Public Involvement Calendar

**CALENDAR**

Public Hearings, Meetings, Workshops, Open Houses

Public Comment Periods

More Ecology Events

## Public Involvement Calendar

The Public Involvement Calendar is designed to engage the public in our **decision-making process**. We encourage you to read Frequently Asked Questions about Effective Public Commenting.

Activities that are educational only or are co-sponsored by Ecology may be found under the "More Ecology Events" link in the left column of this page. We invite your **feedback** about this Public Involvement Calendar.

## Public Hearings, Meetings, Workshops, Open Houses

**(Next 21 days. Use the search feature (right) for events beyond 21 days.)**

**Jun 27 2017 6:00PM** **Public Hearing / Webinar - Lacey**
**-------------------------** **Washington Regional Haze 5-Year Progress Report**

The Regional Haze 5-Year Progress Report describes our progress since 2010 to improve visibility in Washington's national parks and certain wilderness areas. We will hold a public hearing if one is requested by July 19, 2017. If a public hearing is not requested by then, we will post a cancellation on this calendar and on the web page.

**More Information:** More Information
**Location:** Dept of Ecology HQ/Southwest Regional Office
300 Desmond Drive SE
Lacey , WA
**Sponsor:** Ecology
ECY SWRO
**Contact:** Anya Caudill
(360) 407-6630 / anya.caudill@ecy.wa.gov
**Public Comment Period - Jun 20 2017 - Aug 1 2017**

**Jun 20 2017** **Public Comment Period - Statewide**
**Aug 01 2017** **Washington Regional Haze 5-Year Progress Report**

The Regional Haze 5-Year Progress Report describes our progress since 2010 to improve visibility in Washington's national parks and certain wilderness areas. We will hold a public hearing if one is requested by July 19, 2017. If a public hearing is not requested by then, we will post a cancellation on this calendar and on the web page.

**More Information:** More Information
**Location:**
Statewide , WA
**Sponsor:** Ecology
ECY SWRO
**Contact:** Anya Caudill
(360) 407-6630 / anya.caudill@ecy.wa.gov
**Public Hearing / Webinar - Jun 27 2017 6:00PM**

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| **Subject:** | Washington SIP Notice: Give input on the Regional Haze 5-Year Progress Report |
| **Date:** | Tuesday, June 20, 2017 3:16:19 PM |

**State of Washington**

**Notice of Opportunity to Comment and Request a Hearing**

The Washington Department of Ecology is opening a public comment period on the Regional Haze 5-Year Progress Report that describes changes in visibility since 2010. The report determined that visibility has improved at all Washington's mandatory federal Class I areas. You may review and comment on the recommendation from June 20, 2017 through August 1, 2017.

- Review the Regional Haze 5-Year Progress Report

Para información en español, manda un correo electrónico al equipo de español de Ecología a preguntas@ecy.wa.gov.

***How to Comment:***

- Online
- Email
- Mail to:
  Anya Caudill
  Department of Ecology
  PO Box 47600
  Olympia, WA 98504-7600

**Public Hearing**

We will accept requests for a public hearing until July 19, 2017 by email or over the phone at 360-407-6630. If we receive a request, we will hold the hearing at 6 pm on Thursday, July 27, 2017 at the Department of Ecology, 300 Desmond Drive SE, Lacey, WA 98503. You can find a map and directions on Ecology's website http://www.ecy.wa.gov/contact.html. If you choose to attend the hearing, please refrain from wearing strong scented products as they may prevent people with allergies from participating in this public event. We will also have a webinar set up for those who would like to participate in the hearing remotely.

If we do not receive a hearing request, we will post a cancellation of the July 27 hearing on our public involvement calendar: https://fortress.wa.gov/ecy/publiccalendar/.

To request translation of the documents, interpretation at the hearing, ADA accommodation or materials in a format for the visually impaired, call Ecology at 360-407-6800, Relay Service 711, or TTY 877-833-6341.

Anya Caudill
Environmental Planner

(360) 407-6630 | (360) 791-5499 (Cell)
anya.caudill@ecy.wa.gov

Air Quality Program | Washington State Department of Ecology

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# Affidavit of Publication

The undersigned, on oath states that he is an authorized representative of The Daily Journal of Commerce, a daily newspaper, which newspaper is a legal newspaper of general circulation and it is now and has been for more than six months prior to the date of publication hereinafter referred to, published in the English language continuously as a daily newspaper in Seattle, King County, Washington, and it is now and during all of said time was printed in an office maintained at the aforesaid place of publication of this newspaper. The Daily Journal of Commerce was on the 12th day of June, 1941, approved as a legal newspaper by the Superior Court of King County.

The notice in the exact form annexed, was published in regular issues of The Daily Journal of Commerce, which was regularly distributed to its subscribers during the below stated period. The annexed notice, a

PN:2018 GOALS HEARING

was published on

06/20/17

The amount of the fee charged for the foregoing publication is the sum of $170.20 which amount has been paid in full.

Subscribed and sworn to before me on

06/20/2017

Notary public for the State of Washington,
residing in Seattle

JENNIFER A BARNES NOTARY PUBLIC STATE OF WASHINGTON COMMISSION EXPIRES 12-24-19

Affidavit of Publication

## State of Washington

**Notice of Opportunity to Comment and Request a Hearing**

The Washington Department of Ecology is opening a public comment period on our review of progress to attaining our 2018 goals to improve visibility in Washington's 3 national parks and 5 of Washington's wilderness areas.

You may review and comment on the recommendation from June 20, 2017 through August 1, 2017. More information about the Regional Haze Program and the document is available at:

http://www.ecy.wa.gov/programs/air/globalwarm_RegHaze/regional_haze.html

**Public Hearing**

We will accept requests for a public hearing until July 19, 2017. If we receive a request, we will hold the hearing at 6 pm on July 27, 2017 at the Department of Ecology, 300 Desmond Drive SE, Lacey, WA 98503. You can find a map and directions on Ecology's website http://www.ecy.wa.gov/contact.html. If you choose to attend the hearing, please refrain from wearing strong scented products as they may prevent people with allergies from participating in this public event. We will also have a webinar set up for those who would like to participate in the hearing remotely.

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***To comment: To request a hearing:***

Online: http://ac.ecology.commentinput.com/?id=Zh35U

Email to: AQComments@ecy.wa.gov Email: anya.caudill@ecy.wa.gov

Mail to: Call: 360-407-6630

Anya Caudill

Department of Ecology

PO Box 47600

Olympia, WA 98504-7600

To request translation of the documents, interpretation at the hearing, ADA accommodation or materials in a format for the visually impaired, call Ecology at 360-407-6800, Relay Service 711, or TTY 877-833-6341.

Para información en español, manda un correo electrónico al equipo de español de Ecología a preguntas@ecy.wa.gov.

Date of publication in the Seattle Daily Journal of Commerce, June 20, 2017.

6/20(351093)


Wednesday, June 21, 2017

## Regional haze, it's nothing like Jimi Hendrix' purple haze

What do cars, dust, manufacturing operations, and national parks have in common? Regional haze.

You may have seen regional haze when trying to get a look of Mount Rainier or the North Cascades and were disappointed because you couldn't see them easily because of a brown or white haze. That haze is air pollution and comes from a variety of sources such as vehicles, industrial and power-generating plants, and some natural sources. It can impair visibility and reduce the vibrancy of colors and other inspirational details.

### Managing air pollution so we can all see a little better

Washington and other states throughout the nation have been working to ensure that you and your kids and their kids will be able to see, and enjoy, our majestic mountain wilderness areas. It's the same sort of far-sighted vision that motivated Theodore Roosevelt when he established our national parks.

Regional haze has reduced scenic views in national parks and wilderness areas from an average of 140 miles down to 35-90 miles in the western United States. At first blush this might not seem like a serious issue, but consider this. What if you grew up never clearly seeing the epic Olympic Mountains, Mount Baker, or Mount Rainier because our air pollution was too dense? It would certainly change our quality of life and impact our health and environment.

### A report on Washington's regional haze

We just released our 5-year progress report on regional haze. The report includes the advances we've made to improve visibility. It also shares visibility information about the areas in Washington that are being monitored.

Search

Visit Ecology's Website

**About us**

At Ecology, we're proud to help protect Washington's environment and quality of life. We strive to promote the wise management of our air, land and water for the benefit of current and future generations.

**Follow by Email**

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**More stories**

More stories

**Keep up with us**

Visibility is measured by collecting and analyzing particles in the air as part of an interagency monitoring effort. We do this in partnership with the National Park Service and U.S. Forest Service. In Washington, there are nine monitoring sites. We collect one 24-hour air sample at each site every three days, providing up to 121 samples a year per site.We analyze the samples for substances such as sulfate, nitrate, carbon-containing particles, sea salt, and dirt and sand — all of which affect visibility. We calculate visibility based on the types and amounts of substances in the particles.

The Federal Clean Air Act requires that we make efforts to improve visibility through a Regional Haze Plan. In 1977 the Act declared a national goal to remedy existing visibility issues and prevent future haze caused by man-made air pollution at selected national parks and wilderness areas of the United States, known as mandatory federal Class 1 Areas.

Washington has eight mandatory federal Class 1 areas, totaling more than 3.3 million acres of land:

- Alpine Lakes Wilderness Area
- Glacier Peak Wilderness Area
- Goat Rocks Wilderness Area
- Mount Adams Wilderness Area
- Mount Rainier National Park
- North Cascades National Park
- Olympic National Park
- Pasayten Wilderness Area

## Visibility is improving

Long-term monitoring trends suggest that visibility is improving somewhat at our national parks and wilderness areas listed above.

You can learn more about these trends and more by reading our Regional Haze 5-year Progress Report.

## Share your opinion on our Regional Haze Report

We're asking people to weigh in our report and have opened a public comment period. You can comment on our Regional Haze 5-year Progress Report through Aug. 1, 2017:

- Visit our regional haze web pages for more background information.
- Read the Regional Haze 5-year Progress Report.
- Comment on the report.

If you'd like to see more pictures of regional haze and improvements being made, visit the Interagency Monitoring of Protected Visual Environments website.

*By Camille St. Onge, Air Quality and Climate Change Communications*

Posted by Camille St. Onge at 3:20 PM

## No comments:

Post a Comment

**WA Dept of Ecology**
@EcologyWA

Follow

Regional haze, it's nothing like Jimi Hendrix' purple haze. Check out our progress report on it and weigh in. bit.ly/hazyskiesWA

9:11 AM - 23 Jun 2017

**6** Retweets **6** Likes

6 6

# Appendix G.  Ecology's Responses to Comments Received during the Public Comment Period

## Appendix G. Ecology's Responses to Comments Received during the Public Comment Period

Ecology held a public comment period on the report from June 20, 2017 through August 1, 2017. We received three comments during the public comment period: one from a citizen, one from an environmental organization, and one from the National Park Service. Our response to comments and copies of all the comments are below. You may also review these comments online at Ecology's e-Comment website.

**Douglas Skitch:**

Five years ago the Puget Sound was not routinely experiencing the level of aerial aerosol injection that we see today in the skies above us. Today the skies are full of man made clouds and haze. Human engineering of the climate has reached sickening proportions. The haze we saw five years ago is minor in comparison to the haze we now see from geoengineering today. I thought I would never see the day where humans could control the climate but we I think have arrived. Long dry summers, extremely wet winters. I have live here since 1984, the climate change due to human manipulation, not from human ground activity but mans attempt to control the weather and the resulting metallic contamination of the lands, forest die off are the result of weather modification is startling. See attached photos of chem trail aerosol injection over Olympia Washington. When will you uncover the fraud and lie begin the conversation on what exactly it is 'they' are trying to accomplish. It is readily apparent that population control will be the outcome as nano particle metallic salts kill over time. This website poor design is preventing uploading of photographic evidence.

**Response:**

Thank you for the review and comment. Ecology believes the comment is outside of the scope of the report. For information about chem trails, please consider the information on these internet pages:

*Quantifying expert consensus against the existence of a secret, large-scale atmospheric spraying program.* **Peer-Reviewed Journal Article**

http://iopscience.iop.org/article/10.1088/1748-9326/11/8/084011/pdf

*What is a contrail and how does it form?* **NOAA**

http://www.wrh.noaa.gov/fgz/science/contrail.php?wfo=fgz

*Information on contrails and aircraft.* **US Air Force and EPA**

https://www.epa.gov/regulations-emissions-vehicles-and-engines/information-contrails-aircraft

*Statement to the House Subcommittee on Asia, the Pacific and Global Environment, 4 June 2009.* https://assets.aspeninstitute.org/content/uploads/files/content/upload/Quy.pdf

Thank you for letting us know about the difficulty in uploading photos. The e-Comment website allows for uploading up to five digital pictures, up to 30 mb each. We apologize for any inconvenience the e-Comment website design has caused. Our staff responded to you via email and provided alternative ways to submit pictures to us. We included the pictures we received via email at the end for the Appendix, after the response to comments. We also contacted the software developers of the e-Comment design to notify them about your experience.

**U.S. National Park Service, Air Resource Division:**

I reviewed the revised regional haze progress report and have no further comments or questions. WA Ecology has established the emissions reductions in the State of Washington and the visibility improvements at Class I areas in Washington since 2004. We agree that the 2010 Regional Haze SIP is sufficient to meet the 2018 reasonable progress goals set by Washington. We look forward to discussions with the State pertaining to continued visibility improvement in the next regional haze planning period 2018-2028.

**Response:**

Thank you for your review and acknowledgement. Likewise, Ecology looks forward to working with you on the next 10-year regional haze plan.

**National Park Conservation Association:**

On behalf of the National Parks Conservation Association ("NPCA") and our more than 1 million members and supporters, we respectfully submit the following comments regarding Washington's Regional Haze 5-Year Progress Report. We appreciate the opportunity to submit comments.

NPCA's mission is to protect and enhance America's national parks for the use and enjoyment of present and future generations. Our members and supporters regularly visit and care deeply about Mt. Rainier, North Cascades, and Olympic National Parks. They are likewise committed to a clean and clear air future for our treasured public lands.

In Section 4 of the draft report, Washington addresses 40 C.F.R § 51.308(g)(5)'s requirement to discuss anthropogenic emissions changes impeding progress towards the national goal of natural visibility in Class I areas. Unfortunately, the draft report fails to discuss Air Emission Prevention of Significant Deterioration Permit No. 16-01, BP West Coast Products LLC, BP Cherry Point Refinery, issued by the Washington Department of Ecology on May 23, 2017. This permit allows for modifications to the BP Cherry Point refinery near Ferndale, Washington that will result in significantly more heavy crudes processed at the refinery and which will significantly increase pollutants emitted from the refinery including nitrogen oxides ("NOx"), sulfur dioxide ("SO2"), and greenhouse gases ("GHGs"). Ecology has estimated that the Project will increase pollutants by 266 tons per year for NOx, 221 tpy for SO2, and 1,097,792 tpy of GHG, among other pollutant increases.

On December 15, 2016, in compliance with their affirmative obligation to protect air quality related values at national parks, the National Park Service issued an adverse impact determination to Ecology notifying the agency that the BP Cherry Point modifications would degrade the visibility at North Cascades and Olympic National Parks. NPS projected that the expansion will increase the number of poor visibility days from 54 to 70 at Olympic and from 38 to 54 at North Cascades.

Issuance of this permit constitutes an anthropogenic change that impedes visibility progress, and must be discussed as a part of Washington's progress report.

Further, under 40 C.F.R § 51.308(g)(6), Washington is required to provide an assessment of the adequacy of its SIP to enable the state or other affected states to meet established reasonable progress goals. In its final response to comments on the BP Cherry Point permit, Washington admitted that its state implementation plan (SIP) is inconsistent with Prevention of Significant Deterioration (PSD) rules that protect Class I areas, and has stated that Washington will revise the SIP. This is an admission of the current SIP's inadequacy to enable the state and affected states to meet the established reasonable progress goals not just in 2018 but also moving forward. As such, in fulfilling its declarative responsibilities under 40 C.F.R § 51.308(h), Washington must follow 40 C.F.R § 51.308(h)(4), which requires that "Where the State determines that the implementation plan is or may be inadequate to ensure reasonable progress due to emissions from sources within the State, the State shall revise its implementation plan to address the plan's deficiencies within one year."

We ask that Washington address these issues related to the issuance of Air Emission Prevention of Significant Deterioration Permit No. 16-01, BP West Coast Products LLC, BP Cherry Point Refinery in its final regional haze progress report, including a commitment to address the identified SIP deficiencies within one year.

**Response:**

Thank you for your review and comment. We identified three separate issues raised in the comment:

1. Section 4 of the report does not discuss the emissions increase in NOx and $SO_2$ allowed by the PSD permit #16-01, issued to BP West Coast Products.
2. The report does not mention the National Park Service's December 15, 2016 Certification of Impairment submitted to Ecology regarding visibility impairment at the Olympic and North Cascades National Parks.
3. A request for the Department to commit to correcting a rule inconsistency between text in WAC 173-400-117(6)(b) and EPA guidance[1] related to what emissions should be modeled for visibility air quality related values evaluations.

Our responses to the three issues are below:

1. The commenter is correct; Section 4 does not include a discussion of the emissions increase that may occur as a result of PSD 16-01. The review report evaluates progress made from 2010 through 2014. This is the 5 year period required to be reviewed by the

[1] 67 Fed Reg 251 (Dec 31, 2002, 80190).

Regional Haze Rule (40 CFR 51.308(f)(1), as in effect before January 10, 2017). In accordance with those criteria, we are not required to analyze or consider the impact of changes after the end of the review period. We will review those changes as part of the visibility analysis for the next Regional Haze Plan due to EPA by July 31, 2021.

2. As with the response above, we received the FLMs certification after the reasonable progress review period. The FLMs reviewed Ecology's analysis for progress report during the 60-day FLMs comment period that ended on August 8, 2016. Their comments and our responses to those comments are in the Appendix E of the report.

3. We agree that WAC 173-400-117 is inconsistent with EPA's current interpretation and guidance on what emissions from a modification project are to be evaluated for air quality related values and visibility analyses. This is covered in our Response to Comments on PSD 16-01 for comment 61 and 86.

   We will update WAC 173-400-117(6)(b) to delete the word 'net' at the next opportunity to amend Ch. 173-400 WAC.

**Copies of the Comments:**

# Regional Haze 5-year Progress Report

Submitted By:

All

| Submitted By | Submitted | Comment |
|---|---|---|
| National Parks Conservation As... ( Nathan Miller ) ' | 8/01/17 2:05 PM | |
| National Park Service ( Patricia Brewer ) ' | 8/01/17 9:31 AM | |
| Douglas Skitch ' | 7/15/17 4:57 AM | Five years ago the Puget Sound was not routinely experiencing the level of aerial aerosol injection that we see today in the skies above us. Today the skies are full of man made clouds and haze. Human engineering of the climate has reached sickening proportions. The haze we saw five years ago is minor in comparison to the haze we now see from geoengineering today. I thought I would never see the day where humans could control the climate but we I think have arrived. Long dry summers, extremely wet winters. I have live here since 1984, the climate change due to human manipulation, not from human ground activity but mans attempt to control the weather and the resulting metallic contamination of the lands, forest die off are the result of weather modification is startling. See attached photos of chem trail aerosol injection over Olympia Washington. When will you uncover the fraud and lie begin the conversation on what exactly it is 'they' are trying to accomplish. It is readily apparent that population control will be the outcome as nano particle metallic salts kill over time. This website poor design is preventing uploading of photographic evidence. |

[ Previous Page / Next Page ]

Alan Newman
Washington State Department of Ecology

r (360) 407-6810
h [email protected]
Accessibility

[redacted]

Thank you for subscribing to the Regional Haze 5-year Progress Report mailing list.

Olympia Washington Aerosol Injection weather modification

Olympia Washington Aerosol Injection weather modification

| | |
|---|---|
| **From:** | Brewer, Patricia |
| **To:** | Caudill, Anya (ECY) |
| **Cc:** | Cummings, Tonnie; Don Shepherd; Kirsten King; McCoy, Carol |
| **Subject:** | Re: Washington SIP Notice: Give input on the Regional Haze 5-Year Progress Report |
| **Date:** | Tuesday, August 01, 2017 9:30:50 AM |

Anya,

I reviewed the revised regional haze progress report and have no further comments or questions. WA Ecology has established the emissions reductions in the State of Washington and the visibility improvements at Class I areas in Washington since 2004. We agree thatthe 2010 Regional Haze SIP is sufficient to meet the 2018 reasonable progress goals set by Washington. We look forward to discussions with the State pertaining to continued visibility improvement in the next regional haze planning period 2018-2028.

thank you, Pat Brewer

On Tue, Jun 20, 2017 at 9:24 PM, Caudill, Anya (ECY) <ACAU461@ecy.wa.gov> wrote:

**State of Washington**

**Notice of Opportunity to Comment and Request a Hearing**

The Washington Department of Ecology is opening a public comment period on the Regional Haze 5-Year Progress Report that describes changes in visibility since 2010. The report determined that visibility has improved at all Washington's mandatory federal Class I areas. You may review and comment on the recommendation from June 20, 2017 through August 1, 2017.

- Review the Regional Haze 5-Year Progress Report

Para información en español, manda un correo electrónico al equipo de español de Ecología a preguntas@ecy.wa.gov.

***How to Comment:***

- Online
- Email
- Mail to:

Anya Caudill
Department of Ecology
PO Box 47600
Olympia, WA 98504-7600

**Public Hearing**

We will accept requests for a public hearing until July 19, 2017 by email or over the phone at 360-407-6630. If we receive a request, we will hold the hearing at 6 pm on Thursday, July 27, 2017 at the Department of Ecology, 300 Desmond Drive SE, Lacey, WA 98503. You can find a map and directions on Ecology's website http://www.ecy.wa.gov/contact.html. If you choose to attend the hearing, please refrain from wearing strong scented products as they may prevent people with allergies from participating in this public event. We will also have a webinar set up for those who would like to participate in the hearing remotely.

If we do not receive a hearing request, we will post a cancellation of the July 27 hearing on our public involvement calendar: https://fortress.wa.gov/ecy/publiccalendar/.

To request translation of the documents, interpretation at the hearing, ADA accommodation or materials in a format for the visually impaired, call Ecology at 360-407-6800, Relay Service 711, or TTY 877-833-6341.

Anya Caudill

Environmental Planner

(360) 407-6630 | (360) 791-5499 (Cell)

anya.caudill@ecy.wa.gov

Air Quality Program | Washington State Department of Ecology

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Pat Brewer
NPS Air Resources Division
P.O. Box 25287
Denver, CO  80225-0287
303-969-2153

August 1, 2017

Ms. Anya Caudill
Air Quality Program
Washington State Dept. of Ecology
P.O. Box 47600
Olympia, WA 98504-7600

Via email to AQcomments@ecy.wa.gov

Re: Regional Haze Progress Report

Dear Ms. Caudill,

On behalf of the National Parks Conservation Association ("NPCA") and our more than 1 million members and supporters, we respectfully submit the following comments regarding Washington's Regional Haze 5-Year Progress Report. We appreciate the opportunity to submit comments.

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Sincerely,

Nathan Miller
Senior Engineering and Science Manager, Clean Air Program
National Parks Conservation Association
nmiller@npca.org | 773.230.5823