Oregon Regional Haze Plan

5-Year Progress Report and Update

To Satisfy Sections 308 (g), (h), (i) of the Regional Haze Rule (40 CFR 51.308)

Final Report

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Air Quality Planning
700 NE Multnomah Street
Portland, OR 97232
Phone: 503-229-6549
800-452-4011
Fax: 503-229-6762
Contact: Kevin Downing
www.oregon.gov/DEQ

DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

State of Oregon
Department of Environmental Quality

This report prepared by:

Oregon Department of Environmental Quality
700 NE Multnomah Street
Portland, OR 97232
1-800-452-4011
www.oregon.gov/deq

Contact:
Kevin Downing
503-229-6549

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- Tom Moore, Western Governors' Association
- Cassie Archuleta, Air Resource Specialists, Inc
- Emily Vanden Hoek, Air Resource Specialists, Inc
- Bob Lebens, Western States Air Resources Council, WESTAR

Principal Author: Kevin Downing, Environmental Solutions Division, Air Planning
Brian Finneran, Environmental Solutions Division, Air Planning

DEQ Staff Contributors: Jeffrey Stocum, Environmental Solutions Division, Air Technical
Brandy Albertson, Environmental Solutions Division, Air Technical
Chris Swab, Environmental Solutions Division, Air Technical
Rachel Sakata, Environmental Solutions Division, Air Planning

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Executive Summary

Regional haze is air pollution that reduces visibility in scenic areas. The haze that affects visibility in Oregon comes from motor vehicles, power plants, industrial and manufacturing processes, forestry, agricultural (including dairies) and other open burning, as well as natural sources such as wildfire and windblown dust. The federal Clean Air Act contains requirements to protect and improve visibility in national parks and wilderness areas in the country. In 1977, Congress designated certain national parks and wilderness areas as "Class 1 areas," where visibility was identified as an important value deserving protection. Oregon has 12 Class 1 areas that include Crater Lake National Park and 11 wilderness areas.

To address the problem of regional haze, the Environmental Protection Agency (EPA) adopted the Regional Haze Rule in 1999. This rule requires states to adopt regional haze plans to incrementally improve visibility in all Class 1 areas over the next 60 years. The visibility improvement goal is to ensure that visibility on the worst days improves toward a natural conditions goal, and that visibility on the best days does not get worse.

This progress report evaluates progress towards the reasonable progress goals prescribed for the first ten year interval of Oregon's regional haze state implementation plan. These progress reports are required to summarize recent changes in monitoring and emissions data, and evaluate the adequacy of the current State Implementation Plan to meet interim progress goals.

On Dec. 9, 2010, the Environmental Quality Commission adopted the first regional haze plan for Oregon. A plan was first adopted in 2009 but amended in 2010 based on a revision to the Best Available Retrofit Technology (BART) determination for the PGE Boardman coal-fired power plant. Since visibility impairing pollutants readily cross state lines, it is important to note that Washington State has developed a closure plan for an electrical generating facility in Centralia, Washington that would eliminate coal fired burning by 2025.

In the years since the regional haze plan was adopted, Oregon has taken several significant steps to reduce anthropogenic sources of visibility impairing pollutants. The BART analysis for the coal fired electrical generating facility at PGE Boardman has resulted in the installation of controls reducing NO_x and SO_2. Full implementation of BART will require the plant to permanently cease burning coal in the main boiler by December 31, 2020. Analyses for four other permitted facilities identified potential impacts to Class I areas. These sources have agreed to federally enforceable permit limits to reduce pollution causing visibility impacts to insignificant levels.

Modifications to the Oregon Smoke Management Plan governing forestry practices were incorporated into the State Implementation Plan after analysis identified impacts on Class I areas in southern Oregon from prescribed burning. Additionally the state has adopted statutory restrictions on grass field burning in the Willamette Valley that will reduce visibility impacts in the Cascades.

Strategies implemented at the federal level to reduce emissions from diesel and gasoline powered vehicles and equipment will also result in lower levels of visibility impairing pollutants like SO_2 and NO_x. The North American Emission Control Area, in place as a result of an international treaty, will similarly reduce emission of these pollutants from ocean going ships that travel coastwise to Oregon as well as upriver to inland ports.

Each strategy is in varying stages towards full implementation but improvements in visibility are already evident in the monitoring data.

Visibility impairment is measured by a network of monitors that capture pollution and calculate the light scatter effect of each pollutant such as carbon, sulfur and ammonia. The main metric describing visibility impairment is the deciview, analogous to decibel as a measurement of sound. In the case of deciview, a low deciview number means clearer visibility while a high deciview number reflects increased haziness.

To assess Oregon's progress under the timeframe for the 5-year progress report, DEQ is analyzing the period between 2010-2014. This encompasses the 5-year timeframe since Oregon adopted the first Regional Haze Plan in 2009. The analysis will help Oregon assess its progress towards meeting the reasonable progress goals in 2018.

A review of 2014 data from monitors associated with most Oregon Class I areas shows improvements in visibility for both the worst and best days, exceeding reasonable progress goals set for 2018.

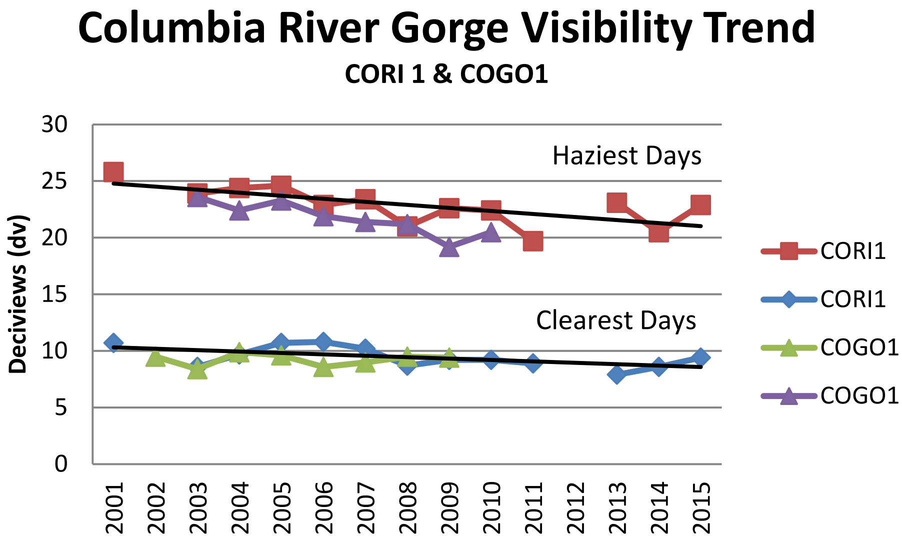
Table 1: Comparison of current visibility data (2014) to reasonable progress goals (2018)

Actual Visibility Observed in 2014 Relative to 2018 Goals		Mt. Hood Wilderness Area	Mt. Jefferson, Mt. Washington, Three Sisters Wilderness	Crater Lake NP, Diamond Peak, Mountain Lakes, Gearhart Mountain Wilderness	Kalmiopsis Wilderness	Strawberry Mountain, Eagle Cap Wilderness	Hells Canyon Wilderness
20% Worst Days	2018 Reasonable Progress Goal (dv)	13.8	14.3	13.4	15.1	17.5	16.6
	2014 Visibility (dv)	12.4	14.0	12.9	13.4	13.4	15.3
20% Best Days	2018 Reasonable Progress Goal (dv)	2.0	2.9	1.5	6.1	4.1	4.7
	2014 Visibility (dv)	1.4	2.6	1.0	**6.5**	2.7	4.0

Periodically exceptions occur as in 2012 for the monitor located near the Three Sisters, Mt. Jefferson and Mt. Washington wilderness areas in central Oregon. This monitor showed impairments that are largely attributable to unplanned wildfires in 2011 and 2012 even as other haze impairing pollutants are declining. Unplanned wildfires are episodic and occur in varied geographies that are unpredictable but are nonetheless, over the past five years, increasing in frequency and the number of acres affected. This result at this particular monitor highlights in microcosm, both the advances made in reducing many human-caused sources of visibility impairing pollution and the challenges faced in improving visibility in the face of relatively uncontrollable events.

Figure 1: Columbia River Gorge Visibility Trend, CORI1 and COGO1[1] site

[1] The COGO1 site was discontinued in 2010.



Although the Columbia River Gorge National Scenic Area is not a Class I area, visibility is a very important concern. The Scenic Area faces additional challenges because of the varied land uses within the scenic area itself as well as proximity to other sources of haze pollution. We expect that visibility impairment in the Gorge to be generally higher than in Class I wilderness areas. At the same time, efforts that focus on improving visibility in nearby Class I areas in both Washington state and Oregon have also resulted in improvements to visibility in the Gorge. The long term trend for the Columbia River Gorge Scenic Area, as seen below, also shows a positive improvement in visibility over time.

After review of current visibility data compared to the reasonable progress goals of the Oregon regional haze plan and the suitability of the current visibility monitoring strategy, the state of Oregon, after consultation with tribal governments and federal land managers, concludes that no substantive revision is needed at this time to meet established goals of the regional haze plan.

1. Introduction

1.1 Purpose of this Document

The report has been prepared to meet the requirements of the Federal Regional Haze Rule, Section 40 CFR, Part 51, Section 308(g) for submitting the 5-year progress report.

The original update cycle for Oregon was slated for 2013 based on the Departments' expectation of completing the first haze plan in 2008. The Oregon Regional Haze Plan was not adopted until 2009, and then amended in 2010 because of a revision to the BART determination for the PGE Boardman coal-fired power plant. This submittal occurred in December 2010, and therefore Oregon's first progress report is technically due by December 2015. Resource availability has delayed submission of the update to 2017.

1.1.1 Oregon Class I Areas

The Regional Haze Rule under 40 CFR 51.308 requires states to address visibility protection for regional haze in Class I Areas in each state. In Oregon there are 12 mandatory federal Class I areas, including Crater Lake National Park and 11 wilderness areas. These areas are shown in Figure 2 and listed in Table 2.

Figure 2 Oregon Class I Areas Map

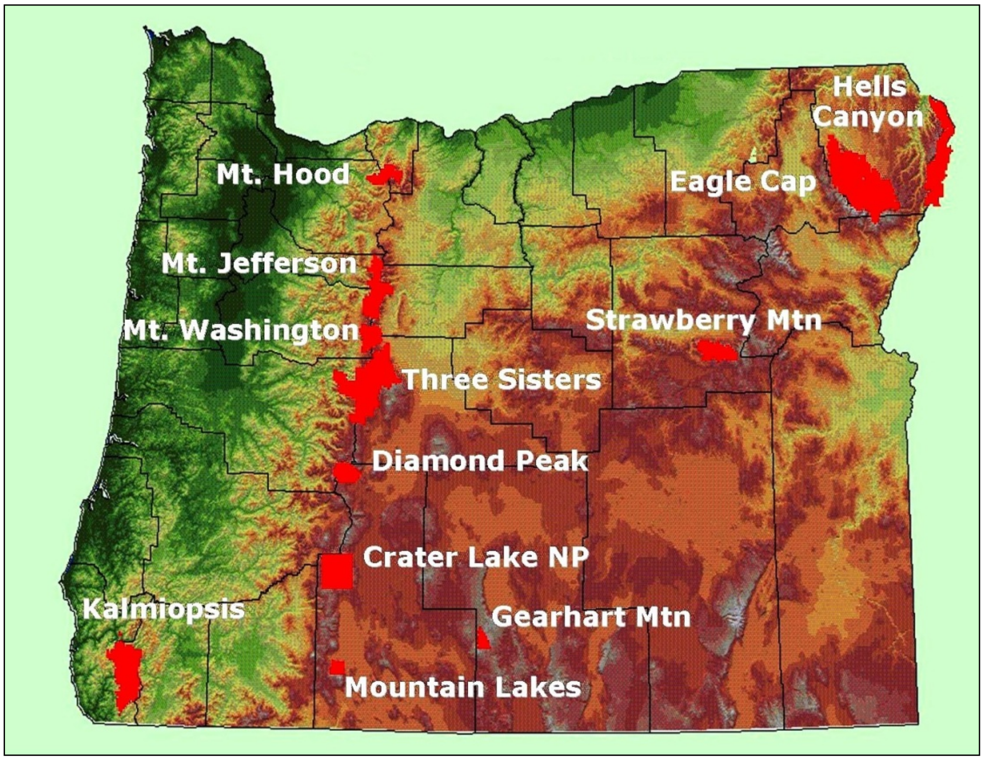


Table 2 Oregon Class I Areas

Class I Area	Acreage
Mt. Hood Wilderness	47,160
Mt. Jefferson Wilderness	107,008
Mt. Washington Wilderness	52,516
Three Sisters Wilderness	285,202
Diamond Peak Wilderness	52,337
Crater Lake	183,315
Mountain Lakes Wilderness	23,071
Gearhart Mtn. Wilderness	22,809
Kalmiopsis Wilderness	179,700
Strawberry Mtn. Wilderness	69,350
Eagle Cap Wilderness	360,275
Hells Canyon Wilderness	131,133*

* Oregon portion only. Total acreage is 214,944

Mt. Hood Wilderness Area

The Mt Hood Wilderness Area is located on the slopes of Mt Hood in the northern Oregon Cascades. Wilderness elevations range from 3,426 m (11,237 ft) on the summit of Mt Hood down to almost 600 m (2,000 ft) at the western boundary. It is almost adjacent to the Portland Oregon metropolitan area; the westernmost boundary is about 20 km east of the Portland Oregon suburb of Sandy and 40 km from the heavily populated metropolitan center, elevation 100 m (300 ft). Visitation to the Mt. Hood Wilderness Area is approximately 50,000 visitors a year, primarily between May and October. Most visitors come from the Portland/Vancouver area that has a population of approximately 2 million.

Mt. Jefferson Wilderness Area

The Mt. Jefferson Wilderness Area is located on the crest of the Cascade Range in central Oregon. Its southern boundary is a few km north of the northern boundary of the Mt Washington Wilderness and it extends 40 to 50 km north along the Cascade crest. West of the crest, it consists primarily of the eastern side of the North Santiam River headwaters basin that connects to the Willamette Valley source region near Salem Oregon, 100 km (60 mi) to the west. East of the crest it occupies the western slopes of the Metolius River drainage that connects eastern slopes with Deschutes River in eastern Oregon. The highest Wilderness elevation is 3,200 m (10,497 ft) at the summit of Mt Jefferson in the northern part of the Wilderness. Lowest Wilderness elevations are near 1,000 m (3,000 ft) along the western boundary in the North Santiam headwaters basin and along the eastern boundary in the Metolius River basin.

Mt. Washington Wilderness Area

The Mt. Washington Wilderness Area is located on the crest of the Cascade Range in central Oregon. Like the Three Sisters Wilderness that it borders to the south, it includes headwaters tributaries of the McKenzie River that flow west into the Willamette Valley near Eugene and connect the Wilderness with that source region. On the east side eastern slopes of the Cascades descend to the Deschutes River near Bend. The highest Wilderness elevation is 2,376 m (7,794 ft) at the summit of Mt Washington. Lowest elevations are near 900 m (3,000 ft) in the upper headwaters basin of the McKenzie River.

Three Sisters Wilderness Area

The Three Sisters Wilderness Area is located abreast the crest of the Cascade Range in central Oregon. It includes headwaters tributaries of the McKenzie River that flow west into the Willamette Valley near Eugene and connect the Wilderness with that source region. On the east side streams flow east to the Deschutes River near Bend. The highest crest elevation is 3,158 m (10,358 ft) at the summit of the South Sister. Lowest elevations are near 600 m (2,000 ft) where the South Fork of the McKenzie River exits the Wilderness on the west boundary. This is about 500 m (1,600 ft) above the Willamette Valley at Eugene 70 km (40 mi) west.

Diamond Peak Wilderness Area

The Diamond Peak Wilderness Area straddles the Cascade Range 50 km (30 mi) north of Crater Lake National Park. The highest crest elevation in the Wilderness is 2,666 m (8,744 ft) at Diamond Peak, which is also the highest summit in this region of the Cascade Range. Lowest elevations are near 1,450 m (5,000 ft) where streams exit the Wilderness on the west side. On the east side the Wilderness is bordered by mountain lakes with elevations from 1,459 m to 1,693 m (4,786 to 5,553 ft). The area includes headwaters of the Middle Fork of the Willamette River that flows to the Willamette Valley near Eugene, elevation 100 m (300 ft) and 90 km (60 mi) distant. Wilderness elevations are thus some 1,400 m (4,600 ft) above the Willamette Valley floor. East of the Cascade crest, streams flow to the Deschutes River in eastern Oregon.

Crater Lake National Park

Crater Lake National Park is the only national park in Oregon. The park was established on May 22, 1902, and now consists of 183,315 acres. It is located in southwestern Oregon on the crest of the Cascade Mountain range, 100 miles east of the Pacific Ocean. Rim elevations range from about 900 to 1,873 ft above lake level. The highest park elevation is 8,929 ft at the peak of Mt. Scott, in the eastern Park area. The National Park includes headwaters of the Rogue River that flows southwest towards the Medford/Grants Pass area, and Sun Creek/Wood River that flows southeast to the Klamath Falls area.

Mountain Lakes Wilderness Area

The Mountain Lakes Wilderness Area is a relatively small Class 1 Area in southern Oregon of 23,071 acres, 50 km (30 mi) south of Crater Lake National Park. It consists of several peaks with a highest elevation of 2,502 m (8,208 ft) at the crest of Aspen Butte. Lowest elevations are near 1,500 m (5,000 ft). Primary drainages are Varney Creek and Moss Creek that flow into the Upper Klamath Lake, 3 km northeast of the Wilderness boundary.

Gearhart Mountain Wilderness Area

The Gearhart Mountain Wilderness Area is located on the flanks of Gearhart Mountain in south central Oregon, primarily the northern slope and eastern drainages of Gearhart Mountain, the dominant topographic feature. Elevations range from near 5,900 ft at the North Fork of the Sprague River in the northern Wilderness to 8,364 ft at the summit of Gearhart Mountain.

Kalmiopsis Wilderness Area

The Kalmiopsis Wilderness Area is managed by the U.S. Forest Service. The Kalmiopsis Wilderness is located in the Klamath Mountains of southwestern Oregon, part of the coastal temperate rainforest zone that lies between the Pacific Ocean and the east side of the coast ranges in northwestern U.S. and Canada.

Its western boundary is 20 to 25 km (12 to 15 mi) from the coast. Its easternmost extent is about 40 km (25 mi) from the coast. Elevations range from about 300 m (900 ft) on the western boundary where the Chetco River exits the Wilderness towards the Pacific Ocean 25 to 30 miles further west, to 1,554 m (5,098 ft) on Pearsoll Peak on the eastern Wilderness boundary. Terrain is steep canyons and long broad ridges. The Wilderness is mostly west of the general crest of the coast range, thus exposed to precipitation caused by lifting of eastward moving maritime air, primarily during the winter. Precipitation ranges from 150 to 350 cm (60 to 140 in) annually, depending on elevation.

Strawberry Mountain Wilderness Area

The Strawberry Mountain Wilderness Area is located in eastern Oregon, just east of John Day. The Wilderness comprises most of the Strawberry Mountain Range. Terrain is rugged, with elevations ranging from 1,220 m (4,000 ft) to 2,755 m (9,038 ft) at the summit of Strawberry Mountain. It borders the upper John Day River valley to the north.

Eagle Cap Wilderness Area

The Eagle Cap Wilderness Area is located in northeastern Oregon. Terrain is characterized by bare peaks and ridges and U-shaped glaciated valleys. Elevations range from 5,000 ft in lower valleys to near 10,000 ft at the highest mountain summits. The Lostine and Minam Rivers flow north from the center of the Wilderness towards Pendleton and the Columbia, 130 km northwest.

Hells Canyon Wilderness Area

The Hells Canyon Wilderness Area is located on the Oregon-Idaho border. The Snake River divides the wilderness, with 131,133 acres in Oregon, and 83,811 acres are in Idaho. It is managed by the Bureau of Land Management and the Forest Service. The Snake River canyon is the deepest river gorge in North America. The higher terrain is located on the Oregon side. Popular Oregon-side viewpoints are McGraw, Hat Point, and Somers Point.

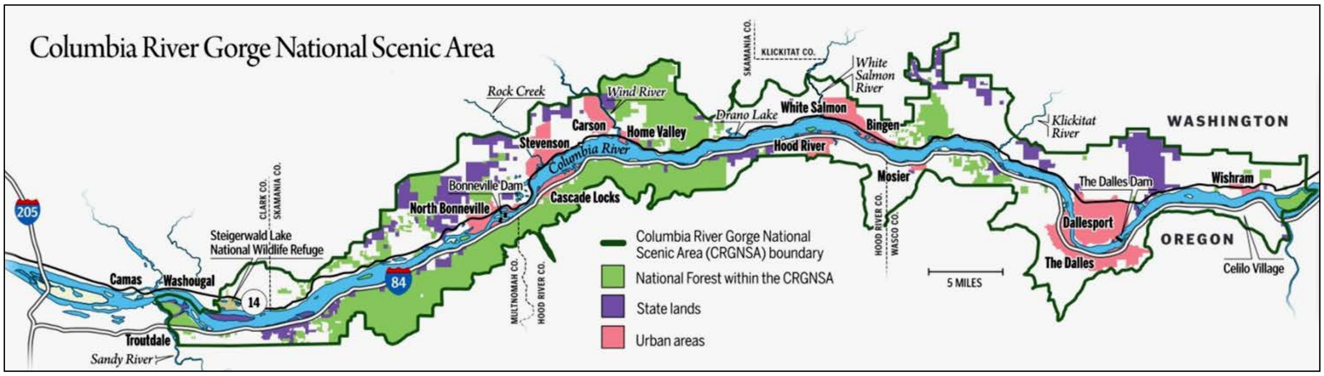
1.1.2 Columbia River Gorge National Scenic Area

The Columbia River Gorge National Scenic Area was designated a National Scenic Area by Congress in 1986 but it is not otherwise a Class I area. The National Scenic Area Act of 1986 requires the protection and enhancement of the scenic, natural, cultural, and recreational resources of the Gorge, while at the same time supporting the local economy. The Scenic Area consists of 292,500 acres, running from the mouth of the Sandy River to the mouth of the Deschutes and spanning southern Washington and northern Oregon.

The Columbia River Gorge Commission was authorized to administer the National Scenic Area Act. While the Gorge is not classified as a Class I area, the CRGC did recognize that air quality degradation can jeopardize those resources, and that in order to protect air quality in the Gorge, the CRGC would rely on state air quality agencies to develop an air quality strategy for the Scenic Area.

The dynamics of regional haze are similar for the Gorge to those impacting visibility in Class I areas. The Scenic Area faces additional challenges because it is a mixed use area, with qualities of both urbanized and rural areas. The Columbia River Gorge Scenic Area is situated between two Class I areas (Mt. Hood and Mt. Adams) and the Gorge will benefit from Oregon and Washington’s long term regional haze process. Although the Gorge is not a Class I area and will not be expected to be on the same reasonable progress glide path as the Class I areas, visibility in the Gorge can be measured against the nearby Class I areas. This comparison will allow DEQ to track the Gorge's progress for continued visibility improvement.

Figure 3 Columbia River Gorge Scenic Area



1.2 Requirements for Periodic Reports

40 CFR Section 51.308 (g) requires periodic reports every five years after the initial regional haze SIP has been submitted. Periodic reports must evaluate progress towards the reasonable progress goals for each Class I area located within the state, as well as those located outside the state which may be affected by emissions from within the state. This report satisfies the first 5-year progress report requirement. The minimum elements required in each periodic report are listed in 40 CFR 51.308(g)(1-7) and 308(h)(1-4). This report is organized according to those elements.

Five-year progress reports must include:

1) the status of implementation of control measures included in the original regional haze SIP (Section 2.1),
2) a summary of emission reductions achieved through the implementation of control measures (Section 2.2),
3) an assessment of visibility conditions (Section 3.2.2, Section 3.2.5),
4) an analysis of the changes in emissions of visibility-impairing pollutants (Section 3.2.3, Section 3.2.4, Section 3.4),
5) a review of the state's visibility monitoring strategy (Section 3.5),
6) an assessment of significant changes in anthropogenic emissions that may have limited or impeded progress in improving visibility (Section 3.7),
7) an assessment of whether the current SIP elements and strategies are sufficient to meet reasonable progress goals (Section 4)

At the same time the state submits its progress report, the state must also make a determination of the adequacy of the existing implementation plan. This 5-year review provides a progress report on the initial 2010 Regional Haze SIP. It addresses each required element based on data that was available as of March 1, 2014. The 2000 through 2004 baseline period planning inventory was developed by the WRAP to represent baseline conditions for comparison with future year projected emissions, as well as for gauging reasonable progress with respect to future year visibility. The baseline inventory, Plan02d, was used in the initial RH SIP and is used in this report, also, as the reference planning period. To assess progress, this report relies on emissions information from the 2008 National Emissions Inventory (NEI) as updated by the WRAP through its WestJump Air Quality Modeling Study (WestJump 2008), 2011 NEI data, and visibility data from the 5-year period from 2008 to 2012.

In discussing the status of control strategies, USEPA guidance suggests that "[t]he report should focus on a targeted evaluation of important control measures that achieve reductions in visibility impairing pollutant species."

The 2010 RH SIP identifies the relative contribution of each visibility impairing pollutant from anthropogenic and natural emission sources. The data show sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) emissions are predominately from anthropogenic sources, such as point, mobile and area sources. Oregon's long-term strategy for the first planning period focused on these pollutants in part due to the important role of Best Available Retrofit Technology[2] for the first planning period, but also due to the controllable nature of these emissions. This report, therefore, focuses on the status of efforts to date to control SO_2 and NO_2 emissions. In addition, controlling SO_2 and NO_2 emissions has a co-benefit of reducing visibility impairment from these pollutants as well as reducing the adverse impact of SO_2 and NO_2 deposition on ecosystems.

Section 308 (i) prescribes requirements for State and federal land managers' coordination, including the opportunity for FLMs to consult with the state on visibility impairment, reasonable progress goals and control strategies for Class I areas in the state. Evidence of compliance with these requirements will be included in Appendix D of this report. Subparagraph (4) requires a plan for continued consultation by the state with FLMs. In the 2010 RH SIP, Oregon committed to continuing consultation between the State and FLMs on the implementation of the visibility protection program, including development and review of implementation plan revisions and 5-year progress reports, and on the implementation of other programs having the potential to contribute to impairment of visibility in any mandatory federal Class I area within the state. Oregon will continue to participate in the WRAP, including coordination and consultation with nearby states, tribes, the U.S. Forest Service, the Bureau of Land Management, the U.S. Fish and Wildlife Service and the National Park Service.

1.3 Technical Information and Data Relied Upon

This section describes the information relied upon by the Department in developing this regional haze progress report. The first part of this chapter describes the IMPROVE monitoring data and network that is used throughout the country by states in measuring Class I area visibility. The second part describes the Western Air Regional Partnership (WRAP) work product provided to Oregon and other western states.

1.3.1 Oregon IMPROVE Monitoring Network

In the mid-1980's, the Interagency Monitoring of PROtected Visual Environments program was established to measure visibility impairment in mandatory Class I Federal areas throughout the United States. The monitoring sites are operated and maintained through a formal cooperative relationship between the EPA, National Park Service, U.S. Fish and Wildlife Service, Bureau of Land Management, and U.S. Forest Service. In 1991, several additional organizations joined the effort: National Association of Clean Air Agencies, Western States Air Resources Council, Mid-Atlantic Regional Air Management Association, and Northeast States for Coordinated Air Use Management.

[2] See Appendix C – Visibility Basics for background discussion on Best Available Retrofit Technology and other elements of regional haze planning.

The objectives of the IMPROVE program include establishing the current visibility and aerosol conditions in mandatory Class I federal areas; identifying the chemical species and emission sources responsible for existing human-made visibility impairment; documenting long-term trends for assessing progress towards the national visibility goals; and support the requirements of the Regional Haze Rule by providing regional haze monitoring representing all visibility-protected federal Class I areas where practical.

In Oregon there are six IMPROVE monitors associated with Class I areas that are listed under the site name in Table 3. Three are located in the Oregon Cascades, two in Eastern Oregon, and one in the Coast Range. Since there are 12 Class I areas in Oregon, some monitors serve multiple Class I areas. While it is desirable to have one monitor per Class I area, in some cases one monitor can be "representative" of haze conditions in nearby Class I areas. Figure 4 shows the location of the IMPROVE monitors and the Class I areas covered by each monitor, as indicated by the yellow circles.

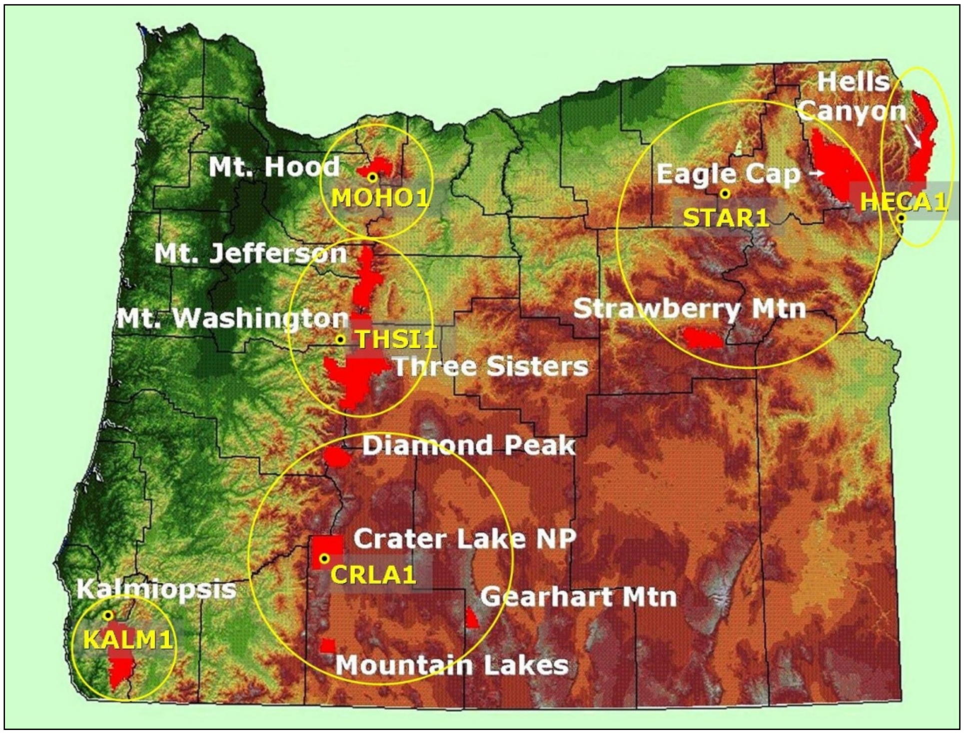
The Columbia River Gorge National Scenic Area, which is not a Class I area, also has had at times two IMPROVE monitors, also described in Table 3. The monitor at the western end of the Gorge was discontinued in 2011.

Table 3 Oregon IMPROVE Monitoring Network

Site Code	**Class I Area**	**Location**	**Sponsor**	**Elevation MSL**	**Start Date**
MOHO1	Mt. Hood Wilderness	inside	USFS	1531 m (5022 ft)	3/7/2000
THSI1	Mt. Jefferson Wilderness Mt. Washington Wilderness Three Sisters Wilderness	10 mi 4 mi 10 mi	USFS	885 m (2903 ft)	7/24/1993
CRLA1	Crater Lake National Park; Diamond Peak Wilderness Mountain Lakes Wilderness Gearhart Mountain Wilderness	inside 35 mi 37 mi 68 mi	NPS	1996 m (6548 ft)	3/2/1988
KALM1	Kalmiopsis Wilderness	6 mi	USFS	80 m (262 ft)	3/7/2000
STAR1	Strawberry Mountain Wilderness Eagle Cap Wilderness	58 mi 39 mi	USFS	1259 m (4130 ft)	3/7/2000
HECA1	Hells Canyon Wilderness Area	9 mi	USFS	655 m (2148 ft)	8/1/2000
Site Code	**Scenic Area**	**Location**	**Sponsor**	**Elevation MSL**	**Start Date**
CORI1	Columbia River Gorge National Scenic Area	inside	USFS	178 m (584 ft)	6/26/1993
COGO1[3]	Columbia River Gorge National Scenic Area	inside	USFS	230 m (755 ft)	9/16/1996

[3] The COGO1 IMPROVE site was discontinued in 2011.

Figure 4 Oregon IMPROVE Sites



MOHO1

The MOHO1 IMPROVE site is the monitor for the Mt. Hood Wilderness Area. It is located just south of the wilderness boundary near Government Camp, at an elevation of 5,022 feet.

THSI1

The THSI1 IMPROVE site is the monitor for the Mt Washington, Three Sisters, and Mt Jefferson Wilderness Areas. It is located 5 miles to the west of Mt Washington, 12 miles southwest of Mt Jefferson, and 10 miles northwest of Three Sisters, at an elevation of 2,903 feet.

CRLA1

The CRLA1 IMPROVE site is the monitor for Crater Lake National Park, and is used as the representative site for Diamond Peak, Mountain Lakes, and Gearhart Mountain Wilderness Areas. It is located at the Park Headquarters in the park, to the south of the crater rim, at an elevation of 6,548 feet. The CRLA1 site is located 40 miles to the south of Diamond Peak, 35 miles to the north of Mountain Lakes, and 70 miles to the northeast of Gearhart Mountain.

KALM1

The KALM1 IMPROVE site is the monitor for the Kalmiopsis Wilderness Area. It is located 6 miles north of the wilderness boundary near where the Illinois River merges with the Rogue River, at an elevation of 262 feet.

STAR1

The STAR1 IMPROVE site is the representative monitoring site for the Strawberry Mountain and Eagle Cap Wilderness Areas. It is located 60 miles north of the Strawberry Mountain Wilderness, and 40 miles west of the Eagle Cap Wilderness, at an elevation of 4,130 feet.

HECA1

The HECA1 IMPROVE site is the monitor for the Hells Canyon Wilderness Area. It is located 10 miles south of the wilderness boundary, at an elevation of 2,148 feet.

CORI1

An additional IMPROVE site has been operating inside the Columbia River Gorge National Scenic Area (CORI1) by the U.S. Forest Service since 1993. This location is on the Washington side of the river about 10 miles upriver from The Dalles.

COGO1

The COGO1 IMPROVE site operated in the Columbia River Gorge Scenic Area between 1996 and 2011 by the U.S. Forest Service. The location was on the Washington side of the river about 8 miles east of Washougal, Washington.

1.3.2 The WRAP Technical Support System

The primary purpose of the TSS is to provide key summary analytical results and methods documentation for the required technical elements of the Regional Haze Rule, to support the preparation, completion, evaluation, and implementation of the regional haze implementation plans to improve visibility in Class I areas. The TSS provides technical results prepared using a regional approach, to include summaries and analysis of the comprehensive datasets used to identify the sources and regions contributing to regional haze in the Western Regional Air Partnership region.

The secondary purpose of the TSS is to be the one-stop-shop for access, visualization, analysis, and retrieval of the technical data and regional analytical results prepared by WRAP Forums and Workgroups in support of regional haze planning in the West. The TSS specifically summarizes results and consolidates information about air quality monitoring, meteorological and receptor modeling data analyses, emissions inventories and models, and gridded air quality/visibility regional modeling simulations. These copious and diverse data are integrated for application to air quality planning purposes by prioritizing and refining key information and results into explanatory tools.

Additional information on the TSS can be found here: http://vista.cira.colostate.edu/tss/.

1.3.3 The WRAP Regional Haze Progress Report

The Department has relied upon the WRAP Regional Haze Reasonable Progress Report completed on June 28, 2013.

This progress report support document was prepared for the 15 western state members in the WRAP region, to provide the technical basis for the first of their individual reasonable progress reports for the

116 Federal Class I areas located in the western states. Data are presented in this report on a regional, state, and Class I area specific basis that characterize the difference between 2000-2004 baseline conditions and current conditions, represented here by the most recent successive 5-year average, or the 2005-2009 period. Changes in visibility impairment are characterized using aerosol measurements from the IMPROVE network, and the differences between emissions inventory years representing both the baseline and current progress period.

Analysis and summaries provided in this report were developed cooperatively with representatives from each state in the WRAP region, and were designed to provide western states with the technical basis necessary to support their evaluation of the current or proposed elements and strategies as outlined in their initial RHR implementation plans. Summaries here are also supported by interactive tools available from the online WRAP Technical Support System.

1.4 Clean Air Act Requirements for Addressing Regional Haze

In 1977, Congress amended the CAA, establishing a national goal to protect visibility in Class I federal areas – national parks and wilderness areas greater than 6,000 or 5,000 acres, respectively. The amendments called for the "prevention of any future, and the remedying of any existing, impairment of visibility in mandatory class I Federal areas which impairment results from manmade air pollution."

In 1979, the USEPA, in consultation with the Secretary of Interior, promulgated a list of 156 mandatory Class I Areas in which visibility was determined to be an important factor. In Oregon there are twelve Class I Areas.

On July 1, 1999, USEPA issued the Regional Haze Rule, thereby establishing a comprehensive visibility protection program for Class I federal areas. The rule is codified in 40 CFR 51.308. The intent of the RHR is to improve visibility over the long term in all 156 mandatory Class I areas across the country. It requires each affected state to develop and adopt an implementation plan that will improve the haziest days and protect the clearest days at each mandatory Class I area in the state, with a goal of returning to natural visibility conditions by the year 2064. Each plan must provide a comprehensive analysis of natural and man-made sources of haze in each mandatory Class I area in the state and contain strategies to control anthropogenic emissions that contribute to haze. The plan must also address the transport of haze across state boundaries.

The 2010 Regional Haze State Implementation Plan, prepared by the Oregon DEQ, was submitted to the USEPA in December 2010. The 2010 RH SIP addressed the initial planning period of the RHR, 2008-2018, and is considered the foundational plan for subsequent planning periods.

The USEPA designated five Regional Planning Organizations to assist with the technical support, coordination and cooperation needed to address the visibility issue for the first regional haze SIPs. The multistate RPOs were established to perform the technical regional analyses for these SIPs. The RPO supporting the western states' regional haze effort is the Western Regional Air Partnership.

Most of the technical data included in this progress report is from the "Western Regional Air Partnership Regional Haze Rule Reasonable Progress Summary Report" developed by the WRAP (www.wrapair2.org) in June of 2013 and the WRAP Technical Support System (http://vista.cira.colostate.edu/tss/). The WRAP report was prepared to provide the technical basis for use by the western states to develop the first of their individual reasonable progress reports for the 116 federal Class I areas located in the western states. Data are presented in the WRAP report on a regional, state, and Class I area-specific basis that characterize the difference between 2000-2004 baseline conditions and current conditions, represented by the most recent successive 5-year average, that is, the 2005-2009 period. The WRAP report characterizes changes in visibility impairment using aerosol measurements from the Interagency Monitoring of Protected Visual Environments (IMPROVE) network, and it analyzes the differences between emissions inventory years represented by the baseline and current progress periods.

1.5 Summary of the 2010 Oregon Regional Haze Plan

On December 9, 2010, Oregon adopted the final elements of the first regional haze plan for implementing Section 308 of the Regional Haze Rule, as a revision to the State Implementation Plan (SIP). EPA took action for final approval of the Oregon haze plan in the federal register on July 5, 2011 (76 FR 38997) and August 8, 2012 (77 FR 50611).

The plan included:

- A comprehensive review and technical assessment of visibility conditions in each of Oregon's 12 Class I areas, showing major pollutants and source categories in Oregon and other states causing haze, and a projection of visibility by a required "milestone" date of 2018.
- DEQ's evaluation of ten "BART-eligible" sources, and proposal to require retrofit controls on the power plant, and reduce emissions at four other facilities to below the visibility impact level considered to be significant.
- "Reasonable Progress Goals" established by DEQ for Oregon's 12 Class I area, which show improvements in visibility for the haziest or worst days (but less than the first uniform rate of progress (URP) milestone for 2018) and no visibility degradation for the clearest or best days.
- A "Long-Term Strategy" that describes what actions DEQ will take to address major sources of haze over the next 10 years, and commitments for future plan updates and revisions.
- Summary of the efforts by DEQ to consult and coordinate with other States, Tribes, and Federal Land Managers on the regional haze strategies contained in this plan.

DEQ's analysis of emissions data, source apportionment, and modeling results strongly supported the finding that the contribution of natural sources, such as wildfire and windblown dust, is the primary reason for slow progress in achieving the milestones in Oregon's Class I areas.

Similar to the contribution of natural sources, DEQ reported marine vessel emissions were also affecting progress in making visibility improvements. These emissions were estimated to be half of the statewide SO_2 emissions and one-third the statewide NO_x emissions. While modeling of marine emissions has not been conducted with regards to its exact impact on western Oregon Class I areas, the contribution of these emissions is significant in the state. Current DEQ authority to regulate offshore shipping emissions is limited.

DEQ's analysis of projected visibility improvements from sulfate and nitrate impacts in Oregon Class I areas showed about a 20 percent reduction in these pollutants by the 2018 milestone. Given the strong association of these pollutant species to anthropogenic sources, DEQ believes this is a more realistic indicator of reasonable progress. If natural sources are excluded, this 20 percent reduction in sulfates and nitrates corresponds to the same percent reduction that is represented by the 2018 milestone.

Mobile sources (mostly cars and trucks) are the largest anthropogenic source of emissions in Oregon. By 2018 more than half of these emissions are projected to decrease due to numerous federal emission standards that are already "on the books", as well as programs in Oregon that will reduce these emissions. DEQ believes this major reduction supports the demonstration that RPGs are reasonable based on the considerable progress being made reducing this large source of emissions.

DEQ conducted a "Four-Factor Analysis" as required under the Regional Haze rule to evaluate other large sources of emissions (non-BART sources) that could be reduced or controlled to improve visibility by 2018. Using this analysis DEQ did not find any controls that were reasonable to pursue at that time. However the BART controls for the PGE Boardman power plant will result in a 48% reduction in emissions prior to 2018, followed by the elimination of emissions from burning coal in the main boiler after 2020. Overall, this represents a total emission reduction of approximately 25,500 tons per year. Although not a direct result of the four-factor analysis, this does represent a "greater than BART" emission reduction that is significant, and will provide noticeable visibility improvements in 14 different Class I areas. Based on the preliminary information obtained from the four-factor analysis, DEQ has proposed in the Long-Term Strategy of the plan to further evaluate non-BART industrial sources for possible new controls in the next five years to make additional visibility improvements by 2018.

1.5.1 2018 Reasonable Progress Goals for Oregon Class I areas.

States and tribes are required to establish "reasonable progress goals"[4] for each Class I area to improve visibility on the 20% haziest days and to prevent visibility degradation on the 20% clearest days. States are to evaluate their contributions to visibility impairment at Class I areas both within and outside the State and to develop long-term control strategies to reduce emissions of air pollutants that impair visibility. The national goal is to return visibility to natural background levels by 2064. Using the period 2000 to 2004 as the baseline period, the Uniform Rate of Progress (URP) is a linear rate of progress or "glide path" towards natural conditions in 2064. States are to evaluate progress in improving visibility to the 2018 URP planning goal, and every 10 years thereafter.

Table 4 below is a summary of the goals for the 20% worst and best days for Oregon's 12 Class I areas, comparing baseline monitored conditions (2000-04) to estimated natural conditions in 2064. (To see Oregon's progress related to the goals, please see Table 14). For the 20% worst days, the 2018 URP Goal is indicated as is the Reasonable Progress Goal for both worst and best 20% visibility days. Class I areas are grouped by the IMPROVE monitoring site that represents each area.

[4] See Appendix C – Visibility Basics for further background on reasonable progress goals, uniform rates of progress and other elements of regional haze planning.

Table 4 20% Best and Worst Days Baseline, Natural Conditions, Uniform Rate of Progress and Reasonable Progress Goal for Oregon Class I Areas

Region	Oregon Class I Area	20% Worst Days				20% Best Days	
		2000-04 Baseline (dv)	2018 URP Goal (dv)	2018 Reasonable Progress Goal (dv)	2064 Natural Conditions (dv)	2000-04 Baseline (dv)	2018 Reasonable Progress Goal (dv)
Northern Cascades	Mt. Hood Wilderness Area	14.9	13.4	13.8	8.4	2.2	2.0
Central Cascades	Mt. Jefferson, Mt. Washington, and Three Sisters Wilderness Areas	15.3	13.8	14.3	8.8	3.0	2.9
Southern Cascades	Crater Lake National Park; Diamond Peak, Mountain Lakes, and Gearhart Mountain Wilderness Areas	13.7	12.3	13.4	7.6	1.7	1.5
Coast Range	Kalmiopsis Wilderness Area	15.5	14.1	15.1	9.4	6.3	6.1
Eastern Oregon	Strawberry Mountain and Eagle Cap Wilderness Areas	18.6	16.3	17.5	8.9	4.5	4.1
Eastern Oregon/ Western Idaho	Hells Canyon Wilderness Area	18.6	16.2	16.6	8.3	5.5	4.7

2. Status of SIP Measures

The 2010 Oregon Regional Haze Plan included a number of elements adopted as part of the State Implementation Plan. This section of the five year update provides information about the status of the implementation of these measures and emission reductions that have resulted. This addresses the requirements in 40 CFR 51.308 (g) (1) and (2). In addition, 2010 Plan identified work commitments associated with the five year progress report not otherwise identified in the federal regional haze rule. These commitments are identified and discussed below in Section 2.3 Long Term Strategy Update.

2.1 Regional Haze SIP requirements

40 CFR 51.308 (g) (1)

2.1.1 Best Available Retrofit Technology

DEQ evaluated ten BART eligible sources and found that the Portland General Electric Boardman plant had, by far, the greatest visibility impact covering 14 Class I areas throughout the Pacific Northwest and the Columbia River Gorge National Scenic Area. The Title V permit for the facility was amended to include conditions requiring installation of BART controls and permanently cease burning coal in the main boiler by December 31, 2020. DEQ also determined that four other sources, PGE Beaver Power Plant, Georgia Pacific Wauna Mill, International Paper and the Amalgamated Sugar Plant were subject to BART. Each of these facilities opted for one or more federally enforceable permit limits to reduce visibility impacts to below 0.5 dv.

PGE Boardman

PGE Boardman is a coal fired steam electric generating unit near Boardman, Oregon. The plant, which began operation in 1980, operated with a Foster Wheeler dry bottom opposing wall fired design with first generation low NO_x burners and overfire air with a Title V permit number 25-0016. The adopted BART requirements for the PGE Boardman plant that include a December 31, 2020 closure date for the plant. Prior to 2020, PGE Boardman installed low NO_x burners with a modified over-fire air system in 2011 and is meeting BART NO_x emission limitations. In early 2014 BART SO_2 controls, consisting of a dry sorbent injection (DSI) system, were installed and is in compliance with the applicable BART SO_2 emission limitation. A further reduced BART SO_2 emission limit is required in 2018.

PGE Beaver

The PGE Beaver plant is an electrical power generation facility located in Clatskanie Oregon. This plant has a Title V Operating Permit No. 05-2520, which was modified on January 21, 2009 to incorporate the FEPL requirements.

The plant has six combined cycle turbines that are the BART-eligible emission units, which are listed below in Table 5. PGE requested daily fuel oil limits for these turbines based upon the daily quantity and the sulfur content of the fuel oil combusted, as well as a requirement that all future shipments of oil contain no more than 0.0015% sulfur (i.e. Ultra Low Sulfur Diesel). An equation was developed to determine a daily fuel oil quantity limit that is tied to the sulfur content of the fuel, so as not to exceed the visibility impact threshold level of 0.5 dv.

Georgia Pacific Wauna Mill

The Georgia-Pacific Wauna Mill is a large, integrated pulp and paper facility which produces wood pulp using the Kraft pulping process, located in Clatskanie Oregon. This plant has a Title V Operating Permit No. 04-0004, which was modified on June 18, 2009 to incorporate the FEPL requirements. This permit was revised on December 2, 2010 to reflect completion of the CNCG project (see description below) and elimination of a major BART-eligible emission unit.

Georgia-Pacific proposed a FEPL that provided for reduced emissions of visibility pollutants in two steps. The first step would be a FEPL prior to eliminating the Non-Condensible Gas (NCG) Incinerator (EU-23), while second step would be the FEPL after. As indicated below, the NCG Incinerator was the largest source of SO_2 emissions at the mill. The project to eliminate this incinerator was called the CNCG Project, and would route the NCG gases to the Recovery Furnace and the Lime Kiln for destruction. Based on this, the FEPL for this source assumed the NCG Incinerator would be operated until the CNCG Project was completed. This is identified as FEPL1 below. FEPL2 is after the elimination of this emission unit. The major FEPL requirements were:

- The use of fuel oil in the Power Boiler was permanently discontinued.
- Use of fuel oil in the Lime Kiln was discontinued until completion of the CNCG Project, after which fuel oil could again be used; and

- The maximum pulp production rate was limited to 1,030 tons per day until completion of this project, after which the maximum pulp production limit would increase to 1,350 tons per day.

The CNCG Project was completed in April 2010, and the NCG Incinerator has been eliminated. The use of fuel oil in the Power Boiler has been permanently discontinued, and the other conditions above now apply.

International Paper

The International Paper Company, Springfield mill manufactures linerboard, primarily from wood chips and recycled old corrugated containers. The plant is located in Springfield, Oregon, and has a Title V Operating Permit No. 208850, issued by the Lane Regional Air Protection Agency, which was modified on April 7, 2009 to incorporate the FEPL requirements.

The plant has seven different BART-eligible emission units. The No.4 Recovery Furnace is the primary recovery furnace and the No. 3 Recovery Furnace is only operated when it is necessary to take No.4 Recovery Furnace down for maintenance or repair. Due to cracking in the No. 4 Recovery Furnace steam and mud drums, the facility was performing more frequent than normal shutdowns and inspections for safety purposes. It was decided to replace the steam and mud drums on No. 4 Recovery, and this would take up to two years, or by the end of 2010. Until that time, there was the potential that on days that the No. 3 Recovery Furnace was being operated, visibility impacts could equal or slightly exceed the 0.5 dv threshold. In order to minimize the likelihood if this occurring, conditions were added to the Scheduled Maintenance Plan that included a requirement the facility not burn No.6 Fuel Oil in the Power Boiler when the No.3 Recovery Furnace is operating. As an extra measure, emissions from the Package Boiler (EU-150A, a non-BART emission unit) would be included when demonstrating compliance with the visibility permit limit, until the project to replace the steam drum on No. 4 Recovery Furnace was completed. Compliance with the condition to limit visibility impacts is demonstrated through the use of a formula, emission factors and continuous emissions monitoring data.

Amalgamated Sugar

This Amalgamated Sugar plant is a sugar beet processing facility located in Nyssa, in eastern Oregon, near the Idaho border. This facility has a Title V Operating Permit No. 23-0002. The plant is currently shutdown, and has not identified a date to resume operations. DEQ's BART rules in 340-223-0040(3) specify that this facility must either modify its permit by adopting an FEPL or be subject to BART, before resuming operation. At this time, this facility is still shutdown, and the permit has not been modified.

2.1.2 Oregon Smoke Management Plan

Prescribed burning on forest lands is the largest anthropogenic fire source in Oregon at an estimated 18,500 tons per year of PM_{10} in 2005. Under state statute, ORS 477.013, the State Forester and DEQ are required to protect air quality through a smoke management plan. The plan includes consideration of weather, fuels, burning techniques and considerations of impacts to population centers and Class I areas. The Oregon Department of Forestry, in consultation with DEQ, revised the Oregon Smoke Management Plan in November 2007, including new visibility protection measures. These measures have "visibility objectives" that include voluntary measures to minimize smoke impacts in Class I areas during the summer protection period and to use caution when burning upwind to avoid ground plume impacts outside of the summer protection period. The plan was incorporated into the State Implementation Plan in 2009.

In 2013 the Department completed an evaluation of the contribution of prescribed fire to Oregon Class I areas, showing impacts in at least two areas, the Kalmiopsis Wilderness and Crater Lake National Park. (See Appendix A). Recommended changes included:

1) During October and November, prescribed burns within 50 miles of either area would be evaluated for potential to impact visibility;
2) Assessing potential for a direct plume impact at ground level in Class I areas;
3) In the event of a likely impact, utilize additional emission reduction techniques, test fires, partial burns or postponement;
4) Consider use of rapid mop-up of residual smoke when necessary to prevent intrusion;
5) Post-burn reporting and evaluation of smoke intrusion.

The Oregon Department of Forestry subsequently modified the Smoke Management Plan to incorporate the recommended practices. These changes were submitted to EPA in June 2014 as a revision to the State Implementation Plan and are still under review for final approval.

2.2 Emission Reductions Achieved by SIP Measures

40 CFR 51.308 (g) (2)

2.2.1 BART

<u>PGE Boardman</u>

Table 5 shows the emissions modeled for the BART-eligible emission unit, by pollutant, and the emissions reduction achieved to date by the BART controls, and corresponding change in visibility impact for the highest impacted Class I area (98th percentile, or 22nd highest day, per DEQ modeling protocol). Based on DEQ's modeling results, the highest visibility impact in any Class I area under this action, at this time is 2.5 dv, but will drop to 1.0 dv when a more stringent BART SO2 emission limit is required starting July 1, 2018. The plant will cease coal burning operation after December 31, 2020.

Table 5 PGE Boardman Emissions to date

		Emissions without BART[4]				Emissions with BART (2014)[5]			
PGE Boardman	Unit	Visibility	SO2	NOx	PM10	Visibility	SO2	NOx	PM10
BART Emission Units	ID	dv	tons/yr	tons/yr	tons/yr	dv	tons/yr	tons/yr	tons/yr
Main Boiler H22H (2003-2005) =	MB.EU	**4.6**	**30449.1**	**17762.0**	**1015.0**	**2.5**	**3044.9**	**5836.1**	**304.5**

<u>PGE Beaver</u>

Table 6 shows the emissions modeled for each BART-eligible emission unit, by pollutant, and the emissions reduction achieved by the FEPL, and corresponding change in visibility impact for the highest impacted Class I area (98th percentile, or 22nd highest day, per DEQ modeling protocol). Based on DEQ's

[5] Estimated emissions based on modeling

modeling results, the highest visibility impact in any Class I area under this FEPL is 0.414 dv, well under the 0.5 dv threshold level.

Table 6 PGE Beaver Emissions with FEPL

		Emissions without FEPL[6]				Emissions with FEPL[5]			
PGE Beaver BART Emission Units	Unit ID	Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr	Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr
Combustion Turbine	EU-1		12.3	129.6	17.6		0.8	126.6	2.0
Combustion Turbine	EU-2		12.3	129.6	17.6		0.8	126.6	2.0
Combustion Turbine	EU-3		12.3	129.6	17.6		0.8	126.6	2.0
Combustion Turbine	EU-4		12.3	129.6	17.6		0.8	126.6	2.0
Combustion Turbine	EU-5		12.3	129.6	17.6		0.8	126.6	2.0
Combustion Turbine	EU-6		12.3	129.6	17.6		0.8	126.6	2.0
Total Emissions =			**73.7**	**777.7**	**105.5**		**4.6**	**759.8**	**12.2**
H22H (2003-2005) =		**0.679**				**0.414**			

[6] Estimated emissions based on modeling

Georgia Pacific Wauna Mill

Table 7 shows the emissions modeled for each BART-eligible emission unit, by pollutant, and the emissions reduction achieved by the FEPL, and corresponding change in visibility impact for the highest impacted Class I area (98th percentile, or 22nd highest day, per DEQ modeling protocol). Based on DEQ's modeling results, the highest visibility impact in any Class I area under FEPL1 is 0.483 dv, and FEPL 2 is 0.447 dv. The plant is now operating under FEPL2, which is well under the 0.5 dv threshold level.

Table 7 GP Wauna Emissions with FEPL

		Emissions without FEPL				**Emissions with FEPL1**			
G-P Wauna BART Emission Units	Unit ID	Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr	Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr
Lime Kiln	EU-21		41.6	23.9	34.1		8.6	42.9	31.3
NCG Incinerator	EU-23		342.4	1.3	14.0		357.6	10.7	0.5
Chem Recovery Stack 1	EU-24		0.0	80.0	50.6		37.1	60.2	42.7
Chem Recovery Stack 2	EU-24		0.0	0.0	0.0		37.1	60.2	42.7
Smelt Dissolving Tank	EU-25		0.0	5.7	8.4		8.6	7.0	21.5
Power Boiler	EU-33		437.6	128.1	24.4		1.4	252.8	1.3
Paper Machine #1	EU-39		0.1	1.2	10.3		0.1	3.1	8.0
Paper Machine #2	EU-39		0.1	2.8	10.3		0.1	3.1	8.0
Chip silos	EU-51		0.0	0.0	11.9		0.1	0.0	12.3
Total Emissions =			**821.9**	**243.0**	**163.8**		**450.6**	**439.9**	**168.3**
H22H (2003-2005) =		**0.568**				**0.483**			

		Emissions with FEPL2			
G-P Wauna BART Emission Units	Unit ID	Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr
Lime Kiln	EU-21		90.0	56.3	41.1
NCG Incinerator	EU-23		0.0	0.0	0.0
Chem Recovery Stack 1	EU-24		72.1	84.2	55.2
Chem Recovery Stack 2	EU-24		72.1	84.2	55.2
Smelt Dissolving Tank	EU-25		11.3	9.2	28.1
Power Boiler	EU-33		1.4	252.8	1.3
Paper Machine #1	EU-39		0.1	3.1	8.0
Paper Machine #2	EU-39		0.1	3.1	8.0
Chip silos	EU-51		0.0	0.0	12.3
Total Emissions =			**247.0**	**492.9**	**209.2**
H22H (2003-2005) =		**0.447**			

International Paper

Table 8 shows the emissions modeled for each BART-eligible emission unit, by pollutant, and the emissions reduction achieved by the FEPL, and corresponding change in visibility impact for the highest impacted Class I area (98th percentile, or 22nd highest day, per DEQ modeling protocol). Based on DEQ's modeling results, the highest visibility impact in any Class I area under this FEPL is 0.444 dv, well under the 0.5 dv threshold level.

The facility completed repairs of the No. 4 Recovery Furnace steam and mud drums on December 7, 2009. The FEPL continues to remain in the permit since the facility would continue to have the potential to emit above the levels that exceed the 0.5 dv threshold level, as noted under "Emissions without FEPL" below.

Table 8 International Paper Emissions with FEPL

International Paper BART Emission Units	Unit ID	Emissions without FEPL Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr	Emissions with FEPL Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr
Power+Package Boilers	EU-150A		561.7	191.7	36.9		210.65	99.1	39.23
# 3 Recovery Furnace	EU-445A		521.2	46.9	9.5				
# 3 Smelt Tank East	EU-445B		1.4	1.3	6.7				
# 3 Smelt Tank West	EU-445B		1.4	1.3	5.4				
# 4 Recovery Furnace	EU-445C		41.9	78.7	21.1				10.69
#4 Smelt Tank Vent	EU-445D		2.9	3.4	8.3				6.9
Lime Kilns	EU-455		59.6	15.7	3.2				1.23
Total Emissions =			**1190.1**	**339.0**	**91.1**		**210.7**	**99.1**	**58.1**
H22H (2003-2005) =		**1.457**				**0.444**			

Amalgamated Sugar

Table 9 shows the emissions that were modeled for the one BART-eligible emission unit, by pollutant, and the emissions reduction achieved by the recommended FEPL, along with the corresponding change in visibility impact for the highest impacted Class I area (98th percentile, or 8th highest day, per DEQ modeling protocol). Based on DEQ's modeling results, the highest visibility impact in any Class I area under the recommended FEPL would be 0.437 dv, well under the 0.5 dv threshold level.

Table 9 Amalgamated Sugar Emissions with FEPL

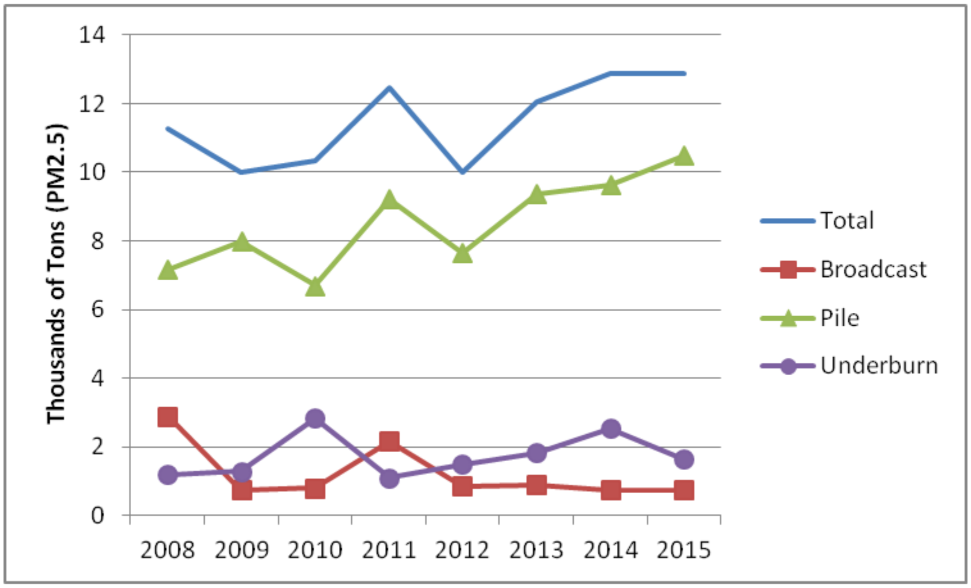
Amalgamated Sugar BART Emission Units	Unit ID	Emissions without FEPL Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr	Emissions with FEPL Visibility dv	SO2 lbs/hr	NOx lbs/hr	PM10 lbs/hr
Foster Wheeler Boiler	S-B3		**205.0**	**127.0**	**9.2**		**197.0**	**120.0**	**9.2**
H8H (single year) =		**0.514**				**0.437**			

2.2.2 Smoke Management Plan

The Smoke Management Plan's overall purpose is to keep smoke from forestland prescribed burning from being carried into Smoke Sensitive Receptor Areas, generally population centers, and to provide maximum opportunity for essential forestland burning while minimizing emissions. In 2014 the program began tracking acres of treated public and private forestland where alternatives to burning or emission reduction techniques were employed instead of using prescribed fire as shown in Table 10. Alternatives to burning include biomass removal, scattering material, chipping, crushing, firewood removal, non-treatment, other techniques to reduce fire hazard and/or creating planting spots. Emission reduction techniques include piling clean piles instead of broadcast or underburning, use of rapid ignition techniques, covering piles to keep dry, other techniques to reduce particulate and gaseous emissions. Of all the acres treated in 2015, 48 percent used prescribed burning and alternative methods were used on the remainder of acres treated. The program is not exclusively focused on prescribed burning but on the variety of treatment methods that that most effectively reduce fire hazard, maintains productive and resilient forests and keeps or improves air quality. Table 11 shows the number of acres burned over the past 8 years and the number of intrusions into one or more of the 37 listed communities defined by rule as a Smoke Sensitive Receptor Areas. The average number of intrusions per year remains low at 7 and continues to represent a very small percentage of overall prescribed burning activity. A smoke intrusion is defined as the verified entrance of smoke from prescribed burning into a Smoke Sensitive Receptor Area.

An estimate of fine particulate matter emissions from prescribed burning from 2008 to 2015 is detailed in Figure 5. Avoided emissions from the techniques included as alternatives to burning is not ordinarily tracked but if the material were burned instead, it may have resulted in up to 13,500 tons of fine particulate emissions, which in 2015 would have exceeded emissions from prescribed burning.

Figure 5 Prescribed Burning Emissions Estimate PM 2.5



The Smoke Management Plan was amended in 2014 to incorporate practices to minimize impacts to the Kalmiopsis Wilderness and Crater Lake National Park. While it is too early to assess the impact from these changes, it is clear that the management competence otherwise demonstrated in minimizing smoke intrusions into SSRAs (see Table 11) offers confidence the recommended changes can be effectively implemented.

The rules for Smoke Management Plan can be found here, http://arcweb.sos.state.or.us/pages/rules/oars_600/oar_629/629_048.html, and the implementing guidance document here, http://www.oregon.gov/ODF/Documents/Fire/smd.pdf.

Table 10 Forest Land Acres Treated - 2015

from: *Oregon Smoke Management Annual Report 2015*	Total Statewide Acres
Prescribed Burning	179,613
Alternatives to Burning	193,942
Emission Reduction Techniques	143,572

Table 11 Prescribed Forestry Burns and Intrusions 2008 - 2015

Year	Total No. Units	No. Units Burned	Acres Burned	Number Intrusions	Percentage of Units with Intrusion
2008	3,270	2,608	162,405	6	0.23%
2009	3,222	2,492	139,000	5	0.20%
2010	3,471	2,451	157,224	8	0.33%
2011	3,544	2,880	162,154	6	0.21%
2012	3,651	3,092	141,892	7	0.23%
2013	3,890	3,104	182,189	3	0.10%
2014	4,095	3,443	208,593	13	0.38%
2015	3,601	3,076	179,613	9	0.29%

2.3 Long Term Strategy Update

In the 2010 Regional Haze Plan Oregon DEQ identified several work commitments associated with the five-year progress report, not otherwise required in the federal regional haze rule (40 CFR 51.308 (g),(h) or (i)) for the purpose of achieving reasonable further progress. DEQ's commitment was to evaluate the prescribed burning contribution to haze, described in Appendix A, and an evaluation of non-BART sources, described in Appendix B. Other work items are listed below with current updates and descriptions on evaluations completed to date as resources have allowed.

2.3.1 Non-BART Source Evaluation

The non-BART source evaluation was intended to identify facilities that may possibly contribute to impairment of visibility in Class I areas as a prelude to determine if additional controls are needed in the 10 year plan revision. A technical analysis protocol was developed for an initial screening evaluation relying on the four factors outlined in Section 308 of the Regional Haze Rule. Lacking specific guidance, DEQ relied on seven factors including size, location, distance to Class I area, quantity/distance calculation, visitation data, date of permit issuance and availability of modeling, to evaluate potential eligibility. This assessment is not a definitive impact analysis, but is meant simply to identify potential source candidates for further and more refined analysis in the next planning cycle. Thirty one sources were considered in the basic screening evaluation. Within that group, seven facilities were identified as potentially having an impact on one or more Class I areas in the state. No further action is required or needed at this time but these sources will be evaluated further during the next planning cycle.

Consideration of impact from non-BART sources is not required under the regional haze rule. DEQ undertook this evaluation as a commitment under the initial Regional Haze Plan. In undertaking any fuller analysis during the ten year plan update, which may include modeling, DEQ will consider any future guidance provided by EPA.

2.3.2 Update on Columbia Gorge Visibility

The Columbia River Gorge National Scenic Area was designated in 1986. While not a Class I area, air quality degradation, including visibility impairment, can lead to damaging the scenic, natural, cultural and recreational resources the designation was intended to protect. The Columbia River Gorge Commission and the U.S. Forest Service have the responsibility to administer the National Scenic Area Act and in its the Management Plan for the Columbia River Gorge National Scenic Area it requests state air quality agencies in Washington state and Oregon to develop and implement an air quality strategy for the Scenic Area.

Oregon DEQ and the Washington Southwest Clean Air Agency worked with the CRGC from 2001 to 2010 to study air quality and visibility in the Gorge, and the emission sources that contributed to haze in the Gorge. The study also included a projection of future visibility conditions in the Scenic Area. The study results identified that haze in the Gorge, attributed mostly to organic carbon, sulfates and nitrates, originated from many different sources. Improvements in visibility will necessarily result from the cumulative effect of numerous emission reduction activities.

Subsequently, the air agencies developed a strategy that is consistent with the National Scenic Area Act's charge to "protect and enhance" the scenic, natural, cultural, and recreational resources of the Gorge. The goal for visibility in the Gorge is continued improvement using the same approach used in the Oregon's regional haze plan. Because many of the same problems that affect haze in the Gorge are the same problems that affect haze across the western region, much of the visibility efforts under the regional haze program will benefit the Gorge, including for instance reductions in emission from the PGE Boardman facility. The Columbia River Gorge Scenic Area is situated between two Class I areas (Mt. Hood and Mt. Adams) and the Gorge will benefit from Oregon and Washington's long term regional haze process.

The Gorge strategy also included commitments to review visibility trends in the Gorge as part of future regional haze plan updates. Therefore, as part of this federally mandated five-year regional haze plan update, DEQ is including a description of visibility conditions in the Gorge. DEQ can track Gorge visibility conditions to determine continued improvement, similar to but not on the same glide path as conditions in the Class I areas. If visibility in the Gorge is not improving or showing an increasing trend, then DEQ will reassess its Gorge strategy and potentially identify new strategies to ensure continued visibility improvement in the Gorge. Figure 6 shows visibility trends in the Gorge, from the baseline time period through the most recent available year. The COGO1 monitor (located in the western end of the Gorge) does not have data prior to 2002 and was discontinued in 2011 due to lack of funding. The CORI1 monitor (located in the eastern end of the Gorge) has two data gaps in 2002 and 2012 when data was not available.

Figure 6 Visibility Trends - Columbia River Gorge - CORI1 & COGO1

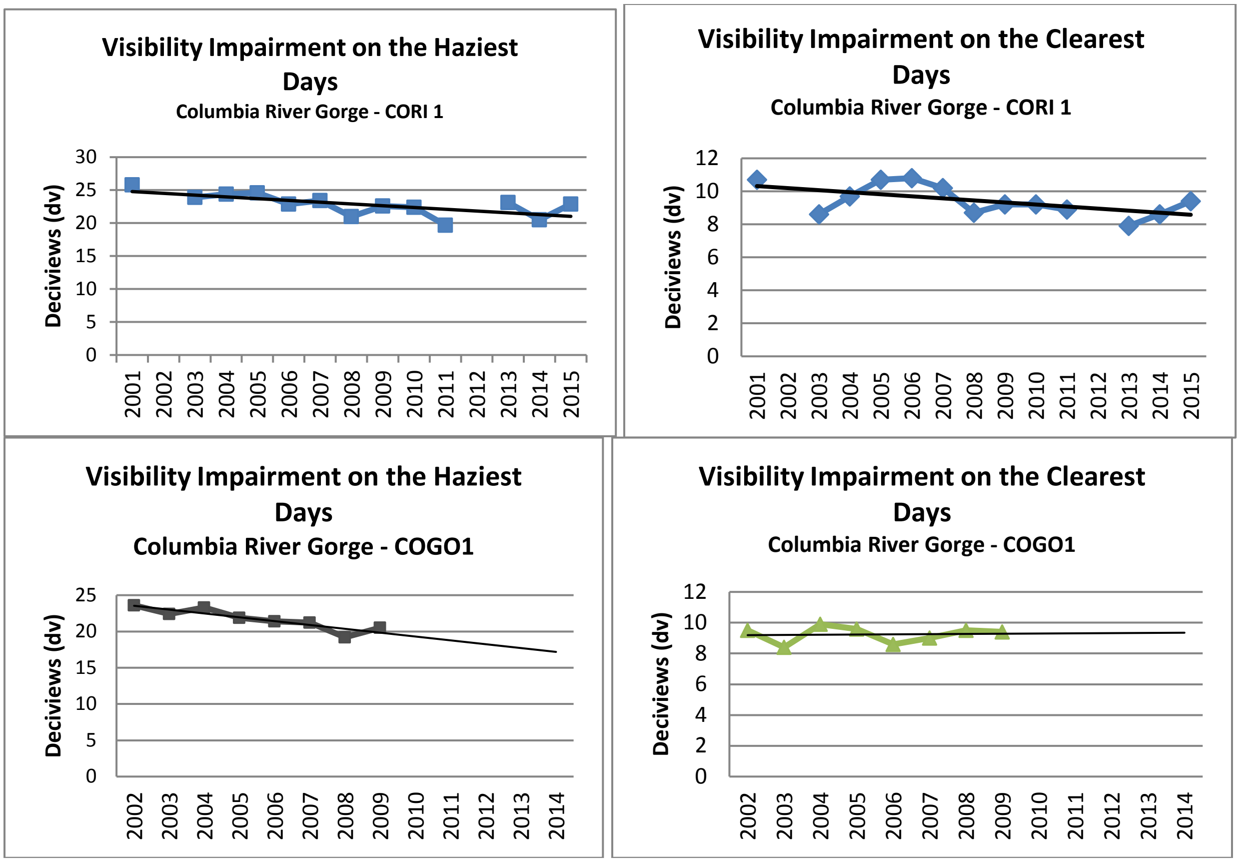


Table 12 shows the changes in visibility affecting pollutants, light extinction and deciview for the Gorge for the most recent progress period as compared to the baseline period. Increases are seen in fine soil, coarse material and sea salt, primarily biogenic sources, highlighted in bold in the table below. The pollutants from anthropogenic sources show declines. Overall visibility has improved over this time period for both the best days and the worst days. Data from the COGO1 site is not included because monitoring stopped in 2011 due to U.S. Forest Service funding cuts.

Table 12 Visibility Progress Summary for Columbia River Gorge National Scenic Area

Site	Group	Change from 2000-04 to 2009-13 (Mm^{-1}/year)								
		Sulfate	Nitrate	Organic Carbon	Elemental Carbon	Fine Soil	Coarse Material	Sea Salt	Total Light Extinction	Deciview
CORI1	20% Best	-1.2	-0.1	-0.6	-0.4	**0.1**	-0.1	**0.1**	-2.1	-0.8
	20% Worst	-1.1	-24	-6.6	-1.5	**0.3**	**1.5**	**0.1**	-31.2	-2.8

The continuing operation of the CORI1 site has been at risk due to possible budget cuts but the U.S. Forest Service has announced that funding has been identified for the near term. DEQ does operate a nephelometer in The Dalles that can provide data on light scattering but does not provide a breakdown, or speciation, of individual pollutants contributing to the light scattering observed.

2.3.3 Evaluate Contribution from General Outdoor Open Burning

Industrial and commercial open burning is prohibited throughout the state except by permit. Residential open burning is restricted, if not prohibited in population centers of the state. Construction and demolition debris burning is prohibited in the Willamette Valley within 6 miles of cities over 45,000 in population and within 3 miles of remaining cities greater than 1,000 population. The net effect is to prohibit construction and demolition burning in population centers in the Willamette Valley. Emissions of nitrogen oxides declined in both types of open burning in contrast to an overall statewide increase as shown in Table 13. Sulfur dioxide emissions declined for residential open burning but increased for construction and demolition open burning. PM emissions increased for residential open burning but declined for construction and demolition burning. For both of these pollutants, the net change in emissions from open burning collectively represents a negligible contribution to the overall change in emissions from all sources statewide. The resulting emissions represent a negligible contribution to the overall inventory as shown by Table 13. Population centers that may be near Class I areas have controls in place. The remaining open burning that may otherwise occur nearer Class I areas is not likely to be a significant contributor to haze.

Table 13 Open Burning Emissions in 2008 and 2011, tons per year

		Nitrogen Oxides	Sulfur Dioxide	$PM_{2.5}$
Residential Open Burning	2008	202.7	34.5	1,132.4
	2011	144.6	24.1	4,505.7
Construction & Demolition Open Burning	2008	556.2	0.0	1,457.9
	2011	301.9	7.9	620.3
Statewide Inventory, Total	2008	79,675.2	25,392.5	145,461.1
	2011	173,522.4	30,284.7	182,517.2

2.3.4 Evaluate Contribution from Rangeland Burning

DEQ has been unable due to resource constraints to conduct a detailed analysis of the contribution to visibility impacts from rangeland burning. However, rangeland burning in southeastern Oregon is not likely to be a significant contributor to haze in Class I areas as the nearest sites, Strawberry Mountain and Eagle Cap Wilderness areas are located generally upwind of prevailing summertime wind flows. Further detailed analysis of the impacts of rangeland burning would require original investigative work as there are not established emission factors or data for this activity.

2.3.5 Efforts to Address Offshore Shipping

Ocean going vessels are sources of visibility impairing pollutants, PM, NO_x and SO_x. The Oregon coast extends approximately 363 miles from the mouth of the Columbia River in the north to the California state border in the south. Ship traffic operating coastwise offshore impacts continental locations because of prevailing westerly wind patterns year round. The Columbia River itself is a major freight corridor with ocean going vessels travelling 94 miles inland to the ports of Portland, Oregon and Vancouver, Washington with intermediate ports at Astoria, Oregon and Kalama and Longview, Washington.

Figure 7 North American ECA Projected PM Concentration Reductions

The only state regulation controlling marine vessel emissions limits visible smoke in the Portland harbor area. Offshore emissions from ocean going vessels contribute as much as 85 percent of PM, NO_x and SO_x from all ocean going vessel emissions in the state. Until very recently those emission were uncontrolled. Under MARPOL Annex VI the United States and Canada obtained designation of an Emission Control Area for North America. This ECA will reduce emissions, primarily through fuel switching for existing vessels and exhaust controls for newer vessels. Overall NO_x, PM and SO_x emissions are expected to be reduced by 23 percent, 74 percent and 86 percent, respectively, below otherwise predicted levels in 2020 without the ECA. Figure 7 shows the extent of emission benefits that may occur inland with most Class I areas in Oregon experiencing a reduction in PM concentrations ranging between 0.03 ug/m^3 to 0.1 ug/m^3.

2.3.6 Update WRAP SO_2 and NO_x Emission Inventory for Point Sources

The WRAP update is not available at this time. See Section 3.4.1 for an analysis of changes in statewide emission inventories for point sources between 2002 and 2008.

2.3.7 Update on Ammonia Emission Inventory and Possible Reductions

To form ammonium sulfate and ammonium nitrate in the atmosphere, there must be readily available ammonia (NH3) in which to react. By far the most significant source of ammonia is the non-point source, agriculture livestock manure management, which includes the application of manure as fertilizer, followed by prescribed burning. Although total ammonia emissions statewide have increased to an estimated 71,695 tons per year in 2011 from 57,154 tons in 2002, the overall contribution of ammonia sulfates and nitrates to visibility impacts has not similarly increased. Table 19 shows only the Crater Lake IMPROVE monitor site with a positive impairment to visibility associated with ammonium sulfate, measured as light extinction even as overall visibility has improved. Considering the major sources of ammonia in the state this incremental change may be more attributable to prescribed burning than agricultural practices. As noted in Section 2.2.2 and Appendix A recent changes to the Smoke Management Plan have been adopted specifically for the Crater Lake and Kalmiopsis Wilderness areas to address prescribed burning impacts. Since these controls have only recently been in place, it is too soon to evaluate effectiveness and consider whether additional controls are necessary. This can be an area for review for the 10 year update.

2.3.8 Update on 2010 Changes to Willamette Valley Field Burning

The 2009 Oregon Legislature adopted SB 528 that has resulted in a further reduction in agricultural field burning in the Willamette Valley. The burning of grass seed and cereal grain fields in the Willamette Valley is a summertime practice to dispose of leftover straw after harvest, improve yield and reduce herbicide and pesticide use. This practice produces smoke and fine particulate matter that can cause health problems and contribute to haze.

SB 528 eliminated regular field burning in the Willamette Valley, starting in 2010. Prior to that, up to 40,000 acres were allowed to be burned every year. The law also reduced burning of fields containing creeping red fescue, chewings fescue and highland bentgrass as well as fields on steep terrain from 25,000 to 15,000 acres per year. These fields are located almost entirely in Marion County. The law does allow up to 2,000 acres of “emergency burning” to address major disease outbreaks or insect infestations. There have been no applications for emergency burning to date. Acreage allowances for stack burning and propane flaming were reduced to 1,000 and 5,000 acres per year, respectively, but were eliminated after 2013. These changes were adopted by administrative rule as part of the State Implementation Plan by the Environmental Quality Commission in August 2010. These changes will provide minor visibility improvement during the summer months.

2.3.9 Updates to Long Term Strategy from Ongoing Air Pollution Programs - Interstate Transport, Ravi BART, Oregon Phase I Visibility Program, PSD/New Source Review, Mobile Sources, PM_{10} & $PM_{2.5}$ NAAQS and Nonattainment Areas

The following summary describes updates to ongoing programs and regulations in Oregon that directly protect visibility, or can be expected to improve visibility in Oregon Class I areas, by reducing emissions in general. This summary does not attempt to estimate the actual improvements in visibility that will occur, as many of the benefits are secondary to the primary air pollution objective of these programs/rules, and consequently would extremely difficult to quantify, due to the technical complexity and limitations in current assessment techniques.

Interstate Transport

Section 12.3 of the 2010 Regional Haze Plan analyzes the impacts of haze pollutants transported from Oregon to Class I areas in adjoining states as well as the impact to Oregon’s Class I areas from haze pollutants transported into Oregon. As for impacts in out of state Class I areas, the BART controls for the PGE Boardman plant will make a significant difference as this facility was modeled to affect visibility in 14 Class I areas in Oregon, Washington, Idaho, Nevada and the Columbia Gorge National Scenic Area. The improvement in visibility in the Mt. Hood Wilderness, for instance will be 4.98 deciviews by 2020. Similarly the phase-out of the coal fired boilers at the TransAlta power plant in Centralia Washington will have visibility benefits in the 13 Class I areas modeled to be impacted by emissions. The phase-out occurs in two steps with one boiler ceasing operation by December 31, 2020 and the remaining coal boiler shut down in 2025. Ultimately the resulting improvement in visibility in the Mt. Hood Wilderness will be 3.47 deciviews.

Oregon Phase 1 Visibility Program

The Oregon Phase I Visibility Program remains in place since its adoption in Oregon in 1986. This program consists of short and long term strategies focused on nearby sources of visibility impairment in

Class I areas. The program consists of RAVI BART, Prevention of Significant Deterioration New Source Review rules for industrial sources and seasonal protection during the summer months associated with prescribed forestry burning and agricultural field burning. The Phase I program also does not allow field burning on summer weekends upwind of Class I areas. Each of these programs remains in place and continue to function as designed.

RAVI BART

The Department includes Reasonably Attributable Visibility Impairment BART requirements as part of the Oregon Visibility Plan. RAVI BART is triggered by a certification from a federal land manager that visibility impairment exists in a federal Class I area. Since the adoption of RAVI BART, there has been no formal certification made in Oregon for reasonably attributable impairment.

PSD/New Source Review

The PSD/New Source Review rules protect visibility in Class I areas from new industrial sources and major changes to existing sources by requiring modeling to show no significant visibility impact defined as impairment above background more than 5%, expressed as visibility extinction. Over the past 5 years ten or more sources have undergone analysis of their potential impacts to visibility in Class I areas. Each of these reviews have resulted in determination of no significant impacts, i.e., below threshold levels, either through modification of the facility's original operating plan, installation of controls or a decision to not build. The program remains in place and continues to protect visibility in the Class I areas.

Mobile Sources

Several mobile source regulations at the federal level are continuing and states like Oregon will see significant visibility benefits as a result. These programs include the movement to lower sulfur fuel concentrations in both diesel and gasoline, reduced PM and NO_x emissions from heavy duty on-road vehicles and non-road equipment. Recent federal rules, such as the 2010 requirements that ultra low sulfur diesel fuel standard of 15 ppm sulfur be applied to all non-road diesel fuel. Locomotive and marine diesel fuel are required to meet the ULSD standard in 2012 resulting in further reductions of SO_2, NO_x and PM emissions.

Beginning with the 2009 model year, light and medium duty gasoline powered vehicles sold in Oregon must meet Low Emission Vehicle emission standards. Although the primary purpose is to reduce greenhouse gas emissions, these rules also lead to decreases in PM and NO_x. The Department also operates vehicle inspection programs in both the Portland and Medford area ensuring that continued maintenance of emission control equipment on existing vehicles ensures the continued benefits of the federal and state programs requiring lower emitting newly manufactured vehicles.

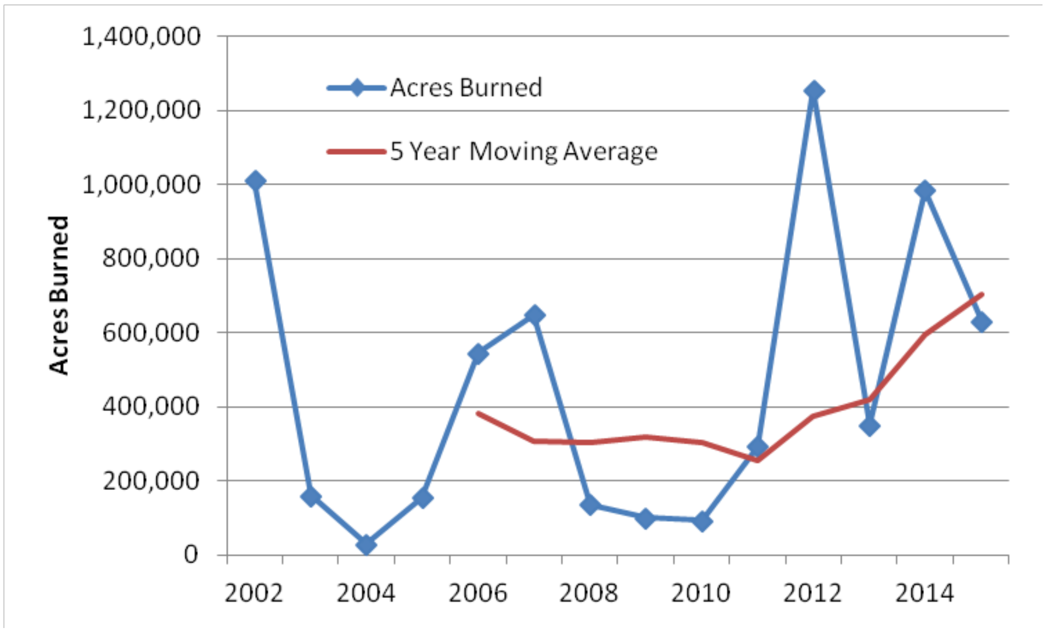
PM_{10} & $PM_{2.5}$ NAAQS and Nonattainment Areas

Oakridge and Klamath Falls are currently the only $PM_{2.5}$ nonattainment areas in the state. Residential woodheating is the primary source of pollutants for each of these areas. The attainment plans include control strategies to reduce $PM_{2.5}$ pollution, specifically through mandatory woodstove curtailment programs and enforcement which are effective in reducing pollution levels during the winter months, increased education and outreach to reduce smoke pollutant levels year-round, and woodstove changeouts. These controls will result in reductions of PM emissions in these communities and the surrounding area.

2.3.10 Wildfire Emission Trends

Oregon, like other western states, is subject to visibility impacts from wildfires. Trends in changing climate resulting in summers with lower precipitation and winters with reduced snow pack can otherwise exacerbate conditions that contribute to increases in the number of acres burned as shown in Figure 8 (from National Interagency Fire Center). Wildfires are occurring more frequently and burning increasing amounts of acreage as indicated in the trend line in the graph. Wildfires cause increases in a variety of visibility impairing pollutants that, depending upon location and wind direction, can have a material effect on Class I area visibility. The impacts are especially challenging because these are not directly controllable anthropogenic events. Wildfire smoke represents a challenge to achieving visibility

Figure 8 Oregon Wildfire Acres Burned - Historic and Trends



improvement goals.

2.3.11 Update to WRAP Regional Modeling

WRAP is not expected to update previous regional modeling work during the timeframe for this report.

2.3.12 Other State Class I Areas Affected by Oregon Emissions

In the 2010 Oregon Regional Haze Plan several Class I areas in adjoining states were identified as receiving impacts from emission sources in Oregon. These included Mt Rainier National Park and the Goat Rock Wilderness in Washington state, Sawtooth Wilderness in Idaho, Jarbridge Wilderness in Nevada, Lava Beds National Monument and Redwood National Park in California. In none of the examples was there a sizeable contribution from Oregon sources identified considering PSAT and WEP source apportionment information. Additional reductions will come when a more stringent BART SO_2 emission limit is required starting July 1, 2018 at the PGE-Boardman coal-fired plant in NE Oregon, which was itself shown to impact 14 Class I areas in Oregon and Washington. Significant anthropogenic Oregon sources contributing to visibility degradation in adjoining states was identified in the first regional haze plan. With controls in place and underway, we expect these impacts to be lessened in the future.

2.3.13 Reasonable Progress Demonstration Relative to Oregon Reasonable Progress Goals

The 2010 Oregon Regional Haze Plan established reasonable progress goals to show achievements, or challenges, to achieving natural visibility conditions. Progress towards those goals at this intermediate interval is shown below but will be subject to a more thorough analysis in the 2018 report.

For both worst day and best day visibilities, the most recent data indicate progress in being made towards the overall regional haze goal but for worst day conditions in the Central Cascades, which includes the Mt. Jefferson, Mt. Washington and Three Sisters Wilderness areas. This adverse change in visibility is attributable to wildfire smoke as discussed in more detail in Section 3.8.

Table 14 Oregon Visibility Observed Relative to Reasonable Progress Goals Through 2014

Region	Oregon Class I Area	20% Worst Days				20% Best Days			
		2000-04 Baseline (dv)	2005-09 First Progress Period (dv)	2010-14 Current Period (dv)	2018 Reasonable Progress Goal (dv)	2000-04 Baseline (dv)	2005-09 First Progress Period (dv)	2010-14 Current Period (dv)	2018 Reasonable Progress Goal (dv)
Northern Cascades	Mt. Hood Wilderness Area	14.9	13.7	13.2	13.8	2.2	1.7	1.3	2.0
Central Cascades	Mt. Jefferson, Mt. Washington, and Three Sisters Wilderness Areas	15.3	16.2	14.9	14.3	3.0	3.0	2.5	2.9
Southern Cascades	Crater Lake National Park; Diamond Peak, Mountain Lakes, and Gearhart Mountain Wilderness Areas	13.7	13.8	11.7	13.4	1.7	1.6	1.2	1.5
Coast Range	Kalmiopsis Wilderness Area	15.5	16.4	14.6	15.1	6.3	6.4	6.1	6.1
Eastern Oregon	Strawberry Mountain and Eagle Cap Wilderness Areas	18.6	16.2	12.5	17.5	4.5	3.6	2.8	4.1
Eastern Oregon/ Western Idaho	Hells Canyon Wilderness Area	18.6	18.2	16.3	16.6	5.5	4.8	4.1	4.7

3. Visibility Trends and Emissions Changes

This section includes summaries of monitoring and emissions data for first 5-year regional haze progress report for Oregon. The monitoring data presented here are from the IMPROVE network, as described in Section 1.3.1. The emissions data was collected by the WRAP using inventories previously developed for the first regional haze plan, and emissions estimates more recently collected by the WRAP for this progress report.

3.1 Overview of Monitoring Data Analysis

The visibility improvement goal, as stated in the RHR, is to ensure that visibility on the worst days improves towards a natural conditions goal, and that visibility on the best days does not get worse. To measure progress towards natural conditions, the EPA provided the concept of a linear, or uniform, rate of reasonable progress between the 2000-2004 baseline period and a default natural conditions goal year of 2064. The RHR specifies that progress is determined for “current conditions” for the best and worst days.

In September 2003, EPA issued formal guidance for tracking progress under the RHR. In this guidance it specified that progress be tracked against the 2000-2004 baseline period using corresponding averages over successive 5-year periods (i.e. 2005-2009, 2010-2014, etc.). In April 2013, EPA issued general principles to assist States in preparing 5-year progress reports, where it specified that progress “should include the 5-year average that includes the most recent quality assured public data available at the time the state submits its 5-year progress report for public review”.

As noted in Section 1.3.2, the Department relied upon the WRAP Regional Haze Reasonable Progress Report completed in June 2013 for detailed information about visibility determinants. The Department also reviewed the 2010-2014 data in addition to the 2005-2009 averaging period, and has included these two five year periods in the evaluation of overall visibility trends, noting any data that indicates significant differences from the prior 5-year trend.

3.1.1 Monitoring Data and the 20% Best and Worst Days

Visibility impairment is the result of the cumulative effect of several different particle pollutant types. Many of these pollutants have individually consistent seasonal patterns. For example, ammonium nitrate is temperature sensitive, and formation often favored during colder winter months, while ammonium sulfate formation may be favored during warmer summer months. Other pollutants, such as particulate organic mass, may be impacted by large and variable episodic events such as unplanned fires, which generally occur during the summer.

To determine the 5-year average of the 20% best and worst days, the highest and lowest 20% of days for each complete year are first selected and averaged on an annual basis, with a 5-year average calculated from these annual averages. The timing for identification of the 20% best and worst days may be significantly influenced by large episodic events (e.g., unplanned fires) which may occur at different time during different years. As a result, the identification of more best or worst days during different seasons of different years may affect the averages for individual species in ways that are independent from actual increases or decreases of individual pollutants from one 5-year period to the next.

3.2 Results of Analysis of Monitoring Data and Visibility Trends

3.2.1 Summary

The following is a summary of current visibility conditions (2010-2014), the differences between the 2000-2004 baseline and current visibility conditions (2010-2014), and the differences between the 2000-2004 baseline and 2005-2009 period based on IMPROVE monitoring data, for the 20% best and worst days. Annual average trend 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 sections that follow. Table 15 refers to the monitoring location sites.

Table 15: Oregon IMPROVE Monitoring Network

Site Code	Class I Area
MOHO1	Mt. Hood Wilderness
THSI1	Mt. Jefferson Wilderness Mt. Washington Wilderness Three Sisters Wilderness
CRLA1	Crater Lake National Park; Diamond Peak Wilderness Mountain Lakes Wilderness Gearhart Mountain Wilderness
KALM1	Kalmiopsis Wilderness
STAR1	Strawberry Mountain Wilderness Eagle Cap Wilderness
HECA1	Hells Canyon Wilderness Area
Site Code	**Scenic Area**
CORI1	Columbia River Gorge National Scenic Area
COGO1[7]	Columbia River Gorge National Scenic Area

3.2.2 Conditions for the 2010-2014 Current Visibility Period
40 CFR 51.308 (g) (3) (i)

This section addresses the required element describing conditions in the 2010-2014 current visibility period. Table 16 and Table 17 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 Class I area IMPROVE monitors in Oregon. 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.

[7] The COGO1 IMPROVE site was discontinued in 2011.

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

- The largest contributor to aerosol extinction at Oregon sites was organic carbon, ammonium nitrate and ammonium sulfate.
- For the 20% most impaired days, particulate organic matter was the highest pollutant contributor to visibility impairment at all Class 1 sites.
- The greatest increase in particulate organic matter was at the THS1 and CRLA1 monitoring sites.
- The highest aerosol extinction (16.3 dv) was measured at the HECA1 site, where organic carbon was the largest contributor to aerosol extinction, followed by ammonium nitrate. The lowest aerosol extinction (13.2 dv) was measured at the MOHO1 site.

Specific observations for the visibility conditions in this progress period 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 1.2 dv (CRLA1) to 6.1 dv (KALM1).
- For all sites except KALM1, ammonium sulfate was the largest non-Rayleigh contributor to the aerosol species of extinction
- At the KALM1 site, organic carbon was the largest contributor to aerosol extinction, followed by ammonium sulfate.

Table 16 Oregon IMPROVE Sites, Visibility Conditions 2010-2014 Current Period, 20% Most Impaired Days

Site	Deciviews (dv)	Percent Contribution to Aerosol Extinction by Species (Excludes Rayleigh) (% of Mm-1) and Rank* (20% most impaired) 2010-2014						
		Sulfate	Nitrate	Organic Carbon	Elemental Carbon	Fine Soil	Coarse Material	Sea Salt
CRLA1	11.7	30%	6%	**44%**	9%	3%	7%	1%
HECA1	16.3	12%	36%	**39%**	6%	1%	5%	1%
KALM1	14.6	26%	7%	**41%**	7%	1%	6%	12%
MOHO1	13.2	26%	10%	**42%**	6%	3%	12%	2%
STAR1	14.5	19%	20%	**43%**	6%	2%	9%	1%
THSI1	14.9	24%	5%	**47%**	7%	3%	14%	1%

*Highest aerosol species contribution per site is highlighted in bold

Table 17 Oregon IMPROVE Sites, 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 (20% least impaired) 2010-2014						
		Sulfate	Nitrate	Organic Carbon	Elemental Carbon	Fine Soil	Coarse Material	Sea Salt
CRLA1	1.2	**43%**	6%	20%	14%	4%	5%	6%
HECA1	4.1	**36%**	11%	27%	6%	4%	12%	3%
KALM1	6.1	25%	5%	**42%**	11%	0%	7%	10%
MOHO1	1.3	**46%**	14%	9%	6%	4%	7%	14%
STAR1	2.8	**44%**	13%	19%	4%	2%	10%	8%
THSI1	2.5	**49%**	9%	19%	5%	0%	7%	11%

*Highest aerosol species contribution per site is highlighted in bold

3.2.3 Differences Between Baseline and Current Period Visibility Conditions 40 CFR 51.308 (g) (3) (ii)

This section addresses the required element, what is the difference between visibility conditions for the most impaired and least impaired days from the baseline period to the current period. Table 18 displays changes in aerosol extinction and total light extinction for the Oregon based Class I IMPROVE monitors for the difference between the baseline period (2000-04) to the most recent 5 year progress period (2010-14). Changes in deciview are also calculated. Values indicating an increase from the earlier period are bolded.

Table 18 Changes in Visibility from Baseline to Most Recent Progress Period

Site	Group	Change from 2000-04 (baseline) to 2010-14 (progress period) (Mm^{-1}/year)								
		Sulfate	Nitrate	Organic Carbon	Elemental Carbon	Fine Soil	Coarse Material	Sea Salt	Total Light Extinction	Deciview
CRLA1	20% Best	**0.1**	-0.2	-0.1	-0.4	0	-0.1	-0.1	-0.6	-0.5
	20% Worst	**0.2**	-1.2	-10.6	-2.1	0	-0.6	**0.2**	-14.1	-2.0
HECA1	20% Best	-0.4	-0.3	-0.9	-0.3	-0.1	-0.3	0	-2.3	-1.4
	20% Worst	-2.6	-11.4	**3.1**	-0.2	0	**0.7**	**0.2**	-10.1	-2.3
KALM1	20% Best	0	-0.1	0	-0.1	0	-0.1	0	-0.3	-0.2
	20% Worst	-1.4	-1.0	-0.6	-0.2	-0.1	0	**1.1**	-2.3	0
MOHO1	20% Best	-0.6	-0.2	-0.1	-0.1	0	0	-0.1	-1.1	-0.9
	20% Worst	-2.8	-2.3	-1.0	-0.9	**0.2**	**1.5**	**0.4**	-4.7	-1.7
STAR1	20% Best	-0.5	-0.3	-1.1	-0.4	0	-0.2	**0.1**	-2.6	-1.7

	20% Worst	-0.5	-8.1	-7.8	-1.9	-0.4	-1.5	**0.1**	-20.1	-4.1
THSI1	20% Best	-0.2	-0.1	-0.2	-0.1	0	-0.1	0	-0.7	-0.5
	20% Worst	-2.6	-0.9	**1.0**	-0.4	**0.6**	**2.7**	**0.2**	**0.6**	-0.4

For the 20% best days, all areas show reductions, or at minimum, no to very little change in extinction over the time considered. Visibility as expressed in deciviews show improvement over this 14 year period.

For the 20% worst days, the change in extinction shows increases in several aerosols that are primarily biogenic in origin. At only the Three Sisters IMPROVE monitor does any of this change in resulting light extinction result in a worsening of visibility conditions. Section 3.8 provides a more detailed discussion of the situation evidenced at THSI1, which is attributed to the influence of wildfires. All other monitors show improvements in visibility over this longer term trend.

3.2.4 Changes in Visibility Impairment for First Progress Period Compared to Baseline Conditions

40 CFR 51.308 (g) (3) (iii)

This section addresses the required element, what is the difference between visibility conditions for the most impaired and least impaired days from the baseline period to the first progress period. Included here are comparisons between the 5-year average baseline conditions (2000-2004) and first progress period extinction (2005-2009).

- For the best days, the 5-year average deciview metric decreased at all except the CORI1 and KALM1 sites. Note that the CORI1 site does not represent a Federal Class I area, but the state of Oregon tracks regional haze progress at this site.
    - Increases on best days at both sites were small (0.3 dv at CORI1 and 0.1 dv at KALM1). At the CORI1 site, higher deciview values were due to increases in ammonium nitrate, soil, coarse mass and sea salt. At the KALM1 site, the only aerosol species that increased on the best days was sea salt.
- For the worst days, the 5-year average deciview metric decreased at most sites, but increased at the CRLA1, KALM1 and THSI1 sites.

Notable differences for individual species averages were as follows:

- The largest increases in 5-year averages at the KALM1, HECA1, and CRLA1 sites were due to particulate organic mass and ammonium sulfate for the KALM1 and CRLA1 sites.
    - For particulate organic mass, several unplanned fire events during the summer months affected measurements at the sites for the current 5-year period. The largest events occurred at the KALM1 site in August 2008, the HECA1 site in July 2007, and at the CRLA1 site in July 2007.

- For ammonium sulfate, increases in 5-year averages were consistent with slightly increasing ammonium sulfate trends for the southwest Oregon and nearby northeast California sites. Emissions inventories showed decreases in state-wide SO_2 for all categories, but off-shore emissions that may affect these sites are not explicitly represented here.

- At the THSI1 site, coarse mass was the largest species contributor to increases in the 5-year average deciview metric. A slightly increasing annual average trend in coarse mass was also measured at the site, and emissions inventories showed increases in fugitive and road dust sources for coarse mass, partially offset by decreases in point and area sources.

- Ammonium nitrate decreased at all sites except KALM1, where the 5-year average remained the same. The largest decreases were measured at the CORI1 and HECA1 sites.

- At the CRLA1 and KALM1 sites, where the average deciview value increased, ammonium sulfate and particulate organic mass contributed to the largest increases in extinction.

  - At the THSI1 site, coarse mass and soil were the largest aerosol species contributors to the increase in the deciview average at the site.

For the 20% least impaired days, the 5-year average deciview metric decreased at all sites except CORI1 and KALM1. Notable differences for individual species averages on the 20% least impaired days were as follows:

- The increase in 5-year average deciviews at the CORI1 site was due to increases in soil, coarse mass, sea salt and ammonium sulfate.

- The increase at the KALM1 site was due to increases in ammonium sulfate and sea salt.

Table 19 Oregon 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
COGO1	23.1	20.8	-2.3	-3.4	-9.5	-10.2	-1.0	-0.1	+0.2	+0.7
CORI1	24.7	22.9	-1.8	-0.7	-20.6	-5.3	-0.5	+0.9	+3.5	+0.4
CRLA1	13.7	13.8	+0.1	+0.9	-0.9	+1.1	-1.0	0.0	-0.5	+0.1
HECA1	18.6	18.1	-0.5	-1.6	-15.0	+15.8	+2.2	+0.2	+1.0	+0.1
KALM1	15.5	16.4	+0.9	+1.7	0.0	+6.2	+1.0	0.0	+0.2	+0.7
MOHO1	14.9	13.7	-1.2	-1.0	-1.3	-2.1	-0.5	-0.1	-0.2	+0.6
STAR1	18.6	16.2	-2.4	0.0	-5.5	-4.8	-0.6	-0.3	-1.5	0.0
THSI1	15.3	16.2	+0.9	-1.0	-0.5	0.0	+0.1	+0.8	+4.9	+0.2

*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 20 Oregon 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
COGO1	9.3	9.2	-0.1	-0.2	-0.4	0.0	-0.1	0.0	+0.1	+0.3
CORI1	9.6	9.9	+0.3	-0.3	+0.2	0.0	0.0	+0.3	+0.3	+0.3
CRLA1	1.7	1.6	-0.1	+0.2	0.0	-0.2	-0.2	0.0	0.0	+0.1
HECA1	5.5	4.8	-0.7	0.0	-0.2	-0.5	-0.1	-0.1	-0.3	+0.1
KALM1	6.3	6.4	+0.1	+0.3	0.0	-0.1	-0.1	0.0	0.0	+0.2
MOHO1	2.2	1.7	-0.5	-0.2	-0.2	-0.1	-0.1	0.0	0.0	0.0
STAR1	4.5	3.6	-0.9	-0.1	-0.1	-0.8	-0.2	0.0	-0.2	+0.1
THSI1	3.0	3.0	0.0	+0.1	-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 9 Average Extinction for Baseline and First Progress Period Extinction for Worst (Most Impaired) Days Measured at Oregon IMPROVE Sites

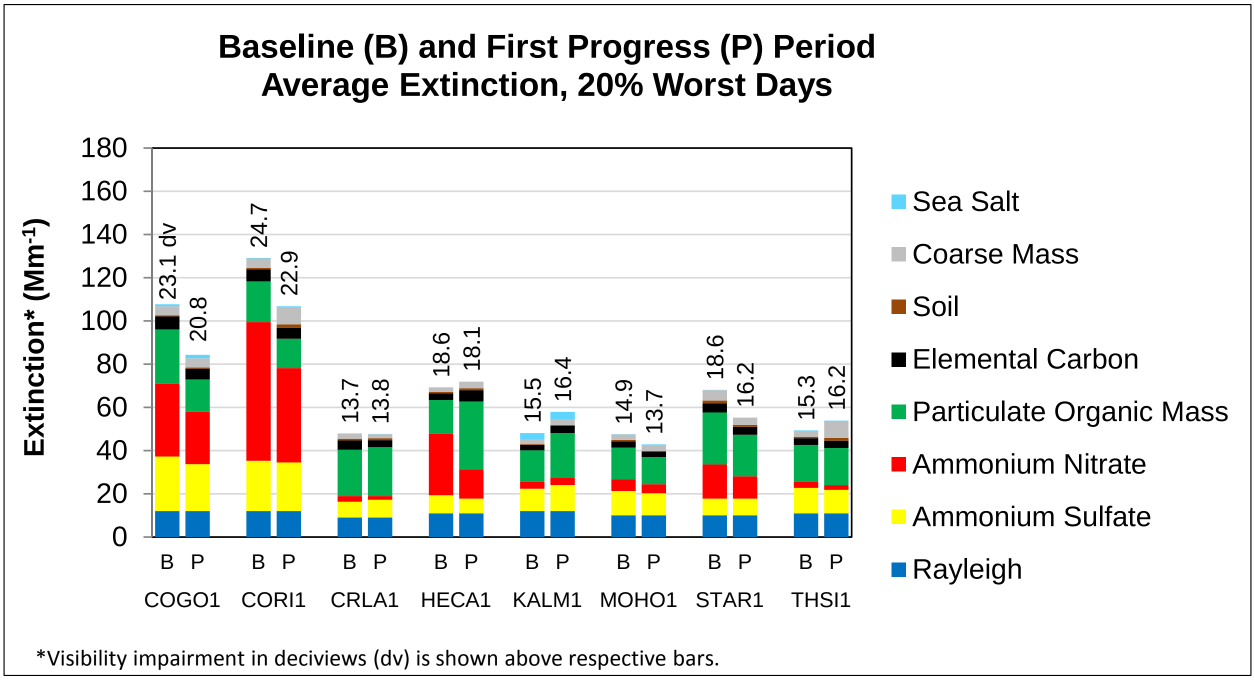


Figure 10: Difference Between Average Extinction for First Progress Period (2005-2009) and Baseline Period (2000-2004) for the Worst (Most Impaired) Days Measured at Oregon IMPROVE Sites

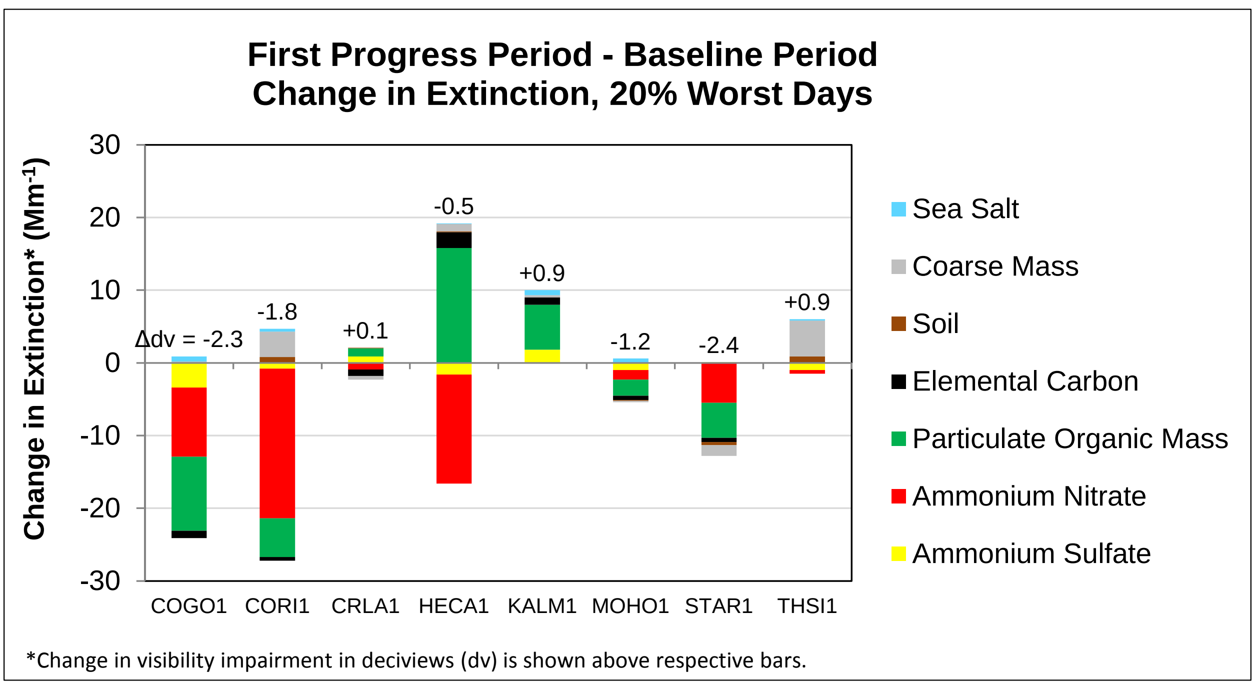


Figure 11 Average Extinction for Baseline and First Progress Period Extinction for Best (Least Impaired)

Days Measured at Oregon IMPROVE Sites

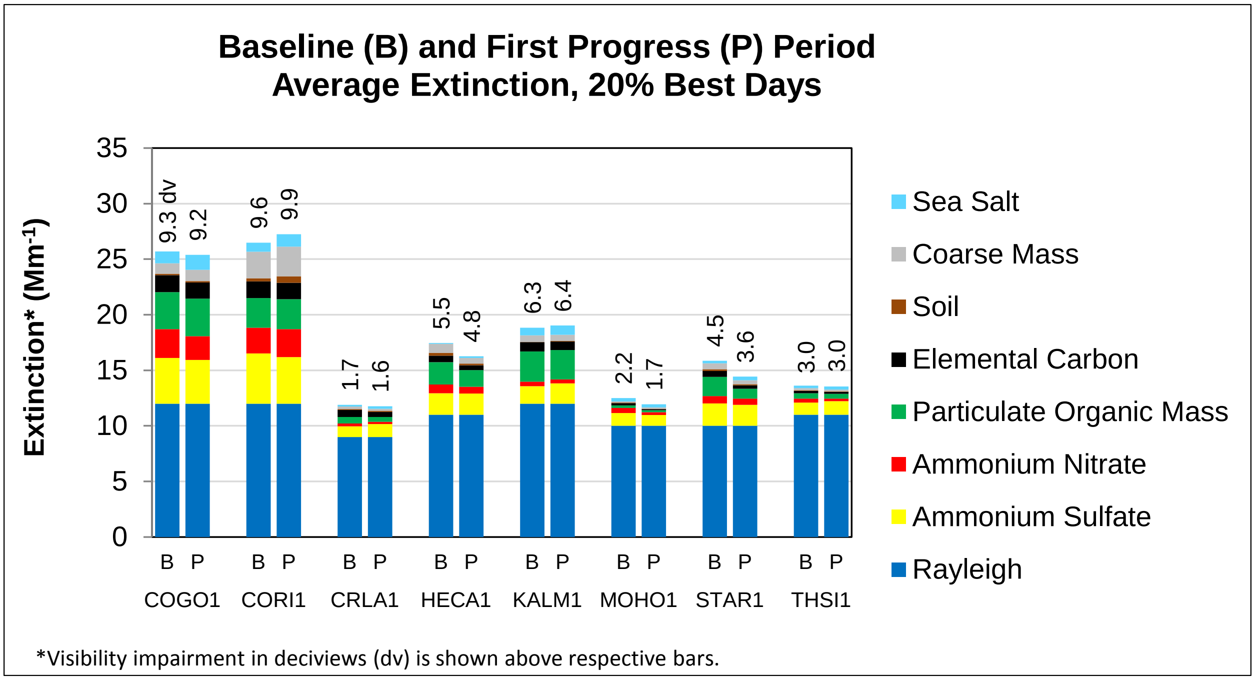
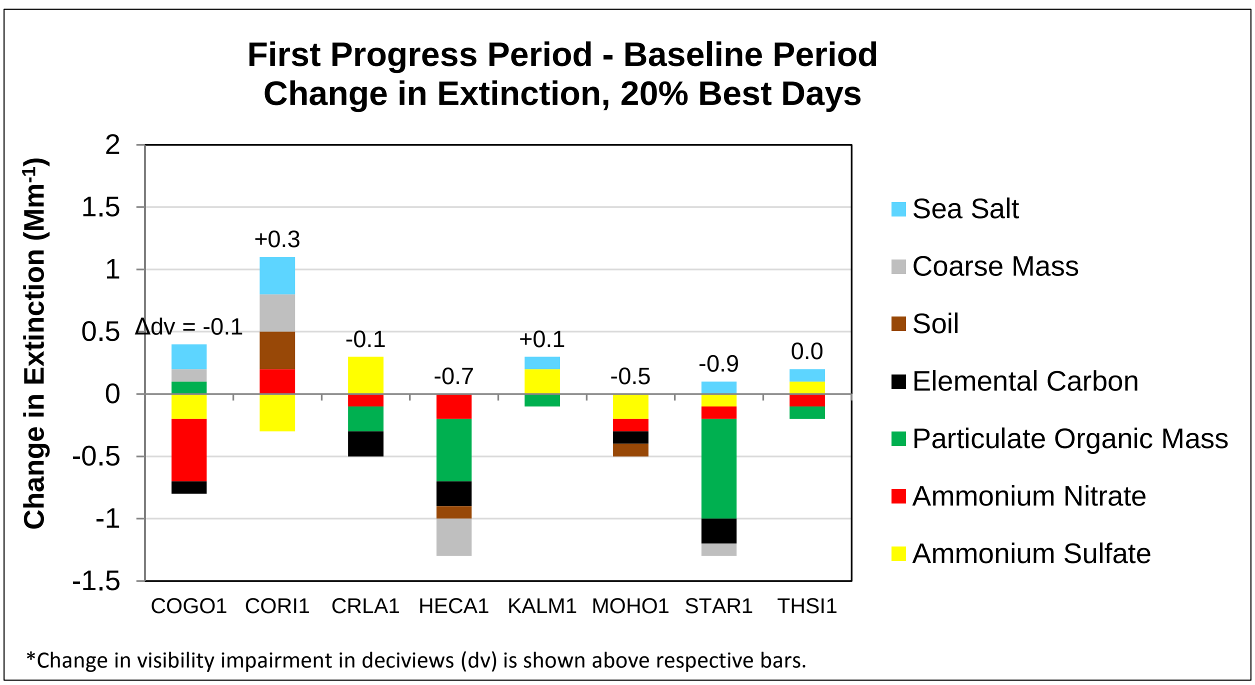


Figure 12 Difference between Average Extinction for First Progress Period (2005-2009) and Baseline Period (2000-2004) for the Best (Least Impaired) Days Measured at Oregon Improve Sites



3.2.5 Visibility through 2010 – 2014 Progress Period

This section addresses trends for the entire 10 year planning period. Trend statistics for the years 2000-2009 for each species at each site in Oregon are summarized in Table 21[8]. 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[9]. In some cases, trends may show decreasing tendencies while the difference between the 5-year averages do not (or vice versa). For instance, increases may be driven by uncharacteristically high average measurements that may not reflect overall downward trends. 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.

[8] 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)

[9] 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.

Table 21 Oregon 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**
COGO1	20% Best	--	-0.1	--	0.0	0.0	0.0	--
	20% Worst	-0.3	-2.6	-2.1	-0.4	--	--	--
	All Days	-0.4	-0.8	-0.4	-0.2	--	-0.1	--
CORI1	20% Best	--	--	--	--	--	--	--
	20% Worst	--	-4.3	-1.1	--	--	--	--
	All Days	-0.2	-0.9	-0.6	-0.1	0.1	--	--
CRLA1	20% Best	--	--	0.0	0.0	--	--	0.0
	20% Worst	0.3	--	--	-0.2	--	--	0.0
	All Days	--	-0.1	--	-0.1	--	0.0	0.0
HECA1	20% Best	--	--	-0.1	0.0	0.0	-0.1	--
	20% Worst	-0.4	-3.7	1.6	--	--	0.3	--
	All Days	--	-0.8	--	--	--	--	--
KALM1	20% Best	--	--	--	--	--	0.0	0.0
	20% Worst	0.4	--	--	--	--	--	--
	All Days	0.1	-0.1	--	-0.1	--	--	0.1
MOHO1	20% Best	-0.1	0.0	0.0	0.0	--	--	0.0
	20% Worst	--	-0.3	--	--	--	--	0.0
	All Days	-0.1	-0.1	--	-0.1	--	--	--
STAR1	20% Best	--	--	-0.2	-0.1	0.0	0.0	--
	20% Worst	--	-1.8	-1.5	-0.3	--	--	--
	All Days	--	-0.4	-0.6	-0.2	--	-0.1	--
THSI1	20% Best	--	0.0	--	0.0	0.0	--	--
	20% Worst	-0.3	-0.1	--	--	0.0	0.4	0.0
	All Days	-0.1	-0.1	--	0.0	0.0	0.1	--

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

For each site, a more comprehensive list of all trends for all species, including the associated p-values, is provided in Appendix K. Additionally, this 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 Oregon are as follows:

- Ammonium nitrate showed decreasing annual average trends for the worst days at all Oregon sites, with the largest decreases measured at the HECA1, STAR1, CORI1, and COGO1 sites.

- Large particulate organic mass events occurred at all sites, generally between August and September. Monthly and daily charts in Appendix K indicate that the largest events occurred in August 2005 at KALM1, August and September 2006 at CRLA1, HECA1, MOHO1, and STAR1, July 2007 at HECA1 and July through September 2008 at CRLA1 and MOHO1.

- The increase in the deciview metric between the baseline period and the progress on the worst days at the THSI1 site was mostly due to coarse mass. Daily extinction plots in Appendix K indicate that this was due an anomalous increase in coarse mass measured between July and September of 2009 at the site.

3.3 Overview of Emission Inventory Analysis

To demonstrate RHR progress, states are required to report how total emissions in the state have changed over the initial reporting period, and to determine if there have been significant changes in emissions from the state or from other states affecting visibility at each Class I area. Comparisons between emissions inventories in this report use the inventories that represent both baseline and current conditions. Baseline emissions cited in the first regional haze plans used the 2002 inventory developed by the WRAP. Current emissions cited in this progress report were also developed by the WRAP, based on an updated and comprehensive inventory for the year 2008 that the WRAP used in modeling projects.

Emissions inventories in this report were complicated by the fact that a number of changes and enhancements have occurred between development of the baseline and current period inventories, such that many of the differences between inventories are more reflective of changes in inventory methodology, rather that changes in actual emissions. Differences in emissions are presented for all categories in this report, but summaries focus on aspects of source categories that have been more consistently inventoried over time, while noting any changes in methodologies that may affect differences in other categories. Detailed references regarding emissions inventories are presented in this section.

3.3.1 Inventory Descriptions

Emissions related to the different particle species that affect regional haze are varied and complex, including a number of both anthropogenic and natural source possibilities. Emissions estimates vary by source category according to the different characteristics and attributes of each category, and how the emissions are modeled. A number of anthropogenic, or man-made, sources such as motor vehicles and electric generating units (EGUs) are reported by states and may be subject to controls. Natural emissions, such as fires, biogenic emissions and some categories of dust can have large regional haze impacts, but are not subject to control strategies. Source categories for both anthropogenic and natural sources are listed and described briefly below.

- Point Sources: These are sources that are identified by point locations, typically because they are regulated and their locations are available in regulatory reports. In addition, elevated point sources will have their emissions allocated vertically through the model layers, as opposed to being emitted into only the first model layer. Point sources can be further subdivided into EGU sources and non-EGU sources, particularly in criteria inventories in which EGUs are a primary source of NO_X and SO_2. Examples of non-EGU point sources include chemical manufacturers and furniture refinishers.

- Area Sources: Sources that are treated as being spread over a spatial extent (usually a county or air district) and that are not movable (as compared to non-road mobile and on-road mobile sources). Because it is not possible to collect the emissions at each point of emission, they are estimated over larger regions. Examples of stationary area sources are residential heating and architectural coatings. Numerous sources, such as dry cleaning facilities, may be treated either as stationary area sources or as point sources.

- On-Road Mobile Sources: These include vehicular sources that travel on roadways. Emissions from these sources can be computed either as being spread over a spatial extent or as being assigned to a line location (called a link). Emissions are estimated as the product of emissions factors and activity data, such as vehicle miles traveled (VMT). Examples of on-road mobile sources include light-duty gasoline vehicles and heavy-duty diesel vehicles.

- Off-Road Mobile Sources: Off-road mobile sources are vehicles and engines that encompass a wide variety of equipment types that either move under their own power or are capable of being moved from site to site. Examples include agricultural equipment such as tractors or combines, aircraft, locomotives and oil field equipment such as mechanical drilling engines. Emissions from marine vessels are included here separately as offshore emissions.

- Off-shore: Commercial marine emissions comprise a wide variety of vessel types and uses. Emissions can be estimated for deep draft vessels within shore and near port using port call data, and offshore emissions generated from ship location data.

- Oil and Gas Sources: Oil and gas sources consist of a number of different types of activities from engine sources for drill rigs and compressor engines, to sources such as condensate tanks and fugitive gas emissions. The variety of emissions types for sources specific to oil and gas activity can, in some cases, overlap with mobile, area or point sources, but these can also be extracted and treated separately.

- Biogenic Emissions: Biogenic emissions are based on the activity fluxes modeled from biogenic land use data, which characterizes the types of vegetation that exist in particular areas. Emissions are generally derived using modeled estimates of biogenic gas-phase pollutants from land use information, emissions factors for different plant species, and meteorology data.

- Dust: Dust emissions may have a variety of sources that could include anthropogenic sources, natural sources, and natural sources that may be influenced by anthropogenic activity. For emissions summary purposes, dust is classified here as fugitive dust and windblown dust. Fugitive dust includes sources such as road dust, agricultural operations, construction and mining operations and windblown dust from vacant lands. The windblown dust category includes more of the natural influences such as wind erosion on natural lands.

- Fire: Fire sources are a mix of natural and anthropogenic influences. Natural sources include unplanned fires, while anthropogenic sources can include agricultural and prescribed fires. In order to better distinguish between natural and anthropogenic fires, the WRAP has created an operational policy level definition of fire activity as discretely natural or anthropogenic, which included allowing certain types of prescribed fires to be treated as natural.

As noted previously, baseline and current period emissions are summarized here using two discreet years, where one year is used to represent baseline emissions, and other is used to represent the current progress period. For contiguous states, the baseline period inventories summarized here for comparison to current conditions is the 2002 inventory that was developed for WRAP states in support of the original SIPs, termed "plan02d". Development of the plan02 inventories were a cooperative effort sponsored by the WRAP in cooperation with WRAP states. This effort built upon 2002 emissions reported by states, and included work with contractors and WRAP workgroups, in consultation with states, to enhance specific categories (e.g., point, area, on- and off-road mobile, oil and gas, fire, and dust) to better characterize regional haze implications. Detailed descriptions of inventory development are available from the WRAP Technical Support System website (http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx).

The WRAP has continued to support emissions data tracking and related technical analyses focused on understanding current and evolving regional air quality issues in the western states. Methods for estimating emissions of many of the source categories that affect regional haze have continued to evolve and be refined over time. This is especially true for inventories of natural emissions categories including windblown dust and biogenic emissions, and also for rapidly evolving industries such as oil and gas exploration. To represent current conditions, this progress report support document leverages 2008 emissions data inventories which have been recently developed as part of the WRAP's West-wide Jumpstart Air Quality Modeling Study (WestJumpAQMS) and Deterministic and Empirical Assessment of Smoke's Contribution to Ozone (DEASCO3) study, which are described briefly below:

- The WestJumpAQMS project (http://wrapair2.org/WestJumpAQMS.aspx) sponsored by the WRAP includes coordination and harmonization with the EPA 2008 National Emissions Inventory (2008 NEI v2). Among other goals, this project is intended to provide technical updates and improvements for multiple air quality issues, including regional haze, ozone, particulate pollution and nitrogen deposition.

- The DEASCO3 study (http://www.wrapfets.org/deasco3.cfm) is a project sponsored by the Joint Fire Sciences Program (JFSP) that looks at impact of weather and fires on ozone formation. This project has included the development of a detailed and comprehensive 2008 fire emissions inventory, which will eventually be incorporated into the WestJumpAQMS project.

Because these inventories have been refined over time, there is not necessarily continuity between the 2002 and 2008 inventories, which affects data comparisons for particular source categories. Detailed references and major methodology differences for the emissions inventories compared here are summarized in Table 22.

Table 22 Emissions Inventory Descriptions

Inventory Sector	2002 Baseline Inventory (Plan02c/Plan02d)[10]	2008 Progress Period Inventory (WRAP WestJump08)[11]	Comments
Point Sources	The Oregon inventory reported here used the Plan02d point source inventories. These inventories were generated using hourly EPA CAMD CEM data for EGUs. Other point were developed in consultation with states by the ERG contractor. Note that the WRAP also generated point source inventories for both actual reported 2002 (Base02b) EGU and all other point source data, and for a 2000-2004 average of EGU point sources (Plan02c and Plan02d). Plan02 emissions are summarize in this report because they are consistent with what was reported as baseline conditions for most initial WRAP region SIPs.	The WRAP WestJump 2008 inventories were generated using hourly EPA CAMD CEM data for EGUs. Other point sources are from the 2008 NEI v2. Note that point source oil and gas inventories were provided separately for WestJump08, but combined here for comparisons with 2002 inventories.	Note that baseline conditions presented here represent a 5-year average for EGUs, while progress period conditions are represented with 2008 data. In addition to inventory changes for these two years, year-to-year variations are also presented separately for Title IV Major Sources on a regional and state basis.[12]
Area Sources	The Oregon inventory reported here used the Plan02d point source inventories. These inventories were developed by the ERG contractor in consultation with states.	The WRAP WestJump 2008 used state reported area source inventories from the 2008 NEI v2.[13]	Note that area oil and gas sources are reported separately in this report. Area source estimates represent broad areas, and include calculations which are, in part, based on population estimates. Because of this, both changes in emissions calculation methods (which can be different from state to state and year to year), and changes in inputs such as population

[10] Detailed inventory descriptions for development of the WRAP Base02b, plan02c and plan02d inventories are available on the WRAP TSS website http://vista.cira.colostate.edu/TSS/Results/Emissions.aspx and archived on the original WRAP website http://www.wrapair.org/forums/ssjf/pivot.html.
11 Detailed inventory descriptions for development of the WRAP WestJump08 inventory are available on the WRAP project page http://wrapair2.org/WestJumpAQMS.aspx.
12 Annual EGU emissions for each state were obtained from EPA's Air Markets Program Database for permitted Title V facilities (http://ampd.epa.gov/ampd/).
13 EPA's 2008 NEI inventory estimates are available at http://www.epa.gov/ttn/chief/net/2008inventory.htm.

			can affect differences between these inventories.
Inventory Sector	**2002 Baseline Inventory (Plan02c/Plan02d)**	**2008 Progress Period Inventory (WRAP WestJump08)**	**Comments**
Area Oil and Gas	These inventories were developed for specific oil and gas basins using WRAP Phase II emissions methodologies.[14] Where WRAP Phase II emissions were not available, area source oil and gas emissions as reported by the state were used. Phase II emissions process estimated for 2002 included: • Drill Rigs • Wellhead Compressor Engines • CBM Pump Engines • Heaters • Pneumatic Devices • Condensate and oil tanks • Dehydrators • Completion Venting	These inventories were developed for specific oil and gas basins using WRAP Phase III emissions methodologies. Where WRAP Phase III emissions were not available, area source oil and gas emissions as reported by the state were used. Phase II emissions process estimated for 2008 included: These inventories used 2008 production data, which was updated with State-reported data in some cases. The following additional categories were included in addition to those listed for 2002: • Lateral compressor engines • Workover rigs • Salt-water disposal engines • Artificial lift engines • Vapor recovery units (VRUs) • Miscellaneous or exempt engines • Flaring • Fugitive emissions • Well blowdowns • Truck loading • Amine units (and gas removal) • Water tanks	Oil and gas development is a rapidly evolving industry, and significant efforts to better characterize emissions have occur between development of the 2002 and 2008 inventories. In addition to expanded development, some notable emission inventory difference include: • Regulatory changes specific to each state may have required more sources to be reported in 2008 than were reported in 2002. • New and/or revised estimation methodologies, especially for VOC emissions rates, were used for more source categories in Phase III. • Phase III estimates included surveys which provided detailed information about specific sources (e.g. counts by device type such as lowbleed vs. high-bleed) among other improvements to activity data. These sources included small area source equipment typically not inventories by the states. Phase II did not have that information available, since no surveys were made in Phase II. • Phase III used the high quality and complete IHS commercial database of O&G production data by well by basin. For Phase II, the state O&G Commission databases, which have been improved quite a bit over time, were used.

[14] Additional phase II oil and gas inventory descriptions are archived on the original WRAP website http://www.wrapair.org/forums/ogwg/documents/2007-10_Phase_II_O&G_Final)Report(v10-07%20rev.s).pdf.

Inventory Sector	2002 Baseline Inventory (Plan02c/Plan02d)	2008 Progress Period Inventory (WRAP WestJump08)	Comments
On-Road Mobile	The 2002 inventory for Oregon used the EPA MOBILE6 model as applied by ENVIRON using inputs from states.	The 2008 on-road mobile inventory used the EPA MOVES2010 model applied to state inputs in inventory mode.	Differences in models contribute to some differences in emissions reported, but other differences are due to a combination of VMT differences and new controls on vehicles.
Off-Road Mobile	The 2002 inventory for Oregon used the draft NONROAD2004 model as applied by ENVIRON using inputs from states.	The 2008 off-road mobile inventory was obtained from the NETv2.0 model.	The off-road models include both emission factors and default county-level population and activity data.
Offshore	For the baseline inventories, off-shore emissions were treated as a region rather than a source category.	For the 2008 inventories, specific SCCs do not distinguish between regions (e.g. Atlantic, Pacific and Gulf), so these are presented as a sum of all offshore emissions.	Note that while offshore emissions are available from both datasets, comparisons are not presented in this report. These emissions were not comparable, as baseline emissions were presented as a region, and not explicitly associated with any of the coastal states for summaries here, and progress period summaries totaled all offshore emissions for the US (e.g. Atlantic, Pacific and Gulf)
Fugitive Dust and Road Dust	The WRAP 2002 inventory by ENVIRON began with inputs from states. For 2002, note that vegetative scavenging factors were applied pre-processing at the county level, as opposed to grid-level for 2008 data.	These emissions were extracted from state reported area source emissions for 2008 (NEI08v2). For 2008, note that vegetative scavenging factors were applied post-processing at a higher resolution grid cell level, as compared to 2002 data.	Note that fugitive dust and road dust categories were available separately in the WRAP Plan02d inventories, but are combined for summary purposes here. For the 2008 inventory, vegetative scavenging factors were applied to the combined sources; thus these source categories were not easily separated.

Inventory Sector	2002 Baseline Inventory (Plan02c/Plan02d)	2008 Progress Period Inventory (WRAP WestJump08)	Comments
Windblown Dust	Generated using WRAP Windblown Dust Model and 2002 MM5 meteorology, at 36km grid cell resolution. Vegetative scavenging factors were applied pre-processing at the county level.	Generated using WRAP Windblown Dust Model and 2008WRF meteorology, at 4km and 12km grid cell resolution for the WRAP region. Vegetative scavenging factors applied post-processing at the grid cell level.	Significant updates to enhance the accuracy of the WRAP Windblown Dust Model will affect comparisons between the 2002 and 2008 inventories. Specific differences between the inventories include: • Different meteorological models; MM5 (2002) vs. WRF (2008) met models • Higher resolution of grid cells in 2008, which led to higher average wind speeds in individual cells, and increased windblown dust emissions aggregated at the county level. • MM5 Layer 1 used 36 meter height winds vs. WRF average winds across lowest 3 layers spanning ~40 meter height. • An error in 2002 WBD model was corrected where rainfall in centimeters was treated as inches.
Biogenic	The 2002 biogenic inventory used the BEIS3.12 model with BELD3 landuse and 2002 MM5 meteorology data, at 36km grid cell resolution.	The 2008 biogenic inventory used the MEGAN2.10 with 2008 WRF meteorology data, at 4 and 12 km grid cell resolution.	Significant model changes designed to enhance the accuracy of the biogenic emissions estimates will affect comparisons between the 2002 and 2008 inventories. Specific differences between the BEIS3.12 and MEGAN2.10 model outputs include: • Different meteorological years and models (2002 MM5 vs. 2008 WRF). • Higher temporal and spatial variability of land cover and other environmental input factors. • Improved emissions factors based on better sources of data (e.g., satellites and field studies).

Inventory Sector	2002 Baseline Inventory (Plan02c/Plan02d)	2008 Progress Period Inventory (WRAP WestJump08)	Comments
Fires (Natural and Anthropogenic)	Baseline estimates used the WRAP Phase III fire inventory, which represent a 2000-2004 5-year average of fire activity. Inventories included both anthropogenic and natural emissions.	2008 estimates use DEASCO3 fire summaries, which account for fires in 2008, and include separate reporting of anthropogenic and natural fires.[15]	Baseline conditions are represented with a 5-year average of fire, while progress period conditions are represented with 2008 data. Comparisons between these inventories are complicated by the variable and sporadic nature of wildfires. Also, differences between methodologies will affect comparisons of inventories used for 2002 and 2008 estimates.

3.4 Results of the Emission Inventory Analysis

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.

3.4.1 Changes in Emissions

B. 40 CFR 51.308 (g) (4)

This section addresses the required element, 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. 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 DEASCO3 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 3.3.1. 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 23 and Figure 14 present the differences between the 2002 and 2008 sulfur dioxide (SO_2)

[15] Additional details regarding fire inventory descriptions for development of the DEASCO3 inventory are available on the WRAP project page http://www.wrapfets.org/deasco3.cfm.

inventories by source category. Table 24 and Figure 15 present data for oxides of nitrogen (NO_X), and subsequent tables and figures (Table 25 through 28 and Figures 16 through 21) 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.

- Largest differences for point source inventories were decreases in SO_2, NO_X, VOCs, fine soil, and coarse mass.

- Area source inventories showed decreases in all parameters except NO_X. These changes may be due to a combination of population changes and differences in methodologies used to estimate these emissions, as referenced in Section 3.3.1. 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_2 and VOCs, indicating that these increases were likely due use of different on-road models, as referenced in Section 3.3.1.

- Off-road mobile source inventories showed decreases in NO_X, SO_2, and VOCs, and slight 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 3.3.1. 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, and anthropogenic fire estimates increased. 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 3.3.1.

- 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 3.3.1.

- Fine soil and coarse mass decreased for the windblown dust inventory comparisons and increased for 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 3.3.1, rather than changes in actual emissions.

Table 23 Sulfur Dioxide Emissions by Category

Source Category	Sulfur Dioxide Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	18,493	15,918	-2,575
Area	9,932	1,528	-8,404
On-Road Mobile	3,446	654	-2,792
Off-Road Mobile	6,535	431	-6,104
Area Oil and Gas	0	0	0
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	1,586	1,403	-182
Total Anthropogenic	**39,992**	**19,934**	**-20,058 (-50%)**
Natural Sources			
Natural Fire	7,328	1,207	-6,121
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**7,328**	**1,207**	**-6,121 (-84%)**
All Sources			
Total Emissions	**47,320**	**21,140**	**-26,180 (-55%)**

Figure 13 2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Sulfur Dioxide by Source Category

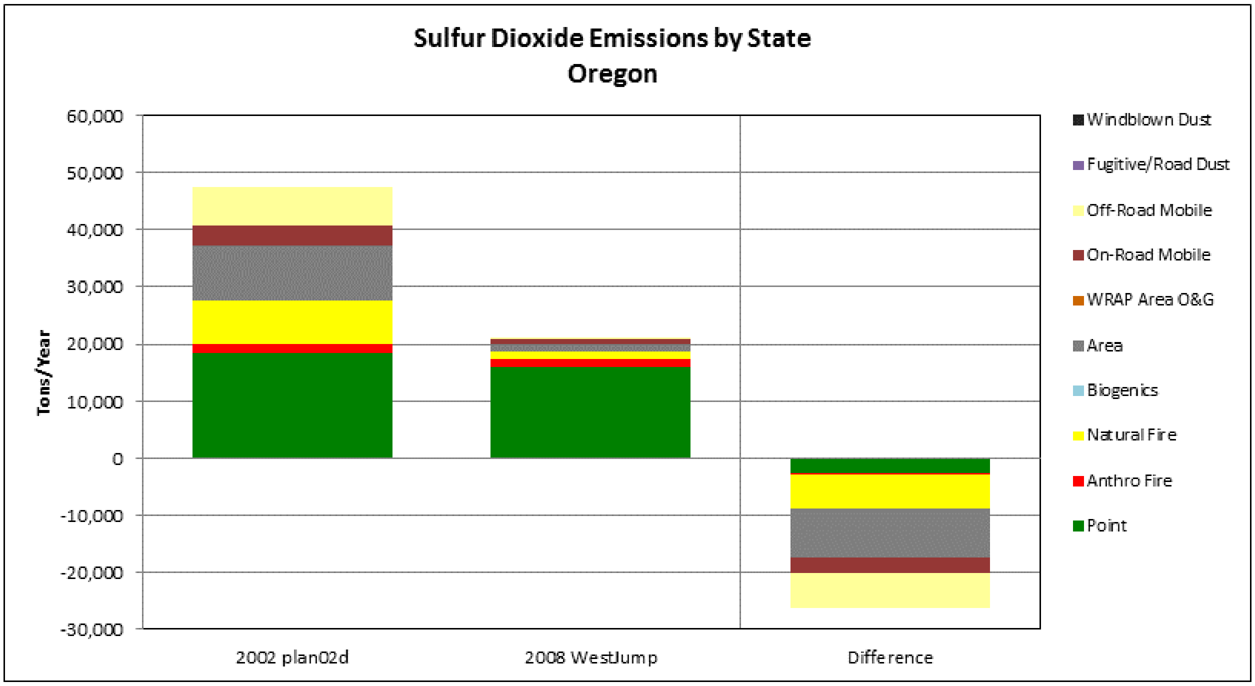


Table 24 Oxides of Nitrogen Emissions by Category

Source Category	Oxides of Nitrogen Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	26,160	23,548	-2,612
Area	14,740	24,121	9,381
On-Road Mobile	111,646	98,399	-13,247
Off-Road Mobile	53,896	23,463	-30,434
Area Oil and Gas	85	0	-85
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	6,292	9,923	3,630
Total Anthropogenic	**212,819**	**179,453**	**-33,366 (-16%)**
Natural Sources			
Natural Fire	27,397	8,521	-18,876
Biogenic	16,527	5,560	-10,967
Wind Blown Dust	0	0	0
Total Natural	**43,924**	**14,081**	**-29,843 (-68%)**
All Sources			
Total Emissions	**256,744**	**193,534**	**-63,209 (-25%)**

2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Oxides of Nitrogen by Source Category

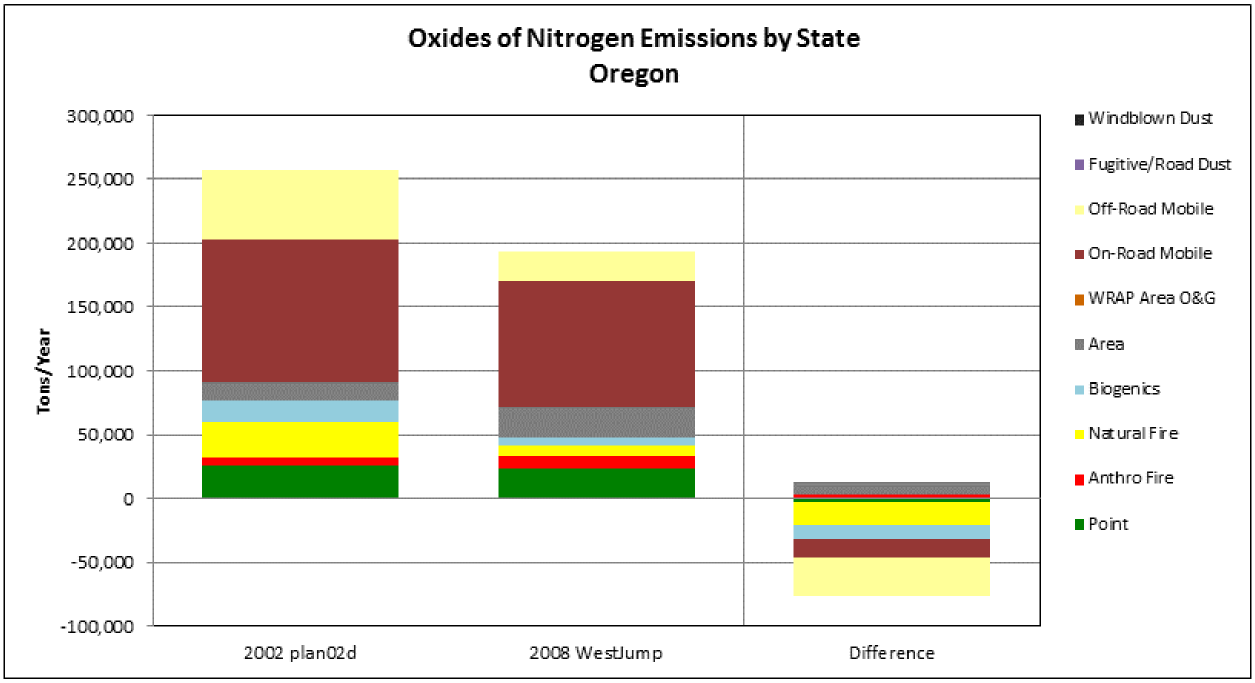


Table 25 Ammonia Emissions by Category

Source Category	Ammonia Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	919	255	-664
Area	45,591	43,814	-1,777
On-Road Mobile	3,263	1,668	-1,594
Off-Road Mobile	39	27	-12
Area Oil and Gas	0	0	0
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	1,211	6,900	5,690
Total Anthropogenic	**51,022**	**52,665**	**1,643 (3%)**
Natural Sources			
Natural Fire	6,132	5,907	-225
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**6,132**	**5,907**	**-225 (-4%)**
All Sources			
Total Emissions	**57,154**	**58,571**	**1,418 (2%)**

Figure 14 2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Ammonia by Source Category

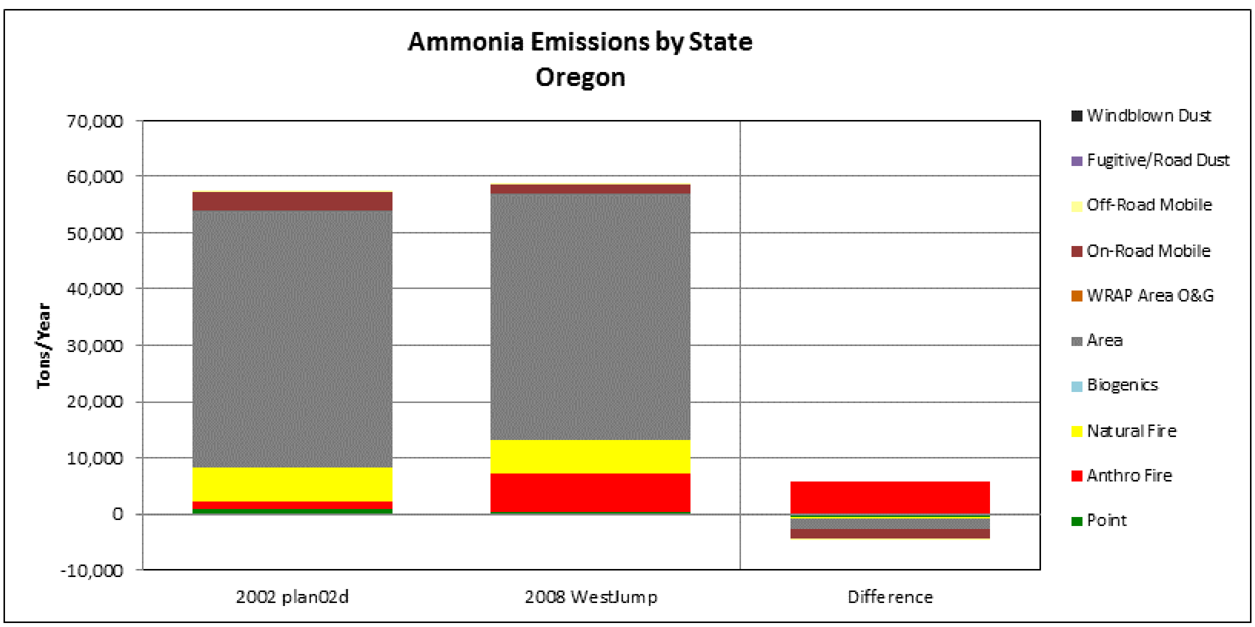


Table 26 Volatile Organic Compound Emissions by Category

Source Category	Volatile Organic Compound Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point	28,762	8,554	-20,208
Area	245,649	63,741	-181,908
On-Road Mobile	88,784	39,649	-49,135
Off-Road Mobile	39,516	33,308	-6,208
Area Oil and Gas	34	0	-34
Fugitive and Road Dust	0	0	0
Anthropogenic Fire	9,939	9,639	-300
Total Anthropogenic	**412,685**	**154,891**	**-257,793 (-62%)**
Natural Sources			
Natural Fire	60,336	9,023	-51,314
Biogenic	1,148,266	339,630	-808,636
Wind Blown Dust	0	0	0
Total Natural	**1,208,602**	**348,653**	**-859,950 (-71%)**
All Sources			
Total Emissions	**1,621,287**	**503,544**	**-1,117,743 (-69%)**

Figure 15 2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Volatile Organic Compounds by Source Category

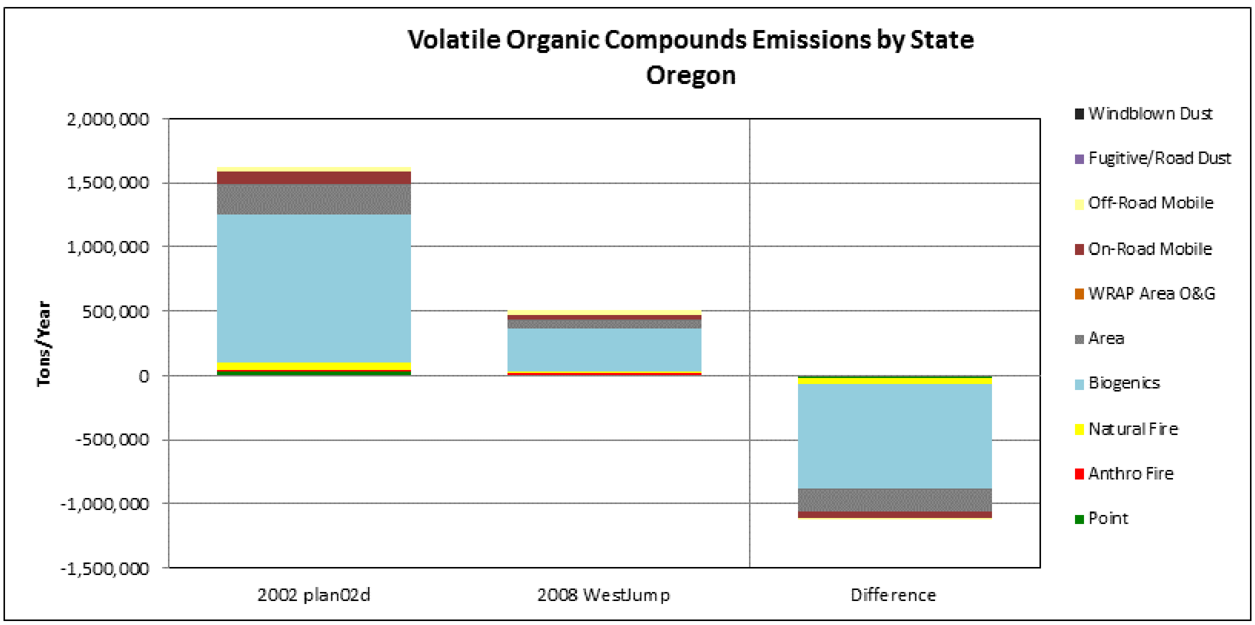


Table 27 Primary Organic Aerosol Emissions by Category

Source Category	Primary Organic Aerosol Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	1,445	88	-1,358
Area	22,281	10,459	-11,822
On-Road Mobile	1,009	2,314	1,305
Off-Road Mobile	1,323	1,005	-318
Area Oil and Gas	0	0	0
Fugitive and Road Dust	298	617	319
Anthropogenic Fire	10,937	19,073	8,136
Total Anthropogenic	**37,293**	**33,555**	**-3,738 (-10%)**
Natural Sources			
Natural Fire	81,047	17,462	-63,585
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**81,047**	**17,462**	**-63,585 (-78%)**
All Sources			
Total Emissions	**118,340**	**51,017**	**-67,323 (-57%)**

*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/).

2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Primary Organic Aerosol by Source Category

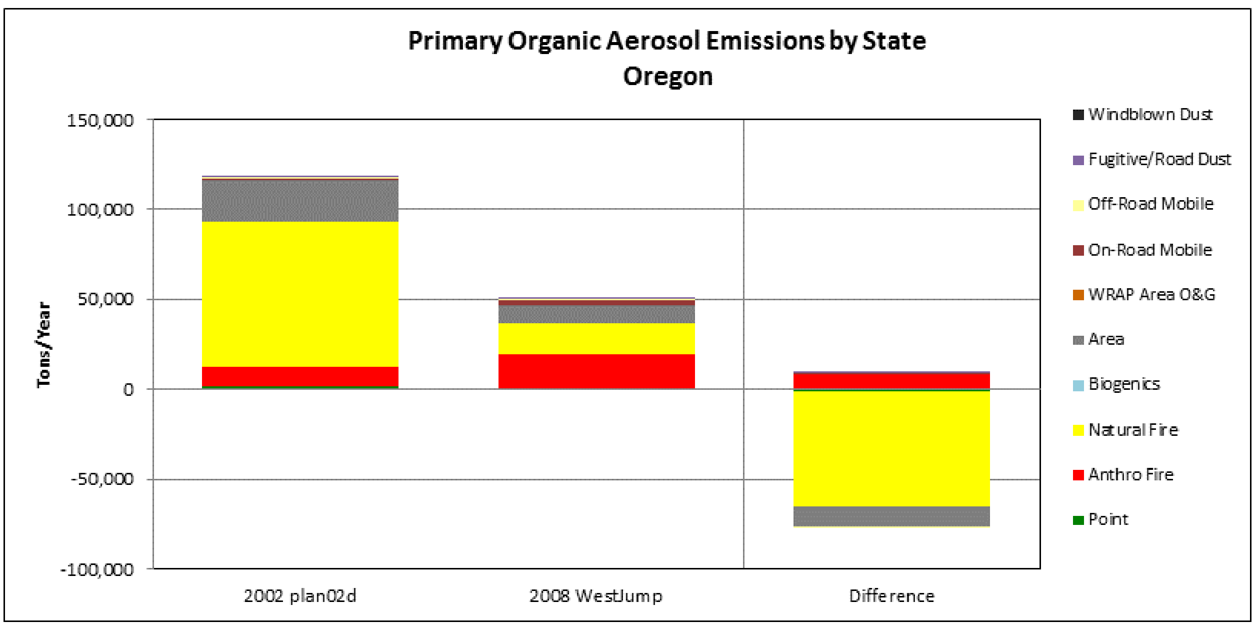


Table 28 Elemental Carbon Emissions by Category

Source Category	Elemental Carbon Emissions (tons/year)		
	2002 (Plan02d)	2008 (WestJump2008)	Difference (Percent Change)
Anthropogenic Sources			
Point*	45	103	59
Area	4,121	1,533	-2,588
On-Road Mobile	1,166	4,041	2,876
Off-Road Mobile	3,038	1,199	-1,839
Area Oil and Gas	0	0	0
Fugitive and Road Dust	21	21	0
Anthropogenic Fire	1,935	2,872	938
Total Anthropogenic	**10,325**	**9,769**	**-556 (-5%)**
Natural Sources			
Natural Fire	16,403	2,448	-13,955
Biogenic	0	0	0
Wind Blown Dust	0	0	0
Total Natural	**16,403**	**2,448**	**-13,955 (-85%)**
All Sources			
Total Emissions	**26,728**	**12,218**	**-14,510 (-54%)**

*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 16 2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Elemental Carbon by Source Category

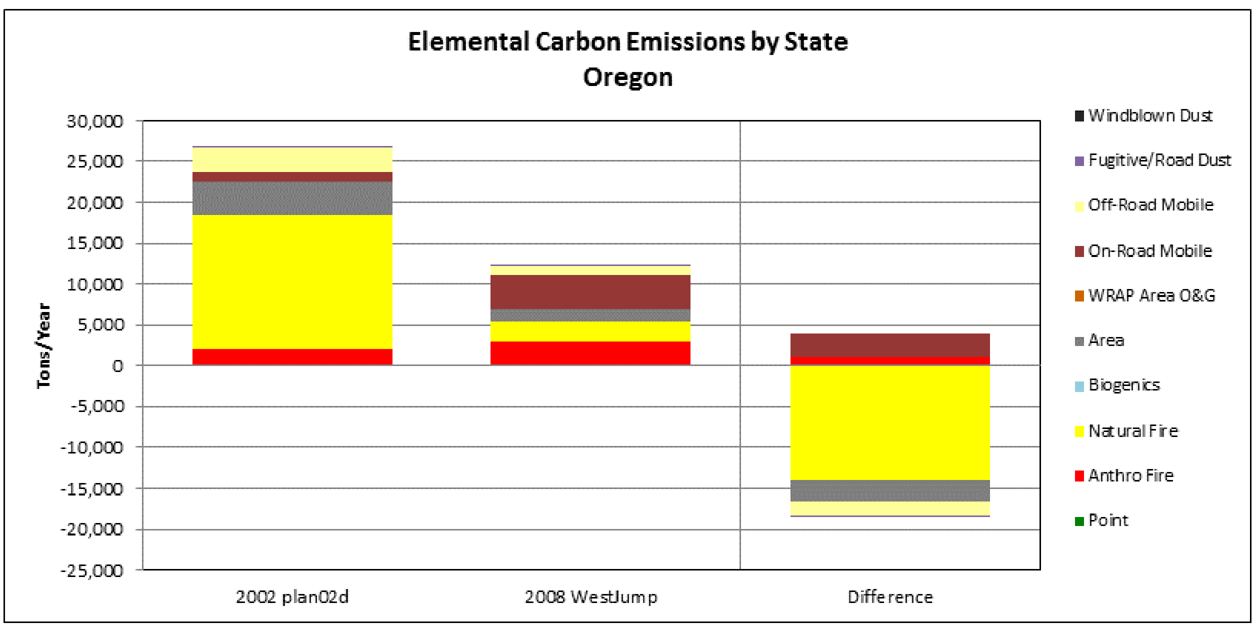


Table 29 Fine Soil Emissions by Category

Source Category	Fine Soil Emissions (tons/year)		
	2002 (Plan02d)	**2008 (WestJump2008)**	**Difference (Percent Change)**
Anthropogenic Sources			
Point*	5,728	430	-5,298
Area	15,295	5,038	-10,256
On-Road Mobile	606	394	-212
Off-Road Mobile	0	70	70
Area Oil and Gas	0	0	0
Fugitive and Road Dust	5,022	9,364	4,342
Anthropogenic Fire	1,483	6,972	5,490
Total Anthropogenic	**28,133**	**22,269**	**-5,864 (-21%)**
Natural Sources			
Natural Fire	6,090	6,396	305
Biogenic	0	0	0
Wind Blown Dust	11,586	8,499	-3,087
Total Natural	**17,676**	**14,894**	**-2,782 (-16%)**
All Sources			
Total Emissions	**45,809**	**37,163**	**-8,645 (-19%)**

*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 17 2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Fine Soil by Source Category

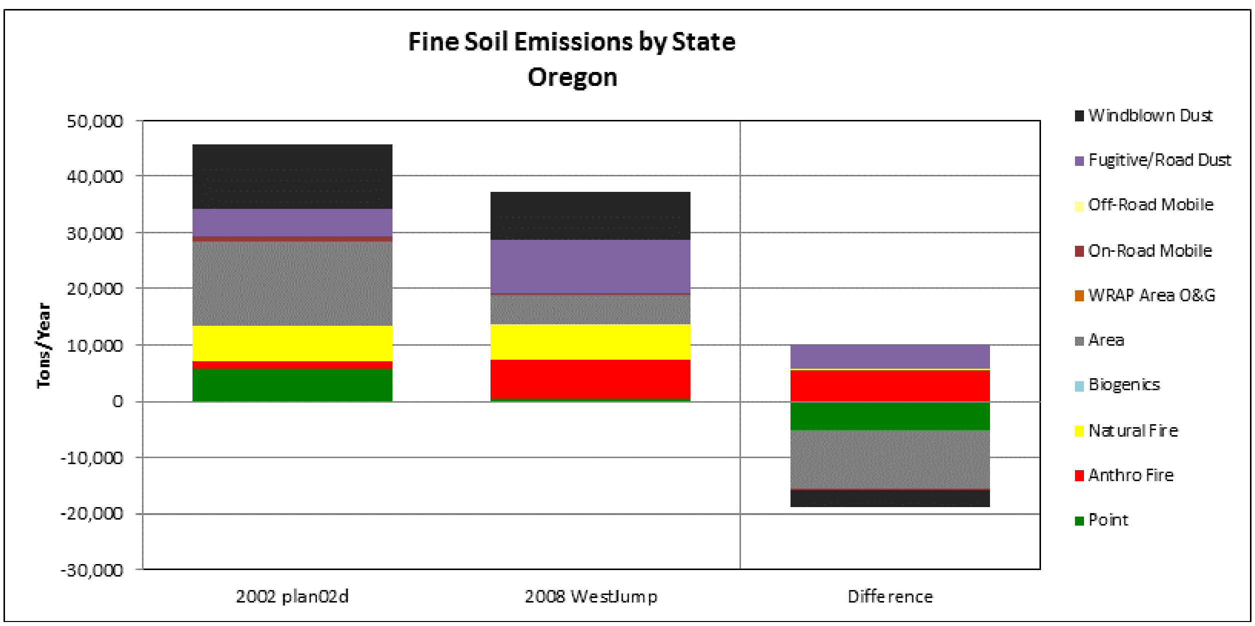
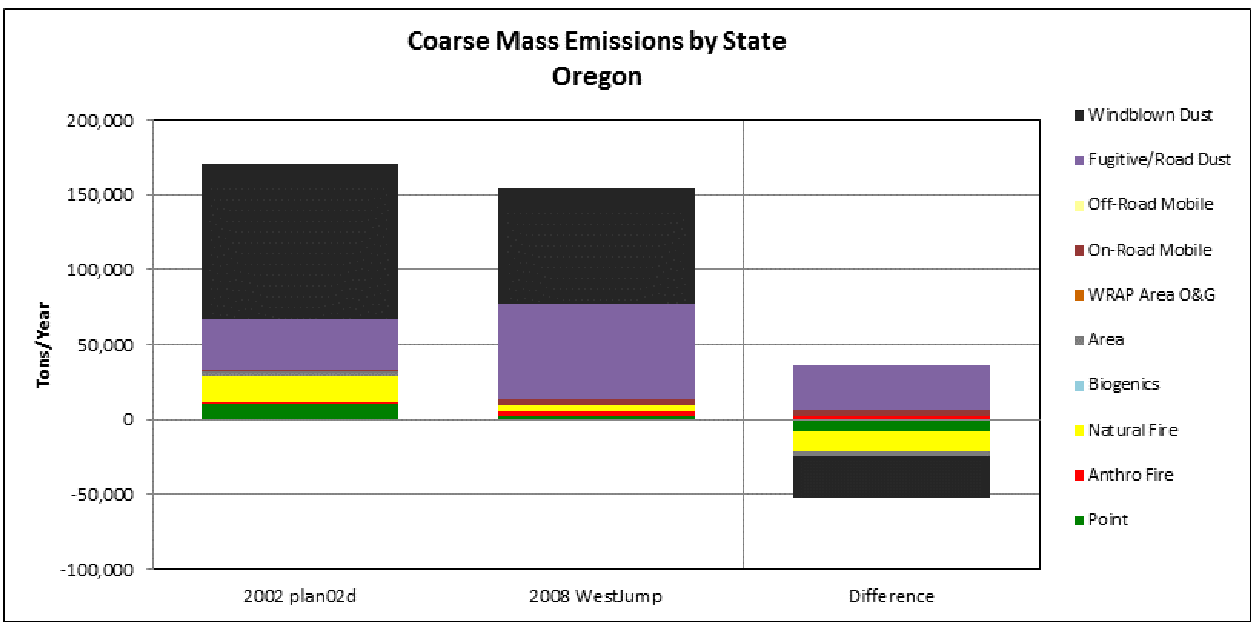


Table 30 Coarse Mass Emissions by Category

Source Category	Coarse Mass Emissions (tons/year)		
	2002 (Plan02d)	**2008 (WestJump2008)**	**Difference (Percent Change)**
Anthropogenic Sources			
Point*	10,211	2,067	-8,145
Area	3,546	597	-2,949
On-Road Mobile	618	4,295	3,677
Off-Road Mobile	0	116	116
Area Oil and Gas	0	0	0
Fugitive and Road Dust	33,999	63,599	29,600
Anthropogenic Fire	1,282	3,648	2,365
Total Anthropogenic	**49,657**	**74,321**	**24,664 (50%)**
Natural Sources			
Natural Fire	17,036	3,326	-13,709
Biogenic	0	0	0
Wind Blown Dust	104,272	76,489	-27,783
Total Natural	**121,307**	**79,815**	**-41,492 (-34%)**
All Sources			
Total Emissions	**170,964**	**154,136**	**-16,828 (-10%)**

*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 18 2002 and 2008 Emission and Difference Between Emission Inventory Totals, for Coarse Mass by Source Category



3.5 Assessment of Current Monitoring Strategy

C. 40 CFR 51.308 (g) (7)
D. 40 CFR 51.308 (h)

The state is required in this report to review the visibility monitoring strategy and discuss any modifications to the strategy as necessary. The primary monitoring network for the measurement and characterization of the contributors to regional haze, both nationwide and in Oregon, is the IMPROVE network. The IMPROVE network documents the visual air quality in wilderness areas and national parks throughout the United States. Given that IMPROVE monitoring data from 2000-2004 serve as the baseline for the regional haze program and for tracking progress, the regional haze monitoring strategy must necessarily be based on, or directly comparable to, the IMPROVE program. The IMPROVE measurements provide the only long-term record available for tracking visibility improvement or degradation. Therefore, Oregon intends to rely on the continued availability of quality assured data collected through the IMPROVE network to comply with regional haze monitoring requirement in the Regional Haze rule.

The IMPROVE sites in Oregon provide sufficiently representative data sufficient to support demonstrations of reasonable further progress. The WRAP has analyzed, reduced and provided information on relative contributions to visibility impairment using the data reported by the IMPROVE program. Oregon has and will continue to use the regional technical support analysis tool found at the Visibility Information Exchange Web System and WRAP's TSS, as well as other analysis tools and efforts sponsored by the WRAP. The State will continue to participate in the regional analysis activities of the WRAP to collectively assess and verify the progress toward reasonable progress goals, as the Regional Haze rule continues to be implemented.

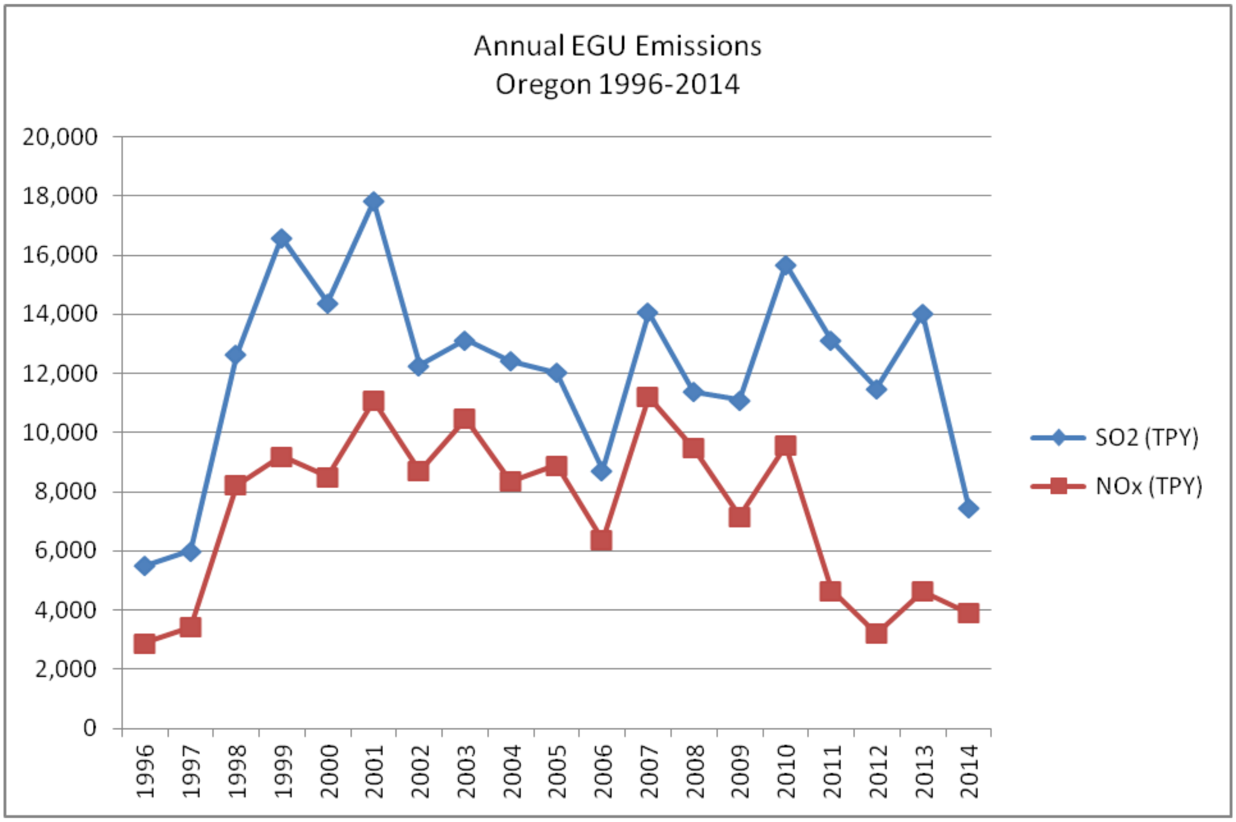
Oregon concludes that no modifications to Oregon's visibility monitoring strategy are necessary at this time. Each of the IMPROVE monitoring locations in the state are sufficient for a monitoring strategy that is representative to provide coverage of all Class I areas in the State. Oregon is committed to continue using the IMPROVE monitoring network. If economic challenges are faced by the IMPROVE monitoring program, Oregon commits to working with federal agencies as a team to try to resolve the situation.

3.6 Electrical Generating Unit Emission 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 entire 5-year monitoring periods compared. To better account for year-to-year changes in emissions, annual emission totals for Oregon 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 19 presents a sum of annual NO_X and SO_2 emissions as reported for Oregon EGU sources between 1996 and 2014. While these types of facilities are targeted for controls in state regional haze SIPs, it should be noted that many of the controls planned for EGUs in the WRAP states had not taken place yet in 2010, while other controls separate from the RHR may have been implemented. The chart shows several periods of increases and decreases for both SO_2 and NO_X.

Figure 19 Electrical Generating Unit Emissions of SOx and NOx, 1996 - 2014



3.7 Oregon's Impact on Nearby Class I Areas

The Regional Haze Plan detailed the closest Class I areas in other states that could be impacted by emissions originating in Oregon based on review of PSAT and WEP source apportionment data on the WRAP TSS website focusing on the 20% worst day impacts. These included Mt Rainier National Park and the Goat Rocks Wilderness in Washington state, the Sawtooth Mountain Wilderness in Idaho, Jarbridge Wilderness in Nevada and Lava Beds National Monument and Redwood National Park in California. In none of those areas were Oregon emissions considered to represent a sizeable contribution.

For Washington state, Nevada and Idaho Class I areas, the largest pollutant contribution category was SO_2 point sources. Much of this impact can be attributed to the PGE Boardman coal-fired power plant in NE Oregon. Starting July 1, 2018 a more stringent BART SO_2 emission limit is required that will significantly reduce emissions with corresponding visibility benefits. Oregon emissions affecting California Class I areas are also very low with impacts from SO_2 point sources and NO_x mobile source emissions representing the largest source categories. While we will track this during the next stage regional haze plan development we expect further reductions from mobile sources due to vehicle turnover among heavy and light duty vehicles to lower emission vehicles. An anticipated evaluation of non-BART industrial sources may identify further opportunities for improvement in sulfur oxide emissions.

3.8 Analysis of Impediments to Progress

Significant steps have been taken in Oregon to implement controls on anthropogenic sources of visibility impairing pollutants. These steps are in addition to the visibility improvements that have come from federal actions taken on on-road and non-road vehicles and equipment as well as benefits from international treaties reducing emissions from ocean going vessels. The improvements in deciview values and light extinction for most of the IMPROVE monitoring locations in Oregon is evident in Table 19 for both least and most impaired visibility days. As these locations are showing progress toward visibility improvements, the analysis of impediments focuses on the one location that whose trend is not as positive. The one exception is represented at monitor THSI1 for worst 20% visibility days, the site tracking conditions for three Class I areas in central Oregon, Mt. Jefferson, Mt. Washington and Three Sisters wilderness areas.

While any impediment to progress can be a cause for concern and deserving of analysis, Figure 20 shows that, even so, overall progress is being made through the latest progress period. The figure does show the extensive variability that underlies the progression toward natural conditions. The major factor accounting for that variability is also the largest contributor to haze conditions at this location, particulate organic mass aerosol (Figure 20).

Figure 20 Trend line for Worst 20% Visibility Days, THSI1

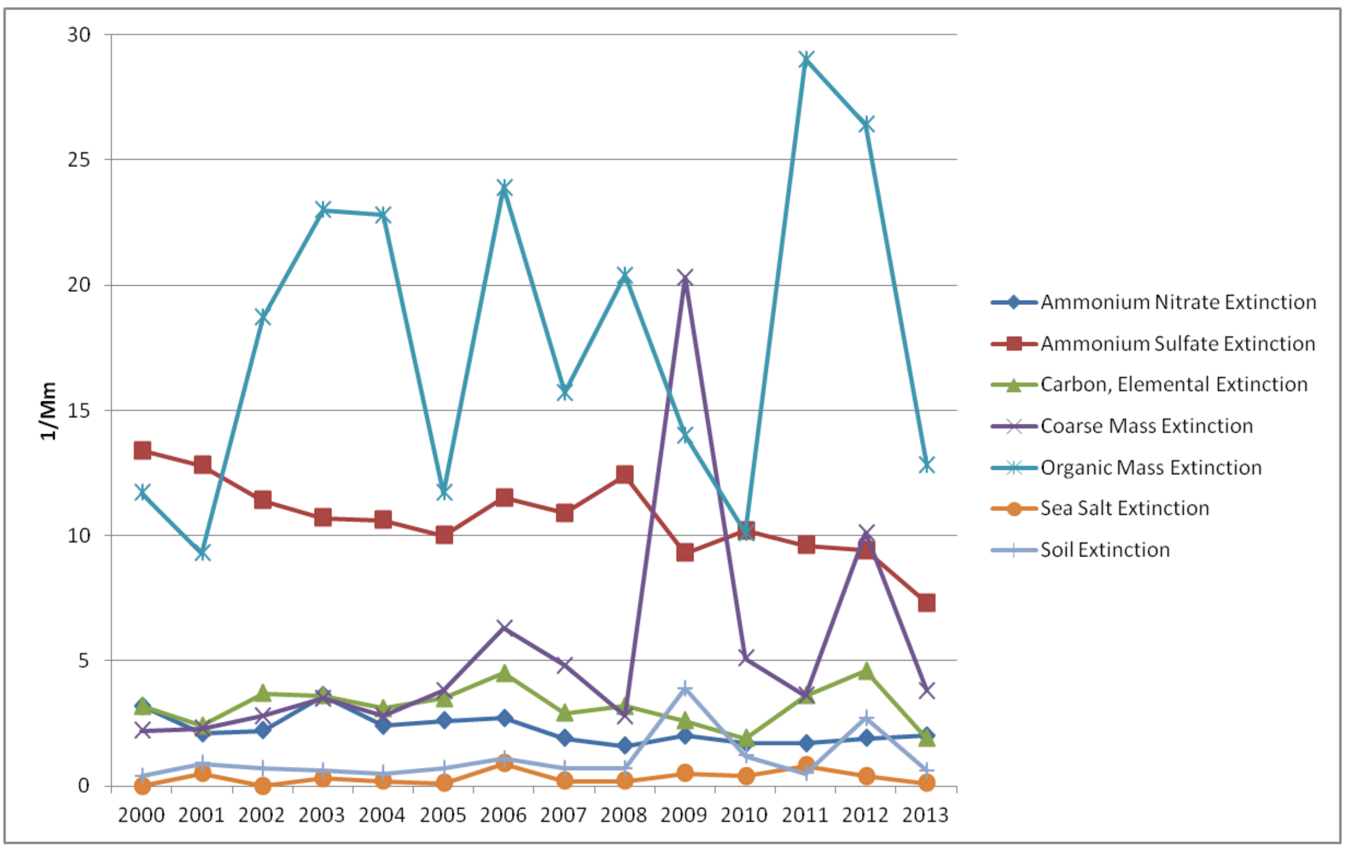
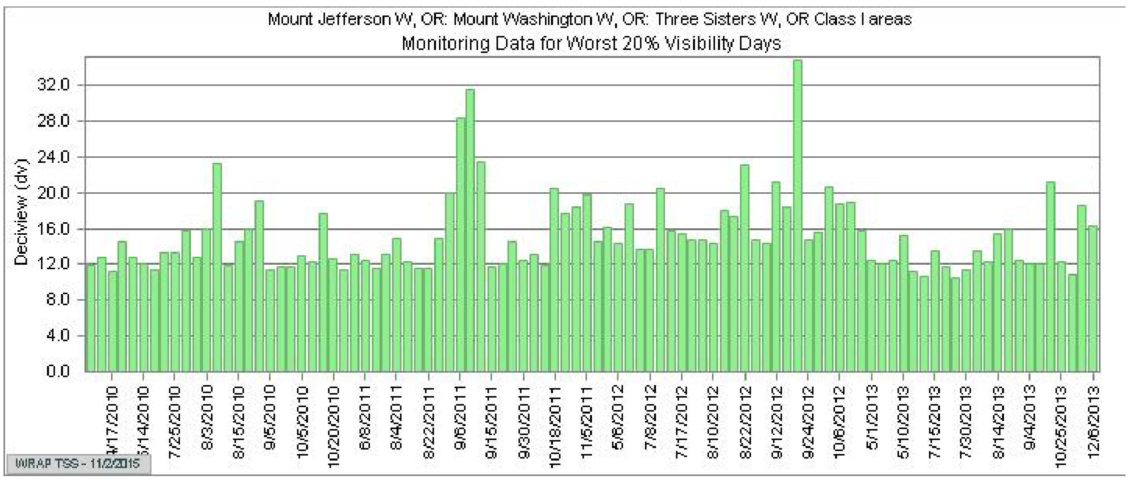


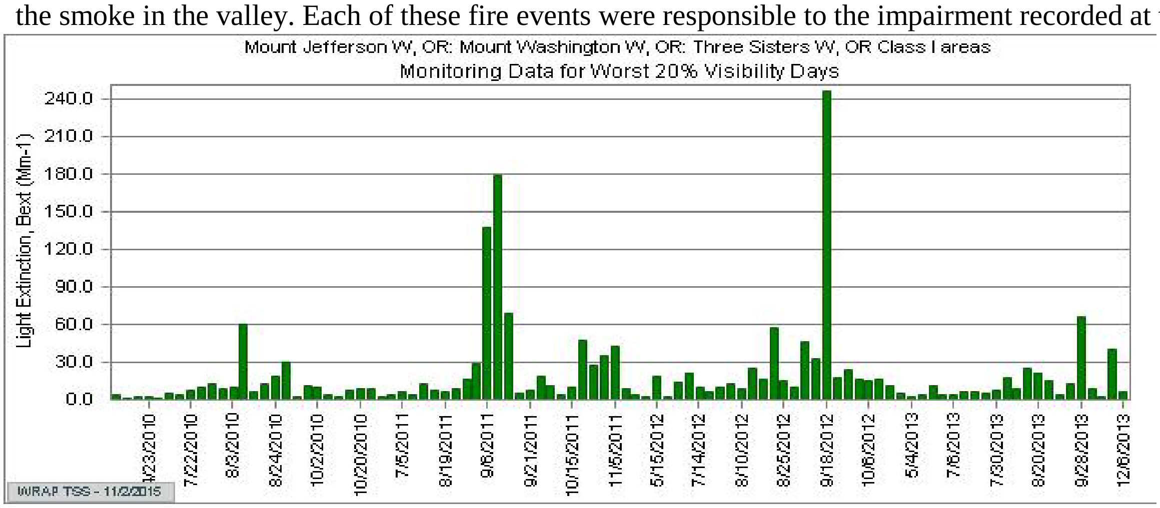
Figure 21 shows the close correspondence between light extinction attributable to organic mass and elevated deciview readings in 2011 and 2012, the two most recent years adversely contributing to visibility trends. Area sources can be a contributor to organic mass aerosols but in this case the resulting visibility impact was caused by wildfire. Areas sources, as exemplified by woodstoves, tend not to be episodic and neither were they likely to be a significant source in mid September, as indicated in Figure 21. By mid-September 2011, there were 16 fires active across Washington (2), Oregon (8), Idaho (4), and Montana (2). Across the region, temperatures were above average and precipitation was below average during the first half of the month, which lowered fuel moistures of all sizes (10-hour, 100-hour, and 1,000-hour fuel moistures) and increased the fire danger and Keetch-Byram Drought Index values. The 2011 fires potentially impacting the THSI1 monitor included the Mother Lode (2,661 acres), Shadow Lake (10,000 acres) and the High Cascades (108,154 acres) fires. In 2012 numerous wildfires developed

Figure 21 Recent Deciview and OM Extinction at THSI1 on Worst Days



Deciview

in the Cascade Mountains as a result of lightning strikes. The Pole Creek fire charred over 26,000 acres near Sisters, Oregon. The wildfire impacted air quality for residents as well as nightly inversions trapped the smoke in the valley. Each of these fire events were responsible to the impairment recorded at the



Organic Mass

THSI1 monitor. As Figure 8 showed, there has been an unfortunate trend towards in the number of acres burned in Oregon as a result of wildfires over the past five years. While wildfires are not considered anthropogenic sources, efforts to control these fires through smoke management efforts such as prescribed burning, could increase the amount of short-term burning that could occur near the Class I areas. As increasing numbers of wildfires occur, continued progress to achieving visibility goals will be challenged should this trend continue.

Climate change is a global phenomenon resulting from increasing levels of heat trapping gases. The expression of the consequences of this varies by region. In the Pacific Northwest an expected climate outcome is increased precipitation in the winter, falling as rain not snow, and in the summer as well, in the form of more frequent downpours. From a regional haze perspective, we can expect to see an increase in relative humidity, which adversely impacts visibility by increasing light scattering by water soluble particles, such as sulfates and nitrates. Generally relative humidity is lower in western states as a starting point and along with continued reductions in anthropogenic emissions of water soluble particles, the net impact may not be large. Multiple efforts to reduce climate forcing factors in Oregon are underway but a complete solution will require larger scale efforts from regional, national and international sources that place it outside the scope of regional haze planning efforts.

Windblown dust also contributes to visibility impairment by light scattering. This is not a major source of concern from sources in Oregon. Although large scale dust storms have originated in Asia with enough force and volume to reach the continental United States, these sources of pollution represent a lesser pollution source than local sources. While we can continue to track this source of light scattering pollution, effective control is beyond the scope of regional haze plans.

In the original Regional Haze Plan (2009) the greatest reductions from anthropogenic sources were addressed. Some of the strategies included the BART requirements for the PGE Boardman plant and "on the books" federal mobile source regulations. Other anthropogenic sources, such as other non-BART sources, prescribed burning, and open burning are not sources determined to be "significant" contributors to Class I visibility impairment; therefore it may be more challenging to meet the 2064 goal of natural conditions even with additional controls or regulations.

4. Determination of Adequacy, Procedural Requirements and Conclusions

E. 40 CFR 51.308 (g) (6)

The final report will include a discussion of coordination efforts with tribal governments and federal land managers and comments from public participation as summarized in Appendices C and D.

Oregon is making adequate progress in improving visibility as a result of actions taken outlined within the State Implementation Plan as well as actions taken by adjoining states, the federal government and driven by compliance with international treaty. The trends for Worst Days averages show improvement at most every monitoring location. The central Oregon Cascades location shows a slight decrement that can be understood to be affected by wildfires and is otherwise trending positively for other visibility impairing pollutants. Current best day visibility at all locations is lower than Reasonable Progress Goals (see Table 14).

Oregon continues to strengthen existing control measures due to the severity of the air quality problem. Oregon is currently implementing SIPs for the 35 ug/m3 daily PM2.5 and is working with additional communities to implement PM Advance Plans for areas in danger of violating federal health standards. In addition, smoke emissions from California wildfires sometimes impacted Oregon Class 1 Area monitors.

Oregon has determined that absent these natural wildfire smoke impacts, visibility is improving sufficiently due to reduction of anthropogenic emissions, in-state and out-of-state.

Oregon staff also meets routinely with state and federal land management agencies (FLMs) to review visibility progress, to share technical and research information, and to discuss policies leading to air quality improvement. This occurs at the staff level throughout the year at smoke management advisory committee meetings and through senior management meetings of DEQ, ODF, and FLM. DEQ provided the draft Progress Report to the FLMs sixty days in advance of the public notice of the hearing on the Progress Report, for their review and comments. Appendix D includes their written comments and the responses from DEQ staff.

With the reductions in anthropogenic emissions in Oregon and the resulting improvement in visibility at the Class I area IMPROVE monitors, DEQ determines that the current regional haze plan strategies are sufficient for Oregon and its neighboring states to meet their 2018 reasonable progress goals. Additionally, in accordance with the requirements of the Regional Haze Rule 40 CFR 51.308(h), Oregon has determined that no further substantive revision of the Regional Haze Plan is necessary at this time to achieve the 2018 goals for visibility improvement.

Appendix A – Prescribed Burning Impact Analysis

Table of Contents

1. Introduction

The *2010 Oregon Regional Haze Plan* identifies DEQ work commitments for achieving "reasonable progress" in reducing regional haze, as required by the federal regional haze rule. This analysis the first of these commitments: Is prescribed burning a significant contributor to the 20% worst visibility days in Oregon's Class I areas?

1.1 Prescribed Fire and Haze

As described elsewhere in this update, there are several pollutant species (sulfates, nitrates, organic carbon, elemental carbon, and soil dust) that contribute to haze at different times of year and in different amounts. The regional haze rule is focused on protecting the 20% best days and improving the 20% worst days. The most common pollutant species found at Oregon's Class I areas on the 20% worst days is organic carbon (OC), and to a much lesser degree, elemental carbon (EC). These two pollutant species are an indicator of vegetative burning, or fire. The highest contribution of OC and EC tends to be in the summer, attributable primarily to wildfire. During the summer months in Oregon, nearly all forest prescribed burning is rarely permitted for fire safety and resource protection reasons.

During the remainder of the year, there are days with significant amounts of forest prescribed burning. The IMPROVE data shows a very distinct pattern of OC and EC contribution to the worst 20% visibility days. Given that most of Oregon's Class I areas are surrounded by forested land, it is strongly suspected that forestry burning is a significant contributor to these days.

The Oregon Department of Forestry (ODF) manages prescribed burning across the state through the Oregon Smoke Management Plan (OSMP). ODF rules have "visibility objectives" in OAR 629-048-0130 that are voluntary measures intended to ensure the OSMP is operated in a manner consistent with the Oregon Regional Haze Plan, and the Enhanced Smoke Management Program criteria listed in the federal regional haze rule to protect Class I area visibility. OAR 629-048-0130(5) encourages that prescribed burning upwind of Class I areas be managed to avoid ground level plume impacts. This protection is purely voluntary. No mandatory provisions exist in the OSMP that require Class I areas be protected from smoke/visibility impacts.

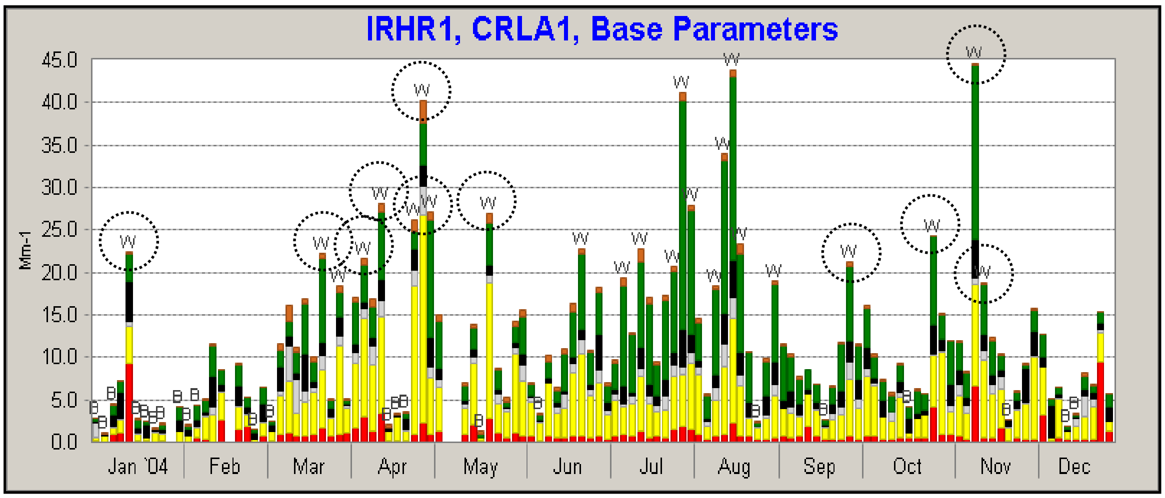
2. Evaluation Methodology

The focus of this evaluation is two-fold. One is to identify if prescribed burning being conducted near Class I areas is a likely significant contributor to the 20% worst days. The other is whether any additional smoke management measures (either voluntary or mandatory) should be considered to reduce impacts from prescribed burning within a certain distance of Class I areas. The long-distance transport of prescribed burning smoke is more of a regional issue, for which any additional smoke management measures to address "plume impacts" would have limited benefit. As noted in the *2010 Oregon Regional Haze Plan*, regional smoke management coordination is being addressed under the Enhanced Smoke Management Program criteria.

2.1 Retrospective Analysis

This evaluation is based on IMPROVE data from the six monitoring sites in Oregon, for the period of 2004-2009. The monitoring data was reviewed to identify the pollutant species on the 20% worst days, specifically those days with elevated OC and EC as an indicator of vegetative burning. Figure 1 below illustrates the daily variations in pollutant species at Crater Lake National Park over a given year, with the green indicating OC and the black EC. Other significant contributing pollutant species are nitrate (red) and sulfate (yellow). The peaks with a "W" represent the 20% worst case days. Those with a circle around the "W" are days outside of the summer when prescribed burning may have been occurring. The summertime peaks are assumed to be wildfire since practically no prescribed burning in Oregon occurs in the summer. The small "B" indicates the 20% best days.

Figure 1 Crater Lake IMPROVE Site - Pollutant Species and 20% Worst Days



2.2 Limits and Constraints

In developing the methodology for this evaluation, there were several limitations and constraints faced for this kind of "plume impact" study. First, due to the large volume of 20% worst days over the 2004-2009 period from six different monitoring sites, a process was needed for refining the data set to a more manageable (but still robust) size. This required making some assumptions on the significance levels of OC and EC (i.e., carbon) on 20% worst days, and identifying a distance threshold for defining burning that is in "close proximity". Second, given the retrospective nature of this review, an in-depth daily meteorological analysis would have been very difficult, so the primary focus was on identifying general transport wind direction and speed associated with each burn. Third, given the nature of evaluating "plume impacts", the location of IMPROVE monitor was in some cases a limiting factor. As Table 3 in the *Update* indicates, there are two Class I areas with monitors located within their boundaries, five Class I areas with monitors only a few miles away, and five Class I areas many miles from the monitor, making it difficult to confirm those Class I areas were directly impacted by the burn unit in question. Also, the IMPROVE monitoring network does not operate on a daily basis, but rather samples air quality once every three days. Lastly, unlike the "real-time" monitors that many smoke management programs use, IMPROVE monitors can provide only the 24-hour average concentration, and thus cannot provide information on the time and duration of the smoke impact. All of these factors had to be taken into consideration in the methodology used for this evaluation.

For this reason, a “weight of evidence” approach was used, which is basically a systematic review of data, following a step-by-step process of elimination for showing a correlation between cause and effect.

As noted at the conclusion of this report, the principle benefits of a weight of evidence evaluation of this kind is the degree it can confirm existing research that prescribed fire is a known contributor to haze, and more significantly help identify which Oregon Class I areas may be more prone to prescribed burning impacts, and whether improvements could be made in managing burning in close proximity to these areas to reduce the severity of these impacts, and improve the 20% worst days.

2.3 Methodology Outline

1. For all six of the Oregon’s IMPROVE sites over the period of 2004-2009, the highest 20% worst case days were identified, the pollutant species for days identified, specifically those with elevated OC and EC levels. Summer days were excluded, as this was assumed to be mostly wildfire, and practically no prescribed burning occurs during this time of year. In this manner, a “master list” of 20% worst days with elevated carbon levels was compiled.

2. Using this list, a review of ODF burn records was conducted, to verify prescribed burning activity on the 20% worst days with elevated carbon impacts. Any burning within 100 miles of a Class I area was identified, on both the day of the “impact” and the day before, to take into account possible smoke transport over a two day period.

3. On days where impacts and burning matched, a review of ODF meteorological records was conducted to identify general transport wind direction, between the location of the burn unit and the Class I area. The days where the burn unit and transport winds were not aligned and no apparent possibility of an impact, those burn units were eliminated from further consideration. In addition to wind direction, other information reviewed in this screening process was time of ignition, mixing height, elevation of the burn, tons burned, and approximate distance in miles (0-100 miles).

4. A refined list of burn units was compiled, where the transport winds and other factors showed the burn unit to be potentially upwind and capable of impacting the Class I area in question.

5. From this refined list, the final step was to select a handful of days for which further analysis would be conducted through modeling. The HYSPLIT model (Hybrid Single-Particle Lagrangian Integrated Trajectory) was selected based on its ability to simulate movement of an air particle, either starting from or ending at a certain location. This model is a good tool for estimating the potential for smoke transport and impact from a prescribed burn. In the model, an air particle is transported in the model domain by the mean windfield and spread by a turbulent component. In order to estimate smoke plume heights from which the transport starts, the particle is released from three different atmospheric heights above ground level (250, 500, and 1000 meters). Both HYSPLIT back and forward trajectory modeling were used – the former starting at the Class I area and going backwards towards the burn unit, and the latter showing the path the smoke would have followed starting at the burn unit. Results of both approaches were then compared. The backward trajectories from Class I areas were started at midnight and extended out to 24 hours, with a new trajectory starting every six hours. The trajectories were mapped along with the location of a burned area on that day. For the burn units with ignition times occurring one day prior to the 20% worst day, additional forward trajectories were calculated. The forward trajectories were started at the ignition time and extended for the next 12 hours, with new trajectory starting at each hour, with a release height 500 meters above ground. The trajectories were then mapped together with Class I areas to examine whether smoke released from the burn unit could have impacted the area. The meteorological data was from

Eta Data Assimilation System (EDAS) North American regional analysis and forecasts, based on 3-hour intervals with a spatial resolution of 40 km.

6. Finally, as noted in Table 3 of the *Update*, the location of the IMPROVE monitors varies from being inside, nearby, or in some cases many miles away from a Class I area. Since the focus is on plume impacts from individual prescribed burns, the location of the monitor is a key factor to account for in this kind of an evaluation. Of the five Class I areas not located near a monitor, three were not included in this review – Diamond Peak, Mountain Lakes, and Gearhart Mountain. These three Class I areas, and Crater Lake National Park, are all covered by the same monitor, located inside the park. Therefore, Crater Lake was used as a surrogate for these three Class I areas. The two other Class I areas not located near a monitor – Strawberry Mountain and Eagle Cap – were included in this review, as no other surrogate data was available. However, the extent of the review for these two Class I areas was limited, and is reflected in the results described below.

3. Evaluation Results

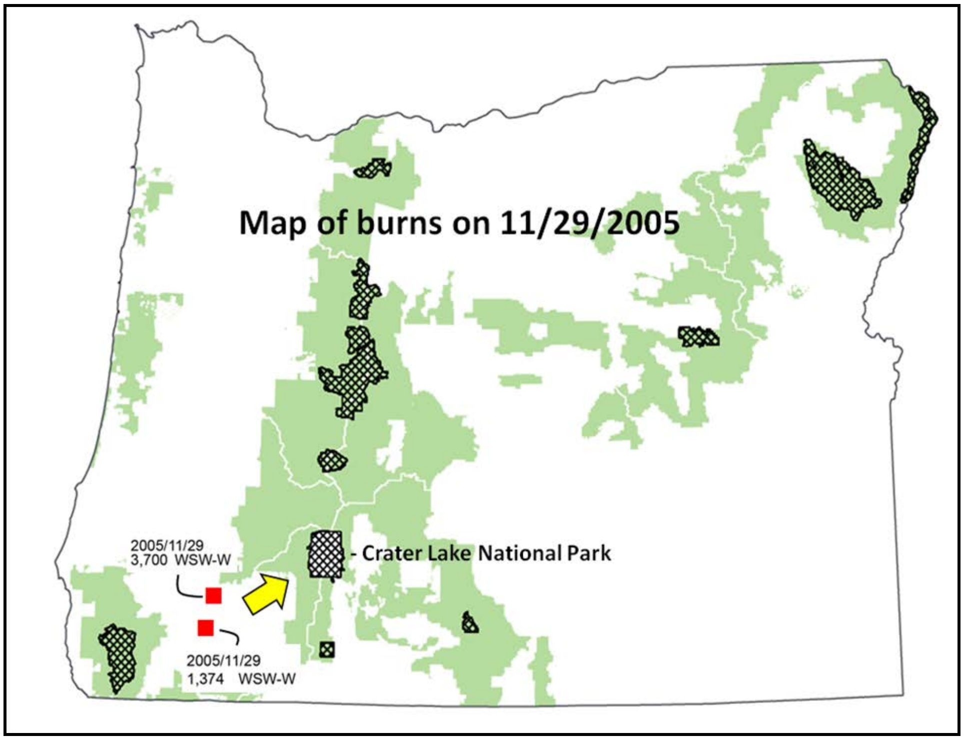
Based on steps outlined above, the following summarizes the results of this evaluation.

1. Over the 2004-2009 period there were 94 days identified as 20% worst days with elevated OC and EC levels (excluding summer months). As noted in Chapter 7 of the *2010 Oregon Regional Haze Plan*, OC is the most common pollutant species found in Oregon's Class I areas on the worst days.

2. Using this list of 94 days, ODF burn records were reviewed to identify burn days, and a total of 46 days were found where burning was accomplished within 100 miles of a Class I area with a 20% worst day and elevated carbon levels. The next step was to identify any burning on the prior day, to take into account possible smoke transport over a two-day period. An additional 14 days were found, for a total of 60 days. The majority of these days had multiple burn units rather than just a single burn.

3. From this list of 60 burn days, a total of 253 individual burn units were identified as burned on those days, within approximately 100 miles. The next step was to review ODF records to identify the average transport winds (direction and speed) and effective mixing height on these 60 burn days, and eliminate those burn units that were clearly not upwind and not capable of impacting the Class I area. Of the 253 burn units evaluated, the majority were eliminated, with 71 remaining. These 71 burn units were then more closely analyzed by their size (tons burned), ignition time, burn elevation relative to monitor elevation, and distance and direction to the nearest Class I area. These units were then mapped by their township, range, and section number. Figure 2 is an example of one of the maps with burn units and Class I areas shown. This maps shows just the two burn units that were evaluated on this day, and indicates the size of the burn, direction from the Class I area in question (in this case Crater Lake NP), and the prevailing transport winds.

Figure 2 Burn Unit Location and Nearby Class I Areas on One Burn Day



4. After this analysis of 71 burn units, 39 were determined to be upwind and with a high probability of impacting a Class I area on the 20% worst days. The next step was to conduct HYSPLIT modeling to further refine this list. Fourteen of the larger burn units were selected for this modeling. Time and resource constraints prevented additional modeling. The methodology used for the modeling is described in Section 2.3 (see paragraph #5). The objective was to provide further evidence of whether burn unit in question could have caused the 20% worst day impact. As a result of the modeling, another 2 burn units were removed from the list, while confirming the remaining 12 burn units. Figure 3 is an example of two HYSPLIT modeling runs, one forward trajectory modeling from the burn unit towards the Class I area, and the other backward trajectory from the Class I area back towards the burn unit, to illustrate how both techniques were used in this analysis.

Figure 3 Example of HYSPLIT Forward and Back Trajectory Modeling

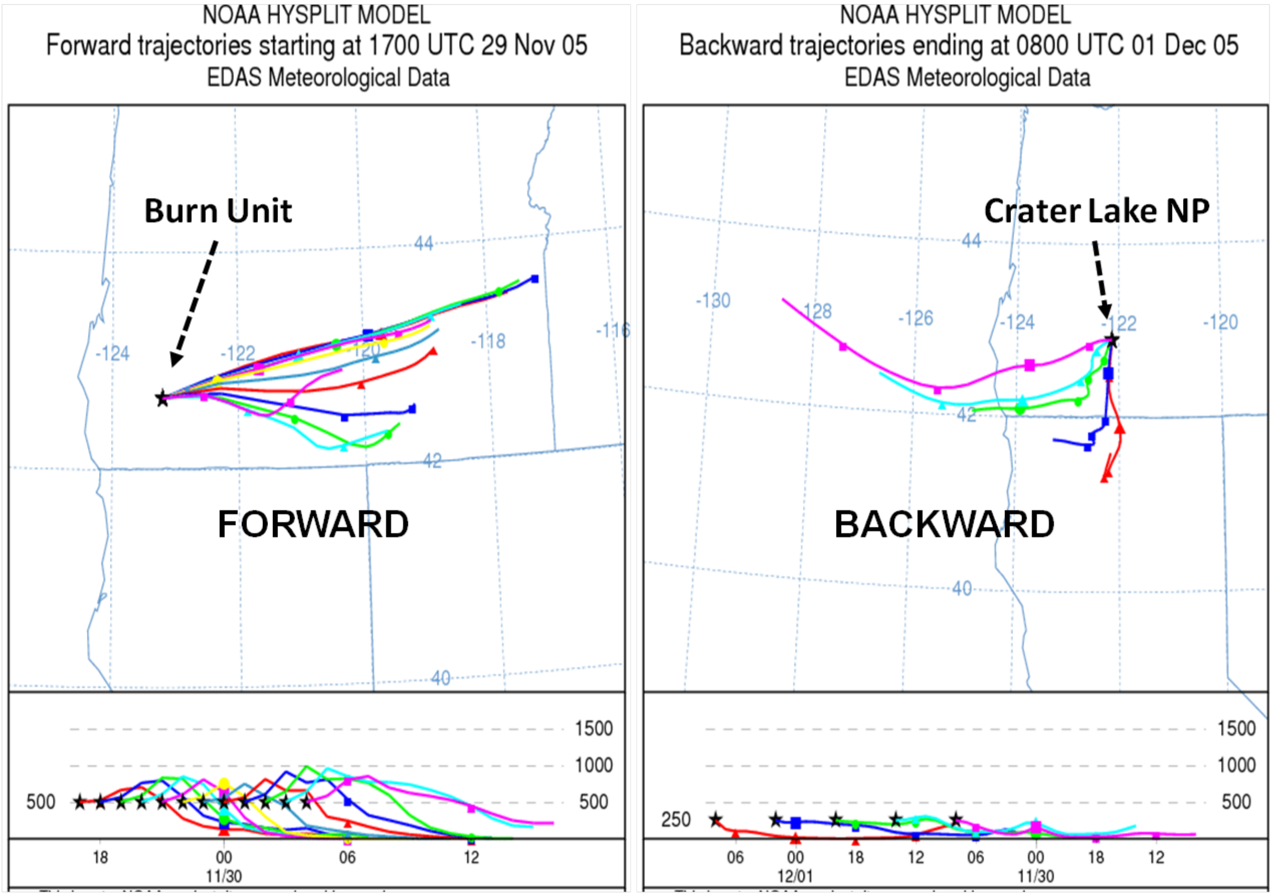


Table 1 below is the final list of 37 burn units (with the 2 removed) that were determined to have a high probability of impacting a Class I area on the 20% worst days. Those burn shaded in grey below were the 14 modeled units. Another 7 burn units partially shaded occurred on the same day and same general location as those modeled, and thus supported by the modeling results.

Table 1 Prescribed Burn Units Identified as Impacting Class I Areas 20% Worst Days

date burned	ignition time	Class I area	unit location	unit tons	elevation	unit direction	distance in miles	transport winds
4/29/2004	1100	Crater Lake	37S 14E 34	7200	5300	SE	65	E-SE
4/29/2004	1030	Crater Lake	33S 14E 13	7000	5400	ESE	55	E-SE
10/15/2004	800	Hells Canyon	2N 42E 2	3300	3900	NNW	55	NNW-N
10/15/2004	1300	Hells Canyon	2N 45E 21	750	4400	NNW	42	NNW-N
10/21/2004	945	3 Sisters	16S 1E 32	900	2300	WSW	45	WSW-WNW
10/21/2004	800	3 Sisters	14S 1E 3	949	1100	WNW	45	WSW-WNW
10/21/2004	900	3 Sisters	13S 1W 5	2446	800	WNW	54	WSW-WNW
10/21/2004	930	3 Sisters	13S 2W 9	2339	1000	WNW	45	WSW-WNW
10/21/2004	1400	3 Sisters	13S 2W 9	1581	1100	WNW	55	WSW-WNW
10/21/2004	1300	3 Sisters	14S 1E 9	2343	250	WNW	45	WSW-WNW
11/10/2004	830	Kalmiopsis	36S 9W 19	3119	4000	SE	22	E-SE
11/10/2004	830	Kalmiopsis	36S 10W 23	853	3200	SE	22	E-SE
11/11/2004	800	Crater Lake	33S 14E 26	976	5300	ESE	58	E-SE
11/11/2004	1400	Crater Lake	35S 14E 14	988	5200	ESE	60	E-SE
11/11/2004	800	Crater Lake	35S 15E 19	2180	5600	ESE	63	E-SE
11/23/2004	1330	Kalmiopsis	27S 13W 6	900	200	NNW	40	NW-NNW
12/1-2/2004	multiple	Kalmiopsis	multiple	2585	various	NE	15-25	NE-ENE
10/25/2005	1000	Mt Hood	14S 1E 27	1476	2300	SSW	80	S-SSW
10/25/2005	1000	Mt Hood	12S 3E 25	2101	1650	SSW	65	S-SSW
10/25/2005	1000	Mt Hood	14S 1E 23	2894	1700	SSW	80	S-SSW
10/25/2005	1145	Starkey	18S 32E 26	2400	5300	SSW	75	S-W
11/8/2005	900	Kalmiopsis	40S 7W 21	2063	3000	SSE	50	ESE-SE
11/9/2005	1200	Kalmiopsis	40S 7W 21	1969	3500	SSE	50	ESE-SE
11/21/2005	1300	Crater Lake	37S 13E 12	1200	5000	SE	60	ESE-SSE
11/21/2005	900	Crater Lake	35S 14E 10	1216	5200	ESE	58	ESE-SSE
11/29/2005	900	Crater Lake	33S 4W 32	3700	2600	WSW	57	WSW-W
11/29/2005	800	Crater Lake	35S 5W 20	1374	1800	WSW	66	WSW-W
2/22/2006	1100	Kalmiopsis	29S 14W 10	901	250	NW	30	SW-N
10/15/2007	1130	Starkey	16S 35E 24	5140	5300	SSE	58	SSE-S
10/27/2007	1100	Mt Hood	5S 11E 17	500	3000	SE	15	SE-S
10/30/2007	1300	Kalmiopsis	31S 12W 25	312	1000	NNW	12	LV
10/30/2007	1010	Kalmiopsis	30S 8W 7	380	1900	NE	18	LV
11/7/2007	1100	Kalmiopsis	32S 8W 7	330	3000	ENE	14	LV/NE-ESE
10/27/2009	800	Kalmiopsis	30S 13W 21	591	1600	NW	20	WNW-NW
10/27/2009	730	Kalmiopsis	31S 13W 36	489	720	NW	12	WNW-NW
10/27/2009	1200	Kalmiopsis	31S 13W 15	530	880	NW	18	WNW-NW
10/28/2009	1445	Kalmiopsis	30S 13W 12	429	800	NNW	22	NW-N

4. Conclusion

A "weight of evidence" approach is a systematic review of data, often following a step-by-step process of elimination for showing a correlation between cause and effect. This evaluation of prescribed burning relied upon monitoring, meteorological, and modeling information, but was constrained by several key factors. While the focus was on prescribed burning in close proximity to Oregon Class I areas, it was not possible to determine the extent long-range smoke transport from prescribed burning may have contributed to the impacts. Also, as noted earlier in this report, the IMPROVE monitors conduct sampling every third day, which did not allow a daily assessment to be made. More significantly was 24-hour averaging of the IMPROVE data, and the lack of real-time monitoring data to assess the time and duration of smoke impacts. It was for this reason that HYSPLIT modeling was added to the analysis.

These types of constraints are inherent in any evaluation of prescribed burning. However, given the fact that the Class I areas in Oregon are surrounded by forests where large amounts of prescribed burning take place during the year, there is considerable evidence to suggest prescribed burning close to Class I areas is a significant source of haze, and major contributor to many of the 20% worst day impacts. This evidence is in the form of annual reports on prescribed burning activity, emission inventories, regional haze modeling, and IMPROVE monitoring data showing elevated carbon levels. Add to this is the lack of specific measures to mitigate impacts in Oregon Class I areas under the current Oregon Smoke Management Program. As a result, despite the constraints described above, the primary value of this evaluation is to help identify which Oregon Class I areas may be more prone to prescribed burning impacts, and to consider whether this burning could be managed in such as way as to reduce the more severe smoke impacts, and improve the 20% worst days, as required under the federal regional haze rule.

The 37 prescribed burns identified in Table 1 show a high probability of being the primary cause of the 20% worst day impacts between 2004 and 2009 in those Class I areas, given the elevated carbon levels on the days in question. These findings provide further evidence that prescribed burning in close proximity to Class I areas can be a significant source of the impact. Table 1 shows that the Kalmiopsis and Crater Lake Class I areas accounted for more than half of the impacts. The other impacts in the central and northern Cascade Class I areas were less, but still noteworthy. Since the Starkey IMPROVE monitor in Eastern Oregon is some distance away from the Strawberry Mountain and Eagle Cap Class I areas, the extent of the contribution of the burn units in that part of the state could not be easily assessed.

The findings of this evaluation suggest that the Kalmiopsis and Crater Lake Class I areas would benefit from new measures for smoke management protection in the months of October and November. As noted at the beginning of this report, at the time this analysis was done, the Oregon Smoke Management Plan did provide limited smoke protection to Class I areas through voluntary "visibility objectives" to avoid "ground level plume impacts". However, the plan did not define or elaborate how these impacts are to be avoided.

Based on this analysis DEQ recommended new measures to provide seasonal visibility protection for the Kalmiopsis and Crater Lake Class I areas through basic smoke management techniques upwind and within a certain distance of these Class I areas. The objective of these new measures would not be to prevent any smoke from impacting the Class I areas, but rather to protect against any major smoke impacts that could result in or significantly contribute to a 20% worst day. Reviewing the burn units listed in Table 1, the average distance of the 37 units from the Class I areas indicated is approximately 50 miles. This would be an adequate distance to provide a reasonable level of protection. These measures would be relatively easy to implement, and provide some additional visibility protection while being considerably less restrictive than current controls which prevent any burning upwind of Smoke Sensitive Receptor Areas (SSRAs).

The following recommendations for modification of the Smoke Management Plan were presented for consideration by the Oregon Department of Forestry. Most of the emphasis is on planning and analysis prior to burning, and use of emission reduction techniques (ERTs), with various mitigation options only if a major impact is predicted.

1. When registering prescribed burns, all units within a 50 mile radius of the Kalmiopsis and Crater Lake Class I areas would be identified, and the transport wind direction indicated that would trigger the need for further evaluation of potential downwind Class I impact, prior to the actual burning. This would apply to the months of October and November only.

2. An assessment would be made prior to authorizing any burning on the potential for a direct plume impact at ground level in the Class I areas. This assessment would be based on the following (but not limited to) - transport wind direction and speed, size of the proposed burn, mixing height, visual observations of local weather and burning conditions, use of pilot balloons, or other methods, including the use of ERTs that could affect the potential downwind impact. The closer the proximity of the burning to the Class I area, the greater weight would be given to these factors.

3. If the assessment finds that a significant Class I area impact is likely, the following options would be available to mitigate or avoid the impact: (1) use additional ERTs to reduce total emissions, improve combustion, increase plume rise, etc.; (2) use test fires to confirm transport wind direction before burning; (3) burn only a portion of the burn unit; (4) delay the burn to see if transport winds change; or (5) postpone the burning to another day.

4. In addition to the actions listed in (3), consider the need for rapid mop-up of residual smoke after the burn if necessary to prevent excessive residual smoke into the Class I area.

5. Post-burn reporting would include information on any ground level smoke observed in downwind Class I area, or if not known, a description of smoke plume behavior and transport, or other observations that could be useful to determine the extent of any smoke impact at a later time.

These measures were adopted and made part of the Oregon Smoke Management Plan in June 2014. They represent an improvement from the prior visibility objectives by providing additional visibility protection that could reduce prescribed burning impacts in two Class I areas that this evaluation indicates are more frequently impacted than other Class I areas in the state. This is especially a concern for Crater Lake National Park, which has the highest visitation of all Class I areas in Oregon, with over 400,000 visitors per year.

These new measures are not expected to have a significant impact on prescribed burning, given that they would only apply two months of the year, only apply to two Class I areas, and would still allow burning upwind of these areas, with options to mitigate any potential impacts.

States are required to demonstrate in their regional haze plans efforts to make “reasonable progress” in improving visibility, and develop strategies for major sources that the state has identified as significantly contributing to Class I area visibility impairment. The Department sees these new smoke management measures to provide visibility protection as meeting this requirement.

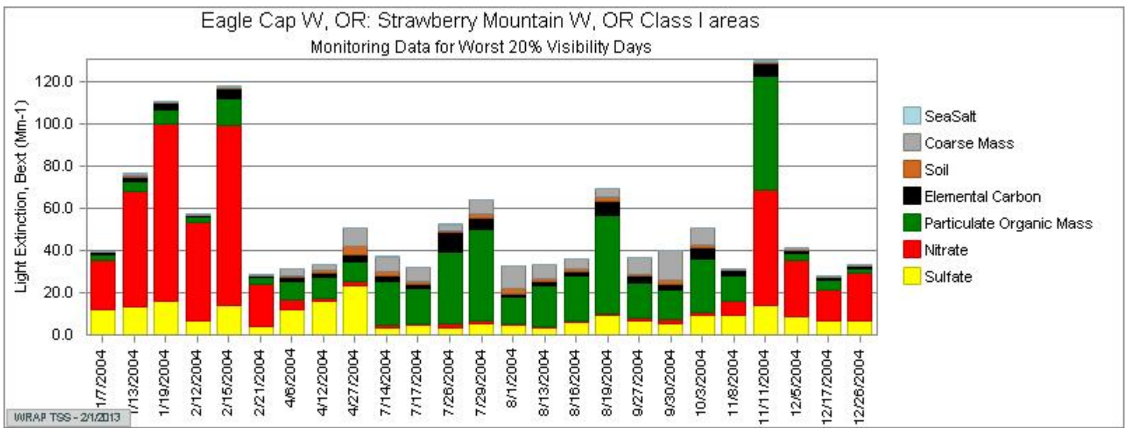
Appendices

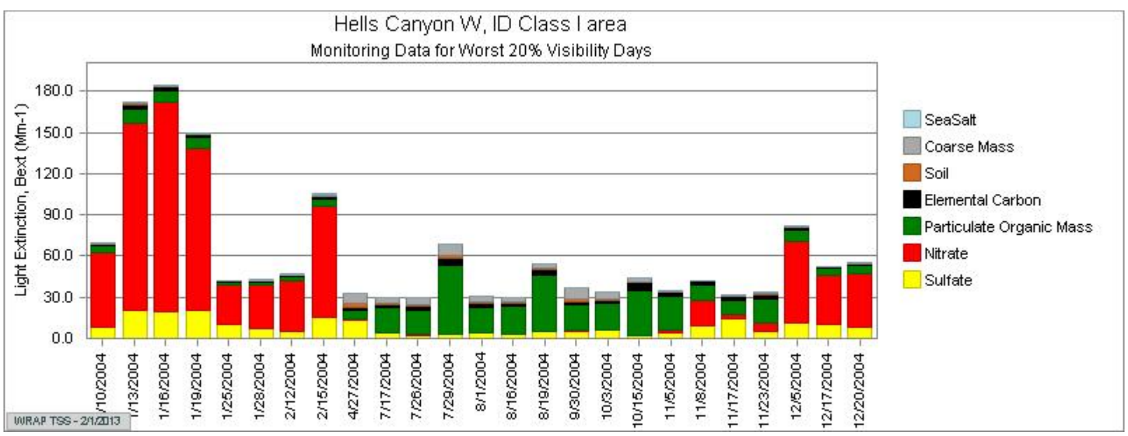
Appendix A: IMPROVE Data Selected for Evaluation

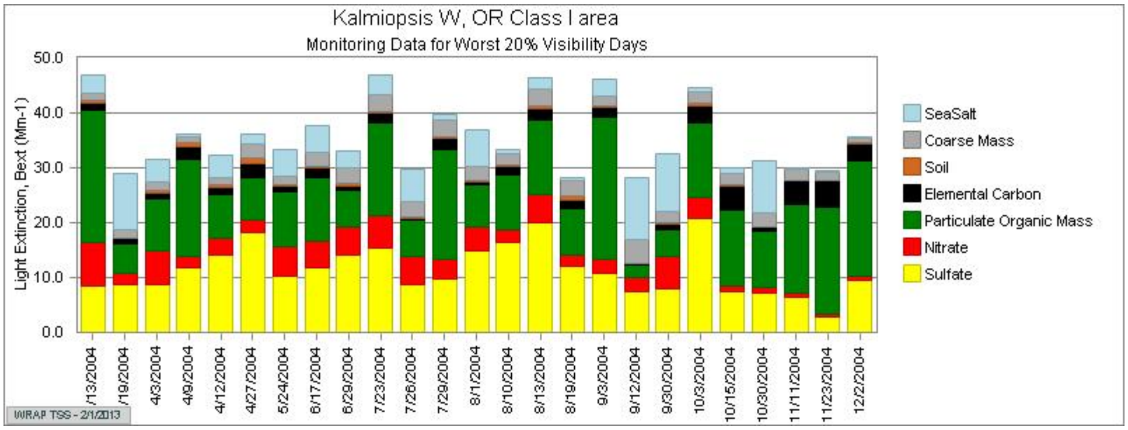
As noted in the report, IMPROVE monitoring data from 2004-2009 was reviewed for this evaluation to identify the 20% worst days, and the pollutant species on those days, noting significant organic carbon and elemental carbon contribution, as an indicator of fire. Next, ODF prescribed burning records were reviewed to identify days where burning occurred on a 20% worst day with elevated carbon impacts. Any burning within 100 miles of a Class I area was identified, on both the day of the "impact" and the day before, to take into account possible smoke transport over a two day period. See Appendix B.

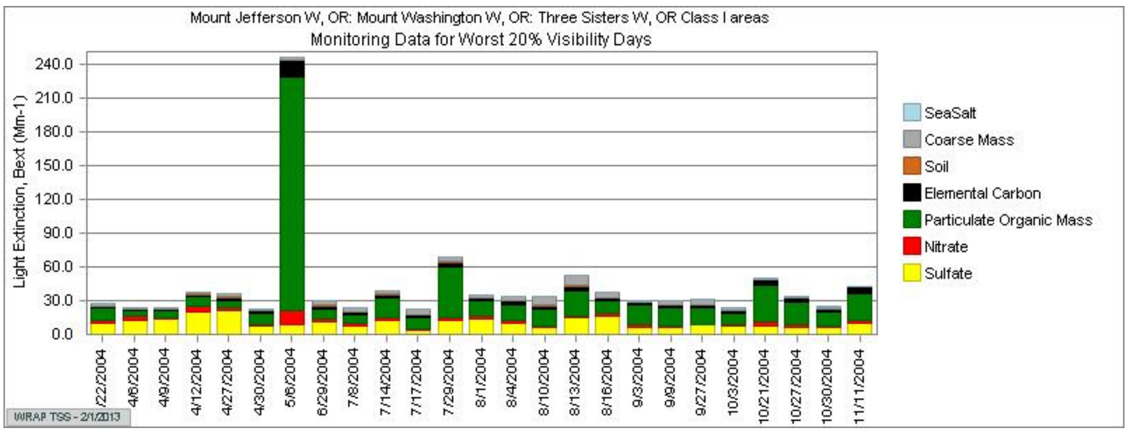
The following monitoring data shows the 20% worst days each year, for each monitoring site and Class I area from 2004-2009, by pollutant species.

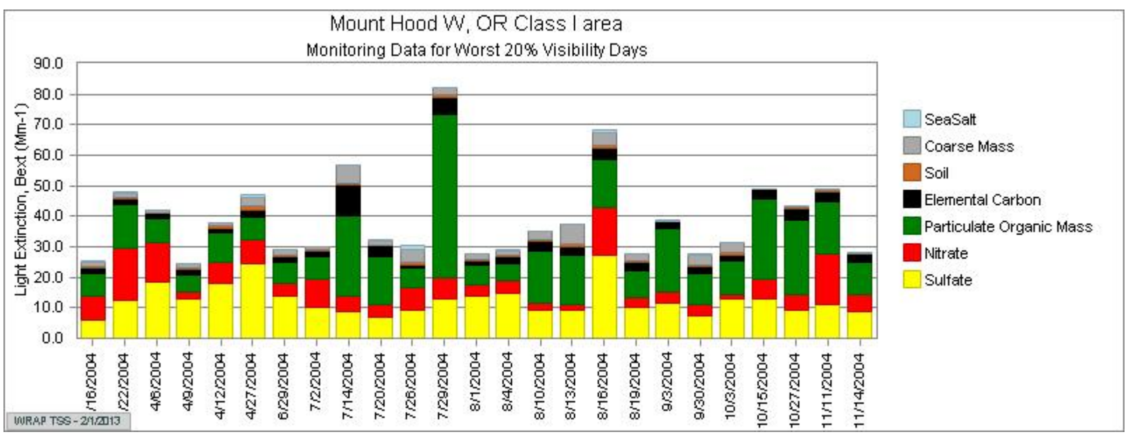
2004: 20% Worst Days






Kalmiopsis W, OR Class I area
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
50.0
40.0
30.0
20.0
10.0
0.0
/13/2004
/19/2004
4/3/2004
4/9/2004
4/12/2004
4/27/2004
5/24/2004
6/17/2004
6/29/2004
7/23/2004
7/26/2004
7/29/2004
8/1/2004
8/10/2004
8/13/2004
8/19/2004
9/3/2004
9/12/2004
9/30/2004
10/3/2004
10/15/2004
10/30/2004
11/11/2004
11/23/2004
12/2/2004
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013


Mount Jefferson W, OR: Mount Washington W, OR: Three Sisters W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
240.0
210.0
180.0
150.0
120.0
90.0
60.0
30.0
0.0
/22/2004
4/6/2004
4/9/2004
4/12/2004
4/27/2004
4/30/2004
5/6/2004
6/29/2004
7/8/2004
7/14/2004
7/17/2004
7/29/2004
8/1/2004
8/4/2004
8/10/2004
8/13/2004
8/16/2004
9/3/2004
9/9/2004
9/27/2004
10/3/2004
10/21/2004
10/27/2004
10/30/2004
11/11/2004
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013


Mount Hood W, OR Class I area
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
/16/2004
/22/2004
4/6/2004
4/9/2004
4/12/2004
4/27/2004
6/29/2004
7/2/2004
7/14/2004
7/20/2004
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7/29/2004
8/1/2004
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10/3/2004
10/15/2004
10/27/2004
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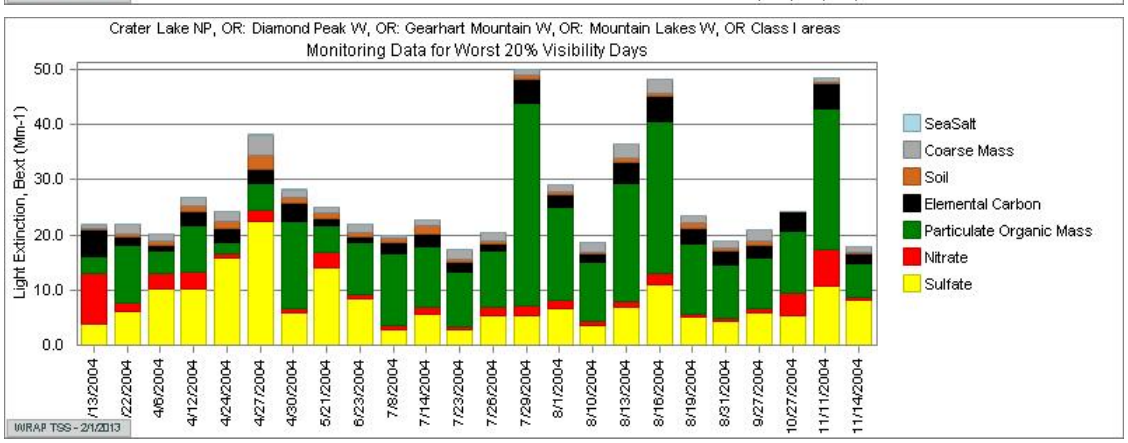
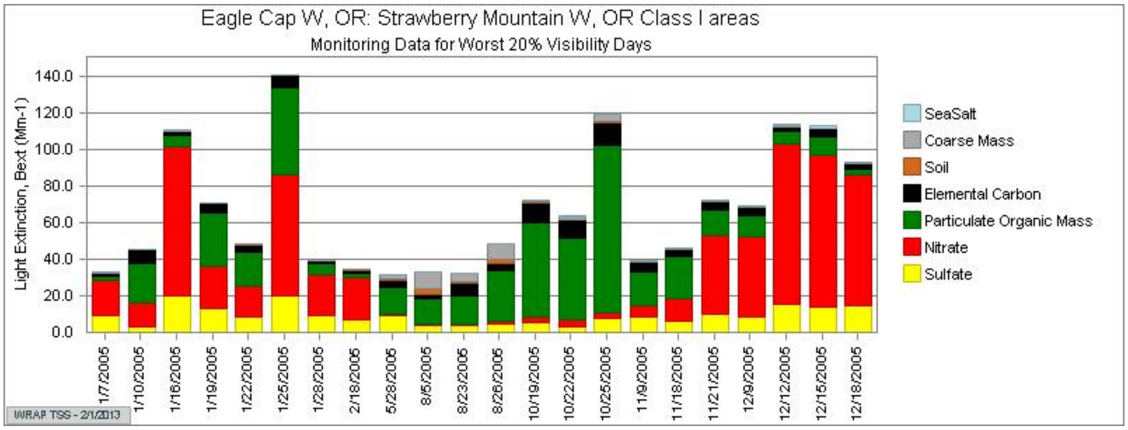
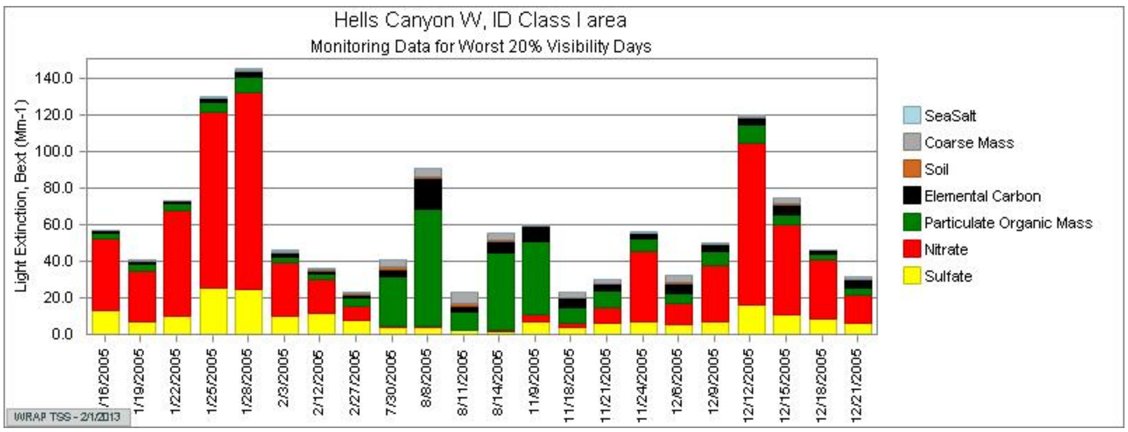
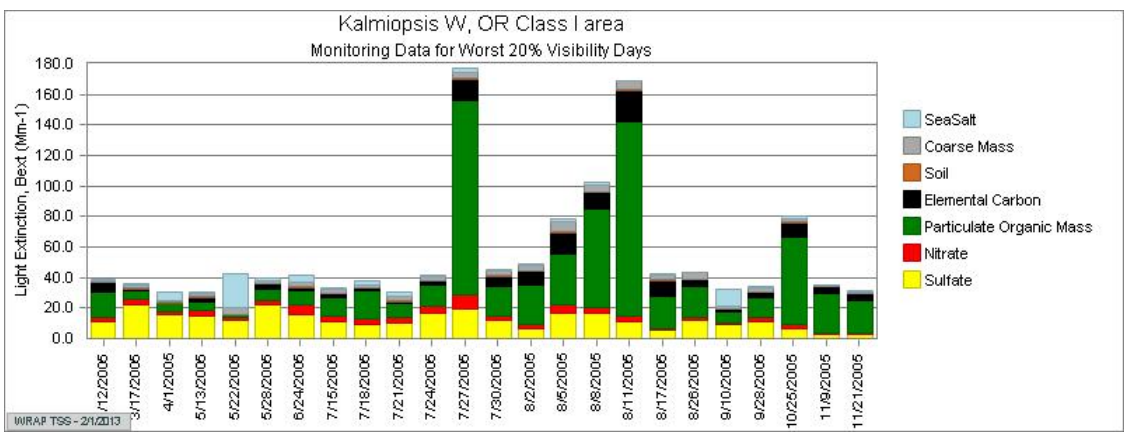
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

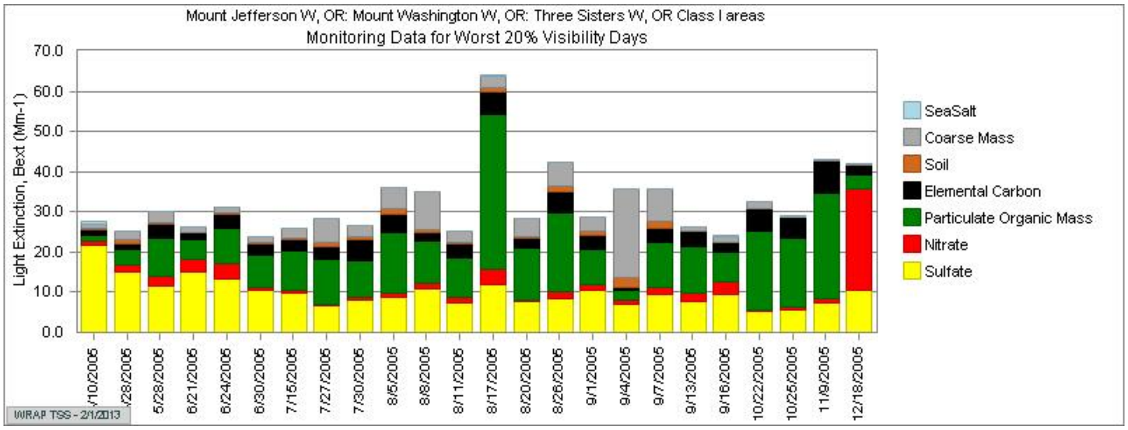

Crater Lake NP, OR: Diamond Peak W, OR: Gearhart Mountain W, OR: Mountain Lakes W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
50.0
40.0
30.0
20.0
10.0
0.0
/13/2004
/22/2004
4/6/2004
4/12/2004
4/24/2004
4/27/2004
4/30/2004
5/21/2004
6/23/2004
7/8/2004
7/14/2004
7/23/2004
7/26/2004
7/29/2004
8/1/2004
8/10/2004
8/13/2004
8/16/2004
8/19/2004
8/31/2004
9/27/2004
10/27/2004
11/11/2004
11/14/2004
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

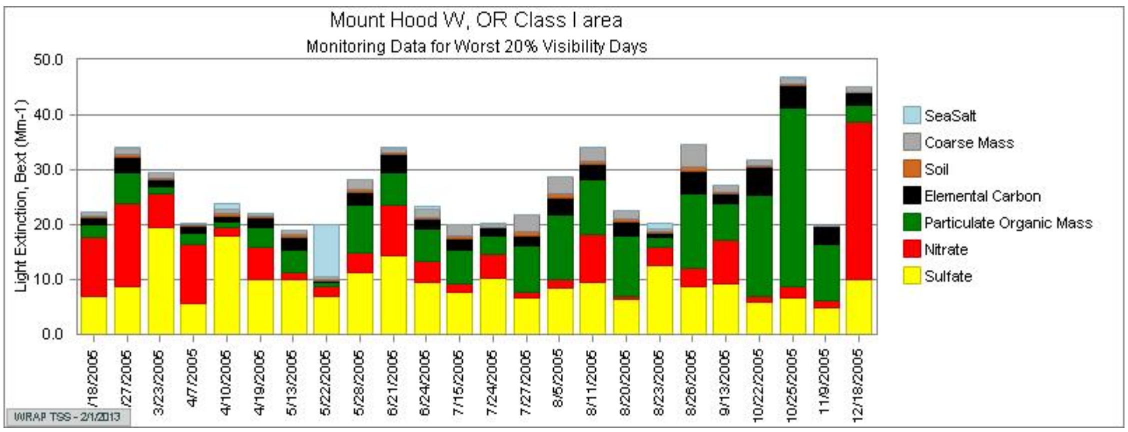
2005: 20% Worst Days

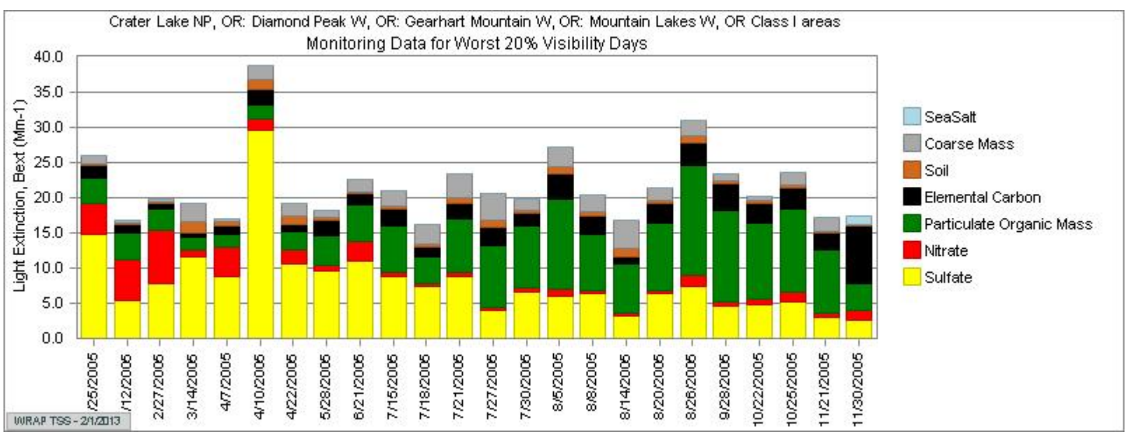




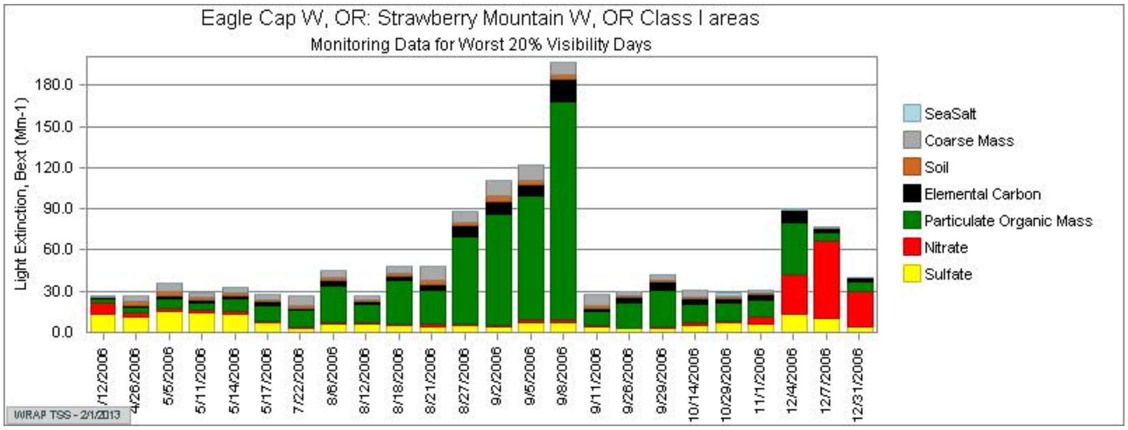


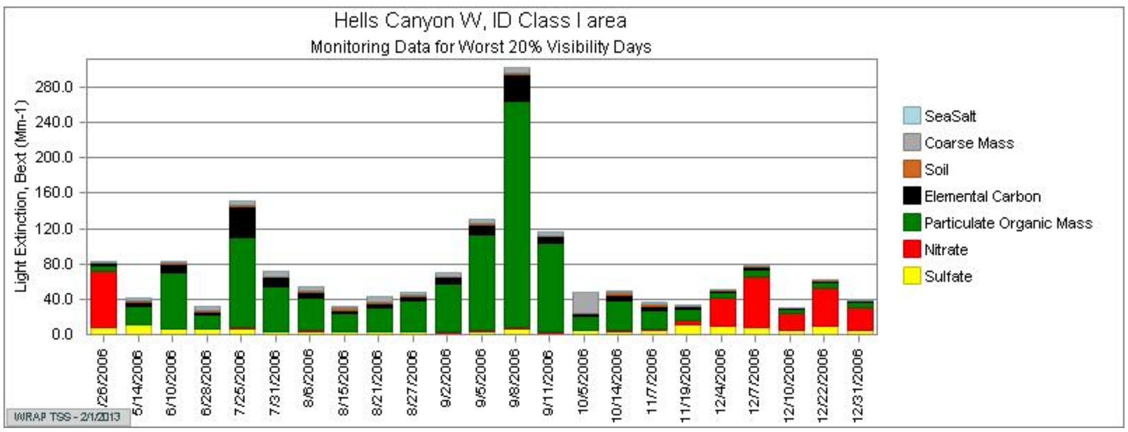

Mount Jefferson W, OR: Mount Washington W, OR: Three Sisters W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
5/28/2005
6/21/2005
6/24/2005
6/30/2005
7/15/2005
7/27/2005
7/30/2005
8/5/2005
8/8/2005
8/11/2005
8/17/2005
8/20/2005
8/26/2005
9/1/2005
9/4/2005
9/7/2005
9/13/2005
9/16/2005
10/22/2005
10/25/2005
11/9/2005
12/18/2005
WRAP TSS - 2/1/2013

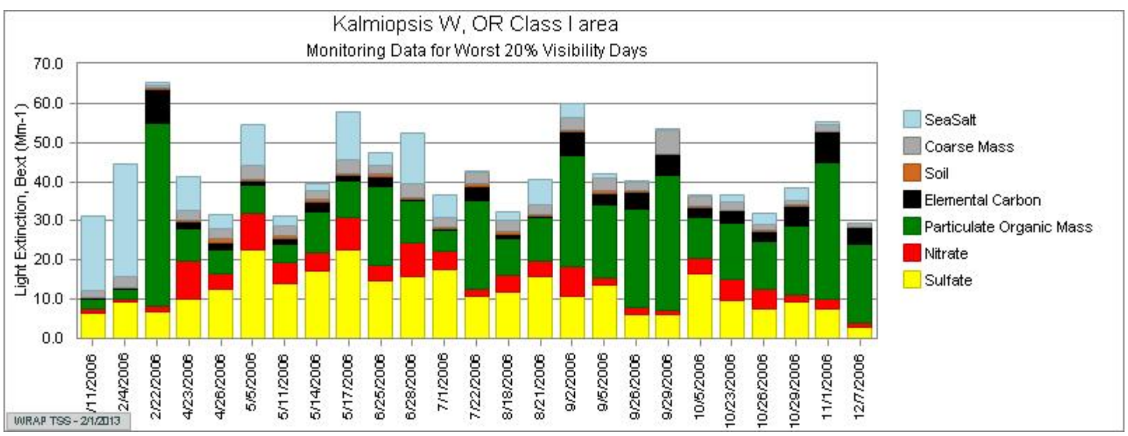

Mount Hood W, OR Class I area
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
50.0
40.0
30.0
20.0
10.0
0.0
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
3/23/2005
4/7/2005
4/10/2005
4/19/2005
5/13/2005
5/22/2005
5/28/2005
6/21/2005
6/24/2005
7/15/2005
7/24/2005
7/27/2005
8/5/2005
8/11/2005
8/20/2005
8/23/2005
8/26/2005
9/13/2005
10/22/2005
10/25/2005
11/9/2005
12/18/2005
WRAP TSS - 2/1/2013

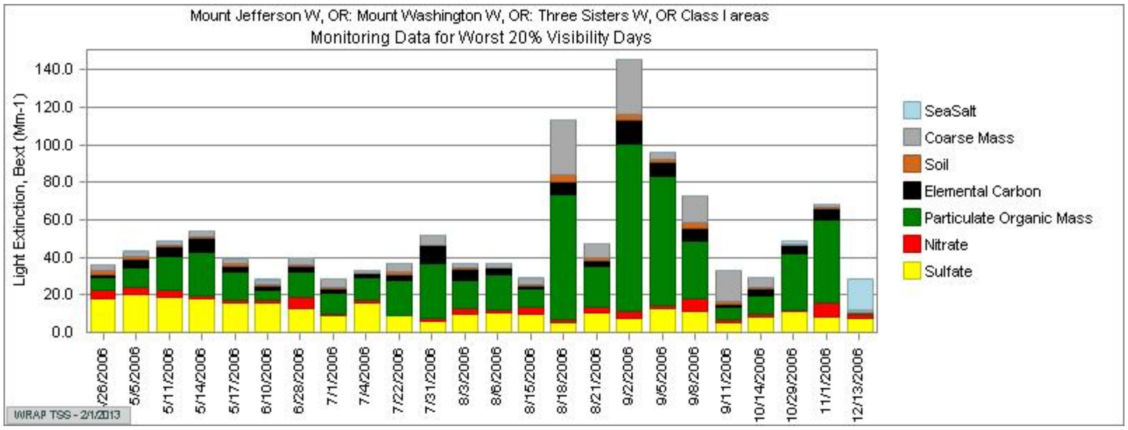

Crater Lake NP, OR: Diamond Peak W, OR: Gearhart Mountain W, OR: Mountain Lakes W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
2/27/2005
3/14/2005
4/7/2005
4/10/2005
4/22/2005
5/28/2005
6/21/2005
7/15/2005
7/18/2005
7/21/2005
7/27/2005
7/30/2005
8/5/2005
8/8/2005
8/14/2005
8/20/2005
8/26/2005
9/28/2005
10/22/2005
10/25/2005
11/21/2005
11/30/2005
WRAP TSS - 2/1/2013

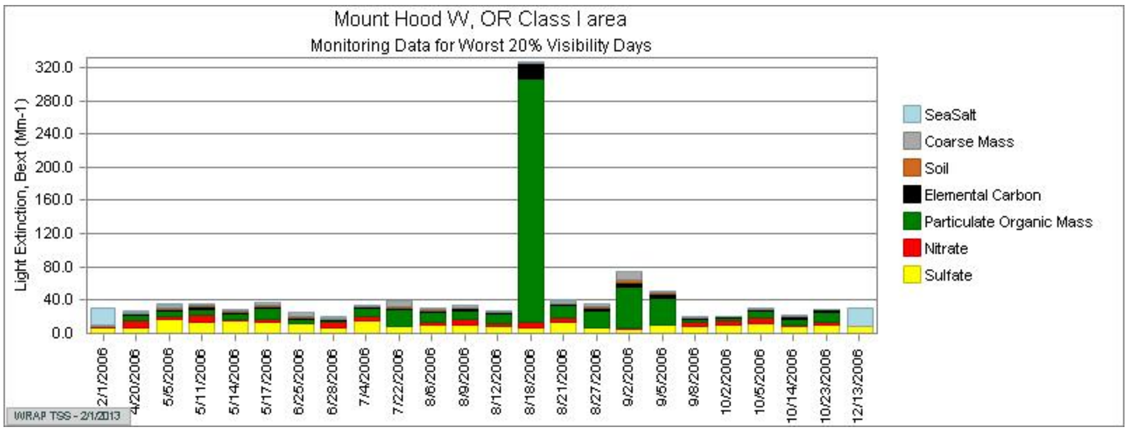
2006: 20% Worst Days

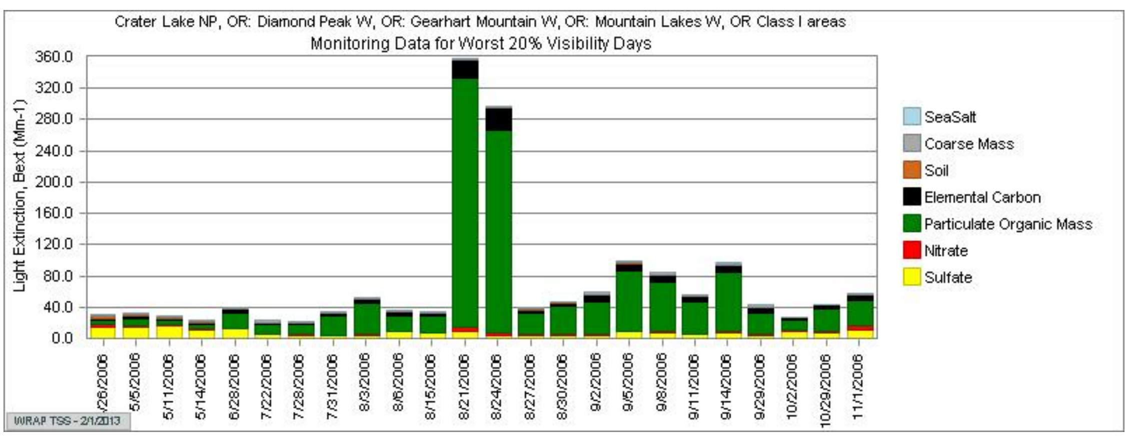




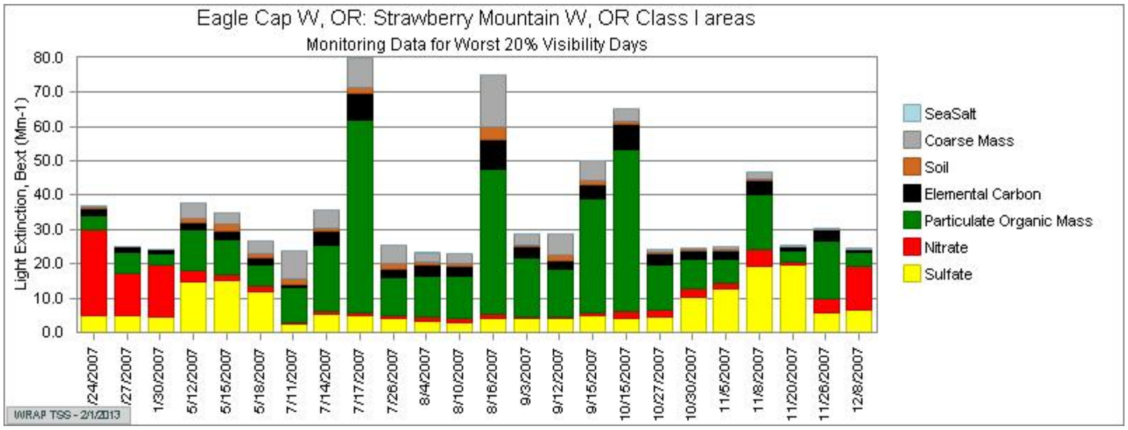


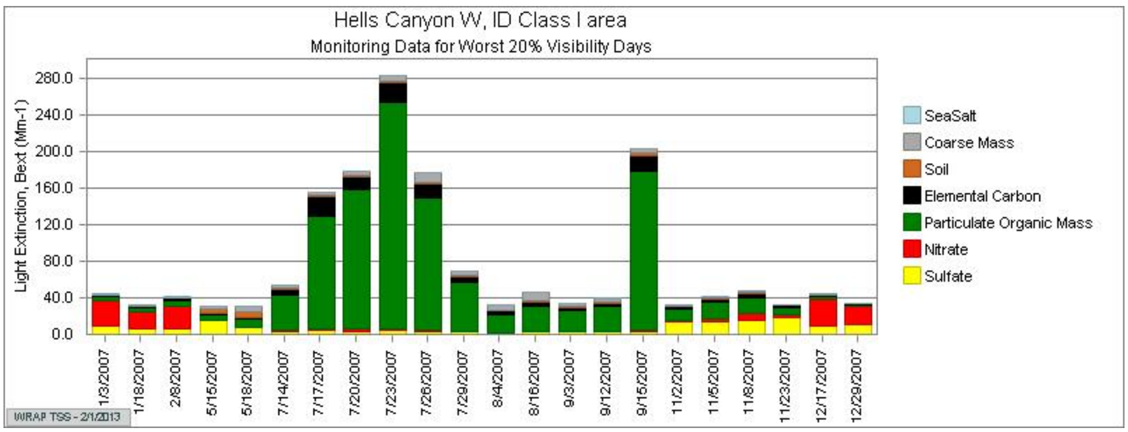

Mount Jefferson W, OR: Mount Washington W, OR: Three Sisters W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
/26/2006
5/5/2006
5/11/2006
5/14/2006
5/17/2006
6/10/2006
6/28/2006
7/1/2006
7/4/2006
7/22/2006
7/31/2006
8/3/2006
8/6/2006
8/15/2006
8/18/2006
8/21/2006
9/2/2006
9/5/2006
9/8/2006
9/11/2006
10/14/2006
10/29/2006
11/1/2006
12/13/2006
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

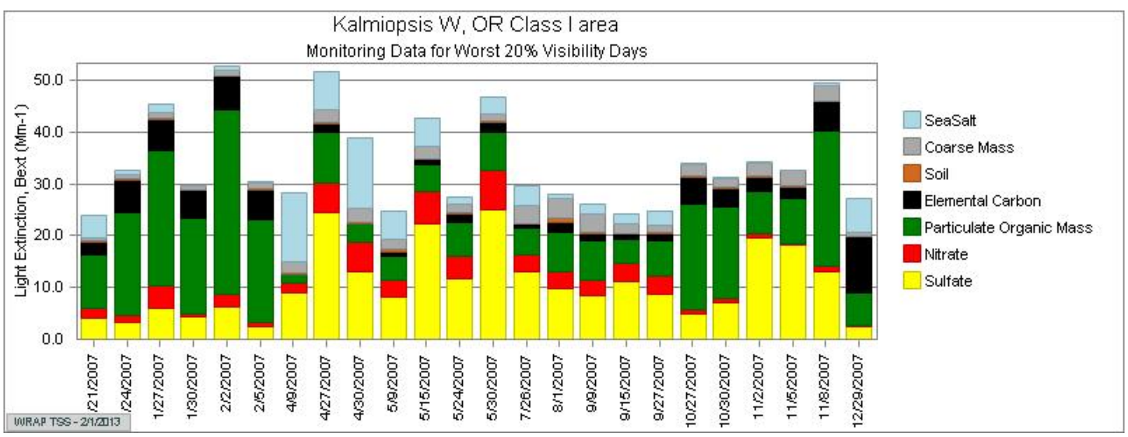

Mount Hood W, OR Class I area
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0.0
2/1/2006
4/20/2006
5/5/2006
5/11/2006
5/14/2006
5/17/2006
6/25/2006
6/28/2006
7/4/2006
7/22/2006
8/6/2006
8/9/2006
8/12/2006
8/18/2006
8/21/2006
8/27/2006
9/2/2006
9/5/2006
9/8/2006
10/2/2006
10/5/2006
10/14/2006
10/23/2006
12/13/2006
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

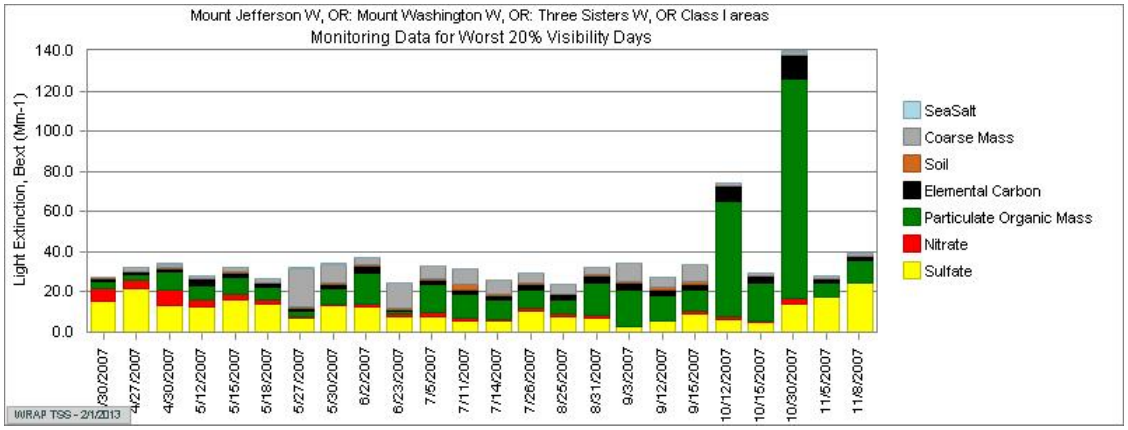

Crater Lake NP, OR: Diamond Peak W, OR: Gearhart Mountain W, OR: Mountain Lakes W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
360.0
320.0
280.0
240.0
200.0
160.0
120.0
80.0
40.0
0.0
/26/2006
5/5/2006
5/11/2006
5/14/2006
6/28/2006
7/22/2006
7/28/2006
7/31/2006
8/3/2006
8/6/2006
8/15/2006
8/21/2006
8/24/2006
8/27/2006
8/30/2006
9/2/2006
9/5/2006
9/8/2006
9/11/2006
9/14/2006
9/29/2006
10/2/2006
10/29/2006
11/1/2006
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

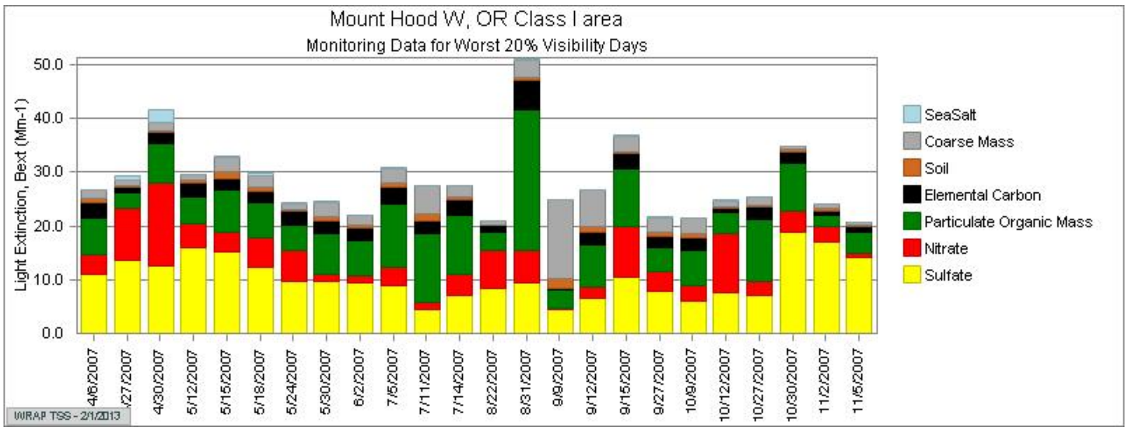
2007: 20% Worst Days

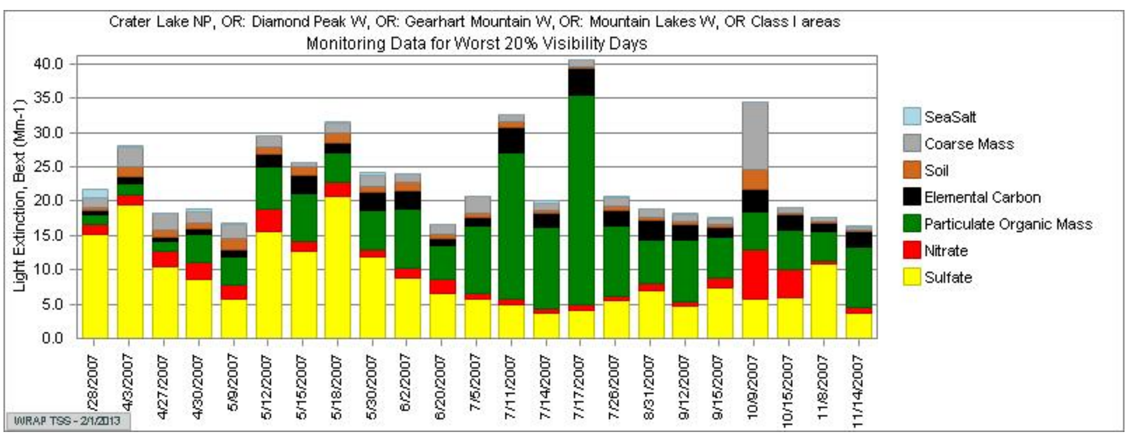




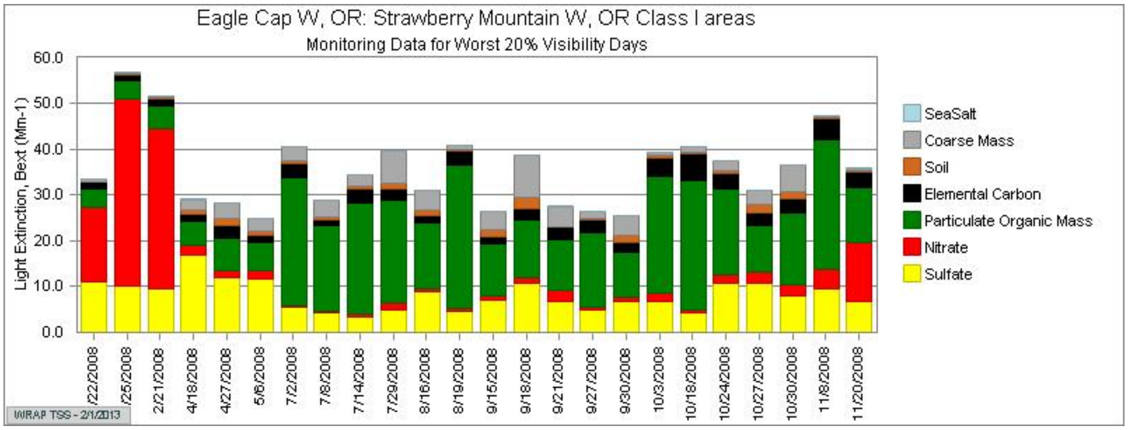


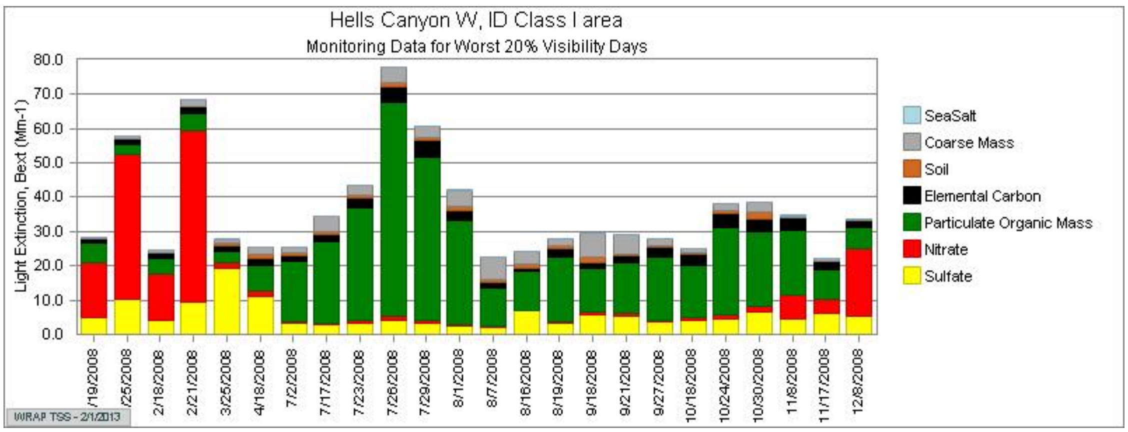

Mount Jefferson W, OR: Mount Washington W, OR: Three Sisters W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
/30/2007
4/27/2007
4/30/2007
5/12/2007
5/15/2007
5/18/2007
5/27/2007
5/30/2007
6/2/2007
6/23/2007
7/5/2007
7/11/2007
7/14/2007
7/26/2007
8/25/2007
8/31/2007
9/3/2007
9/12/2007
9/15/2007
10/12/2007
10/15/2007
10/30/2007
11/5/2007
11/8/2007
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

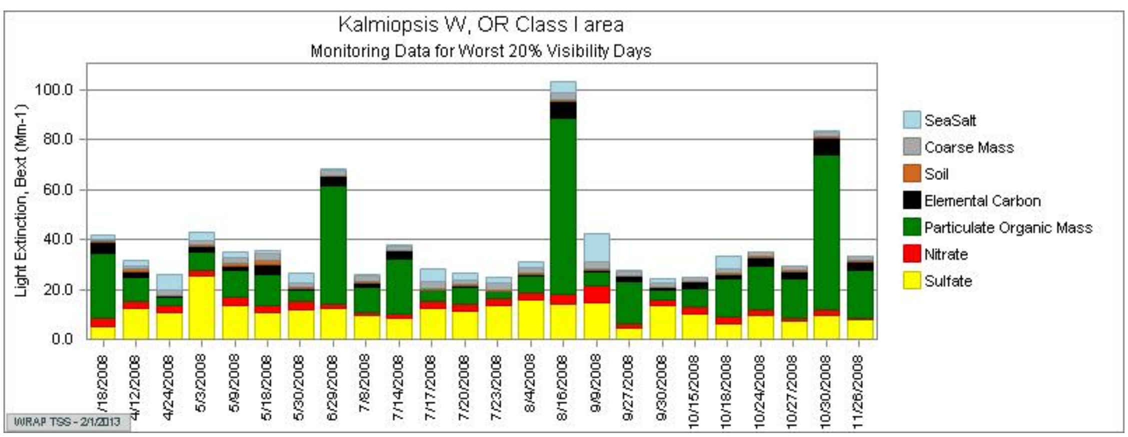

Mount Hood W, OR Class I area
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
50.0
40.0
30.0
20.0
10.0
0.0
4/6/2007
/27/2007
4/30/2007
5/12/2007
5/15/2007
5/18/2007
5/24/2007
5/30/2007
6/2/2007
7/5/2007
7/11/2007
7/14/2007
8/22/2007
8/31/2007
9/9/2007
9/12/2007
9/15/2007
9/27/2007
10/9/2007
10/12/2007
10/27/2007
10/30/2007
11/2/2007
11/5/2007
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

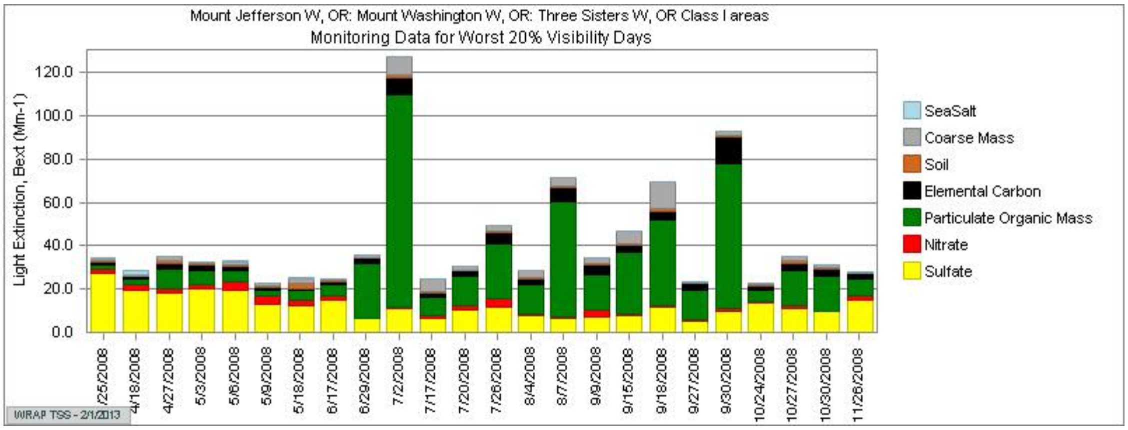

Crater Lake NP, OR: Diamond Peak W, OR: Gearhart Mountain W, OR: Mountain Lakes W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
/28/2007
4/3/2007
4/27/2007
4/30/2007
5/9/2007
5/12/2007
5/15/2007
5/18/2007
5/30/2007
6/2/2007
6/20/2007
7/5/2007
7/11/2007
7/14/2007
7/17/2007
7/26/2007
8/31/2007
9/12/2007
9/15/2007
10/9/2007
10/15/2007
11/8/2007
11/14/2007
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013

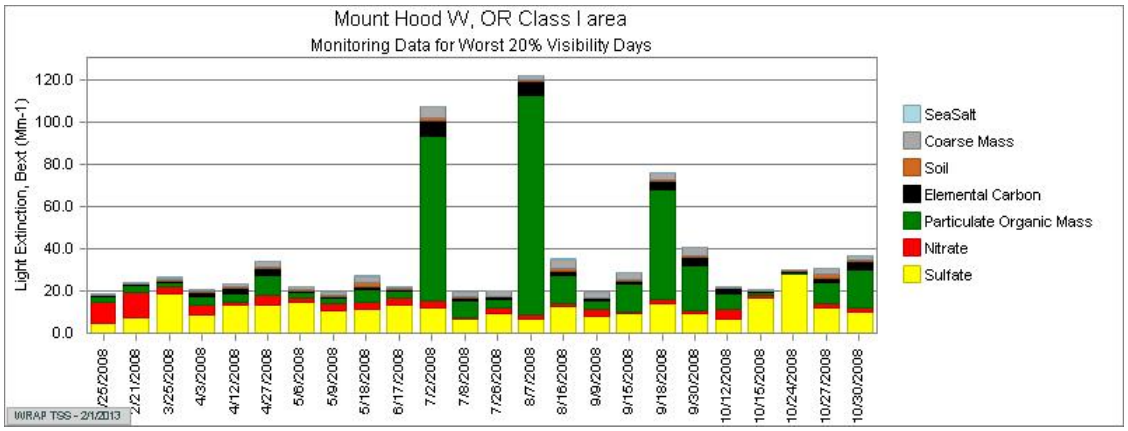
2008: 20% Worst Days

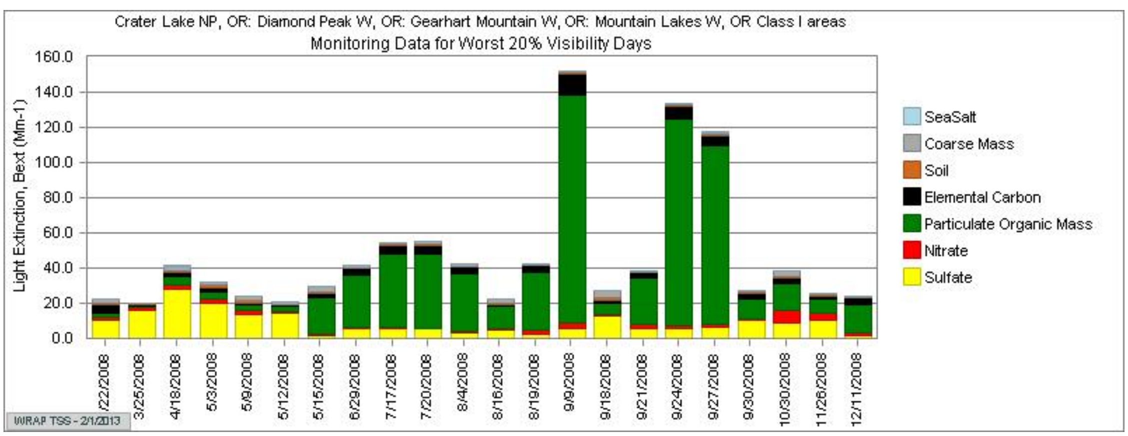




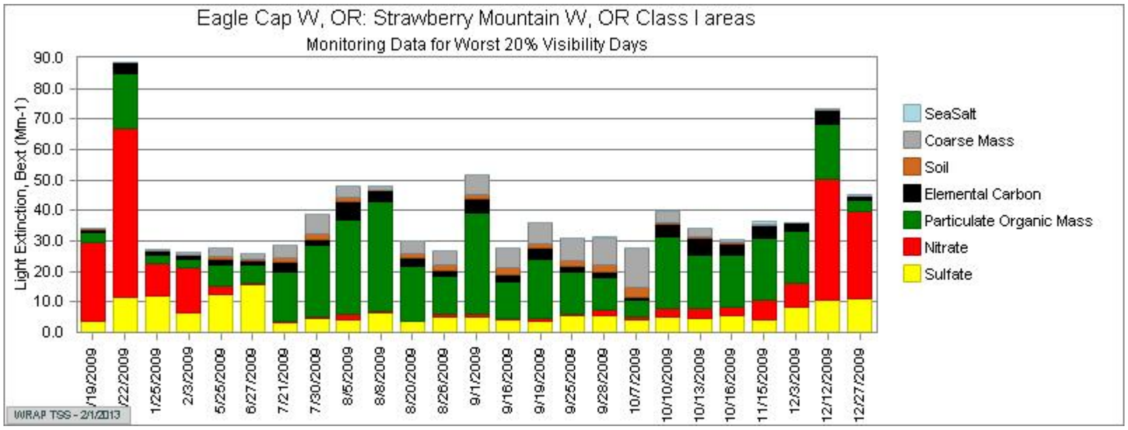


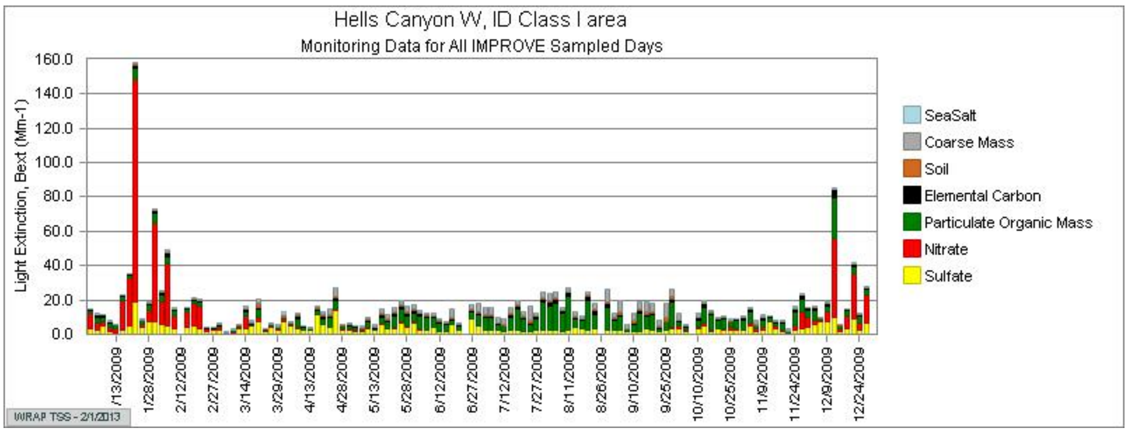


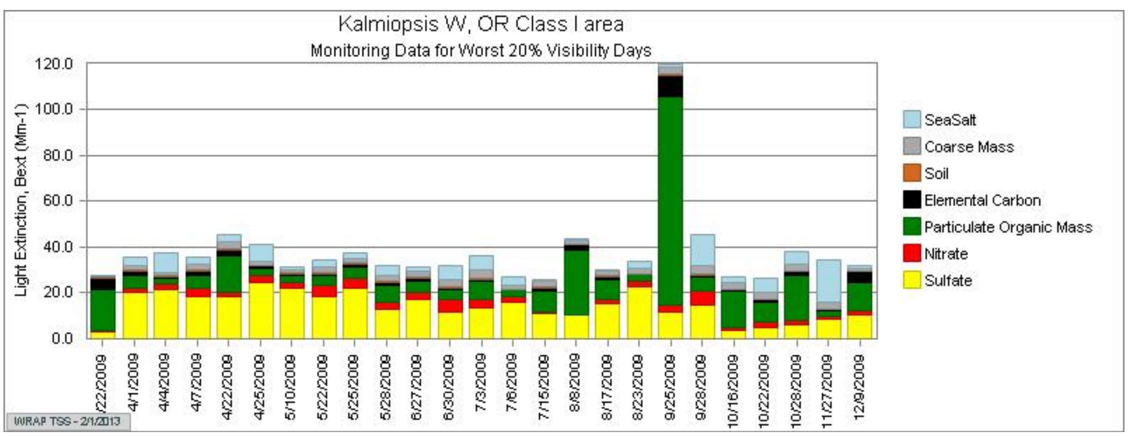


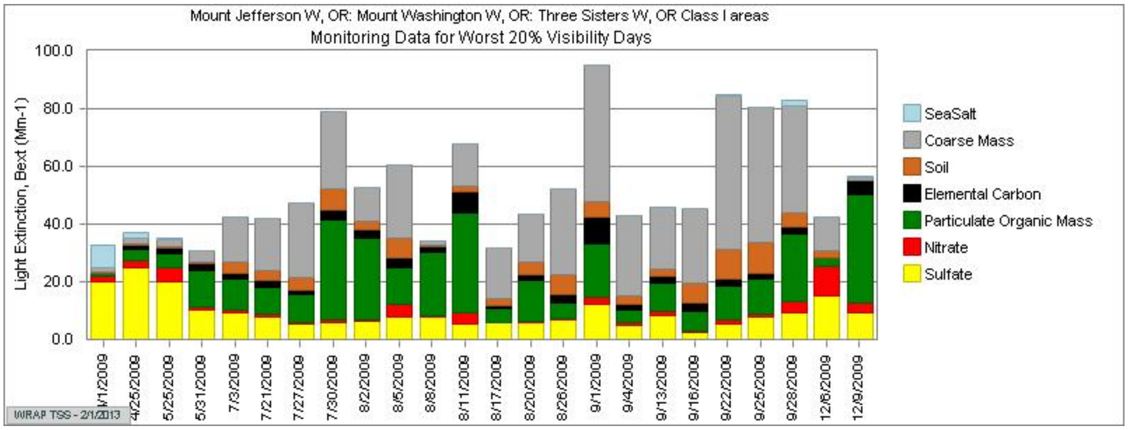


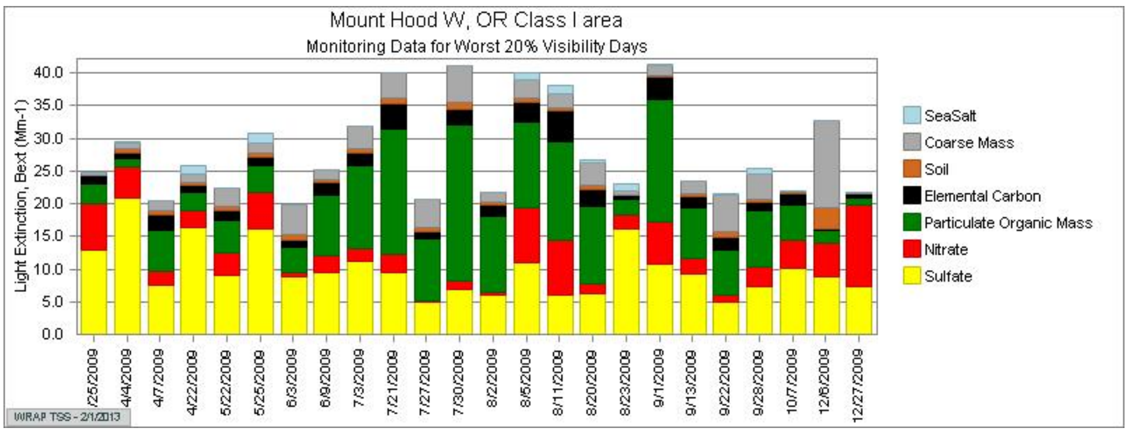
2009: 20% Worst Days

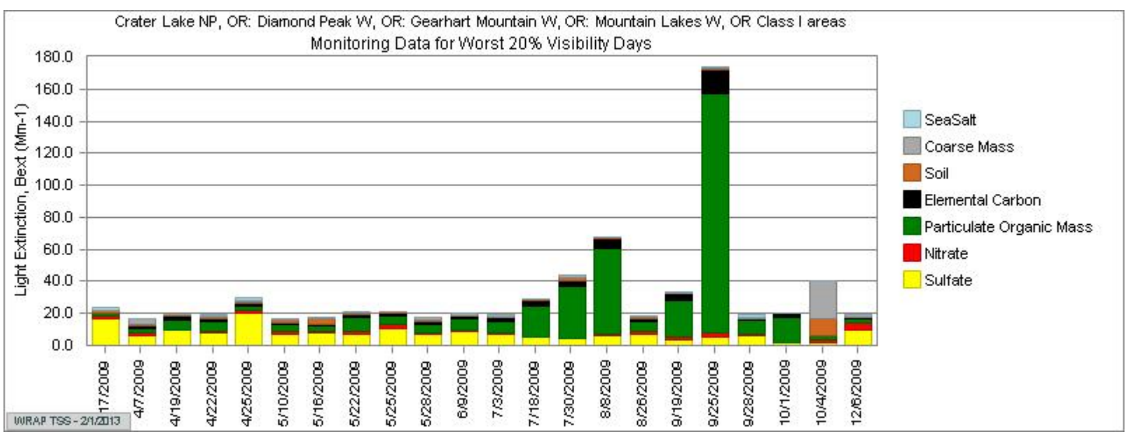

Eagle Cap W, OR: Strawberry Mountain W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
/19/2009
/22/2009
1/25/2009
2/3/2009
5/25/2009
6/27/2009
7/21/2009
7/30/2009
8/5/2009
8/8/2009
8/20/2009
8/26/2009
9/1/2009
9/16/2009
9/19/2009
9/25/2009
9/28/2009
10/7/2009
10/10/2009
10/13/2009
10/16/2009
11/15/2009
12/3/2009
12/12/2009
12/27/2009
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013


Hells Canyon W, ID Class I area
Monitoring Data for All IMPROVE Sampled Days
Light Extinction, Bext (Mm-1)
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
/13/2009
1/28/2009
2/12/2009
2/27/2009
3/14/2009
3/29/2009
4/13/2009
4/28/2009
5/13/2009
5/28/2009
6/12/2009
6/27/2009
7/12/2009
7/27/2009
8/11/2009
8/26/2009
9/10/2009
9/25/2009
10/10/2009
10/25/2009
11/9/2009
11/24/2009
12/9/2009
12/24/2009
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013


Kalmiopsis W, OR Class I area
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
120.0
100.0
80.0
60.0
40.0
20.0
0.0
/22/2009
4/1/2009
4/4/2009
4/7/2009
4/22/2009
4/25/2009
5/10/2009
5/22/2009
5/25/2009
5/28/2009
6/27/2009
6/30/2009
7/3/2009
7/6/2009
7/15/2009
8/8/2009
8/17/2009
8/23/2009
9/25/2009
9/28/2009
10/16/2009
10/22/2009
10/28/2009
11/27/2009
12/9/2009
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate
WRAP TSS - 2/1/2013


Mount Jefferson W, OR: Mount Washington W, OR: Three Sisters W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
100.0
80.0
60.0
40.0
20.0
0.0
/1/2009
4/25/2009
5/25/2009
5/31/2009
7/3/2009
7/21/2009
7/27/2009
7/30/2009
8/2/2009
8/5/2009
8/8/2009
8/11/2009
8/17/2009
8/20/2009
8/26/2009
9/1/2009
9/4/2009
9/13/2009
9/16/2009
9/22/2009
9/25/2009
9/28/2009
12/6/2009
12/9/2009
WRAP TSS - 2/1/2013
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate


Mount Hood W, OR Class I area
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
40.0
35.0
30.0
25.0
20.0
15.0
10.0
5.0
0.0
/25/2009
4/4/2009
4/7/2009
4/22/2009
5/22/2009
5/25/2009
6/3/2009
6/9/2009
7/3/2009
7/21/2009
7/27/2009
7/30/2009
8/2/2009
8/5/2009
8/11/2009
8/20/2009
8/23/2009
9/1/2009
9/13/2009
9/22/2009
9/28/2009
10/7/2009
12/6/2009
12/27/2009
WRAP TSS - 2/1/2013
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate


Crater Lake NP, OR: Diamond Peak W, OR: Gearhart Mountain W, OR: Mountain Lakes W, OR Class I areas
Monitoring Data for Worst 20% Visibility Days
Light Extinction, Bext (Mm-1)
180.0
160.0
140.0
120.0
100.0
80.0
60.0
40.0
20.0
0.0
17/2009
4/7/2009
4/19/2009
4/22/2009
4/25/2009
5/10/2009
5/16/2009
5/22/2009
5/25/2009
5/28/2009
6/9/2009
7/3/2009
7/18/2009
7/30/2009
8/8/2009
8/26/2009
9/19/2009
9/25/2009
9/28/2009
10/1/2009
10/4/2009
12/6/2009
WRAP TSS - 2/1/2013
SeaSalt
Coarse Mass
Soil
Elemental Carbon
Particulate Organic Mass
Nitrate
Sulfate

Appendix B: Review process lists for identifying potential impacts

The lists provided in this appendix show the step-by-step process described in the Evaluation Methodology on page 6 of the report. The three parts below show the refinement of the list of prescribed burns identified in this review, and the process of elimination to end up with a final list of burn units with high probability of impacting a Class I area on the 20% worst days.

DEQ Prescribed Burning Evaluation – Part 1

Date 20% WD	Class I Area(s) IMPROVE monitor	Region	Check if PB occurred on date or day before. Is further analysis needed? Describe	
2004				
3/13	Kalmiopsis	SW	X	Yes, check winds
4/9	Kalmiopsis	SW	X	Yes, check winds
4/30	Crater Lake	Central	X	Yes, check winds
5/6	3 Sisters	Central-N	X	Yes, check winds
7/8	Crater Lake	Central		No burning
7/14	Mt Hood	N	X	No, small unit 100+ miles away
7/23	Kalmiopsis	SW		No burning
7/26	Starkey	E		No burning
7/29	Kalmiopsis/Crater Lake/3 Sisters/Mt Hood/ Starkey/ HellsC	statewide		No burning
9/3	Kalmiopsis/Mt Hood	SW-N		No burning
10/3	Kalmiopsis/Starkey	SW-E	X	Yes, check winds
10/15	Kalmiopsis/Mt Hood/HellsC	SW-N-E	X	Yes, check winds
10/21	3 Sisters	Central-N	X	Yes, check winds
10/27	Mt Hood	N	X	Yes, check winds
11/11	Kalmiopsis/Crater Lake/3 Sisters/Mt Hood/Starkey	statewide	X	Yes, check winds
11/23	Kalmiopsis	SW	X	Yes, check winds
12/2	Kalmiopsis	SW	X	Yes, check winds
2005				
7/27	Kalmiopsis	SW	X	No, small unit 100+ miles away
8/5	Kalmiopsis	SW		No burning
8/8	Kalmiopsis	SW		No burning
8/11	Kalmiopsis	SW		No burning
8/26	Crater Lake	Central		No burning
9/28	Crater Lake	Central		No burning
10/19	Starkey	E	X	Yes, check winds
10/22	Crater Lake/3 Sisters/Mt Hood/Starkey	statewide	X	Yes, check winds
10/25	Kalmiopsis/ Crater Lake/3 Sisters/Mt Hood/Starkey	statewide	X	Yes, check winds
11/9	Kalmiopsis/3 Sisters	SW-central	X	Yes, check winds
11/21	Kalmiopsis/ Crater Lake	SW-central	X	Yes, check winds
11/30	Crater Lake	Central	X	Yes, check winds

2006				
2/22	Kalmiopsis	SW	X	Yes, check winds
7/22	Kalmiopsis	SW		No burning
8/27	Starkey	E		No burning
9/2	Kalmiopsis/3 Sisters/Mt Hood/ Starkey /HellsC	SW-central-E		No burning
9/5	Kalmiopsis/Crater Lake/3 Sisters/Mt Hood/ Starkey/ HellsC	statewide		No burning
9/8	Crater Lake/3 Sisters//Starkey/HellsC	statewide		No burning
9/11	Crater Lake//HellsC	Central-E	X	Yes, check winds
9/14	Crater Lake	Central	X	Yes, check winds
9/26	Kalmiopsis	SW	X	Yes, check winds
9/29	Kalmiopsis	SW	X	No, burning 100+ miles away
10/29	Kalmiopsis/3 Sisters	SW-central	X	Yes, check winds
11/1	Kalmiopsis/3 Sisters	SW-central	X	Yes, check winds
2007				
1/27	Kalmiopsis	SW	X	Yes, check winds
1/30	Kalmiopsis	SW	X	Yes, check winds
2/2	Kalmiopsis	SW	X	Yes, check winds
2/5	Kalmiopsis	SW	X	Yes, check winds
6/2	Crater Lake	Central	X	Yes, check winds
7/5	Crater Lake	Central		No burning
7/11	Crater Lake	Central		No burning
7/14	Crater Lake	Central		No burning
7/17	Crater Lake/Starkey/HellsC	Central-E		No burning
7/20	HellsC	E		No burning
7/23	HellsC	E		No burning
8/31	Mt Hood	N		No burning
9/3	3 Sisters/HellsC	Central-N-E		No burning
9/12	Crater Lake/3 Sisters/HellsC	Central-N-E	X	Yes, check winds
9/15	Mt Hood/Starkey/ HellsC	N-E	X	No, small unit 100+ miles away
10/12	3 Sisters	Central-N	X	Yes, check winds
10/15	Starkey	E	X	Yes, check winds
10/27	Kalmiopsis/Mt Hood	SW-N	X	Yes, check winds
10/30	Kalmiopsis/3 Sisters	SW-central	X	Yes, check winds
11/8	Kalmiopsis	SW	X	Yes, check winds
11/14	Crater Lake	Central	X	Yes, check winds
2008				
6/29	Kalmiopsis/Crater Lake	SW-central		No burning
7/2	3 Sisters/ Mt Hood/Starkey	Central-N-E	X	No, small unit 100+ miles away
7/8	Starkey	E	X	No, small unit 100+ miles away
7/14	Starkey	E		No burning
7/17	Crater Lake	Central	X	No, small unit 100+ miles away
7/20	Crater Lake	Central		No burning
7/26	HellsC	E		No burning
7/29	Starkey/HellsC	E		No burning
8/16	Kalmiopsis	SW	X	Yes, check winds
9/9	Crater Lake	Central	X	No, small unit 100+ miles away
9/18	3 Sisters/Mt Hood	Central-N		No burning
9/24	Crater Lake	Central	X	No, small unit 100+ miles away

9/27	Crater Lake	Central-N		No burning
9/30	3 Sisters/Mt Hood	E		No burning
10/3	Starkey	E	X	Yes, check winds
10/18	Starkey	E	X	Yes, check winds
10/24	Starkey/HellsC	SW-N-E	X	Yes, check winds
10/30	Kalmiopsis/Mt Hood/Starkey	E	X	Yes, check winds
11/8	Starkey		X	Yes, check winds
2009				
7/3	Mt Hood	N		No burning
7/21	Mt Hood	N		No burning
9/1	Mt Hood/Starkey	N-E	X	No, small unit 100+ miles away
9/13	HellsC	E		No burning
9/19	Crater Lake	Central		No burning
9/25	Kalmiopsis/Crater Lake	SW-central	X	No, five ton unit 50 miles away
9/28	HellsC	E	X	No, small unit 100+ miles away
10/10	Starkey	E	X	Yes, check winds
10/13	Starkey	E	X	Yes, check winds
10/16	Starkey	E	X	Yes, check winds
10/28	Kalmiopsis	SW	X	Yes, check winds
11/15	Starkey	E	X	Yes, check winds
12/12	HellsC	E	X	No, burning 100+ miles away

DEQ Prescribed Burning Evaluation – Part 2

Date 20% WD	Class I Area	Tons Burned/ # of units	Approx. distance to Class I area	Possibly Upwind?
2004				
3/13	Kalmiopsis	8 units/ 5750 tons	15-70 miles	Yes
4/9	Kalmiopsis	3 units/ 6628 tons	10-18 miles	Yes
4/30	Crater Lake	4 units/ 14400 tons	60 miles	Yes
5/6	3 Sisters	3 units/ 297 tons	18 miles	Yes
	Starkey	10 units/ 18247 tons	35 miles	Starkey yes/ wilderness no
10/15	Kalmiopsis	3 units/ 3681 tons	20-80 miles	Yes
	Hells C	4 units/ 6351 tons	45-95 miles	Yes
10/21	3 Sisters	46 units/ 16855 tons	10-60 miles	Yes
11/11	Kalmiopsis	13 units/6719 tons	25-85 miles	Yes
	Crater Lake	6 units/ 5540 tons	50-60 miles	Yes
	Mt. Hood	1 unit/150 tons	22 miles	Yes
11/23	Kalmiopsis	3 units/900 tons	40 miles	Yes
12/2	Kalmiopsis	13 units/ 4357 tons	20-30 miles	Yes
2005				
	3 Sisters	5 units/ 1776 tons	90 miles	Yes
	Starkey	5 units/ 1742 tons	15-35 miles	Yes – mainly Starkey
10/25	Kalmiopsis	2 units/ 1696 tons	30 miles	Yes
	Crater Lake	1 unit/ 999 tons	45 miles	Yes
	3 Sisters	2 units/ 292 tons	80 miles	Yes
	Mt Hood	19 units/ 11472 tons	65-70 miles	Yes
	Starkey	6 units/ 12284 tons	25-50 miles	Yes
11/9	Kalmiopsis	6 units/ 5547 tons	30-50 tons	Yes
	3 Sisters	9 units/ 750 tons	10-35 miles	Yes
11/21	Kalmiopsis	1 unit/ 337 tons	30 miles	Yes
	Crater Lake	2 units/ 2416 tons	60-65 miles	Yes

11/30	Crater Lake	16 units/ 8640 tons	40-80 miles	Yes
2006				
2/22	Kalmiopsis	1 unit/ 901 tons	30-35 miles	Yes
	3 Sisters	1 unit/ 270 tons	10 miles	Yes
2007				
1/30	Kalmiopsis	4 units/ 2095 tons	18-68 miles	Yes
2/2	Kalmiopsis	2 units/ 814 tons	32-68 miles	Yes
10/15	Starkey	4 units/ 5700 tons	48-60 miles	Starkey Yes/ wilderness no
10/27	Kalmiopsis	1 unit/ 3500 tons	65 miles	Yes
	Mt Hood	1 unit/ 500 tons	15 miles	Yes
10/30	Kalmiopsis	5 units/ 1386 tons	18-40 miles	Yes
	3 Sisters	11 units/ 3770 tons	72-85 miles	Yes
11/8	Kalmiopsis	5 units/ 1673 tons	15-35 miles	Yes
11/14	Crater Lake	13 units/ 3486 tons	10-50 miles	Yes
2008				
10/18	Starkey	4 units/ 2344 tons	35 miles	Starkey Yes/ wilderness no
10/24	Starkey	1 unit/ 150 tons	30 miles	Starkey Yes/ wilderness no
10/30	Kalmiopsis	3 units/ 2867 tons	15-45 miles	Yes
	Starkey	1 unit/ 1200 tons	48 miles	Starkey Yes/ wilderness no
2009				
10/10	Starkey	1 unit/ 750 tons	20 miles	Yes
10/13	Starkey	4 units/ 3265 tons	24-28 miles	Yes
10/28	Kalmiopsis	9 units/ 3214 tons	15-25 miles	Yes
11/15	Starkey	2 units/ 4200 tons	45 miles	Yes

DEQ Prescribed Burning Evaluation – Part 3

Class I Impacts (Verified)-2004

Date Burned	Ign Time	Class I Area	Unit Location	Unit Tons	Elevation	Unit Dir	Class I Dist	Wind Dir	Comments
4/29	1100	Crater Lake	37S 14E 34	7200	5300	SE	65	E-SE	Yes, same unit burned 4/30 wind SW-NW
4/29	1030	Crater Lake	33S 14E 13	7000	5400	ESE	55	E-SE	Yes, same unit burned 4/30 wind SW-NW
10/2	1200-1500	Starkey	12S 35.5E	18247	4700-5200	SE	35	NW-S	Yes, 10 units within 3 miles of each other
									Wind turned S overnight 2nd/3rd.
10/14	1200	Hells Canyon	5N 42E 11	450	3200	NNW	68	LV	No, unit too small
10/14	1200	Hells Canyon	2S 36E 17	2601	4100	WNW	78	LV	No, unfavorable wind dir - mostly NNE
10/15	800	Hells Canyon	2N 42E 2	3300	3900	NNW	55	NNW-N	Yes
10/15	1300	Hells Canyon	2N 45E 21	750	4400	NNW	42	NNW-N	Yes? Unit maybe too small
10/21	945	3 Sisters	16S 1E 32	900	2300	WSW	45	WSW-WNW	Yes? Unit maybe too small
10/21	800	3 Sisters	14S 1E 3	949	1100	WNW	45	WSW-WNW	Yes? Unit maybe too small
10/21	900	3 Sisters	13S 1W 5	2446	800	WNW	54	WSW-WNW	Yes
10/21	930	3 Sisters	13S 2W 9	2339	1000	WNW	45	WSW-WNW	Yes
10/21	1400	3 Sisters	13S 2W 9	1581	1100	WNW	55	WSW-WNW	Yes
10/21	1300	3 Sisters	14S 1E 9	2343	250	WNW	45	WSW-WNW	Yes
10/21	multiple	3 Sisters	multiple	various	various	WSW-WNW	various	WSW-WNW	No, numerous units too small
11/10	830	Kalmiopsis	36S 9W 19	3119	4000	SE	22	E-SE	Yes
11/10	830	Kalmiopsis	36S 10W 23	853	3200	SE	22	E-SE	Yes
11/10	multiple	Kalmiopsis	multiple	various	various	E-ENE	75+	E-SE	No, units too small
11/10	800	Crater Lake	33S 14e 26	976	5300	ESE	58	E-SE	No, unit likely too small
11/11	1400	Crater Lake	35S 14E 14	988	5200	ESE	60	E-SE	No, unit likely too small
11/11	800	Crater Lake	35S 15E 19	2180	5600	ESE	63	E-SE	Yes
11/10 & 11	multiple	Crater Lake	multiple	various	various	ESE	55+	E-SE	No, units too small
11/23	1330	Kalmiopsis	27S 13W 6	900	200	NNW	40	NW-NNW	Yes? 3 units, units maybe too small
12/1 & 2	multiple	Kalmiopsis	multiple	2585	various	NE	15-25	NE-ENE	Yes, 5 units likely, 8 units too small

Class I Impacts (Verified) - 2005

Date Burned	Ign Time	Class I Area	Unit Location	Unit Tons	Elevation	Unit Dir	Class I Dist	Wind Dir	Comments
10/25	1200	3 Sisters	26S 1E 22 &26	292	2200	SSW	80-85	S-SSW	No, 2 units too small
10/25	1000	Mt Hood	14S 1E 27	1476	2300	SSW	80	S-SSW	Yes? Unit maybe too small
10/25	1000	Mt Hood	12S 3E 25	2101	1650	SSW	65	S-SSW	Yes
10/25	1000	Mt Hood	14S 1E 23	2894	1700	SSW	80	S-SSW	Yes
10/25	multiple	Mt Hood	multiple	various	various	SSW	60+	S-SSW	No, numerous units too small
10/24	1000	Starkey	11S 35.5E 35	2080	4800	S	30	SE-S	Yes
10/25	1145	Starkey	18S 32E 26	2400	5300	SSW	75	S-W	Yes
10/24 & 25	multiple	Starkey	multiple	various	various	S-SSW	30-75	SE-W	No, units too small or unfavorable wind
11/8	1000	Kalmiopsis	36S 7W 30	556	2700	ESE	30	ESE-SE	Yes? Unit maybe too small
11/8	900	Kalmiopsis	40S 7W 21	2063	3000	SSE	50	ESE-SE	Yes? Wind direction somewhat unfavorable
11/9	1200	Kalmiopsis	40S 7W 21	1969	3500	SSE	50	ESE-SE	Yes? Wind direction somewhat unfavorable
11/8	900	3 Sisters	14S 9E 16	269	3400	NE	12	E-SE	No, 5 units, wind direction unfavorable
11/9	1200	3 Sisters	19S 10E 31	481	4400	SSE	28	NE	No, 4 units, wind direction unfavorable
11/21	1300	Crater Lake	37S 13E 12	1200	5000	SE	60	ESE-SSE	Yes? Unit maybe too small
11/21	900	Crater Lake	35S 14E 10	1216	5200	ESE	58	ESE-SSE	Yes? Unit maybe too small
11/29	900	Crater Lake	33S 4W 32	3700	2600	WSW	57	WSW-W	Yes
11/29	800	Crater Lake	35S 5W 20	1374	1800	WSW	66	WSW-W	Yes? Unit maybe too small
11/30	1300	Crater Lake	38S 7W 28	1464	4800	S	44	SSE-S	Yes
11/29	multiple	Crater Lake	multiple	various	various	WSW	40+	WSW-W	No, units too small

Class I Impacts (Verified) - 2006

Date Burned	Ign Time	Class I Area	Unit Location	Unit Tons	Elevation	Unit Dir	Class I Dist	Wind Dir	Comments
2/22	1100	Kalmiopsis	29S 14W 10	901	250	NW	30	SW-N	Yes

Class I Impacts (Verified) - 2007

Date Burned	Ign Time	Class I Area	Unit Location	Unit Tons	Elevation	Unit Dir	Class I Dist	Wind Dir	Comments
1/30	1000	Kalmiopsis	29S 12W 12	840	14	N	25	LV/E-SE	No, unfavorable wind direction
1/30	1230	Kalmiopsis	31S 10W 6	840	2160	N	14	LV/E-SE	No, unfavorable wind direction
1/30	1100	Kalmiopsis	40S 13W 2 & 16	1075	500	SSW	42	LV/E-SE	No, 2 units unfavorable wind direction
10/15	1130	Starkey	16S 35E 24	5140	5300	SSW	58	SSE-S	Yes, 2 units
10/27	1000	Kalmiopsis	40S 3W 28	3500	1500	SE	65	SE	Yes
10/27	1100	Mt Hood	5S 11E 17	500	3000	SE	15	SE-S	Yes
10/29	800-1400	3 Sisters	3S 5W 1	2212	1800	NNW	75	NNE-NNW	Yes, 6 units
10/29	multiple	3 Sisters	multiple	various	various	NNW	75+	NNE-NNW	No, 5 units too small
10/30	1300	Kalmiopsis	31S 12W 25	312	1000	NNW	12	LV	Yes? Possible but very light wind
10/30	1010	Kalmiopsis	29S 7W 31	315	1900	NE	29	LV	No, unit too small
10/30	1010	Kalmiopsis	30S 8W 7	380	1900	NE	18	LV	Yes? Possible but very light wind
10/30	1010	Kalmiopsis	30S 9W 13	220	1500	NE	20	LV	No, unit too small
11/7	1100	Kalmiopsis	32S 8W 7	330	3000	ENE	14	LV/NE-ESE	Yes? Possible but wind quite variable
11/7	1300	Kalmiopsis	29S 9W 3	159	2700	NNE	25	LV/NE-ESE	No, 2 units too small
11/7	1215	Kalmiopsis	27S 12W 23	1080	400	N	36	LV/NE-ESE	No, unfavorable wind direction
11/7	1230	Kalmiopsis	31S 12W 25	104	1000	NNW	12	LV/NE-ESE	No, unit too small

Class I Impacts (Verified) - 2008

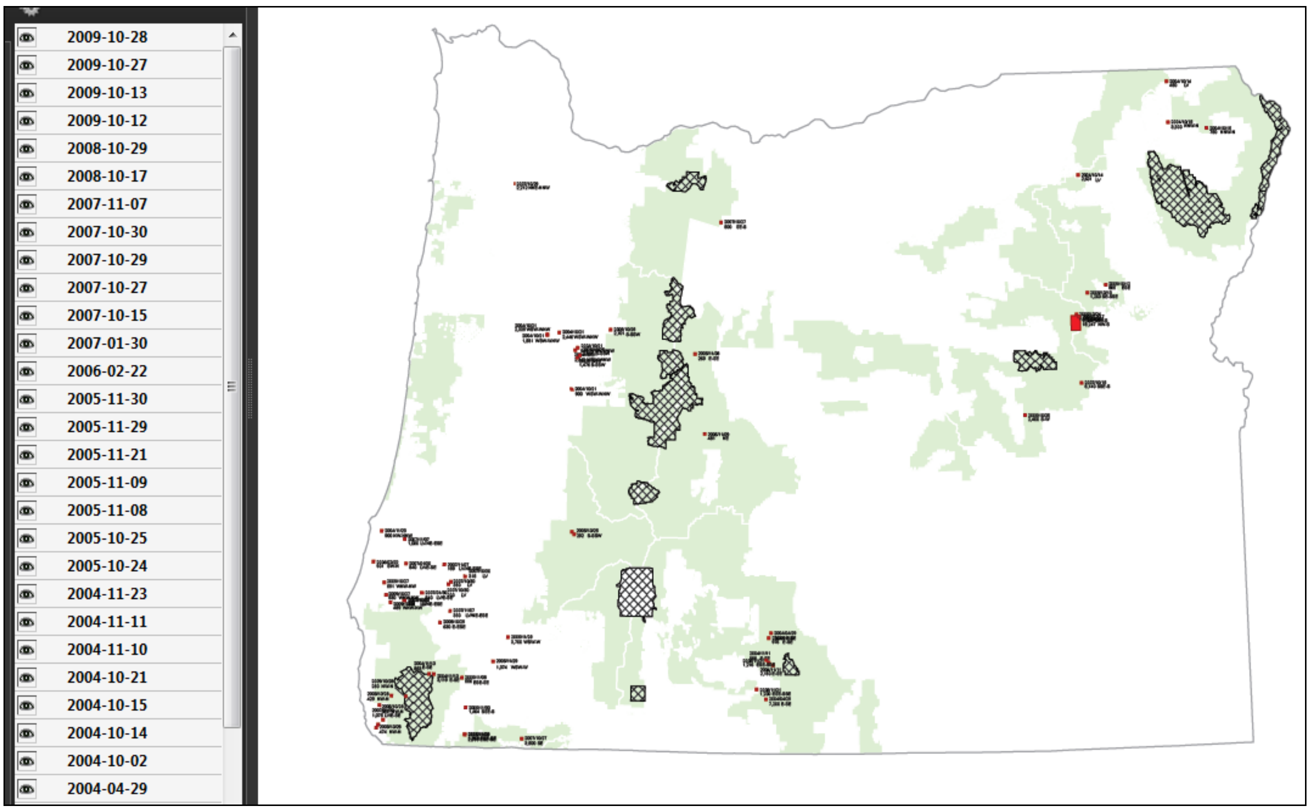
Date Burned	Ign Time	Class I Area	Unit Location	Unit Tons	Elevation	Unit Dir	Class I Dist	Wind Dir	Comments
10/17	1200	Starkey	12S 35.5E 1	2344	4700	S	35	SSE-S	Yes, 4 units
10/29	1000	Kalmiopsis	33S 9W 4	630	3200	E	11	E-ESE	Yes, 2 units

Class I Impacts (Verified) - 2009

Date Burned	Ign Time	Class I Area	Unit Location	Unit Tons	Elevation	Unit Dir	Class I Dist	Wind Dir	Comments
10/12	1200	Starkey	9S 37E 36	885	4500	SE	26	ESE	Yes, 2 units
10/13	1100	Starkey	10S 36E 15	1200	4000	SSE	25	SE-SSE	Yes
10/27	800	Kalmiopsis	30S 13W 21	591	1600	NW	20	WNW-NW	Yes
10/27	730	Kalmiopsis	31S 13W 36	489	720	NW	12	WNW-NW	Yes
10/27	1200	Kalmiopsis	31S 13W 15	530	880	NW	18	WNW-NW	Yes
10/28	1445	Kalmiopsis	30S 13W 12	429	800	NNW	22	NW-N	Yes? Unit maybe too small
10/28	1030	Kalmiopsis	30S 12W 12	280	1500	NNW	18	NW-N	No, unit too small
10/28	1000	Kalmiopsis	30S 13W 31	339	1380	NW	22	NW-N	No, unit too small
10/28	930	Kalmiopsis	32S 14W 13	474	1400	W	15	NW-N	No, 2 units, unfavorable wind direction

Appendix C: Map showing prescribed burn unit locations

Below is a copy of the interactive map showing all the burn units listed above in the six tables in Part 3. The base layers are Class I area boundaries and national forest lands. To see individual burn units requires selecting one day from the column on the left. Information on the map would then show the location, date of burn, size of the burn in tons, and direction from the nearest Class I area. See Figure 2 on page 6 of the attached report for an example. An interactive version of this map is available upon request.



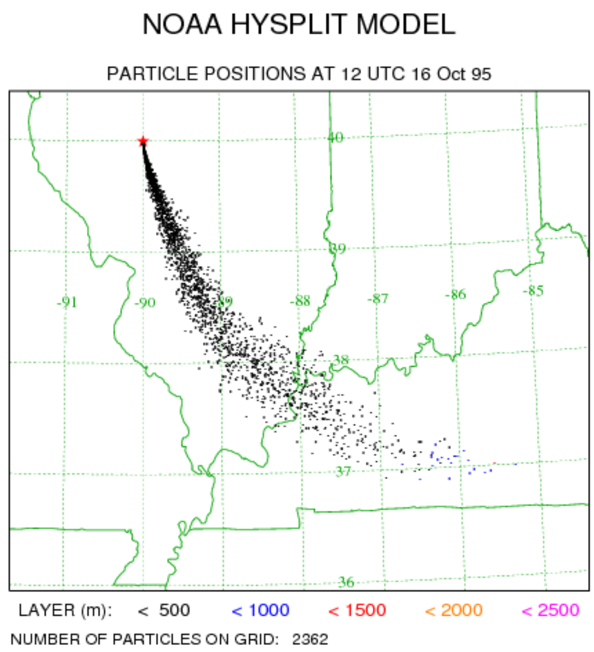
Appendix D: Background Information on HYSPLIT modeling

From the Air Resources Laboratory website:
http://www.arl.noaa.gov/documents/Summaries/Dispersion_HYSPLIT.pdf

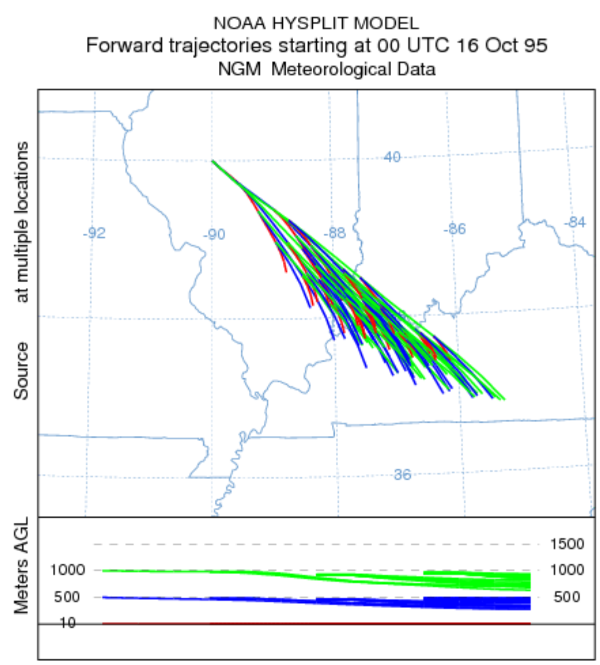
A Complete Modeling System for Simulating Dispersion of Harmful Atmospheric Material

The HYSPLIT model is a complete system for computing both simple air parcel trajectories and complex dispersion and deposition simulations. The model calculation method is a hybrid between the Lagrangian approach, which uses a moving frame of reference for the advection and diffusion calculations as the air parcels move from their initial location, and the Eulerian approach, which uses a fixed three-dimensional grid as a frame of reference to compute the pollutant air concentrations. The model uses existing meteorological forecast fields from regional or global models to compute the advection, stability and subsequent dispersion. An optional graphical user interface is available as well as various modules for chemical transformations. HYSPLIT can be run interactively on ARL's READY (Real-time Environmental Applications and Display sYstem) web site, or it can be installed and run locally on an individual Windows or Apple computer.

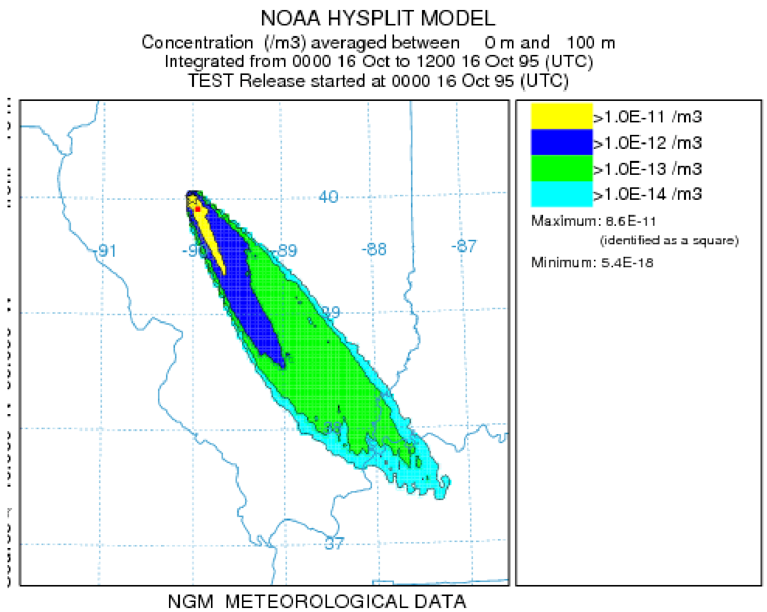
Particle Display



Trajectory Display



Air Concentration Display



Through a joint effort between NOAA and Australia's Bureau of Meteorology, the model uses advection algorithms, updated stability and dispersion equations, a graphical user interface, and the option to include modules for chemical transformations. HYSPLIT can be run interactively on ARL's READY (Real-time Environmental Applications and Display sYstem) web site, or it can be installed on a PC and run using a graphical user interface.

What It Is Used For

The model is designed to support a wide range of simulations related to the atmospheric transport and dispersion of pollutants and hazardous materials, as well as the deposition of these materials (such as mercury) to the Earth's surface. Some of the applications include tracking and forecasting the release of radioactive material, volcanic ash, wildfire smoke, and pollutants from various stationary and mobile emission sources. Operationally, the model is used by NOAA's National Weather Service through the National Centers for Environmental Prediction and at local Weather Forecast Offices.

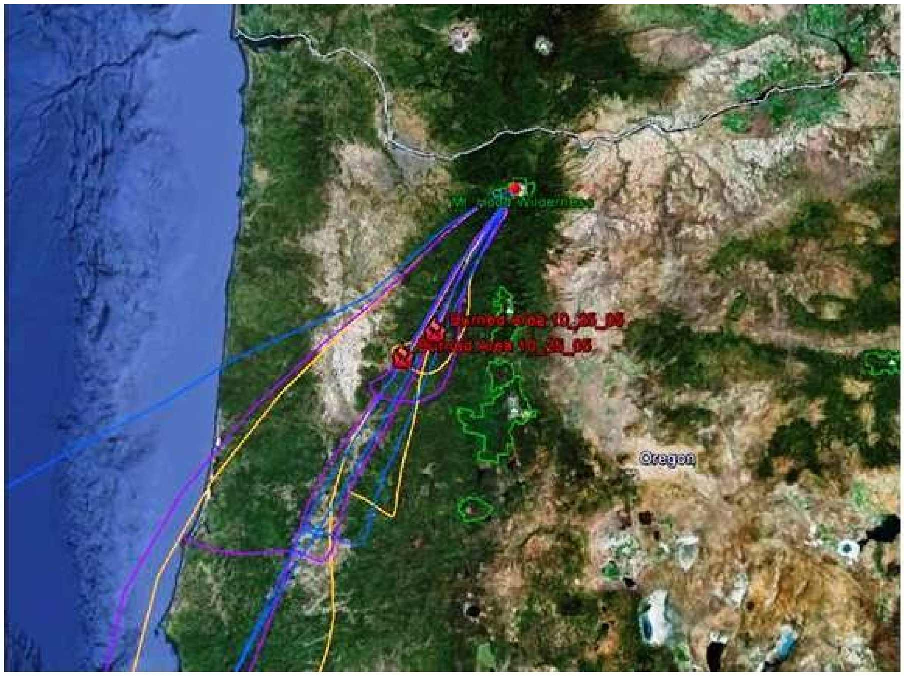
The **Air Resources Laboratory** (ARL) conducts research and development in the fields of air quality, atmospheric dispersion, climate, and boundary layer science. Key activities include the development, evaluation, and application of air quality models; improvement of approaches for predicting atmospheric dispersion of hazardous materials; and the generation of new insights into air-surface exchange and climate variability and trends.

Appendix E: HYSPLIT modeling runs – all days

The methodology used for the modeling is described on page 8 (paragraph #5) of the report. For this evaluation, trajectory modeling was favored over dispersion modeling. Both HYSPLIT back and forward trajectory modeling results are shown below. To factor in plume rise and transport, three different elevations of 250, 500, and 1000 meters above ground level were selected, and run over six-hour time periods, starting with the burn ignition time.

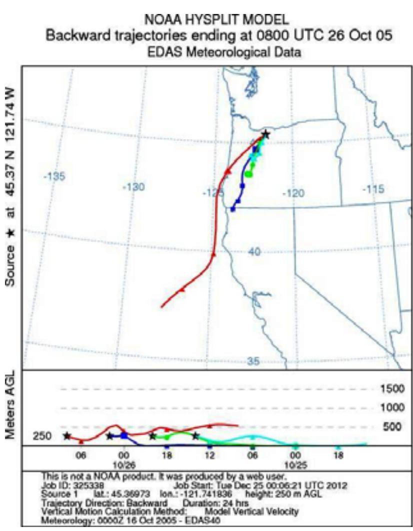
The following are listed by the Class I area that was modeled (see next page).

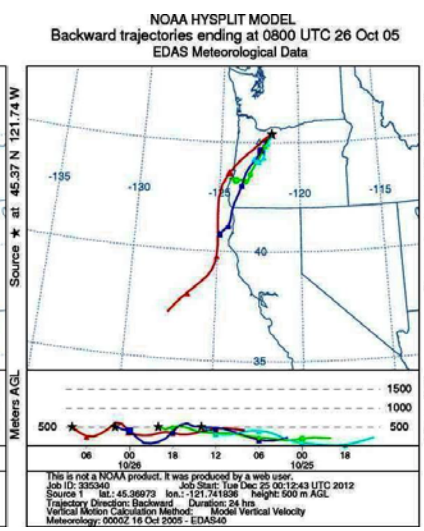
1. Mt Hood

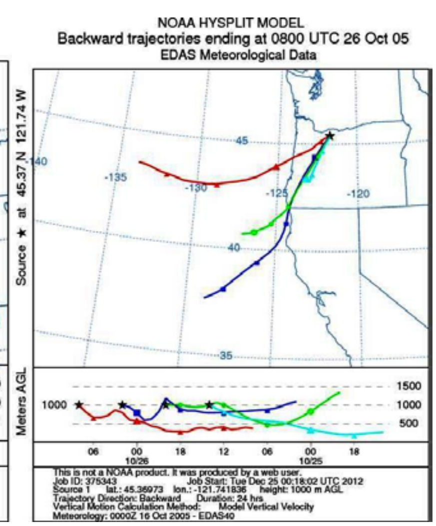


Mt. Hood: Smoke Impact on October 25, 2005

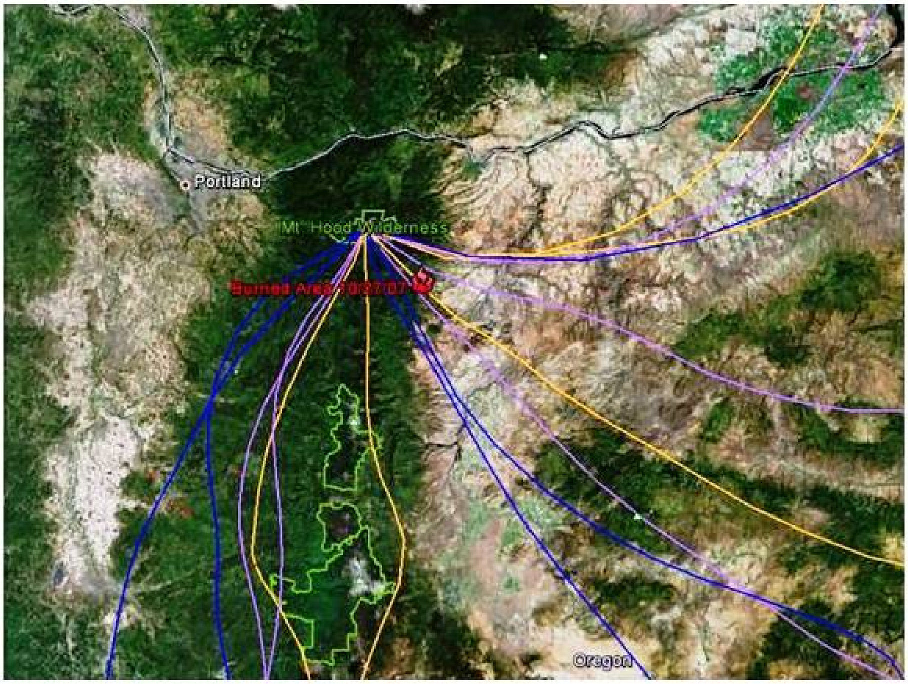
Hysplit trajectories at 3 different elevations:
250m – orange
500m – purple
1000m – blue
Hysplit back trajectory run started at midnight on October 26, 2005 (8:00 UTC). The model run for 24 hours. New trajectory starts every 6 hours, total of 4 trajectories for each level. The results suggest that smoke from the burned areas impacted Mt. Hood Wilderness area.
Following three slides show Hysplit output for three different elevation levels.







1. Mt Hood (cont)



Mt. Hood: Smoke Impact on October 27, 2007

Hysplit trajectories at 3 different elevations:

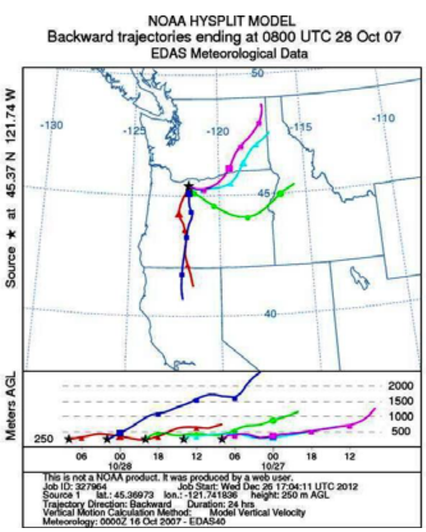
250m – orange

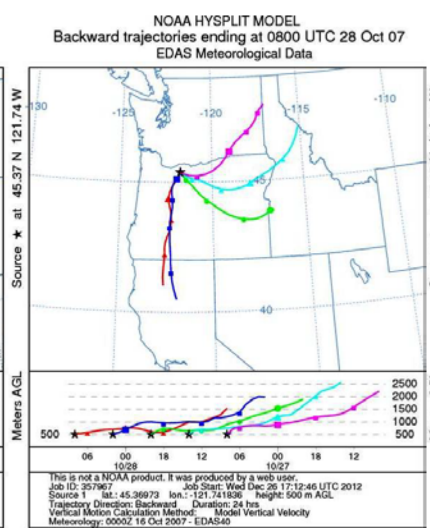
500m – purple

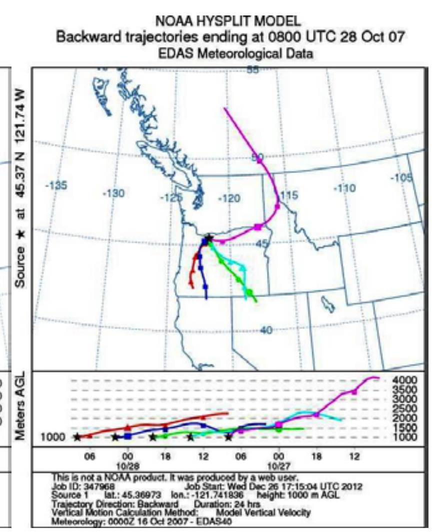
1000m – blue

Hysplit back trajectory run started at midnight on October 27, 20057(8:00 UTC). The model run for 24 hours. New trajectory starts every 6 hours, total of 5 trajectories for each level. The results suggest that smoke from the burned area impacted Mt. Hood Wilderness.

Following three slides show Hysplit output for three different elevation levels.

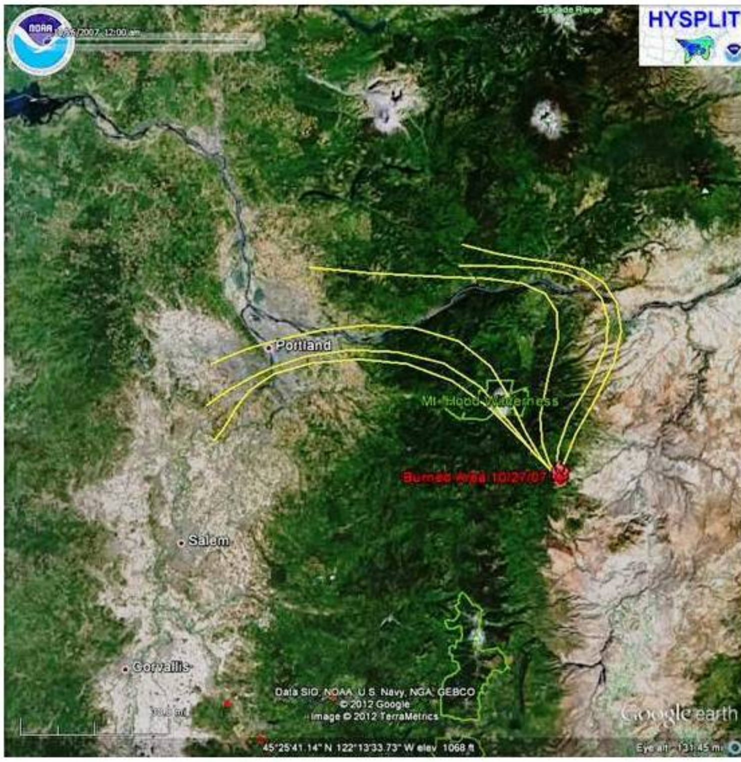


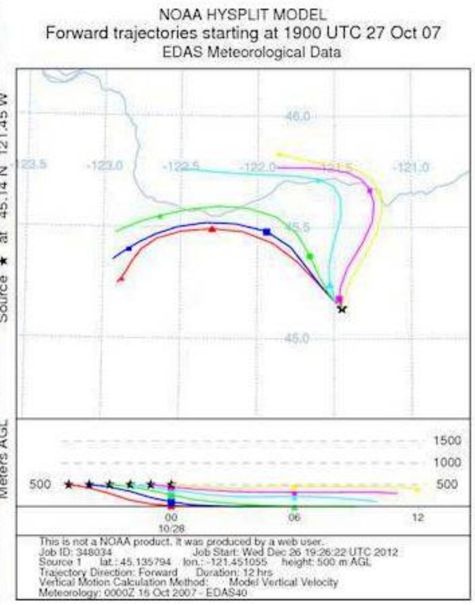




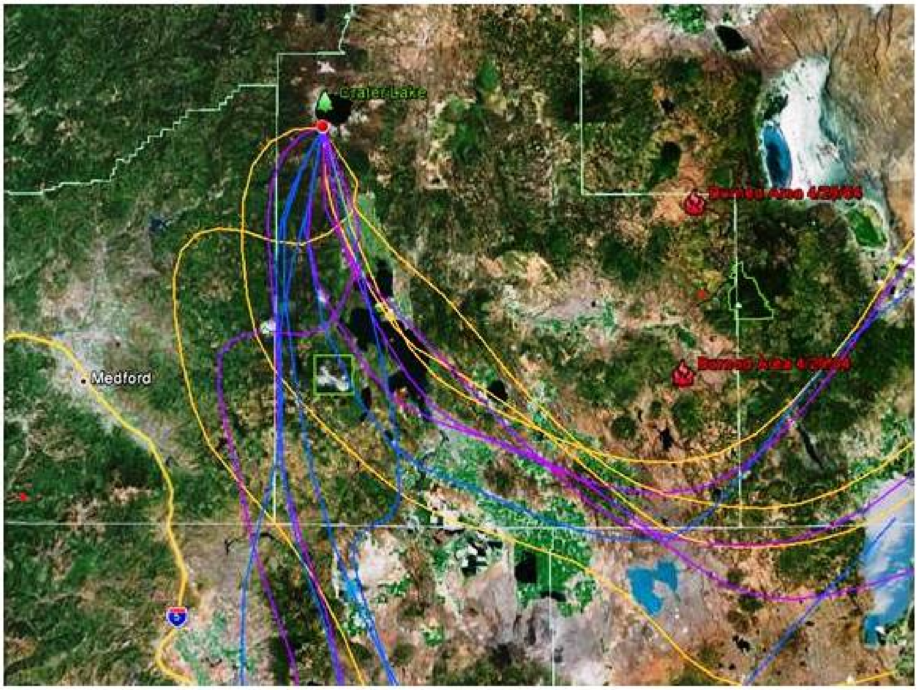
1. Mt Hood (cont)

Mt. Hood: Smoke Impact on October 27, 2007
Forward trajectory from the burned area





2. Crater Lake

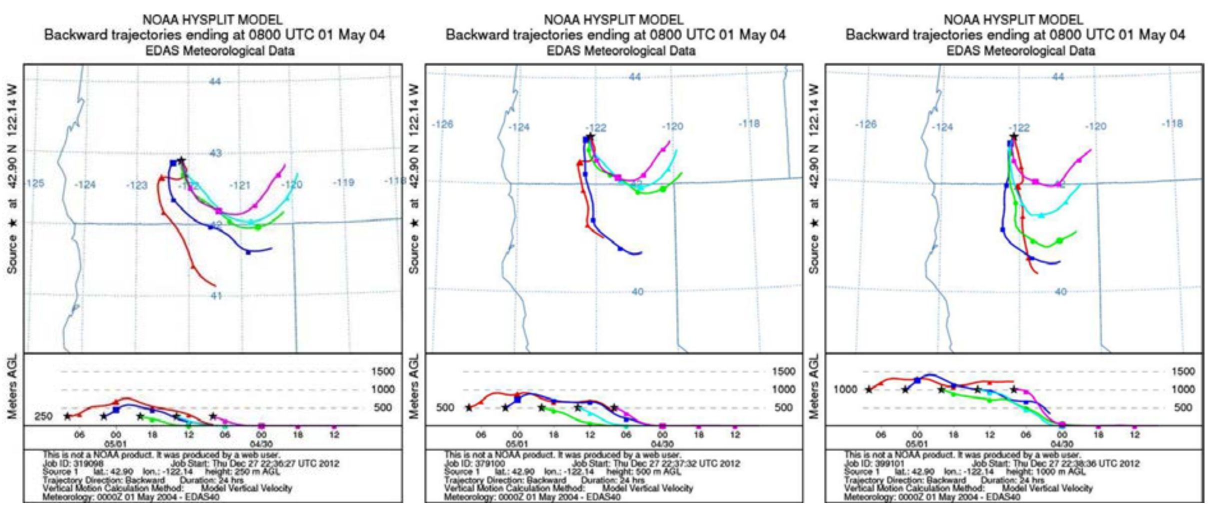


Crater Lake: April 30, 2004

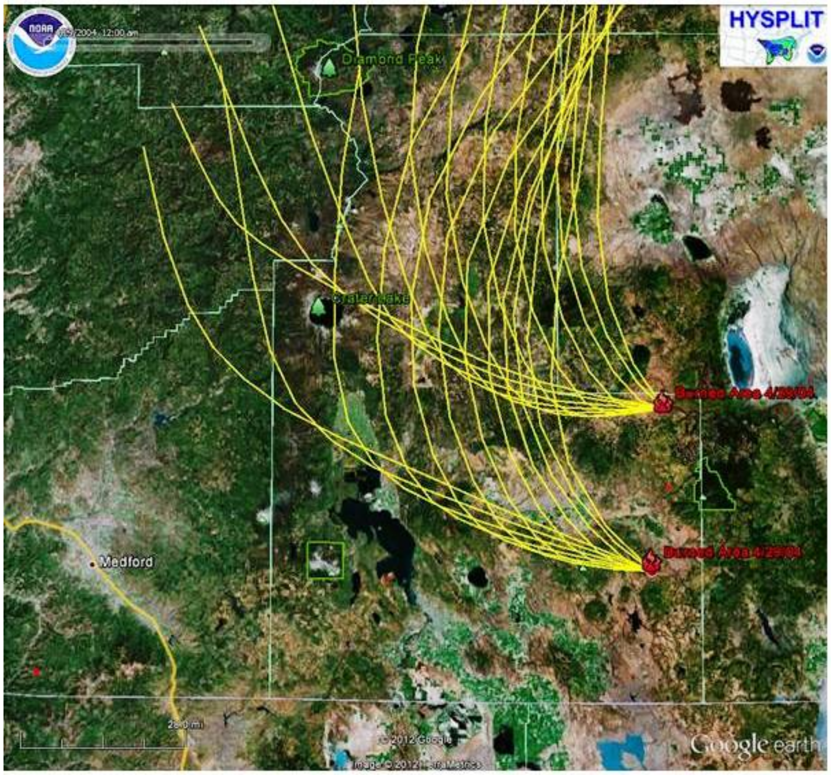
Hysplit trajectories at 3 different elevations:
250m – orange
500m – purple
1000m – blue

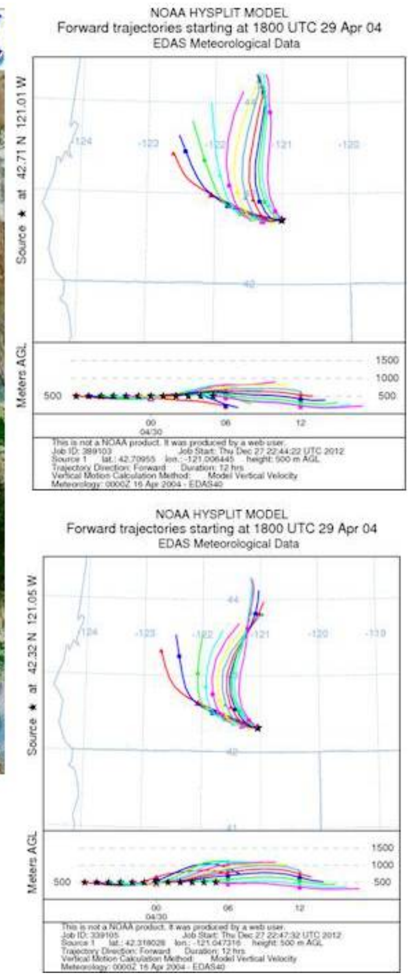
Hysplit back trajectory run sis for April 30, 2004, day after the burn. Forward trajectories on the day of the burn show that there was an impact at Crater Lake.

Following three slides show Hysplit output for three different elevation levels.



2. Crater Lake (cont)





Day of the burn 4/29/04 forward trajectories indicate likely impact at Crater Lake.

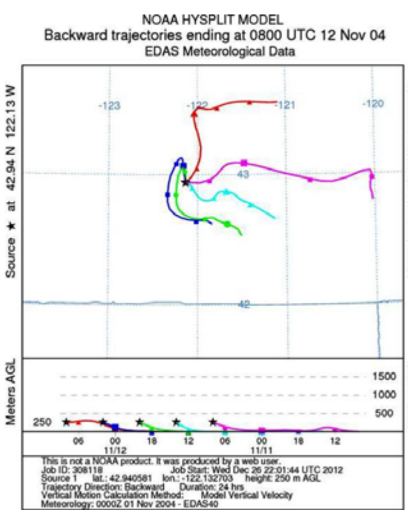
2. Crater Lake (cont)

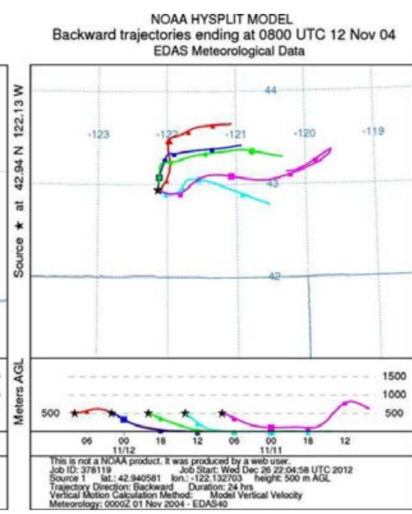
Crater Lake: Smoke Impact on November 11, 2004

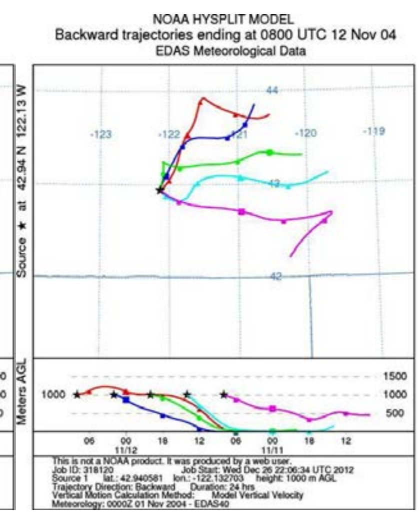
Hysplit trajectories at 3 different elevations:
250m – orange
500m – purple
1000m – blue

Hysplit back trajectory run started at midnight on November 11, 2004. The model run for 24 hours . New trajectory starts every 6 hours, total of 5 trajectories for each level. The results don't suggest impact from this fire at Crater Lake.

Following three slides show Hysplit output for three different elevation levels.

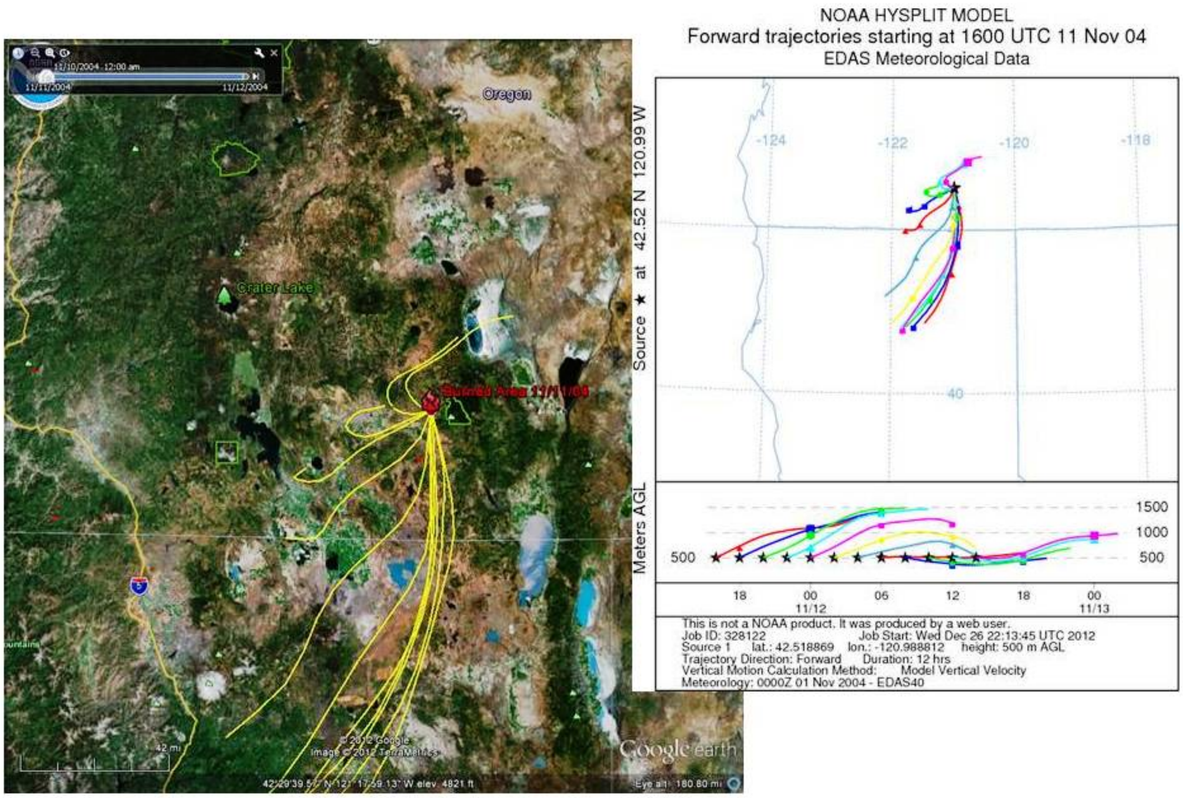




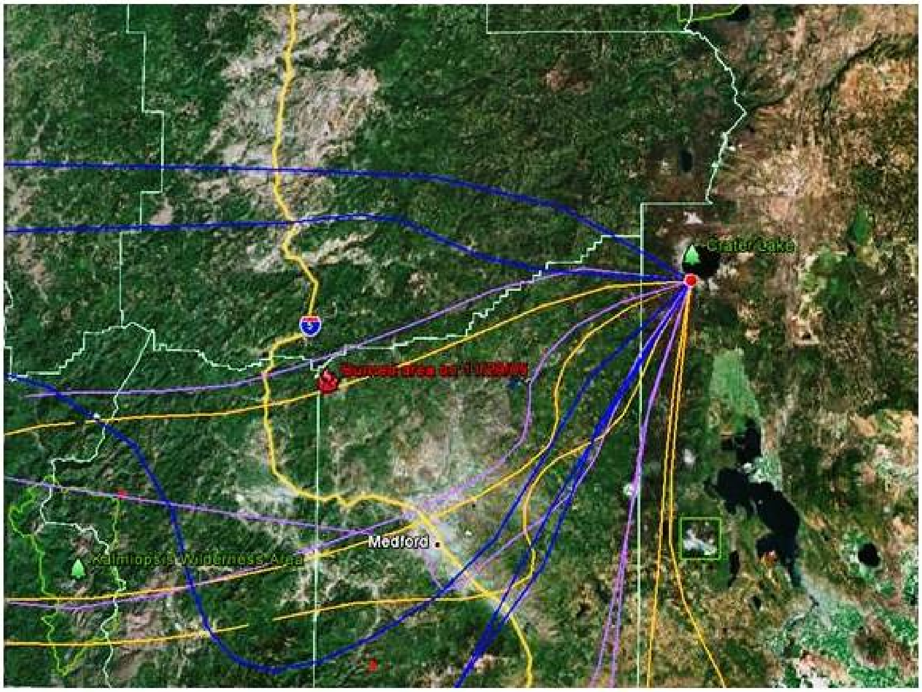


2. Crater Lake (cont)

November 11, 2004: Forward trajectories from the burned unit. Not likely to impact Crater Lake.



2. Crater Lake (cont)



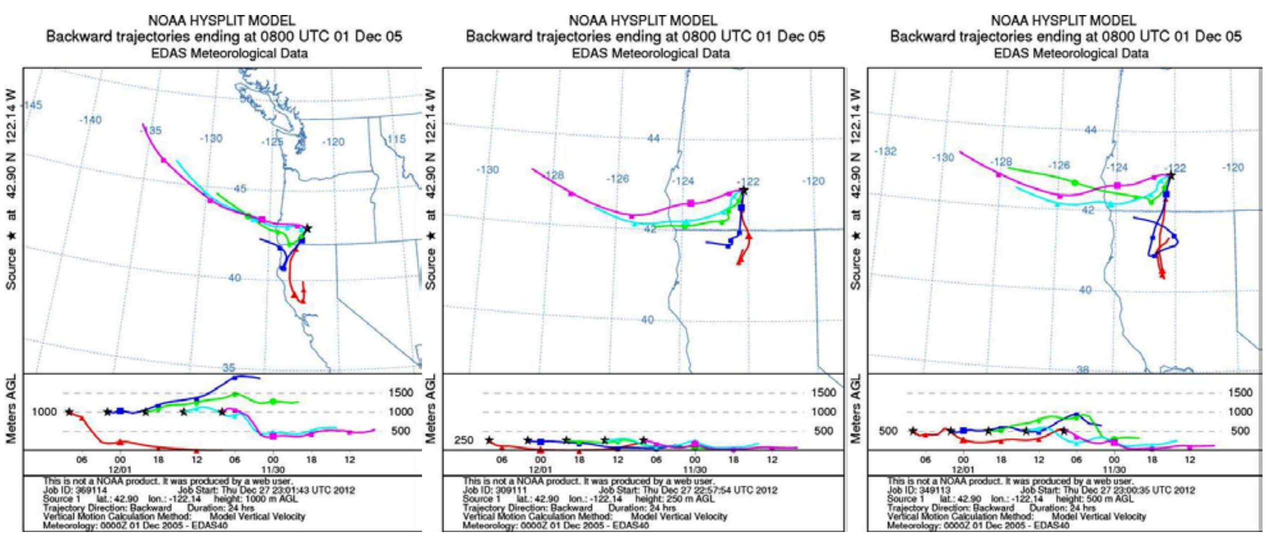
Crater Lake: November 30, 2005

Hysplit trajectories at 3 different elevations:

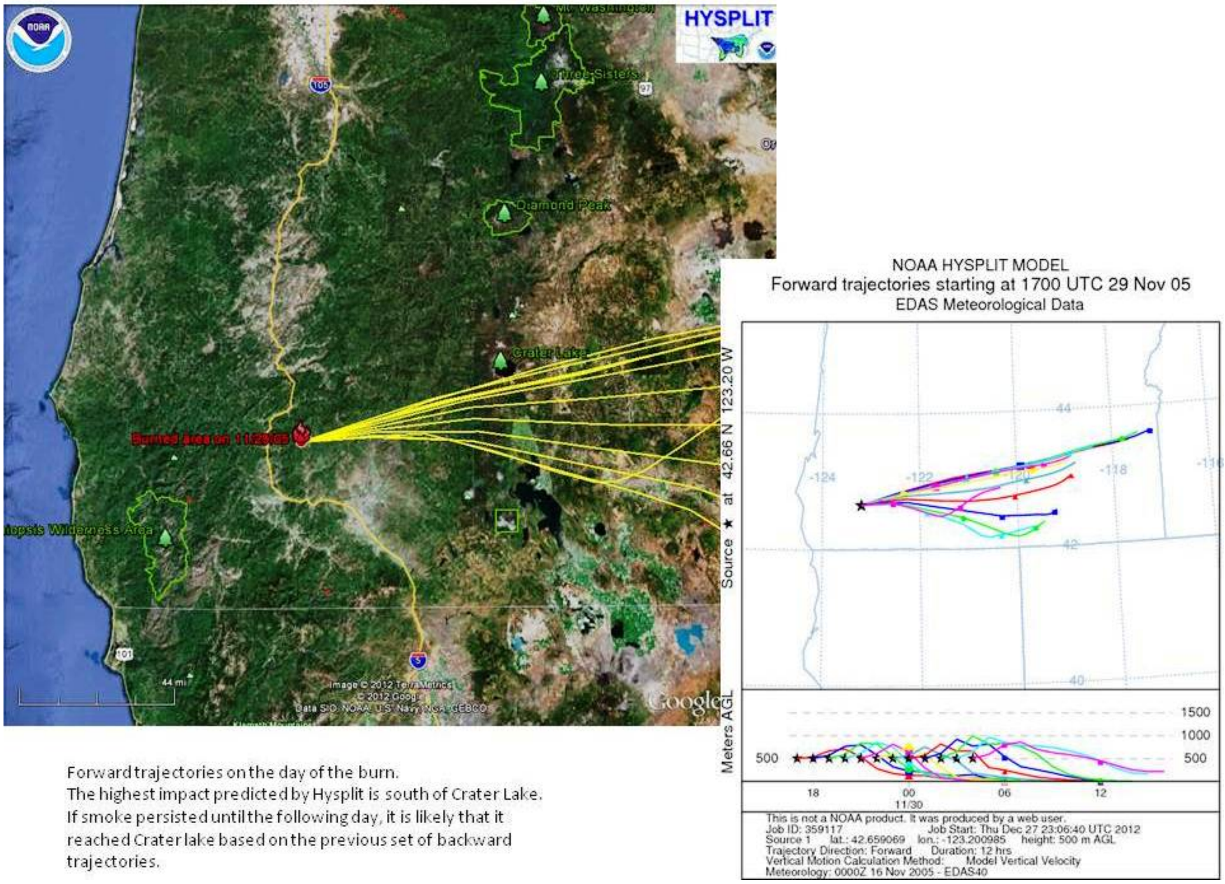
250m – orange

500m – purple

1000m – blue

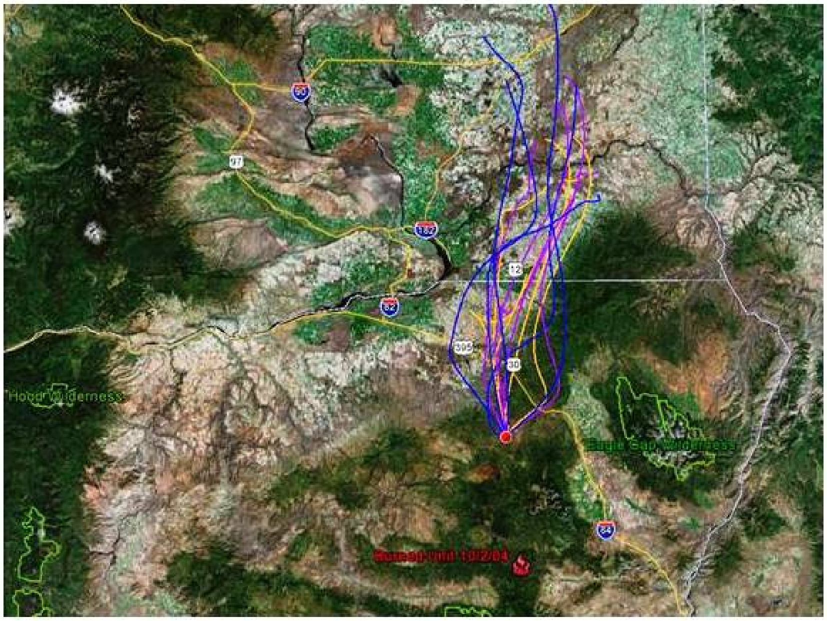


2. Crater Lake (cont)



Forward trajectories on the day of the burn.
The highest impact predicted by Hysplit is south of Crater Lake.
If smoke persisted until the following day, it is likely that it reached Crater lake based on the previous set of backward trajectories.

3. Starkey



Starkey: Back trajectories for 10/3/04

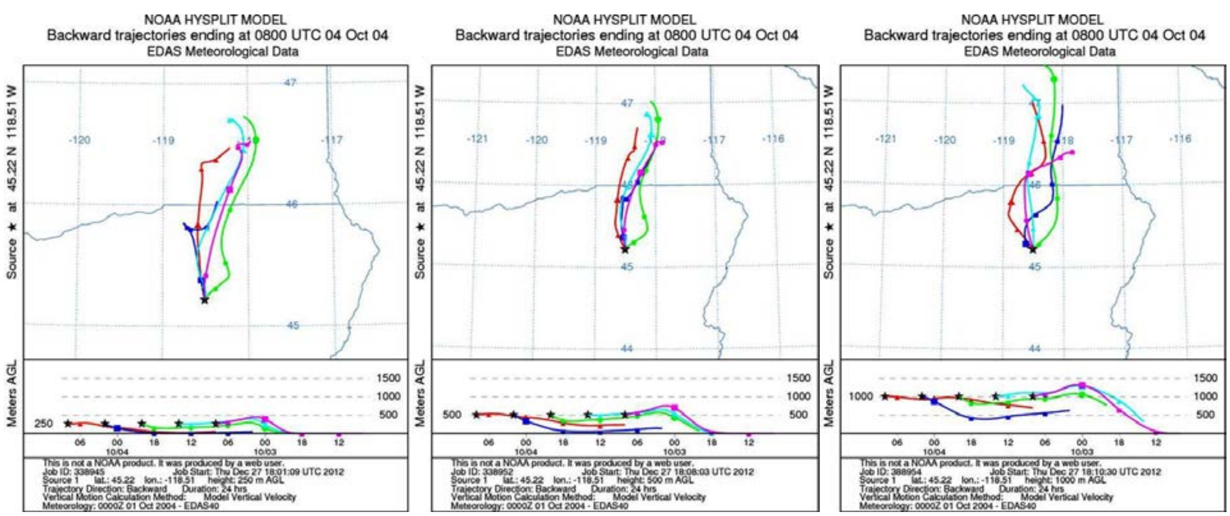
Hysplit trajectories at 3 different elevations:

250m – orange

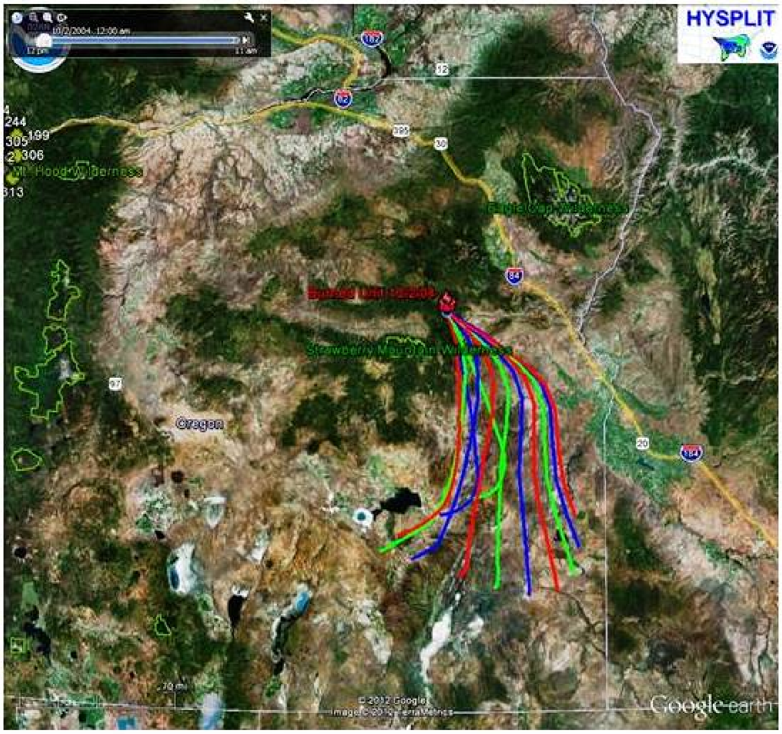
500m – purple

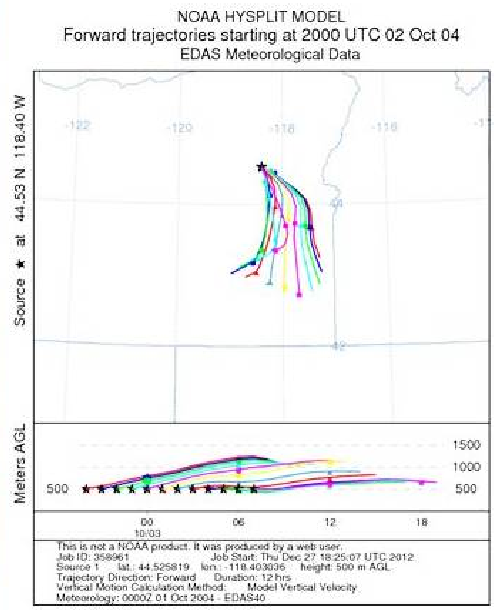
1000m – blue

Hysplit results indicate that air was coming from north during the 24-hour period on 10/3/04 when the measurements were collected, rather than from south where the burn was located on 10/2/04. To see if the burn was affecting areas near monitor on the day of burn, forward trajectories are run from the burn location. See results below. Both sets of results indicate that burn did not impact the monitor.

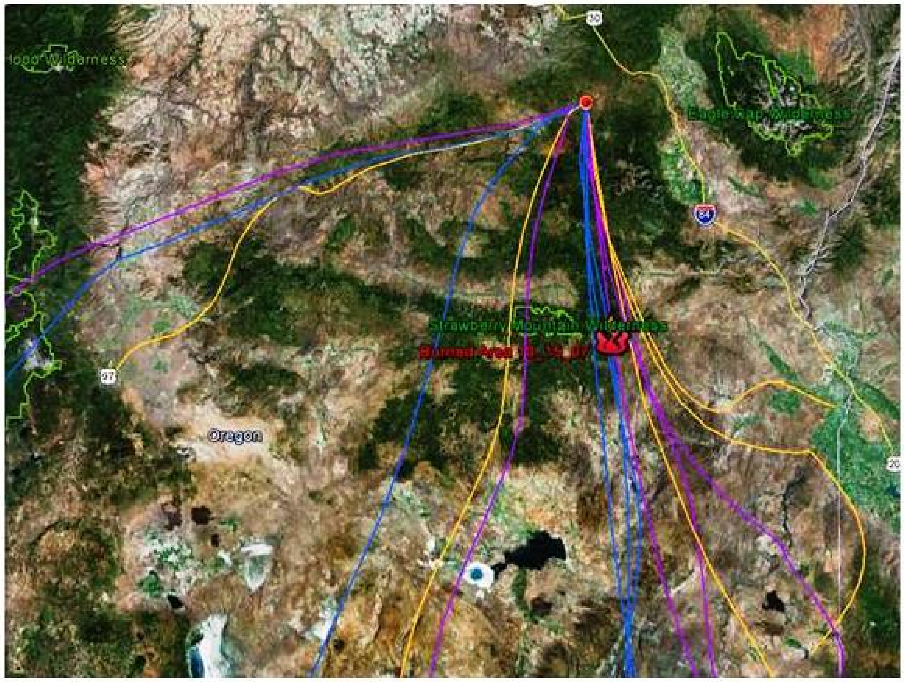


3. Starkey (cont)



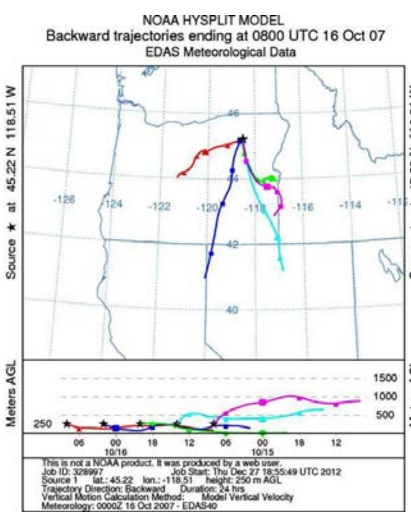


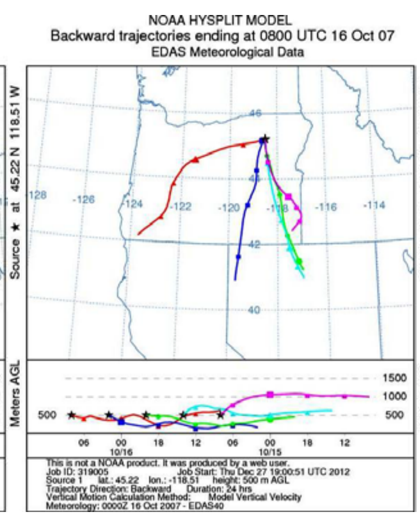
3. Starkey (cont)

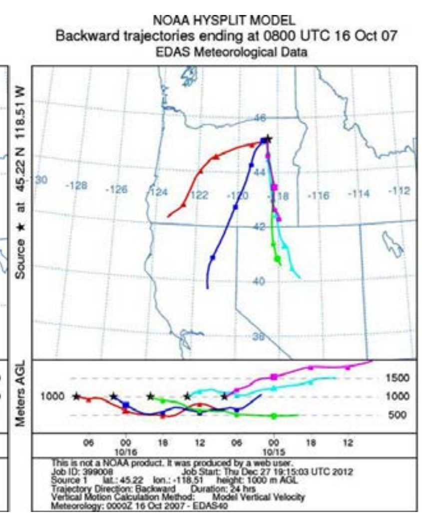


Starkey: Back trajectories for October 15, 2007

Hysplit trajectories at 3 different elevations:
250m – orange
500m – purple
1000m – blue
Impact likely.



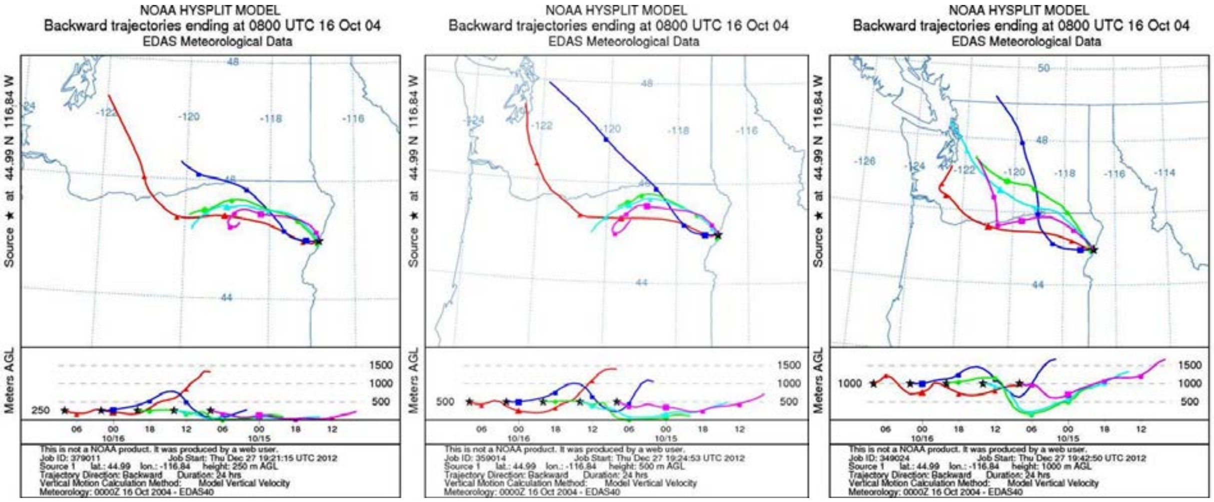




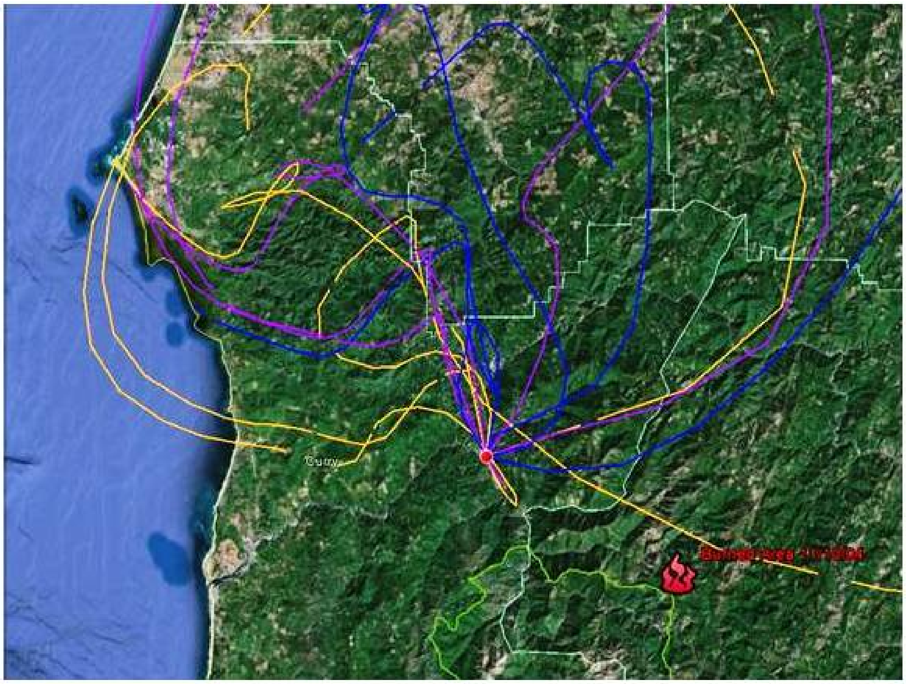
4. Hells Canyon

Hells Canyon: Back trajectories for October 15, 2004

Hysplit trajectories at 3 different elevations:
250m – orange
500m – purple
1000m – blue
The burn is in the vicinity of the trajectories but not sure if it had impact on the monitor.



5. Kalmiopsis



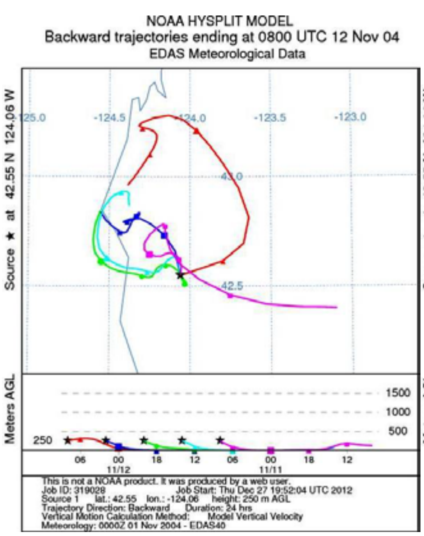
Kalmiopsis: Back trajectories for November 11, 2004

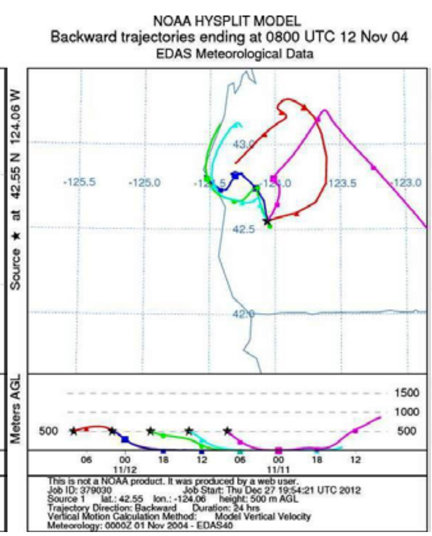
Hysplit trajectories at 3 different elevations:

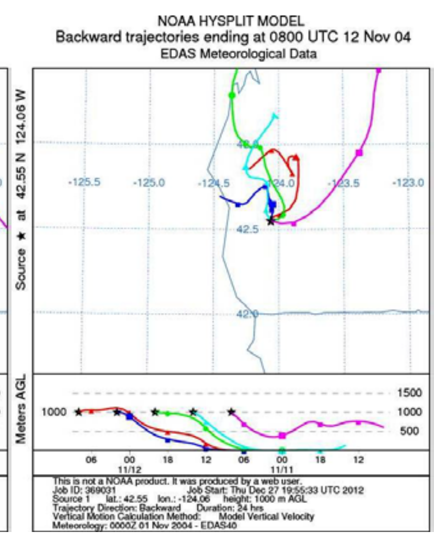
250m – orange

500m – purple

1000m – blue



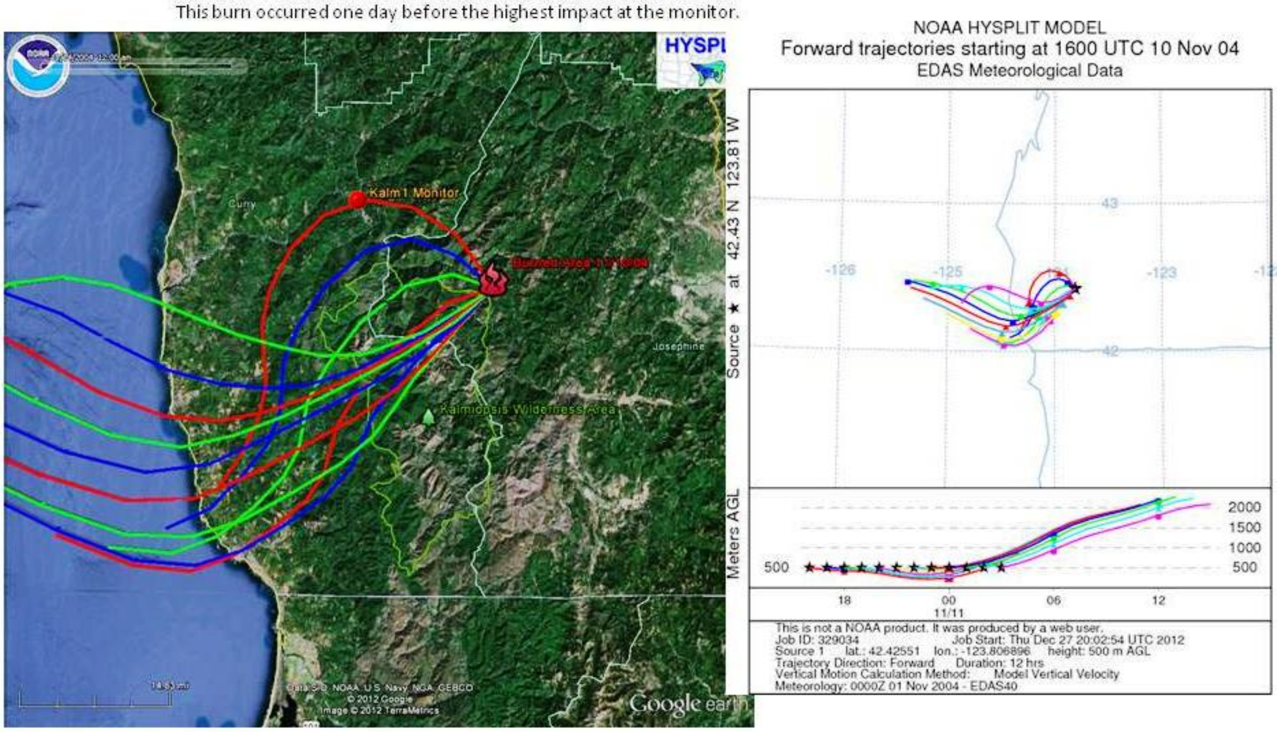




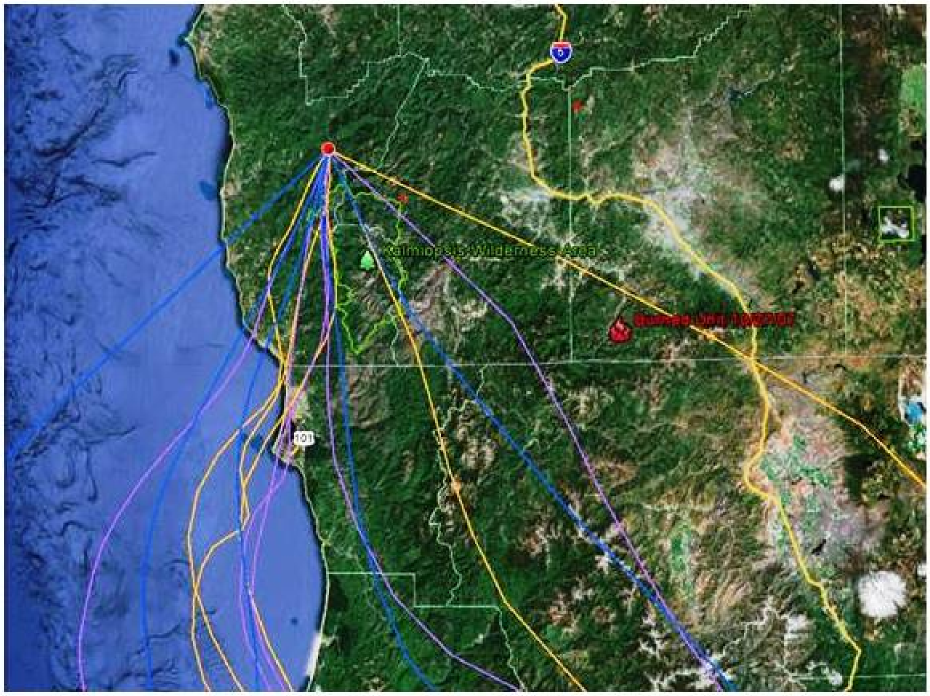
5. Kalmiopsis (cont)

Kalmiopsis: Forward trajectories for November 10, 2004

- Forward trajectories from the burned area. Hysplit results suggest that highest impact from this burn affected northern parts of Kalmiopsis wilderness, but not the monitor. This burn occurred one day before the highest impact at the monitor.

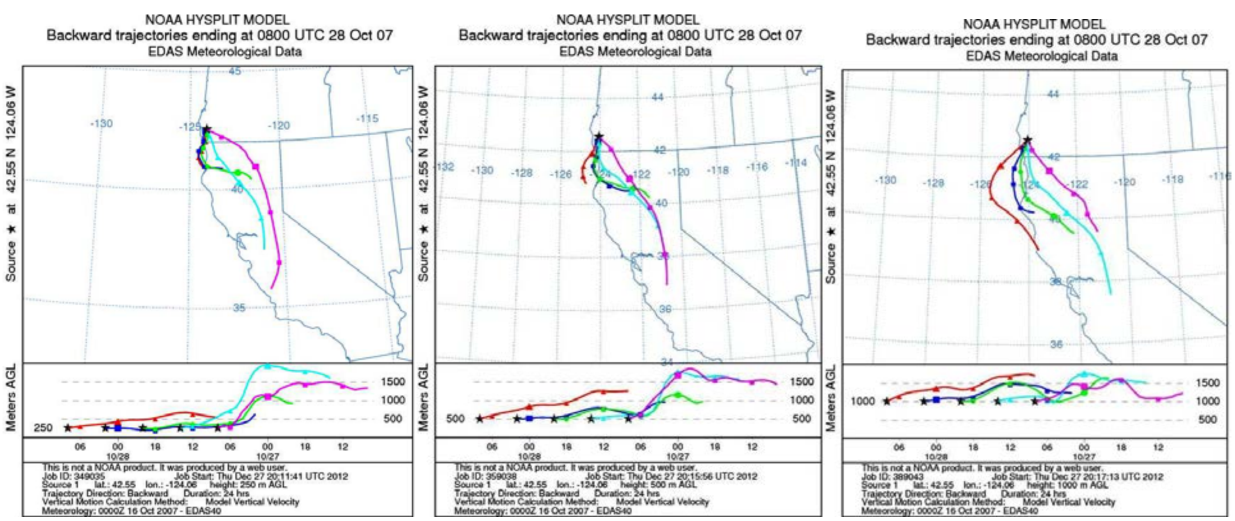


5. Kalmiopsis (cont)

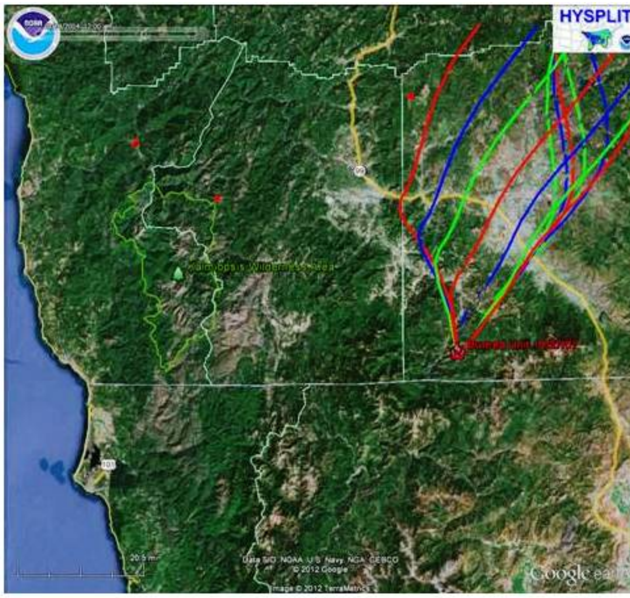


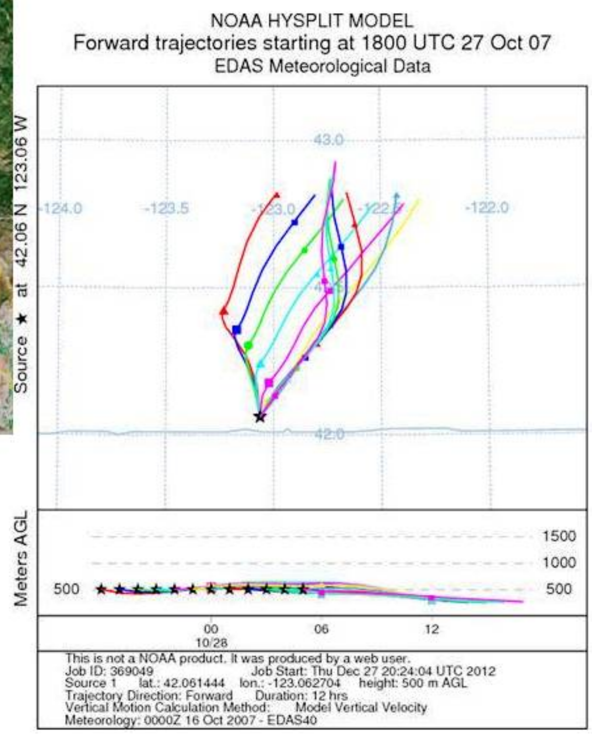
Kalmiopsis: Back trajectories for October 27, 2007

Hysplit trajectories at 3 different elevations:
250m – orange
500m – purple
1000m – blue
Smoke from the burned area likely did not impact the wilderness area. See additional forward trajectories.



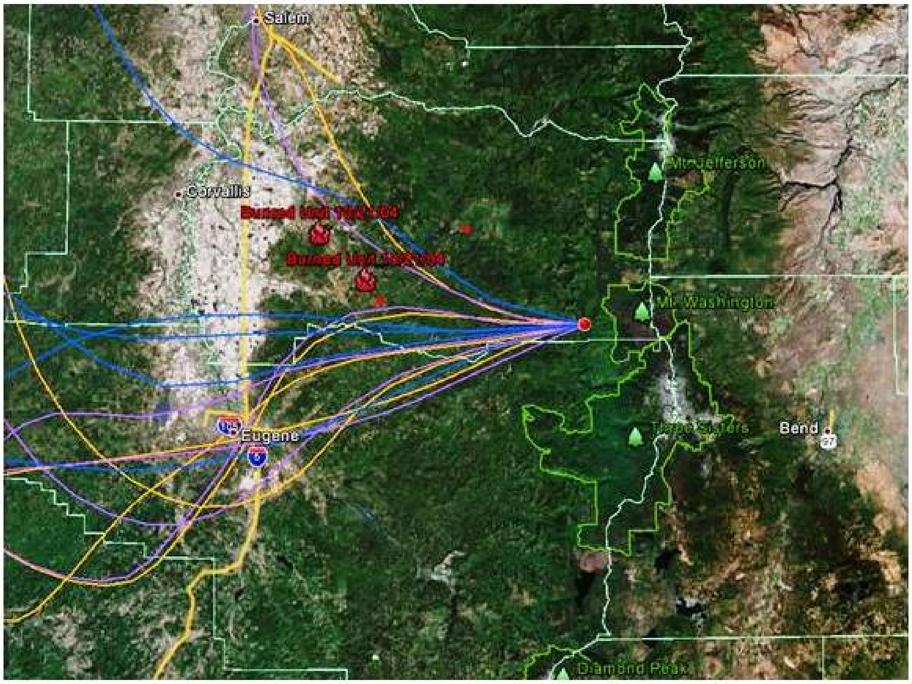
5. Kalmiopsis (cont)





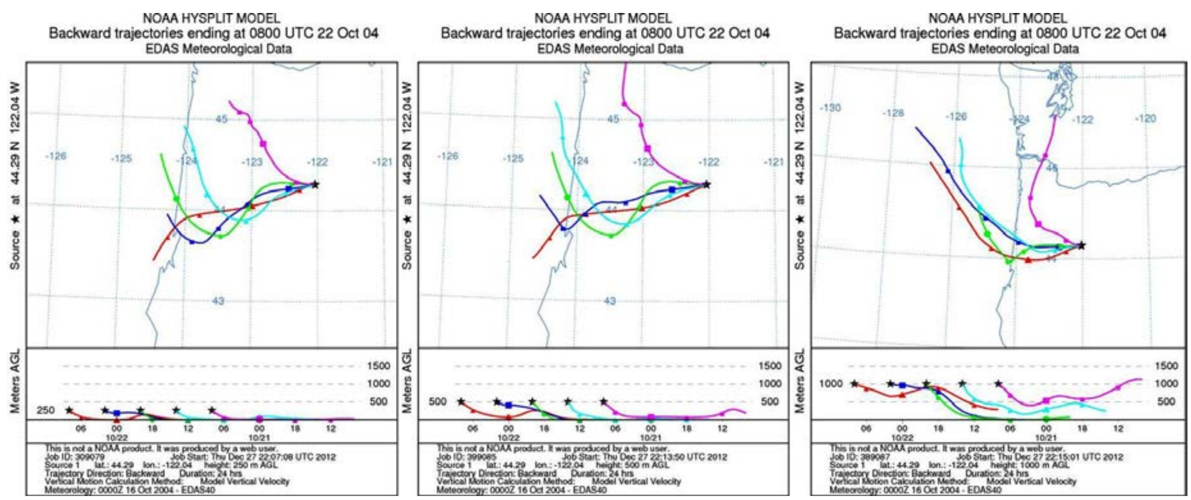
Results show no impact on Kalmiopsis Wilderness from this burn.

6. Three Sisters



Three Sisters: Back trajectories on October 21, 2004

Hysplit trajectories at 3 different elevations:
250m – orange
500m – purple
1000m – blue
The burns likely impacted the wilderness areas.



Appendix B – Non-BART Source Evaluation

1. Introduction

The purpose of the non-BART source evaluation is to identify facilities that may contribute to the impairment of visibility in Class I Areas and determine if additional controls are needed by the 2020 plan revision.

1.1 Background

The regional haze rule requires older facilities to go through analysis for Best Available Retrofit Technology and install emission controls if they significantly impact visibility in federal wilderness areas or national parks. For Oregon, five facilities went through BART analysis and four opted to accept permit conditions to reduce emissions below BART trigger criteria. Portland General Electric's coal-fired power plant near Boardman triggered BART eligibility criteria and was required to install new control technology. On June 19, 2009 the Environmental Quality Commission adopted a regional haze plan for Oregon, which included implementation of stringent pollution controls for PGE Boardman.

In the Regional Haze Plan the Oregon Department of Environmental Quality committed to evaluate non-BART facilities that may possibly be contributing to the impairment of visibility in Class I areas as a prelude to determine if additional controls are needed in the 10 year plan revision. A Technical Analysis Protocol to complete the non-BART Source Evaluation was created by the Air Quality Planning section and reviewed and implemented by the Air Quality Technical Services section. The remainder of this document describes the process for which potential non-BART sources were evaluated and how the final list was created.

1.1.1 Technical Analysis Protocol

The regional haze rule requires states to apply "four factors" to non-BART sources, in determining the need for additional improvements in regional haze. The four factors in Section 308(d)(1)(i)(A) of the RHR are:

1. Costs of compliance;
2. Time necessary for compliance;
3. Energy and non-air quality environmental impacts of compliance; and
4. Remaining useful life of any potentially affected sources.

Unlike BART eligibility requirements, there are no federal rules or guidance for how states conduct the non-BART source evaluation. The following are eight criteria or steps DEQ developed to evaluate non-BART sources:

1. Size
2. Location
3. Distance to nearest Class I area
4. Q/d Calculation
5. Visitation Data

6. Date of Permit Issuance
7. Modeling
8. Final Ranking and Eligibility

The data collected and analyzed from steps 1-7 provide the information to complete step 8 to finalize the list of non-BART facilities.

1. Size The first step of the non-BART source evaluation is to determine which facilities to include in the analysis. DEQ started with major sources or large industrial facilities that required a Title V permit under Division 218 of the Oregon Administrative Rules. This includes facilities with Prevention of Significant Deterioration permits issued after 1977 and sources that never went through PSD analysis. In addition, each facility's actual annual emissions were compared against an emissions threshold of 100 tons or greater per year (tpy) for any one pollutant: NO_X, PM_{10}, or SO_2 to determine if they are eligible for further consideration.

Approximately 115 Title V facilities are reported by DEQ every 3 years to the EPA for the National Emissions Inventory (NEI). There is a wider net of facilities with emissions data available electronically those years than during the off years where only a handful is reported annually. Emission inventories from 2008 and 2011 are the most recent triennial inventories. Emissions from these years were used to put together the non-BART source emissions inventory. The inventory was used to 1) create the list, and 2) compare emission reductions or increases over both triennial inventories. For the purpose of this evaluation only 2011 emissions were compared against the emission threshold to determine which facilities to include on the list and used later in the Q/d calculation to narrow down the list further.

The non-BART source emission inventory was created using facility-wide actual emissions data from 2008 and 2011 inventories. The inventories are developed using emissions data reported by each facility annually. Title V facilities must fulfill permit conditions for annual reporting by submitting activity information, emission factors, continuous emissions monitoring data, and emission estimates for criteria and hazardous air pollutants. This information is used to verify emission calculations and develop an inventory at both the unit and facility level.

Table 1 was prepared using actual emissions from both triennial inventories. Emission changes were calculated for each facility. The table includes 31 facilities that emitted at or above 100 tpy of any one pollutant NO_X, PM_{10}, or SO_2. This information was then rolled up for statewide point source emissions comparison between 2008 and 2011.

Table 1 2008-2011 non-BART Source Emission Inventory

Source Number	Source Name	Actual Emissions 2008 NOx (tpy)	2008 PM10 (tpy)	2008 SO2 (tpy)	2011 NOx (tpy)	2011 PM10 (tpy)	2011 SO2 (tpy)	Total 2011 Combined Emissions (Q) (tpy)	Emission Changes Since 2008 NOx (tpy)	PM10 (tpy)	SO2 (tpy)
01-0029	Ash Grove Cement Company	1,043.0	145.2	21.2	969.0	104.6	24.0	1,097.6	-74.0	-40.6	2.8
01-0038	Northwest Pipeline GP	273.8	1.7	1.3	197.1	2.1	1.2	200.4	-76.6	0.4	-0.1
03-2145	West Linn Paper Company	451.6	10.5	45.2	453.8	16.5	3.3	473.6	2.2	6.0	-41.9
03-2729	Northwest Pipeline GP	394.0	2.1	1.5	313.1	1.8	1.4	316.3	-80.9	-0.2	-0.1
04-0004	Georgia-Pacific Consumer Products LP	1,064.7	1,337.8	859.0	1,062.2	951.4	706.7	2,720.3	-2.5	-386.4	-152.3
05-1849	Cascades Tissue Group-Oregon	710.4	488.5	1,739.2	247.3	13.9	2.1	263.3	-463.1	-474.6	-1,737.2
08-0003	Pacific Wood Laminates, Inc.	60.8	157.4	2.7	63.0	158.8	3.7	225.5	2.2	1.4	1.1
09-0084	Gas Transmission Northwest LLC	151.8	5.5	3.0	111.5	5.3	2.9	119.7	-40.3	-0.2	-0.1
10-0025	Roseburg Forest Products Co.	1,170.3	480.2	77.5	1,125.7	470.6	71.0	1,667.3	-44.6	-9.6	-6.5
10-0078	Roseburg Forest Products Co.	81.9	108.4	21.2	62.3	138.6	15.9	216.8	-19.5	30.1	-5.3
11-0001	Columbia Ridge Landfill	18.2	47.6	9.9	138.7	39.6	21.4	199.7	120.5	-8.0	11.5
15-0025	Timber Products Co.	78.2	36.5	1.4	121.7	133.7	1.5	256.8	43.5	97.1	0.1
15-0073	SierraPine, A California Limited Partner	87.3	128.8	2.8	82.7	122.9	2.8	208.4	-4.7	-5.9	0.0
15-0159	Biomass One, L.P.	259.1	39.0	16.0	206.0	20.8	12.6	239.4	-53.1	-18.2	-3.4
18-0003	Klamath Energy LLC	172.1	39.3	19.5	114.4	15.0	14.3	143.6	-57.7	-24.4	-5.3
18-0005	Interfor Pacific Inc.	0.1	4.9	0.0	91.5	106.2	4.1	201.9	91.4	101.4	4.1
21-0005	Georgia-Pacific Toledo LLC	856.4	530.9	103.6	943.5	594.9	137.2	1,675.5	87.0	63.9	33.5
22-0547	Wah Chang	33.5	159.6	6.1	38.5	121.2	7.0	166.7	5.0	-38.4	0.9
22-3501	Cascade Pacific Pulp, LLC	422.5	222.2	58.0	357.9	266.9	273.3	898.1	-64.6	44.8	215.3
23-0032	EP Minerals, LLC	56.9	53.5	177.0	55.7	45.7	141.0	242.4	-1.2	-7.8	-36.0
24-5398	Covanta Marion, Inc.	285.0	12.8	9.6	274.0	10.6	10.6	295.2	-11.0	-2.2	1.0
25-0026	Gas Transmission Northwest LLC	106.1	2.0	1.4	115.0	2.1	1.5	118.5	8.9	0.1	0.0
26-1865	EVRAZ Inc, NA	193.9	101.9	3.0	192.9	142.8	4.1	339.8	-1.0	40.9	1.1
26-1876	Owens-Brockway Glass Container Inc.	569.8	115.4	141.9	406.5	100.9	119.0	626.4	-163.3	-14.5	-22.9
26-2068	ESCO Corporation	62.8	195.9	5.6	53.3	194.0	5.3	252.7	-9.5	-1.8	-0.3
30-0113	Hermiston Generating Company, L.P.	183.4	59.7	9.2	140.4	40.9	6.6	187.9	-43.0	-18.8	-2.6
31-0002	Boise Cascade Wood Products, L.L.C.	0.0	0.0	0.0	219.2	40.6	2.1	261.8	219.2	40.6	2.1
31-0006	Boise Cascade Wood Products, L.L.C.	178.7	49.9	13.1	192.8	57.2	15.1	265.2	14.1	7.3	2.0
36-0011	Riverbend Landfill Co.	23.7	8.8	14.8	112.4	10.7	17.5	140.6	88.7	1.9	2.7
36-5034	Cascade Steel Rolling Mills, Inc.	303.6	92.7	55.4	201.4	66.7	39.1	307.2	-102.1	-26.0	-16.3
36-6142	SP Fiber Technologies Northwest, LLC	1,178.0	76.0	589.0	648.1	71.2	685.2	1,404.6	-529.9	-4.8	96.2
		10,471.7	**4,714.4**	**4,009.2**	**9,311.6**	**4,068.2**	**2,353.4**	**15,733.3**	**-1,160.0**	**-646.3**	**-1,655.7**

Table 2 2008-2011 Point Source Statewide Emission Inventories

Point Sources	Actual Emissions					
	2008			2011		
	NO_X	PM_{10}	SO_2	NO_X	PM_{10}	SO_2
	tpy			tpy		
PGE Boardman	8696.5	820.4	11303.5	4049.2	683.3	13102.8
Potential non-BART Sources	10471.7	4714.5	4009.1	9311.7	4068.2	2353.4
Statewide*	***20889.6***	***7420.4***	***15225.1***	***15053.5***	***5957.8***	***15682.4***

* All Title V Sources

Table 2 presents emission totals by statewide, potential non-BART sources and PGE Boardman. Statewide point source emissions include all Title V sources regardless of the emissions threshold established above. The potential non-BART sources account for 62% NO_X, 68% PM_{10}, and 15% SO_2 of the total statewide inventory for 2011. PGE Boardman's emissions were separated out because it is already a BART source and required to meet certain regulations to reduce emissions. The focus here is on non-BART sources that may be contributing to poor visibility in Class I areas.

The other objective in using the 2008 and 2011 triennial inventories was to evaluate emission changes between those years due in part to the implementation of BART controls and the introduction of facility elected federally enforceable permit limits, and the economy. Emissions from the potential non-BART sources were compared for reductions or increases and researched for an explanation to why the changes may have occurred. The comparison showed that NO_X and PM_{10} emissions from 2008 to 2011 decreased by approximately 1160 tons and 646 tons respectively. The comparison further revealed a significant decrease in SO_2 emissions by 1656 tons, primarily due to one facility.

Table 3 2008-2011 Point Source Emission Changes

Point Sources	Emission Changes Since 2008		
	NO_X	PM_{10}	SO_2
	tpy		
PGE Boardman	-4647.3	-137.1	1799.3
Potential Non-BART Sources	-1160.0	-646.3	-1655.7
Statewide*	***-5836.1***	***-1462.6***	***457.3***

* All Title V Sources

A comparison of potential non-BART source emission changes since 2008 revealed three facilities that stood out the most when it came to significant changes in NO_X, PM_{10}, and SO_2 emissions:

SP Fiber Technologies Northwest, LLC (36-6142): NO_X emissions dropped by approximately 530 tons for reasons unknown at this time.

Georgia Pacific Consumer Products (04-0004): The most noticeable change is in PM_{10} emissions which dropped approximately 386 tons. Emission reductions likely are due to the facility taking federally enforceable permit limits pertaining to the Regional Haze rule since the last permit renewal in 2009.

Cascade Tissue Group (05-1849): NO_X, PM_{10}, and SO_2 emissions dropped significantly due to the discontinuing of pulping, bleaching, and recovery activities at the plant in 2009. SO_2 emission reductions were the most notable by a drop of approximately 1730 tons.

For overall statewide emission changes, the most obvious emission reductions in NO_X and PM_{10} came from PGE Boardman. The power plant saw a significant decrease in NO_X emissions due to periodic lowering of PSEL according to regional haze and acid rain requirements and the addition of low NO_X burner control technology to the main boiler. However, an increase in SO_2 emissions occurred in 2011 but with no explanation available at this time.

The analysis of the 2008-2011 emissions data established a list of 31 facilities to carry forward to the next steps of the non-BART Source Evaluation. Approximately 84 facilities did not make the list because their 2011 emissions did not exceed the emissions threshold. One facility, Blue Heron Paper Company (03-1850), was not included on the list because it permanently shut down in June 2013 but did have emissions reported in the 2008 inventory. However, the facility has not operated since 2009 and the emission reductions as a result of the closure are considered minimal for this evaluation.

2. Location Table 4 is a list of Oregon Class I areas and includes information on acreage, visitations, and associated national forests and federal land manager designations. The table was developed using information from EPA's List of 156 Mandatory Class I Federal Areas, United States Forestry Service's (USFS) National Visitors Use Monitoring database, and National Park Service's Crater Lake visitation statistics.

Table 4 Visits to Oregon Class I Areas and Designated Wilderness

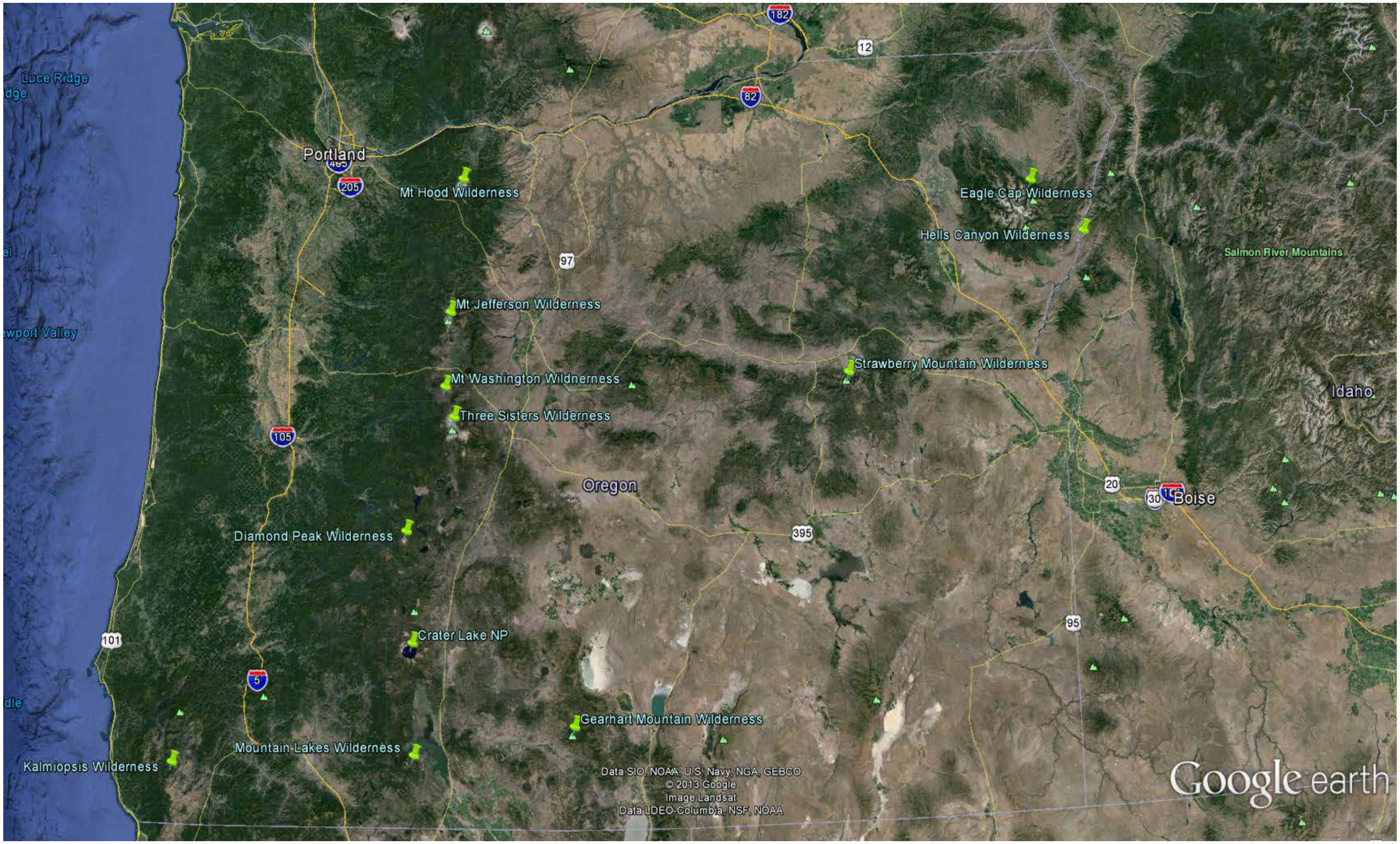
81.425 Class I Areas	Acreage:	Designated Wilderness Visits (per 1000)	Visitation Year	National Forests	Federal Land Mgr:
Crater Lake NP	160,290	482	N/A	N/A	USDA-NPS
Diamond Peak Wilderness.	36,637	42	2008	Deschutes NF	USDA-FS
Eagle Cap Wilderness	293,476	24	2009	Wallowa Whitman NF	USDA-FS
Gearhart Mountain Wilderness	18,709	1	2008	Fremont NF	USDA-FS
Hells Canyon Wilderness*	108,900	24	2009	Wallowa Whitman NF	USDA-FS
Kalmiopsis Wilderness	76,900	5	2007	Siskiyou NF	USDA-FS
Mountain Lakes Wilderness	23,071	6	2007	Rogue River NF	USDA-FS
Mount Hood Wilderness	14,160	203	2011	Mount Hood NF	USDA-FS
Mount Jefferson Wilderness	100,208	45	2007	Willamette NF	USDA-FS
Mount Washington Wilderness	46,116	45	2007	Willamette NF	USDA-FS
Strawberry Mountain Wilderness	33,003	5	2009	Malheur NF	USDA-FS
Three Sisters Wilderness	199,902	45	2007	Willamette NF	USDA-FS

*Hells Canyon Wilderness, 192,700 acres overall, of which 108,900 acres are in Oregon, and 83,800 acres are in Idaho.

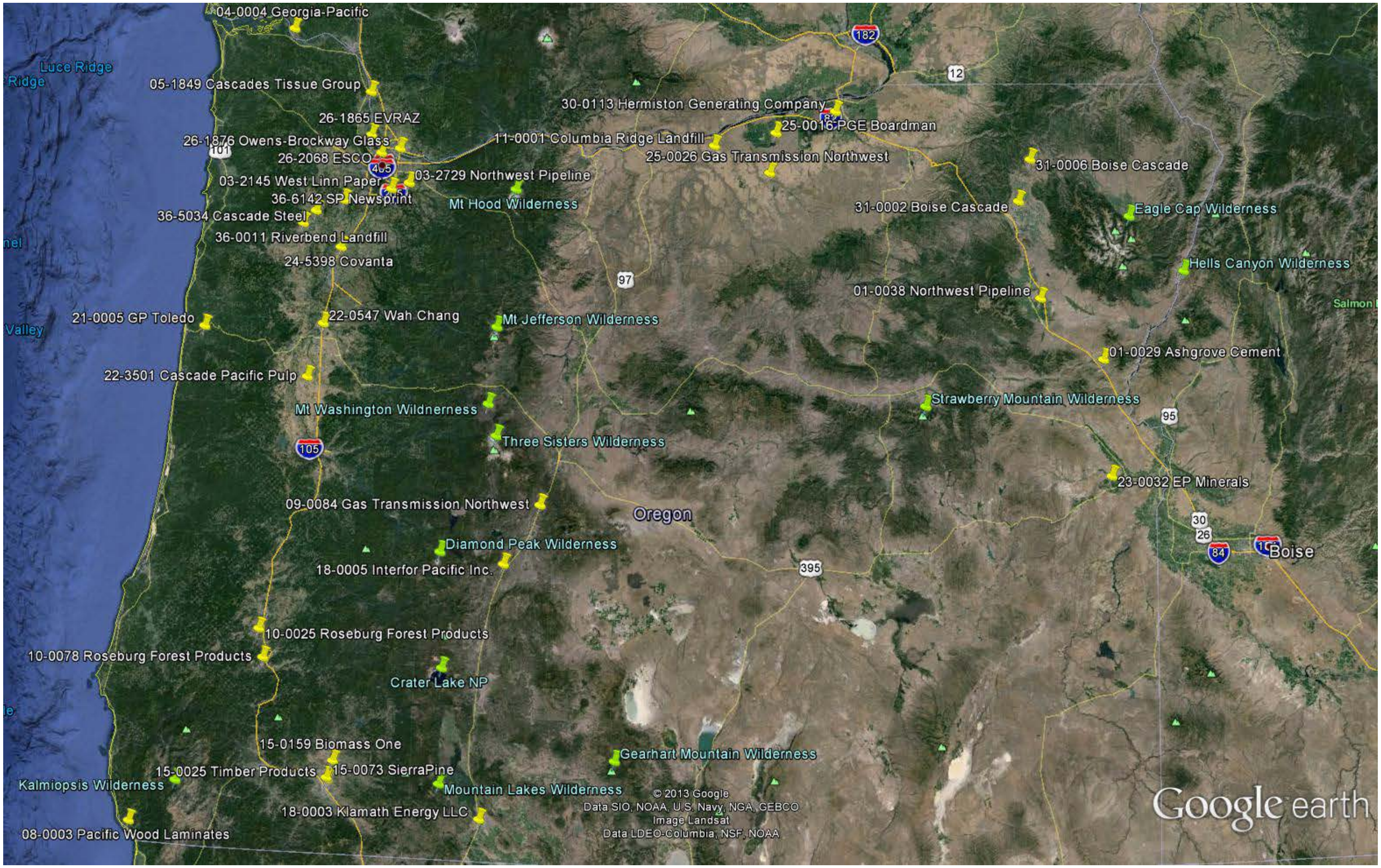
In this step all Class I areas and non-BART facilities were located on topographic maps created with Google Earth. The maps are good visual aids for where facilities are in relation to the Class I areas located around the state.

Map 1 shows all 12 Class I areas across Oregon. Over half the Class I areas including Crater Lake National Park are located in the Cascade Range and run parallel with the I-5 corridor. Map 2 shows all potential non-BART sources statewide in relation to the Class I areas and also includes the BART source PGE Boardman. All 32 facilities were mapped to each Class I area. The results indicate that the largest cluster of facilities is located in the Portland metro area along the I-5 corridor, which mostly impacts the Mt. Hood Wilderness Area.

Map 1 Class I Areas in Oregon



Map 2 Facilities Evaluated Relative to Class I Areas



3. Distance This step requires the measurement of distance in kilometers from facilities to each Class I area. Map 2 was used in Google Earth to obtain the distance measurements between each facility and Class I area. The measurement helps identify the closest Class I area that each facility may impact for visibility. The distance measurement was later used in the Q/d calculation to determine concentration of pollutants per kilometer to each Class I area.

4. Q/d calculation Step 4 requires closer examination of facilities by quantifying their contribution to visibility impairment to each Class I area using the Q/d calculation. Emission estimates from 2011 and distance measurements developed in steps 1 and 3 were used to calculate Q/d from each facility to all 12 Class I areas. Q/d is an estimate of a facility's total pollutant concentration per kilometer, as shown below:

$$Q/d \text{ (tons/km)} = [\text{Total Sum } NO_X, PM_{10}, SO_2 \text{ emissions}] / [\text{Distance to Class I Area}]$$

Table 5 is a list of potential non-BART facilities with emissions quantified to each Class I area and includes a column for Q which is the summation of NO_X, PM_{10}, and SO_2 emissions. The highlighted fields in the table are facilities that met or exceeded a cutoff of $Q/d \geq 10$ tons/km established by lead staff expert judgment for step 8. The cutoff determines which facilities to leave on the list because they significantly impact visibility for one or more Class I areas.

Table 5 Q/d Calculations to each Class I Area

Source Number	Crater Lake NP	Diamond Peak	Eagle Cap	Gearhart Mountain	Hells Canyon	Kalmiopsis	Mountain Lakes	Mount Hood	Mount Jefferson	Mount Washington	Strawberry Mountain	Three Sisters	Q
	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tons/km)	(tpy)
01-0029	3	3	13	3	16	2	2	3	3	3	10	3	1,097.6
01-0038	0	1	3	1	2	0	0	1	1	1	2	1	200.4
03-2145	2	2	1	1	1	1	1	7	5	3	1	3	473.6
03-2729	1	2	1	1	1	1	1	5	3	2	1	2	316.3
04-0004	7	9	6	6	5	6	6	17	13	11	6	10	2,720.3
05-1849	1	1	1	1	1	1	1	3	2	1	1	1	263.3
08-0003	1	1	0	1	0	6	1	1	1	1	0	1	225.5
09-0084	1	2	0	1	0	0	1	1	1	2	1	3	119.7
10-0025	15	15	3	8	3	16	12	6	8	9	4	10	1,667.3
10-0078	2	2	0	1	0	2	2	1	1	1	1	1	216.8
11-0001	1	1	1	1	1	0	1	2	1	1	1	1	199.7
15-0025	3	2	0	2	0	3	4	1	1	1	1	1	256.8
15-0073	2	1	0	1	0	2	3	1	1	1	1	1	208.4
15-0159	3	2	0	1	0	3	4	1	1	1	1	1	239.4
18-0003	2	1	0	2	0	1	5	0	1	1	0	1	143.6
18-0005	3	5	0	2	0	1	2	1	2	2	1	3	201.9
21-0005	7	9	3	5	3	6	6	9	10	10	4	9	1,675.5
22-0547	1	1	0	1	0	1	1	1	2	2	0	1	166.7
22-3501	5	7	2	3	2	4	4	6	8	9	3	8	898.1
23-0032	1	1	2	1	2	0	1	1	1	1	2	1	242.4
24-5398	1	2	1	1	1	1	1	3	3	2	1	2	295.2
25-0026	0	0	1	0	0	0	0	1	1	1	1	1	118.5
26-1865	1	1	1	1	1	1	1	4	3	2	1	2	339.8
26-1876	2	3	1	2	1	2	2	9	5	4	2	4	626.4
26-2068	1	1	1	1	1	1	1	3	2	2	1	1	252.7
30-0113	0	1	1	0	1	0	0	1	1	1	1	1	187.9
31-0002	1	1	4	1	3	0	1	1	1	1	2	1	261.8
31-0006	1	1	4	1	2	0	1	1	1	1	2	1	265.2
36-0011	1	1	0	0	0	0	0	1	1	1	0	1	140.6
36-5034	1	1	1	1	1	1	1	3	2	2	1	2	307.2
36-6142	5	7	3	4	3	4	4	14	12	10	4	9	1,404.6
													15,733.3

5. Visitation Data The USFS visitors' use database and National Park Service's Crater Lake visitation statistics was used to develop the visitor information in Table 4. The purpose of this information is to identify the most visited national parks and wilderness areas in Oregon. Crater Lake National Park and Mount Hood Wilderness have the highest annual visitations for the state.

6. Date of Permit Issuance This step evaluates whether non-BART facilities have gone through New Source Review or PSD analysis. When new facilities are built that will emit pollutants, or existing facilities increase their emissions, additional regulatory requirements may be triggered before the emissions or emissions increase can be approved. There is more than one criterion for determining if additional requirements are triggered, but one of the main criteria is whether the Plant Site Emission Limit is greater than the netting basis by the Significant Emission Rate or more. The triggering of additional requirements may include modeling of emission impacts to ensure that air quality standards are not violated; obtaining emission offsets; identifying and installing new emission control systems; or a combination of requirements. This step identifies potential non-BART facilities that have never triggered NSR/PSD analysis. Therefore, these facilities have never been required to install newer, state-of-the-art control technology or employ emission reduction strategies for NO_X, PM_{10}, and SO_2 throughout their permit history. This information is important to determine if additional controls for certain facilities are needed for the 2018 regional haze plan revision.

PSEL, SER and netting basis are defined in the air quality program rules in OAR 340-200-0020.

7. Modeling Non-BART sources found to have an impact on Class I areas can have an option to conduct modeling, either screening modeling or advanced modeling. A modeling protocol and visibility threshold would be developed, if this option is chosen, similar to the BART Modeling Protocol developed for BART sources.

8. Final Ranking and Eligibility The last step is the final ranking and eligibility of facilities based on data and criteria developed in earlier steps. Table 6 and Table 8 are a culmination of data from steps 1-6 that narrows the final list based on the cutoff of $Q/d \geq 10$ tons/km to the closest Class I area. Further information was included in the tables such as number of Class I areas with $Q/d \geq 10$ tons/km, designated wilderness visits, total facility emissions, and distance and total Q/d to the nearest Class I area from each facility. Twenty four facilities were removed from the original list because they were under the cutoff and two sources remain separated out because they are borderline to the cutoff.

Table 6 is the final list of non-BART Sources with Q/d values that meet or exceed the cutoff to their nearest Class I area. The Class I areas impacted by these five facilities are Hells Canyon, Mount Hood, Mount Jefferson, and Kalmiopsis Wildernesses. Two of the five facilities impact the Mount Hood Wilderness. It is the second most visited Class I area in the state with approximately 203,000 annual visitors. Crater Lake is the most visited Class I area in the state with 482,000 annual visits, more than double that of the Mount Hood Wilderness.

Table 6 Oregon Significant Point Sources with Q/d ≥ 10 to Closest Class I Area

Source Number	Source Name	# of Class I Areas ≥10 Q/d	Closest Class I Area	Designated Wilderness Visits	Q	Distance	Total Q/d
				(per 1000)	(tpy)	(km)	(tons /km)
04-0004	Georgia-Pacific Consumer Products, LP	4	Mount Hood Wilderness	203	2720.3	160	17
10-0025	Roseburg Forest Products Co.	5	Kalmiopsis Wilderness	5	1667.3	102	16
01-0029	Ash Grove Cement Company	3	Hells Canyon Wilderness	24	1097.6	68	16
36-6142	SP Fiber Technologies Northwest, LLC	3	Mount Hood Wilderness	203	1404.6	99	14
21-0005	Georgia-Pacific Toledo, LLC	2	Mount Jefferson Wilderness	45	1675.5	169	10

These facilities not only impact visibility at their nearest Class I area but they also affect visibility at multiple Class I areas. Table 7 lists the other Class I areas these facilities impact with a Q/d ≥ 10 tons/km. With exception to Ash Grove Cement Company the other facilities mostly impact Class I areas located along the Cascade Range.

Table 7 Additional Class I Areas Impacted By Each Facility (Q/d ≥ 10)

Source Number	Source Name	Additional Class I Areas Impacted By Each Facility
01-0029	Ash Grove Cement Company	Eagle Cap and Strawberry Mountain
04-0004	Georgia-Pacific Consumer Products LP	Mount Jefferson, Mount Washington, and Three Sisters
10-0025	Roseburg Forest Products Co.	Crater Lake, Diamond Peak, Mountain Lakes, and Three Sisters
21-0005	Georgia-Pacific Toledo LLC	Mount Washington
36-6142	SP Fiber Technologies Northwest, LLC	Mount Jefferson and Mount Washington

The facilities in Table 8 are noteworthy because their Q/d is 9 tons/km, just under the cutoff. These facilities should be kept on the radar because they could exceed the cutoff in the future. The borderline facilities in Table 8 only affect visibility at their own closest Class I area.

Table 8 Oregon Significant Point Sources Borderline Q/d ≥ 10 to Closest Class I Area

Source Number	Source Name	# of Class I Areas ≥10 Q/d	Closest Class I Area	Designated Wilderness Visits	Q	Distance	Total Q/d
				(per 1000)	(tpy)	(km)	(tons /km)
26-1876	Owens-Brockway Glass Container	0	Mount Hood Wilderness	203	626.4	71	9
22-3501	Cascade Pacific Pulp, LLC	0	Mount Washington Wilderness	45	898.1	105	9

Table 9 and Table 10**,** include information on both the final and borderline facilities which determined if and when they went through NSR, PSD, or BART analysis. Three out of the five facilities and one of the borderline facilities did go through BART analysis and either did not trigger BART criteria or chose to implement emission reductions to avoid triggering BART criteria. Four out of the five facilities and one borderline facility did trigger NSR and/or PSD analysis at some point during their permit cycles. Most likely these facilities had to put on newer more state-of-the-art controls or implement best practices to reduce emissions.

Table 9 Oregon Significant Point Sources with Q/d ≥ 10, NSR/PSD/BART Analysis

Source Number	Source Name	Completed BART Analysis*	Went through NSR/PSD at some point during Permit Cycles?	Year NSR/PSD Analysis or Permit Issued
04-0004	Georgia-Pacific Consumer Products LP	Yes	Yes	2000
10-0025	Roseburg Forest Products Co.	---	NSR/PSD not triggered	N/A
01-0029	Ash Grove Cement Company	---	Yes	1977/1997
36-6142	SP Fiber Technologies Northwest, LLC	Yes	Yes	1980
21-0005	Georgia-Pacific Toledo LLC	Yes	Yes	1999

* Completed BART analysis and opted to do emission reductions to prevent triggering BART requirements.

Table 10 Oregon Significant Point Sources Borderline Q/d ≥ 10, NSR/PSD/BART Analysis

Source Number	Source Name	Completed BART Analysis*	Went through NSR/PSD at some point during Permit Cycles?	Year NSR/PSD Analysis or Permit Issued
26-1876	Owens-Brockway Glass Container	---	NSR/PSD not triggered	N/A
22-3501	Cascade Pacific Pulp, LLC	Yes	Yes	1987/1999/2001/2004

In conclusion, the non-BART source evaluation identified five facilities and two borderline facilities that significantly impact one or more Class I areas in the state. Though, the facilities did not trigger BART eligibility criteria they still present enough of an impact to be evaluated for potential emission reduction strategies for the 2018 plan revision.

Appendix C – Basics of Visibility and Regional Haze

Glossary of Terms

Aerosols: Suspensions of tiny liquid and/or solid particles in the air.

Ammonium Nitrate (NH_4NO_3): Ammonium nitrate is formed in the atmosphere from reactions involving nitrogen dioxide (NO_2) emissions, which are dominated by anthropogenic sources. Common sources include virtually all combustion activities, especially those involving cars, trucks, power plants, and other industrial processes.

Ammonium Sulfate ($(NH_4)2SO_4$): Ammonium sulfate is formed in the atmosphere from reactions involving sulfur dioxide (SO2) emissions. Anthropogenic sources include coal burning power plants and other industrial sources, such as smelters, industrial boilers, and oil refineries, and to a lesser extent, gasoline and diesel combustion.

Anthropogenic: Produced by human activities.

Area Sources: Sources that are treated as being spread over a spatial extent (usually a county or air district) and that are not movable (as compared to non-road mobile and on-road mobile sources). Because it is not possible to collect the emissions at each point of emission, they are estimated over larger regions. Examples of stationary area sources are residential heating and architectural coatings. Numerous sources, such as dry cleaning facilities, may be treated either as stationary area sources or as point sources.

BART: Best Available Retrofit Technology, a process under the CAA to evaluate the need and, if warranted, install the most effective pollution controls on an already existing air pollution source.

Baseline period: The baseline period, or baseline conditions, is the basis against which improvements in worst day visibility, and lack of degradation for the best day visibility, are judged. For initial RHR implementation plan purposes, the baseline is the average visibility impairment as measured by IMPROVE monitors during the 2000-2004 5-year period.

Biogenic Emissions: Biogenic emissions are based on the activity fluxes modeled from biogenic land use data, which characterizes the types of vegetation that exist in particular areas. Emissions are generally derived using modeled estimates of biogenic gas-phase pollutants from land use information, emissions factors for different plant species, and meteorology data.

Class I area: As defined in the Clean Air Act, areas that were in existence as of August 7, 1977: national parks over 6,000 acres, national wilderness areas and national memorial parks over 5,000 acres, and international parks.

Clean Air Act (CAA): The basic framework for controlling air pollutants in the United States, originally adopted in 1963, and amended in 1970, 1977, and 1990. The CAA was designed to "protect and enhance" air quality. Section 169A of the Clean Air Act (CAA), established in the 1977 Amendments, set forth a national goal for visibility which is the ''prevention of any future, and the remedying of any existing, impairment of visibility in Federal Class I areas (CIAs) which impairment results from manmade air pollution.''

Coarse Mass (CM): Coarse mass refers to the mass of large particles greater than 2.5 and smaller than 10 μm in diameter.

Colorado Plateau: A high, semi-arid tableland in southeast Utah, northern Arizona, northwest New Mexico, and western Colorado.

Current conditions: For purposes of this report, current conditions represent the most recent successive 5-year average after the 2000-2004 baseline conditions, or the 2005-2009 period.

Deciview (dv): The deciview metric is used to track regional haze in the RHR. The Haze Index measured in deciviews) was designed to be linear with respect to human perception of visibility. A one deciview change is approximately equivalent to a 10% change in extinction, whether visibility is good or poor. A one deciview change in visibility is generally considered to be the minimum change the average person can detect.

Dust: Dust emissions may have a variety of sources that could include anthropogenic sources, natural sources, and natural sources that may be influenced by anthropogenic activity. Fugitive dust includes sources such as road dust, agricultural operations, construction and mining operations and windblown dust from vacant lands. Windblown dust includes more of the natural influences such as wind erosion on natural lands.

Elemental Carbon (EC): Elemental carbon is the primary light absorbing compound in the atmosphere. These particles are emitted directly into the air from virtually all combustion activities, but are especially prevalent in diesel exhaust and smoke from wild and prescribed fires.

Environmental Protection Agency (EPA): The EPA is an agency of the U.S. federal government which was created for the purpose of protecting human health and the environment by writing and enforcing regulations based on laws passed by Congress.

Extinction (bext): Extinction is a measure of the fraction of light lost per unit length along a sight path due to scattering and absorption by gases and particles, expressed in inverse Megameters (Mm-1).

Fine Soil: Particulate matter composed of pollutants from the Earth's soil that enters the air from dirt roads, fields, and other open spaces as a result of wind, traffic, and other surface mechanical disturbance activities. Fine soil includes soil particles with an aerodynamic diameter less than 2.5 microns.

Fire: Fire sources may have a mix of natural and anthropogenic influences. Natural sources include wildland fires, while anthropogenic sources can include agricultural and prescribed fires.

First progress period: For purposes of this report, the first progress period represents the most recent successive 5-year average after the 2000-2004 baseline conditions, or the 2005- 2009 period.

Grand Canyon Visibility Transport Commission (GCVTC): In 1990, amendments to the Clean Air Act established the Commission to advise the EPA on strategies for protecting visual air quality on the Colorado Plateau.

Haze index (HI): The Haze Index (measured in deciviews) is used to track regional haze in the RHR. It was designed to be linear with respect to human perception of visibility, where a one deciview change is approximately equivalent to a 10% change in extinction, whether visibility is good or poor. A one deciview change in visibility is generally considered to be the minimum change the average person can detect.

Interagency Monitoring of Protected Visual Environment (IMPROVE): A collaborative monitoring program governed by a steering committee composed of representatives from Federal and regional-state organizations to establish present visibility levels and trends, and to identify sources of man-made impairment

Inverse megameters, (Mm-1): A measurement unit used for light extinction, the higher the value, the hazier the air is.

Least impaired days: The least impaired, or best days, refers to the average visibility impairment (measured in deciviews) for the twenty percent of monitored days in a calendar year with the lowest amount of visibility impairment.

Light extinction: A measure of how much light is absorbed or scattered as it passes through a medium, such as the atmosphere. Aerosol light extinction refers to the absorption and scattering by aerosols. Total light extinction refers to the sum of aerosol light extinction, the absorption of gases (such as NO2), and the atmospheric light extinction (Rayleigh scattering). Extinction is often expressed as a measure of the fraction of light lost per unit length in units of inverse Megameters (Mm-1).

Mandatory Federal Class I areas: Certain national parks (over 6,000 acres), wilderness areas (over 5,000 acres), national memorial parks (over 5,000 acres), and international parks that were in existence as of August 1977.

Most impaired days: The most impaired, or worst days, refers to the average visibility impairment (measured in deciviews) for the twenty percent of monitored days in a calendar year with the highest amount of visibility impairment.

Natural background condition: Naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration.

Natural conditions: Natural conditions include any naturally occurring phenomena that reduce visibility as measured in terms of light extinction, visual range, contrast, or coloration.

Off-Road Mobile Sources: Off-road mobile sources are vehicles and engines that encompass a wide variety of equipment types that either move under their own power or are capable of being moved from site to site. Examples include agricultural equipment such as tractors or combines, aircraft, locomotives and oil field equipment such as mechanical drilling engines.

Off-shore: Commercial marine emissions comprise a wide variety of vessel types and uses. Emissions can include deep draft vessels within shore and near port using port call data, and offshore emissions generated from ship location data.

Oil and Gas Sources: Oil and gas sources consist of a number of different types of activities from engine sources for drill rigs and compressor engines, to sources such as condensate tanks and fugitive gas emissions. The variety of emissions types for sources specific to oil and gas activity can, in some cases, overlap with mobile, area or point sources, but these can also be extracted and treated separately.

On-Road Mobile Sources: Vehicular sources that travel on roadways. Emissions from these sources can be computed either as being spread over a spatial extent or as being assigned to a line location (called a link). Emissions are estimated as the product of emissions factors and activity data (vehicle miles traveled (VMT). Examples of on-road mobile sources include light-duty gasoline vehicles and heavy-duty diesel vehicles.

Oxides of nitrogen (NO_X): A mixture of nitrogen dioxide and other nitrogen oxide gases. Nitrogen is the most common gas in the atmosphere. In high temperature and/or high pressure burning (as in an engine), the air's nitrogen is broken down and combined with oxygen, forming unstable or reactive NO_X gases. Nitrogen dioxide (NO_2) is yellowish brown, and thus contributes directly to haze. All the NO_X gases react in the air to form haze-causing aerosols and smog.

Particulate Organic Mass (POM): Particulate organic mass can be emitted directly as particles, or formed through reactions involving gaseous emissions. Natural sources of organic carbon include wildfires and biogenic emissions. Man-made sources can include prescribed forest and agricultural burning, vehicle exhaust, vehicle refueling, solvent evaporation (e.g., paints), food cooking, and various commercial and industrial sources.

Point Sources: These are sources that are identified by point locations, typically because they are regulated and their locations are available in regulatory reports. In addition, elevated point sources will have their emissions allocated vertically through the model layers, as opposed to being emitted into only the first model layer. Point sources can be further subdivided into electric generating unit (EGU) sources and non-EGU sources, particularly in criteria inventories in which EGUs are a primary source of NO_X and SO_2. Examples of non-EGU point sources include chemical manufacturers and furniture refinishers.

Prevention of significant deterioration (PSD): A program established by the Clean Air Act Amendments of 1977 that limits the amount of additional air pollution that is allowed in Class I and Class II areas.

Rayleigh: Light scattering of the natural gases in the atmosphere. At an elevation of 1.8 kilometers, the light extinction from Rayleigh scattering is approximately 10 inverse megameters (Mm-1).

Reasonable progress: Reasonable progress refers to progress in reducing human-caused haze in Class I areas under the national visibility goal. The Clean Air Act indicates that "reasonable" should consider the cost of reducing air pollution emissions, the time necessary, and the energy and non-air quality environmental impacts of reducing.

Reconstructed aerosol extinction: The percent of total atmospheric extinction attributed to each aerosol and gaseous component of the atmosphere.

Regional haze: Regional haze refers to visibility impairment that is caused by the emission of air pollutants from numerous sources located over a wide geographic area.

Regional Haze Rule (RHR): Federal rule that requires states to develop programs to assure reasonable progress toward meeting the national goal of preventing any future, and remedying any existing, impairment of visibility in mandatory Class I Federal areas.

Relative humidity: Partial pressure of water vapor at the atmospheric temperature divided by the vapor pressure of water at that temperature, expressed as a percentage.

Scattering efficiency: The amount of light scattered relative to the particle's size.

Scattering: An interaction of light with an object (e.g., a fine particle) that causes the light to be redirected in its path.

Sea Salt: Sea salt is a natural aerosol emitted in coastal areas. In practice, chloride ion measurements are used to represent sea salt in IMPROVE measurements, and measurements may sometimes show anthropogenic or crustal influences at inland monitors.

Sulfur Dioxide (SO_2): SO_2 gas is associated with emissions from processes such as burning fuels, manufacturing paper, or smelting rock. SO2 is converted in the air to other sulfur oxides (SO_X) or haze-causing aerosols (sulfates).

State Implementation Plans (SIPs): A detailed description of the programs a state will use to carry out its responsibilities under the Clean Air Act. State implementation plans are collections of the regulations used by a state to reduce air pollution. Plans devised by states and tribes to carry out their responsibilities under the Clean Air Act. SIPs and TIPs must be approved by the U.S. Environmental Protection Agency and include public review.

Visibility impairment: Any humanly perceptible change in visibility (light extinction, visual range, contrast, coloration) from that which would have existed under natural conditions.

Visibility: Refers to the visual quality of the view, or scene, in daylight with respect to color rendition and contrast definition. The ability to perceive form, color, and texture.

Visual Range (VR): Visual range is the greatest distance a large black object can be seen on the horizon, expressed in kilometers (km) or miles (mi).

Volatile organic compound (VOC): A carbon-containing material that evaporates, such as gasoline, some paints, solvents, dry cleaning fluids, and the like. VOCs contribute to the formation of particulate organic mass.

Western Regional Air Partnership (WRAP): A partnership of state, tribal and federal land management agencies to help coordinate implementation of the GCTVC's recommendation.

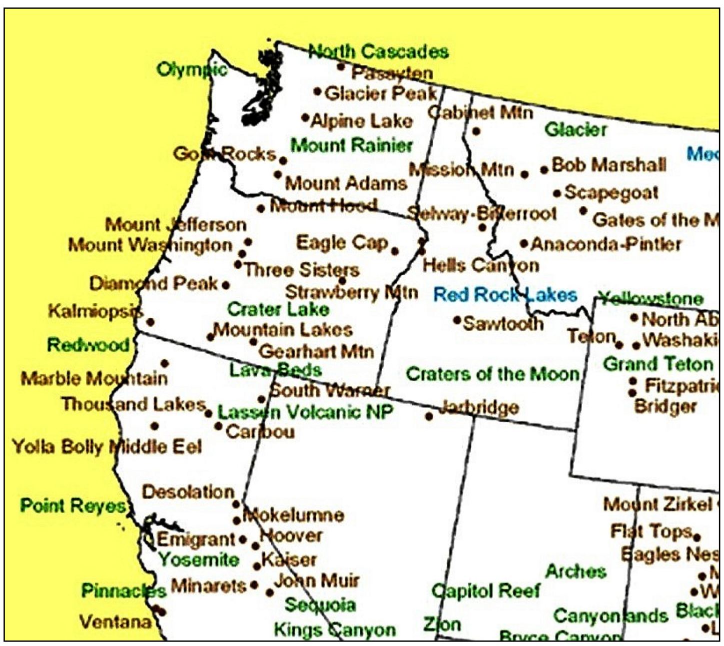
Overview of Visibility and Regional Haze

Good visibility is essential to the enjoyment of national parks and scenic areas. Visibility impairment occurs as a result of the scattering and absorption of light by particles and gases in the atmosphere. This affects the clarity and color of what we see. Without the effects of air pollution, natural visual range is approximately 140 miles in the West and 90 miles in the East. However, over the years, air pollution in many parts of the United States has significantly reduced the range that people can see. In the West, the current range is 35-90 miles, and in the East, only 15-25 miles.

Regional haze is air pollution that is transported long distances and reduces visibility in national parks and wilderness areas. The pollutants that create this haze are sulfates, nitrates, organic carbon, elemental carbon, and soil dust. Human-caused haze sources include industry, motor vehicles, agricultural and forestry burning, and windblown dust from roads and farming practices.

The federal Regional Haze Rule requires states to improve visibility over the next 60 years in 156 national parks and wilderness areas in the country. In 1977, Congress designated all wilderness areas over 5,000 acres and all national parks over 6,000 acres as "mandatory federal Class I areas" (or "Class I areas" for short). These Class I areas receive special visibility protection under the Clean Air Act. The figure below shows the Class I areas located in the Pacific Northwest.

Class I Areas in the Pacific Northwest



Visibility Pollutants in Oregon

Pollutants, Aerosol Species and Major Sources in Oregon

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. 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.
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.

The following sections describe the basic plan elements and key concepts underlying the Oregon Regional Haze Plan.

Natural Sources of Visibility Impairment

Natural sources, particularly wildfire and windblown dust, can be major contributors to visibility impairment. However, these emissions cannot be realistically controlled or prevented by the states, and therefore the focus of the regional haze strategies in this document are on human-caused (anthropogenic) sources, as described below. While current methods of analysis of monitoring data do not provide a clear distinction between natural and anthropogenic emissions, certain pollutant species, such as sulfur dioxide (SO_2) and nitrogen oxide (NOx) are more representative of anthropogenic sources, while organic carbon (OC) and coarse particulate matter (PM10) are more representative of natural sources such as wildfire and dust, respectively.

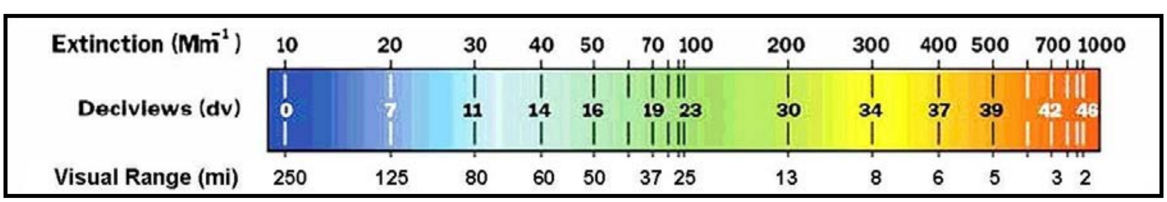
Human-Caused Sources of Visibility Impairment

Anthropogenic or human-caused sources of visibility impairment include anything directly attributable to human-caused activities that produce emissions of visibility-impairing pollutants. Some examples include industry, transportation, agriculture activities, home heating, and managed outdoor burning. Anthropogenic sources can be local, regional, or international. Efforts to regulate anthropogenic emissions are mostly limited to inside the United States. Emissions from Mexico & Canada, and off-shore marine shipping emissions in the Pacific Ocean, are examples of anthropogenic sources that contribute to visibility impairment in Oregon that are beyond the control of the state.

Visibility Measurement

Visibility impairment is measured by a network of monitors that capture pollution and calculate the light scatter effect of each pollutant such as carbon, sulfur and ammonia. The main metric describing visibility impairment is the deciview.

Each IMPROVE monitor collects particulate concentration data which are converted into reconstructed light extinction through a complex calculation using the IMPROVE equation. Reconstructed light extinction (denoted as bext) is expressed in units of inverse megameters (1/Mm or Mm-1). The Regional Haze Rule requires the tracking of visibility conditions in terms of the Haze Index metric expressed in the deciview (dv) unit (40 CFR 51.308(d)(2)). Generally, a one deciview change in the haze index is considered a humanly perceptible change under ideal conditions, regardless of background visibility conditions. The relationship between extinction (Mm-1), haze index (dv) and visual range (mi) are indicated by the following scale:



Baseline and Current Conditions

The Regional Haze Rule requires the calculation of baseline conditions for each Class I area. Baseline conditions are defined as the five year average (annual values for 2000 - 2004) of IMPROVE monitoring data (expressed in deciviews) for the most-impaired (20% worst) days and the least-impaired (20% best) days. For the first regional haze plan submittal, the baseline conditions are the reference point against which further visibility improvement is tracked. For future plan progress reports and updates, baseline conditions are used to calculate progress from the beginning of the regional haze program. Current conditions for the best and worst days are calculated from a multiyear average, based on the most recent 5-years of monitored data available. This value will be revised at the time of each periodic plan revision, and will be used to illustrate: (1) The amount of progress made since the last plan revision, and (2) the amount of progress made from the baseline period of the program.

Natural Conditions

The visibility that would exist under natural conditions (absent any man-made impairment) would vary based on the contribution of natural sources and meteorological conditions on a given day. For that reason, natural conditions, as defined in this document, consists of a level of visibility (in deciviews) for both the most-impaired (20% worst) days and the least-impaired (20 % best) days. Since no visibility monitoring data exists from the pre-manmade impairment period, these estimates of natural conditions are based on EPA guidance on how to estimate natural conditions.

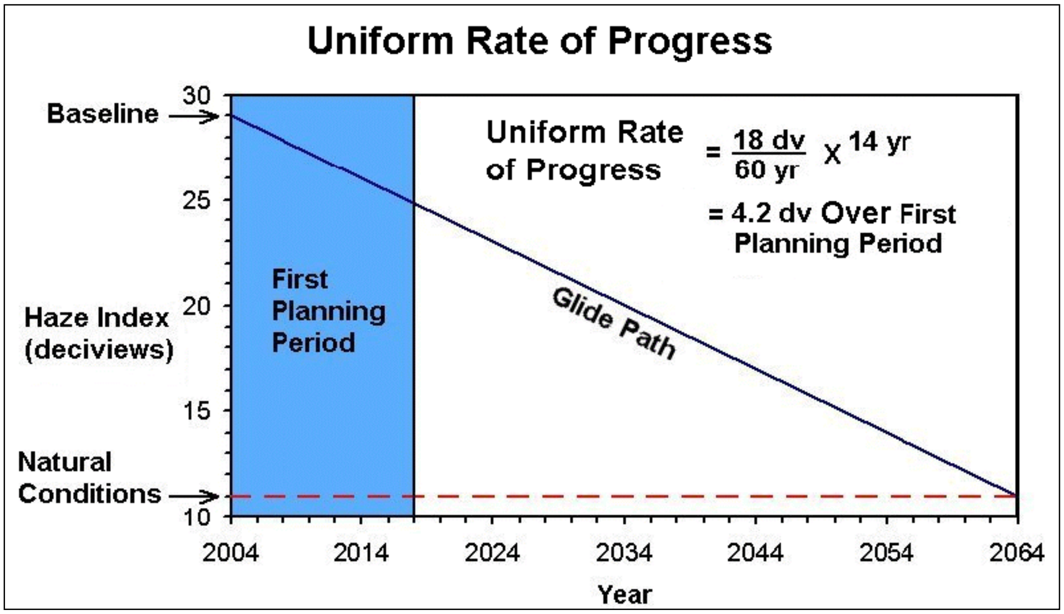
Reasonable Progress Goals

For each Class I area the State must establish goals (measured in deciviews) that provide for reasonable progress towards achieving natural visibility conditions. The reasonable progress goals (RPG) are interim goals that represent incremental visibility improvement over time for the most-impaired (20% worst) days and no degradation in visibility for the least-impaired (20% best) days. The first regional haze plan that States must submit to EPA needs to include RPGs for the year 2018, also known as the "2018 milestone year". The State has flexibility in establishing different RPGs for each Class I area. In establishing the RPG, DEQ considered four factors: the costs of compliance; the time necessary for compliance; the energy and non-air quality environmental impacts of compliance; and the remaining useful life of any potentially affected sources. DEQ demonstrated how these factors were taken into account when establishing the RPGs in the 2010 plan.

Uniform Rate of Progress

The uniform rate of progress is the calculation of the slope of the line between baseline visibility conditions and natural visibility conditions over the 60-year period. For the first regional haze plan, the first benchmark is the deciview level that should be achieved in 2018, as indicated in blue below as the first planning period. This is 2018 Milestone, and applies to both the 20% worst days and the 20% best days.

Example of Uniform Rate of Progress Determination



- Compare baseline conditions to natural conditions. The difference between these two represents the amount of progress needed to reach natural visibility conditions. In this example, the State has determined that the baseline for the 20 percent worst days for the Class I area is 29 dv and estimated that natural background is 11 dv, a difference of 18 dv.

- Calculate the annual average visibility improvement needed to reach natural conditions by 2064 by dividing the total amount of improvement needed by 60 years (the period between 2004 and 2064). In this example, this value is 0.3 dv/yr.

- Multiply the annual average visibility improvement needed by the number of years in the first planning period (the period from 2004 until 2018). In this example, this value is 4.2 dv. This is the uniform rate of progress that would be needed during the first planning period to attain natural visibility conditions by 2064.

The URP is not a presumptive target. When establishing RPGs, the State may determine RPGs at greater, lesser or equivalent visibility improvement than the URP. In cases where the RPG results in less improvement in 2018 than the URP, the State must demonstrate why the URP is not achievable, and why the RPGs are "reasonable".

For the 20% worst days, the URP is expressed in deciviews per year (i.e. slope of the glide path) is determined by the following equation:

URP = [Baseline Condition - Natural Condition] / 60 years

The 2018 Progress Goal (i.e. the amount of reduction necessary for the 1st planning period) is determined by multiplying the URP by the number of years in the 1st planning period.

2018 Progress Goal = [Uniform ROP] x [14 years]

The 14 years comprising the 1st planning period includes the 4 years between the baseline and the SIP submittal date plus the standard 10-year planning period.

Long-Term Strategy

The Regional Haze Rule also requires States to submit a long-term strategy that includes enforceable measures to achieve reasonable progress goals. The long-term strategy must identify all anthropogenic sources inside the State that are affecting Class I areas both inside and outside the State. The first long-term strategy will cover 10 to 15 years, with reassessment and revision of those goals and strategies in 2018 and every 10 years thereafter. At a minimum, the following factors must be considered in developing the long-term strategy:

- Measures to mitigate the impact of construction activities;
- Emission limitations and schedules for compliance to achieve the RPG;
- Source retirement and replacement schedules;
- Smoke management techniques for agricultural and forestry burning, including plans to reduce smoke impacts;
- Enforceability of emission limitations and control measures; and
- The anticipated net affect on visibility due to projected changes in point, area, and mobile source emissions over the period addressed of the long term strategy.

Best Available Retrofit Technology

The RPGs, the long-term strategy, and BART are the three main elements of a Regional Haze Plan. Best Available Retrofit Technology requirements apply to certain older industrial facilities that began operating before national rules were adopted in 1977 to prevent new facilities from causing visibility impairment. BART applies to facilities built between 1962 and 1977, have potential emissions greater than 250 tons per year, and which fall into one of 26 specific source categories. These facilities must be evaluated to see how much they contribute to regional haze and if retrofitting with controls is feasible and cost effective.

The BART process consists of three-steps: (1) determining BART-eligibility; (2) determining is a source is “subject to BART” by conducting modeling of Class I visibility impacts; and (3) conducting an analysis of BART controls (retrofitting) for those sources subject to BART that contribute to regional haze.

In determining BART controls, the State must take into account several factors, including the existing control technology in place at the source, the costs of compliance, energy and non-air environmental impacts of compliance, remaining useful life of the source, and the degree of visibility improvement that is reasonably anticipated from the use of such technology.

Appendix D - Consultation with Tribal Governments and Federal Land Managers

Federal and Tribal Coordination

From: DOWNING Kevin
Sent: Wednesday, February 03, 2016 4:45 PM
To: 'Graw, Rick -FS'; 'jamesmiller2@fs.fed.us'; 'levers@blm.gov'; 'tonnie_cummings@nps.gov'; 'tim_allen@fws.gov'; 'Rose, Keith'; 'jason.kesling@burnspaiute-nsn.gov'; 'mcorvi@ctclusi.org'; 'peterwakeland@coquilletribe.org'; 'jrobison@cowcreek.com'; 'mike.wilson@granderonde.org'; 'will.hatcher@klamathtribes.com'; 'mikek@ctsi.nsn.us'; 'audiehuber@ctuir.org'; 'robert.brunoe@ctwsbnr.org'; YONKER Nick J * ODF
Subject: Oregon Regional Haze 5 Year update review

Hello,

You are invited to review Oregon's interim update of the state's regional haze plan as required by the federal regional haze rule. The Oregon plan, first adopted in 2009, will be updated as needed on a 10 year cycle but is evaluated at 5 year intervals to determine if intermediate adjustments are required.

The plan is available now to you, federal land managers, tribal officials and state officials for a 60 day period with comments due by April 4, 2016. If there is someone else in your organization who should be reviewing the plan, feel free to forward this to them but let me know as well.

Following this review, the plan, with any adjustments necessary based on comments received, will be placed on public notice before being presented for consideration and adoption by the Environmental Quality Commission in November 2016, after which the update is submitted to EPA for their approval.

The update and accompanying documents can be found on this website, http://www.deq.state.or.us/aq/haze/haze.htm. If you desire printed copies, let me know. If you have any further questions, do not hesitate to contact me.

Thank you for the time and care you will take to review this report.

Kevin Downing
Oregon DEQ
811 SW 6th Ave
Portland, Oregon 97204

503.229.6549

Comments Received and DEQ Responses on the February 2016 Draft

Agency	Section	Page #	Comment	Response
EPA	2.1.2	14	Show Smoke Mgt Plan has been submitted but not yet approved by EPA	DEQ has incorporated the change
EPA	2.3.6	21	If WRAP EI update not available, direct reader to section 3.4.1 for analysis of how statewide point source emission inventories have changed between 2002 and 2008	DEQ has incorporated the change
EPA	2.3.5	21	Add reference to Figure 5	DEQ has incorporated the change
EPA	2.3.12	24	Add a chart comparing overall visibility in each Class 1 area for 20% worst and best days between baseline, 2005-09 and 2009-13 periods.	DEQ has incorporated the change
EPA	2.3.12	24	Instead of showing the 2013 visibility in this table, more informative to identify 2018 RPGs for each Class 1 area	DEQ has incorporated the change
EPA	3.1	25	2nd paragraph, 2nd sentence. Eliminate rest of paragraph. 2013 RH guidance is controlling. That IMPROVE data was not available at the time when WRAP issued final report in 2013 does not eliminate DEQ responsibility to analyze more recent data, briefly reviewed in section 3.2.5	DEQ has incorporated the change
EPA	3.2	25	Revise the description of time periods in this section in accordance with the 2013 RH guidance	DEQ has incorporated the change
EPA	3.2.1	25	Table 13 does not show differences between the baseline and the 2005-09 period. Should cite Table 16 and 17 which compare visibility between the baseline and the 2005-09 period	DEQ has incorporated the change
EPA	3.2.1	25	When citing either COGO or CORI, with footnote or asterisk indicate in the Gorge and not Class 1 area.	DEQ has incorporated the change
EPA	3.2.1	26	Any information about trends in off-shore SO2 emissions during this period?	DEQ has incorporated the change
EPA	3.2.2	26	"current visibility" should be for period 2009-13; 2005-09 is referred to as "past five year"	DEQ has incorporated the change
EPA	3.2.2	26	first bullet: also mention that for 20% most impaired days organic matter caused the most visibility impairment at all sites, except in the Gorge	DEQ has incorporated the change
EPA	3.2.3	28	second bullet: also mention that for first progress period there was substantial increase in visibility impairment due to POM at HECA1 and KALM1	DEQ has incorporated the change
EPA	3.7	53	Good explanation potential impediments to progress at Three Sisters but what impediments exist at other locations? Wildfire at other Class 1 and marine emission in Kalmiopsis.	DEQ has incorporated the change
EPA	4	55	In addition a forward looking component requiring a qualitative assessment of progress expected by 2018. Should discuss measures and expected emission reductions for measures with compliance dates that have not yet become effective.	DEQ has incorporated the change

BLM			The minor thing is how the report uses the terms "fire", "natural events" in the context of fire, and "wildland fire". I believe the term "wildland fire" is used incorrectly in the report. By formal definition in the Federal Fire Policy, "wildland fire" includes both prescribed fire and wildfire. Similarly, human-caused wildfires are not considered "natural events". Natural causes of fires are lightning, volcanic eruptions and similar types of events not directly caused by humans. Perhaps less confusing terms might be "planned fires" and "unplanned fires". Planned fires are regulated, unplanned fires are not.	DEQ has incorporated the change
BLM			Where or how do Asian dust episodes fit into the analysis? While these are relatively rare, they can cause significant impacts to visibility. As far as I know, most such episodes occur in spring, although it has been several years since the last significant event.	DEQ has added to the discussion in Section 3.8
BLM			Where or how do the potential impacts of climate change fit in a report of this nature? One observed and predicted impact of warming temperatures is an increase in relative humidity, although I can't recall for certain if relative humidity has shown increase in Oregon. If it has, seems it would have done so in western Oregon more so than eastern Oregon due to the maritime influence. At any rate, as relative humidity increases, visibility declines. Haze caused by high relative humidity in summer is how the Smokey Mountains in east Tennessee got their name (well before pollutants were a factor). Climate change could contribute to increased incidence of Asian dust episodes as well. Lastly climate change is a significant factor in the increase in acres burned and fire severity on a westwide basis. There are several recent reports from forest and fire ecologists stating that the current approach to handling wildland fires is not sustainable. Fire season will continue to lengthen and we should expect to see the current trends in fire size and fire severity continue.	DEQ has added to the discussion in Section 3.8
USFS			We believe that Oregon Department of Environmental Quality (DEQ) has met the requirements established in 40 CFR 51.308(g), (h) and (i).	DEQ appreciates the comment
USFS			We concur with DEQ's assessment that ongoing reductions in nitrates and sulfates have led to a general improvement in visibility, though some areas, like Three Sisters and Kalmiopsis, have had issues pertaining to wildfires in the period of interest as noted.	DEQ appreciates the comment
USFS			USFS has secured funding for the Columbia Gorge site for the year.	DEQ appreciates the comment
NPS			Oregon DEQ has not discussed impacts of Oregon emissions on Class I areas in other states. Please add which Class I areas outside of Oregon are likely impacted by Oregon emissions.	DEQ has made the change and added a new section 2.3.12
NPS	Exec Summary, 2.3.10		Add data showing increased frequency of wildfire	DEQ has made the change and added Figure 6, Section 2.3.10
NPS	1.2	6	Should include USDA US Forest Service among federal agencies to be consulted.	DEQ has incorporated the change

NPS	1.5	11	DEQ characterized the contribution to visibility on 20% haziest days from organic carbon, primarily from wildfires that are episodic and highly variable. DEQ cites projected visibility improvement from sulfate and nitrate of about 20% by 2018. Please include data to support projected improvement. Through 2013 changes in light extinction due to sulfate and nitrate, in response to anthropogenic emission reductions are difficult to demonstrate given high interannual variability in contributions from organic and elemental carbon from wildfire.	In order to determine the significant sources contributing to haze in Oregon's Class I areas, the Department has relied upon source apportionment analysis techniques provided by the WRAP for the Oregon regional haze plan. This information can be found on the WRAP TSS website at http://vista.cira.colostate.edu/TSS/Results/HazePlanning.aspx. There were two techniques used for source apportionment of regional haze. One was the PM Source Apportionment Technology (PSAT) tool, used for the attribution of sulfate and nitrate sources only. It was this analytic tool that projects an approximately 20% reduction by 2018 (see Chapter 9 in the Oregon Regional Haze Plan.)
NPS	2.2,2.3, 3.3,3.3, 3.6		It is not sufficient to rely on 2008 WestJump emission inventory. Instead include 2011 emission from NEI or Intermountain West Data Warehouse, ideally presented in tables and charts.	The need for more recent emissions data is not necessary since the overall trend shows visibility is improving and exceeding the 2018 reasonable progress goals. The Department will evaluate more recent NEI data during the next update of the Regional Haze Plan.
NPS	2.2.2	17	Define smoke intrusion	DEQ has incorporated the change
NPS	2.2.2	17	Add estimated emission reductions from alternatives to burning	DEQ has incorporated the change
NPS	2.2.2	18	Prescribed fire acreage burned is shown in Table 10 but without emission information. Open burning emissions in 2008 and 2011 are shown in Table 12. Pleas add emissions to prescribed burning similar to what is displayed in Table 12.	DEQ has incorporated the change
NPS	2.3.5	21	Fix link to Figure 5	DEQ has incorporated the change
NPS	2.3.7	21	Cites an increase in ammonia from 2002 to 2011 and suggest prescribed fire is responsible for increase. Add 2011 data to Table 23 and/or Figure 13 in Section 3.4. Given that fire inventories are reported as an average of five years for 2002 and as single year inventories for 2008 and 2011, the change in ammonia emissions for fire is likely due to differences in reporting methods. We recommend removing the statement that prescribed fire is responsible for increased ammonia.	DEQ has incorporated the change
NPS	2.3.12	24	Table 13 should report both 2018 RPGs and 2018 URP. Comparison of baseline visibility conditions should be for five year average for 2009-13 rather than single year 2013. See http://vista.cira.colostate.edu/tss/Results/HazePlanning.aspx	Five year average for 2010-14 is shown. RPG is more aggressive than URP, whichis shown in Table 3.
NPS	3.1	25	IMPROVE data are now available through 2014 (http://views.cira.colostate.edu/fed/DataWizard/Default.aspx) and charts are available through WRAP TSS from 2009-13 (http://vista.cira.colostate.edu/tss/Results/HazePlanning.aspx). Update description on page 25 and indicate that Section 3.2.2 reports visibility trends in 2005-09, not current conditions. Data reported in Update do not necessarily reflect conditions resulting from more recent emission reduction strategy implementation.	IMPROVE data are updated to 2014. Labels for five year periods are corrected. Update reflects available data and also recognizes that not all strategies are fully implemented.

NPS	3.6	52	Requirements for BART were not implemented in Oregon until 2009 and later. Figure 20 is incomplete and should include emission data through 2014 for example from EPA Clean Air Markets.	DEQ has incorporated the change
NPS	4	55	Assuming OR DEQ revises draft report in response to recommendations, NPS agrees that substantive revision of the regional haze state implementation plan is not needed at this time.	DEQ appreciates the comment

APPENDIX K:

Oregon Class I Area Monitoring Data Summary Tables and Charts

Includes the following subsections:

Subsection	IMPROVE Monitor	Class I Area(s) Represented
K.1	COGO1	Columbia River Gorge*
K.2	CORI1	Columbia River Gorge*
K.3	CRLA1	Crater Lake NP, Diamond Peak WA, Gearhart Mountain WA, and Mountain Lakes WA
K.4	HECA1	Hells Canyon WA
K.5	KALM1	Kalmiopsis WA
K.6	MOHO1	Mount Hood WA
K.7	STAR1	Eagle Cap WA and Strawberry Mountain WA
K.8	THSI1	Three Sisters WA, Mount Jefferson WA, and Mount Washington WA

*Not a Federal CIA

K.1. COLUMBIA RIVER GORGE (COGO1)

The following tables and figures are presented in this section for the Columbia River Gorge represented by the COGO1 IMPROVE Monitor:

- **Table K.1-1: Annual Averages, 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 K.1-1: Annual and Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

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

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

- **Figure K.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 K.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 K.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.

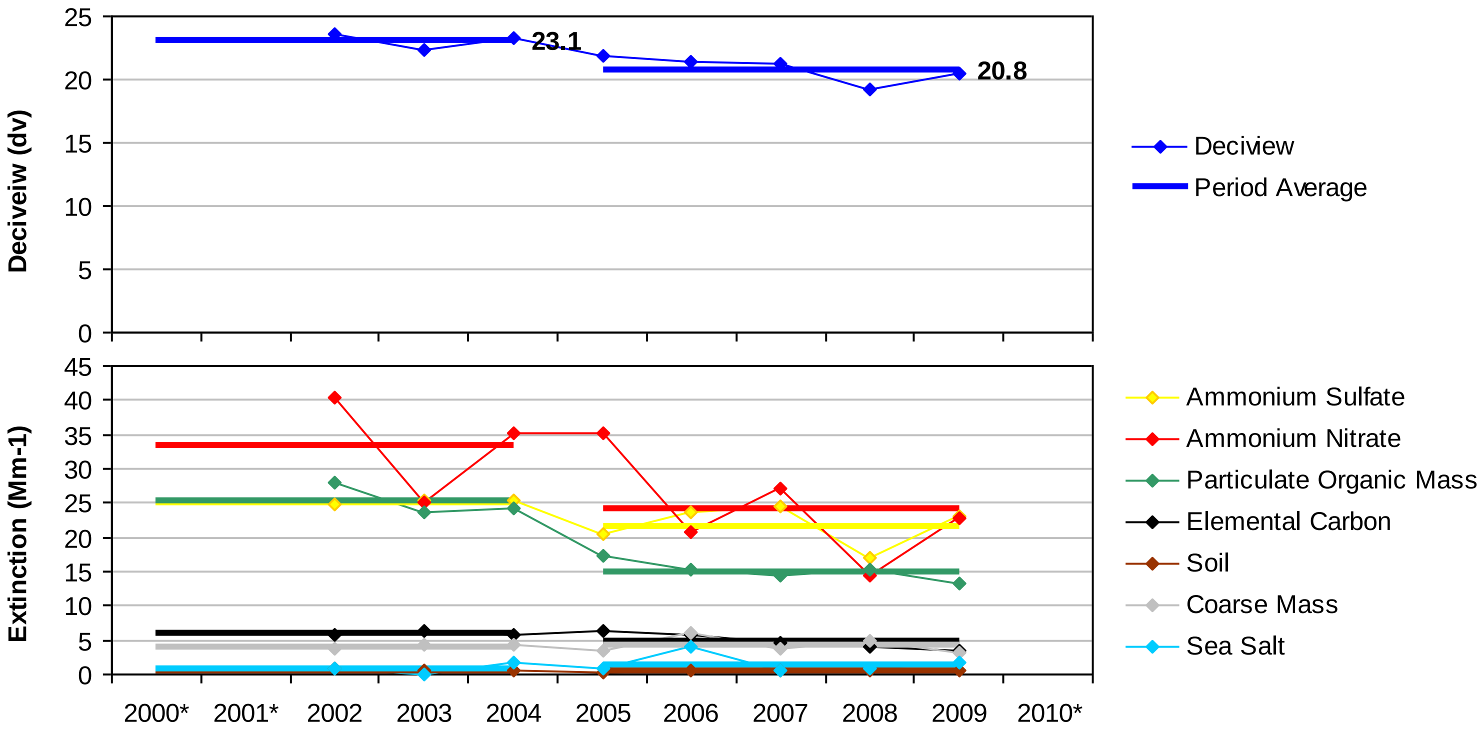
- **Figure K.1-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

Table K.1-1
Columbia River Gorge, WA (COGO1 Site)
Annual Averages, 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	---	---	9.5	8.4	9.9	9.6	8.6	9.0	9.5	9.4	---	0.0	0.5	9.3	9.2	-0.1	-1%
Worst 20% Days	---	---	23.6	22.4	23.3	21.9	21.4	21.2	19.2	20.5	---	-0.5	0.0	23.1	20.8	-2.3	-10%
All Days	---	---	16.0	15.4	16.4	15.5	14.8	14.6	14.1	15.1	---	-0.3	0.0	16.0	14.8	-1.2	-8%
Total Extinction (Mm-1)																	
Best 20% Days	---	---	26.3	23.4	27.4	26.4	23.8	24.9	25.9	26.0	---	0.0	0.6	25.7	25.4	-0.3	-1%
Worst 20% Days	---	---	116.3	97.5	109.1	96.1	88.2	87.5	69.3	80.1	---	-5.7	0.0	107.6	84.3	-23.3	-22%
All Days	---	---	57.9	53.0	58.7	52.9	49.2	48.1	43.7	49.1	---	-1.9	0.0	56.5	48.6	-7.9	-14%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	---	---	4.7	3.0	4.7	4.5	3.1	3.5	4.1	4.4	---	-0.1	0.4	4.1	3.9	-0.2	-5%
Worst 20% Days	---	---	24.9	25.3	25.4	20.4	23.5	24.5	17.1	23.2	---	-0.3	0.1	25.2	21.8	-3.4	-14%
All Days	---	---	13.8	12.8	13.5	12.0	11.9	11.4	10.2	13.0	---	-0.4	0.0	13.4	11.7	-1.7	-13%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	---	---	2.5	2.5	2.8	2.5	1.9	2.2	1.9	2.2	---	-0.1	0.0	2.6	2.1	-0.5	-19%
Worst 20% Days	---	---	40.5	25.1	35.2	35.2	20.9	27.2	14.5	22.9	---	-2.6	0.0	33.6	24.1	-9.5	-28%
All Days	---	---	13.4	9.9	13.0	11.6	8.1	9.1	6.0	9.1	---	-0.8	0.0	12.1	8.8	-3.3	-27%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	---	---	3.4	3.2	3.5	3.3	2.6	3.3	4.3	3.4	---	0.0	0.4	3.3	3.4	0.1	3%
Worst 20% Days	---	---	27.9	23.8	24.3	17.4	15.2	14.3	15.2	13.2	---	-2.1	0.0	25.3	15.1	-10.2	-40%
All Days	---	---	10.7	10.4	11.4	8.8	7.7	7.6	8.2	7.8	---	-0.4	0.0	10.9	8.0	-2.9	-27%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	---	---	1.6	1.4	1.5	1.6	1.4	1.5	1.4	1.2	---	0.0	0.1	1.5	1.4	-0.1	-7%
Worst 20% Days	---	---	5.8	6.3	5.8	6.5	5.9	4.7	4.2	3.3	---	-0.4	0.0	5.9	4.9	-1.0	-17%
All Days	---	---	3.2	3.4	3.4	4.0	3.3	2.9	2.5	2.3	---	-0.2	0.1	3.3	3.0	-0.3	-9%
Soil Extinction (Mm-1)																	
Best 20% Days	---	---	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	---	0.0	0.1	0.1	0.1	0.0	0%
Worst 20% Days	---	---	0.7	0.6	0.5	0.3	0.6	0.5	0.7	0.6	---	0.0	0.5	0.6	0.6	0.0	0%
All Days	---	---	0.5	0.4	0.4	0.3	0.4	0.4	0.4	0.4	---	0.0	0.6	0.4	0.4	0.0	0%
Coarse Mass Extinction (Mm-1)																	
Best 20% Days	---	---	0.9	0.7	1.2	1.0	0.8	1.0	1.0	1.3	---	0.0	0.1	0.9	1.0	0.1	11%
Worst 20% Days	---	---	3.8	4.3	4.3	3.6	6.2	3.8	4.9	3.1	---	0.0	0.5	4.1	4.3	0.2	5%
All Days	---	---	3.2	3.1	3.2	2.9	3.3	3.0	2.8	2.8	---	-0.1	0.1	3.2	3.0	-0.2	-6%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	---	---	1.0	0.6	1.7	1.4	1.7	1.1	1.1	1.4	---	0.0	0.3	1.1	1.3	0.2	18%
Worst 20% Days	---	---	0.8	0.1	1.7	0.7	3.9	0.5	0.8	1.8	---	0.1	0.2	0.9	1.6	0.7	78%
All Days	---	---	1.1	1.0	1.8	1.3	2.5	1.7	1.6	1.7	---	0.1	0.2	1.3	1.8	0.5	39%

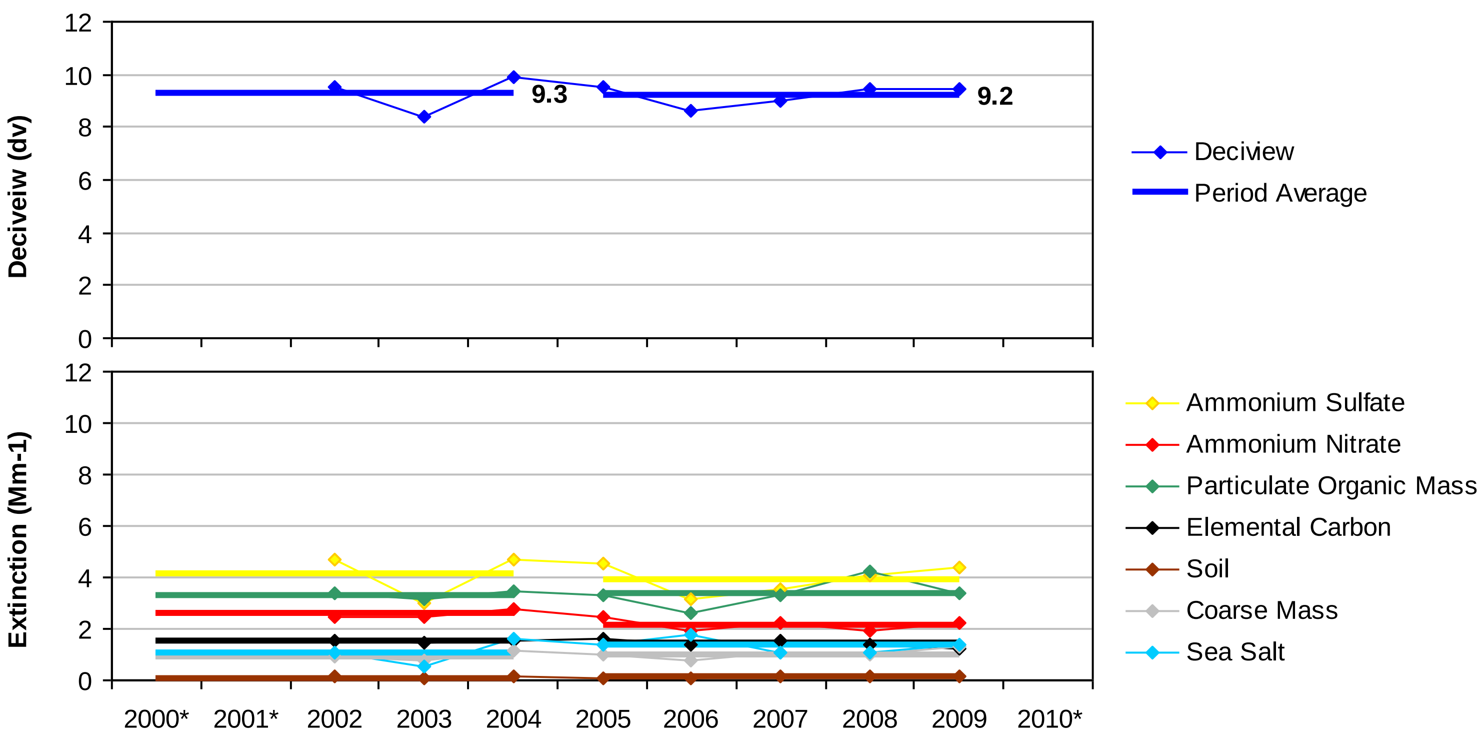
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---"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

Figure K.1-1
Columbia River Gorge, WA (COGO1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days



*Missing years did not meet RHR data completeness criteria.

Figure K.1-2
Columbia River Gorge, WA (COGO1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days

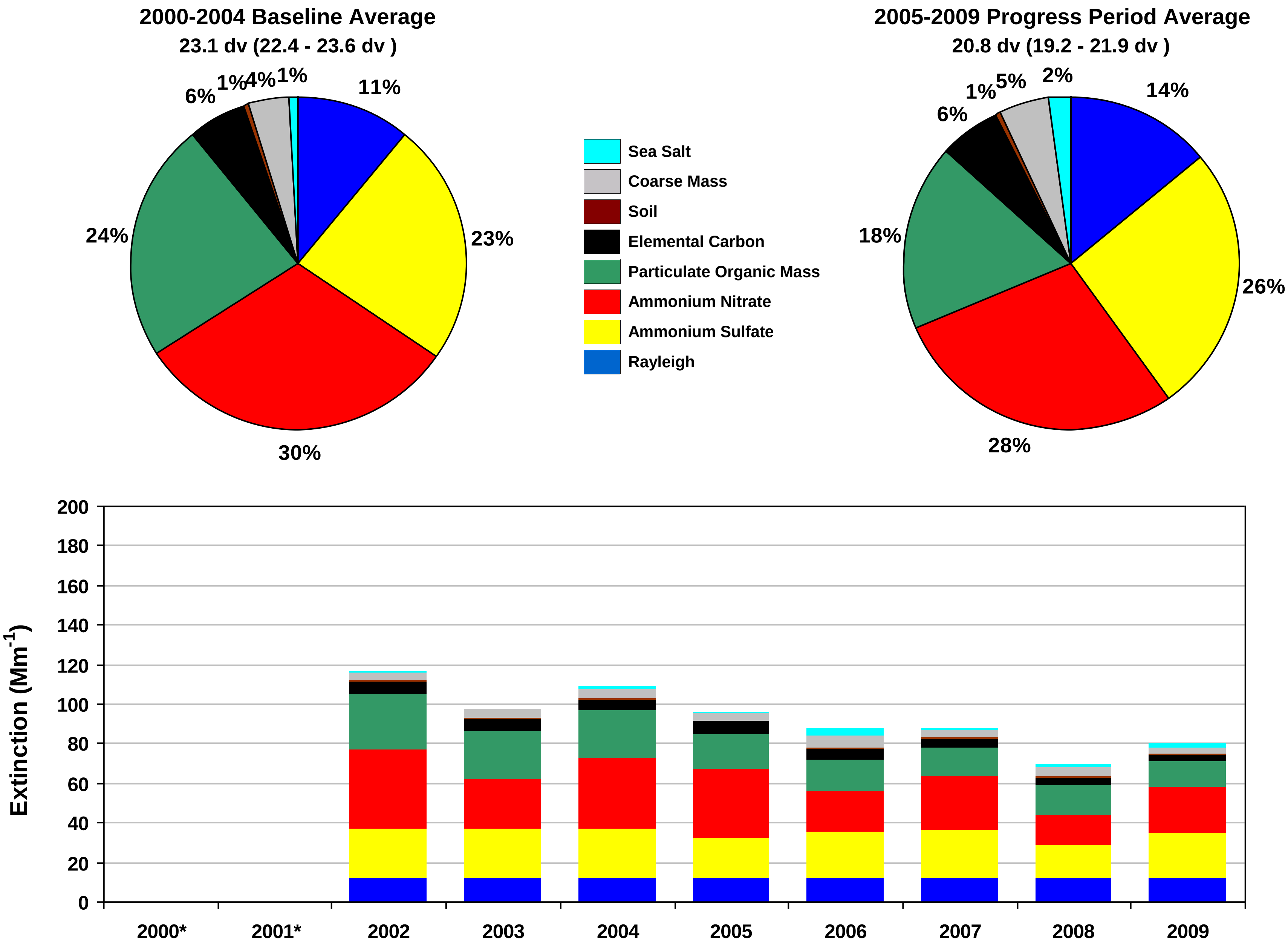


*Missing years did not meet RHR data completeness criteria.

Figure K.1-3

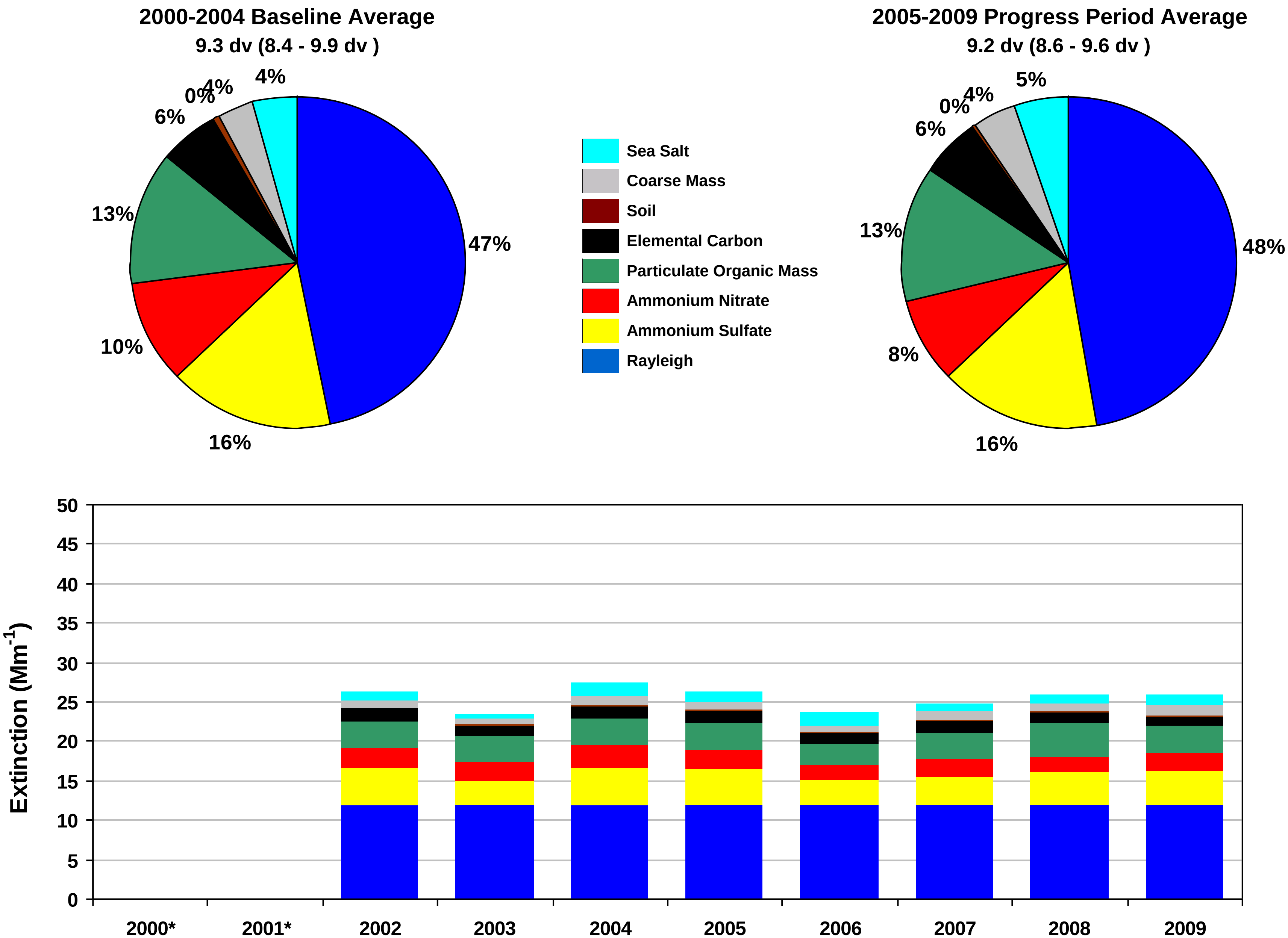
Columbia River Gorge, WA (COGO1 Site)

20% Most Impaired Visibility Days



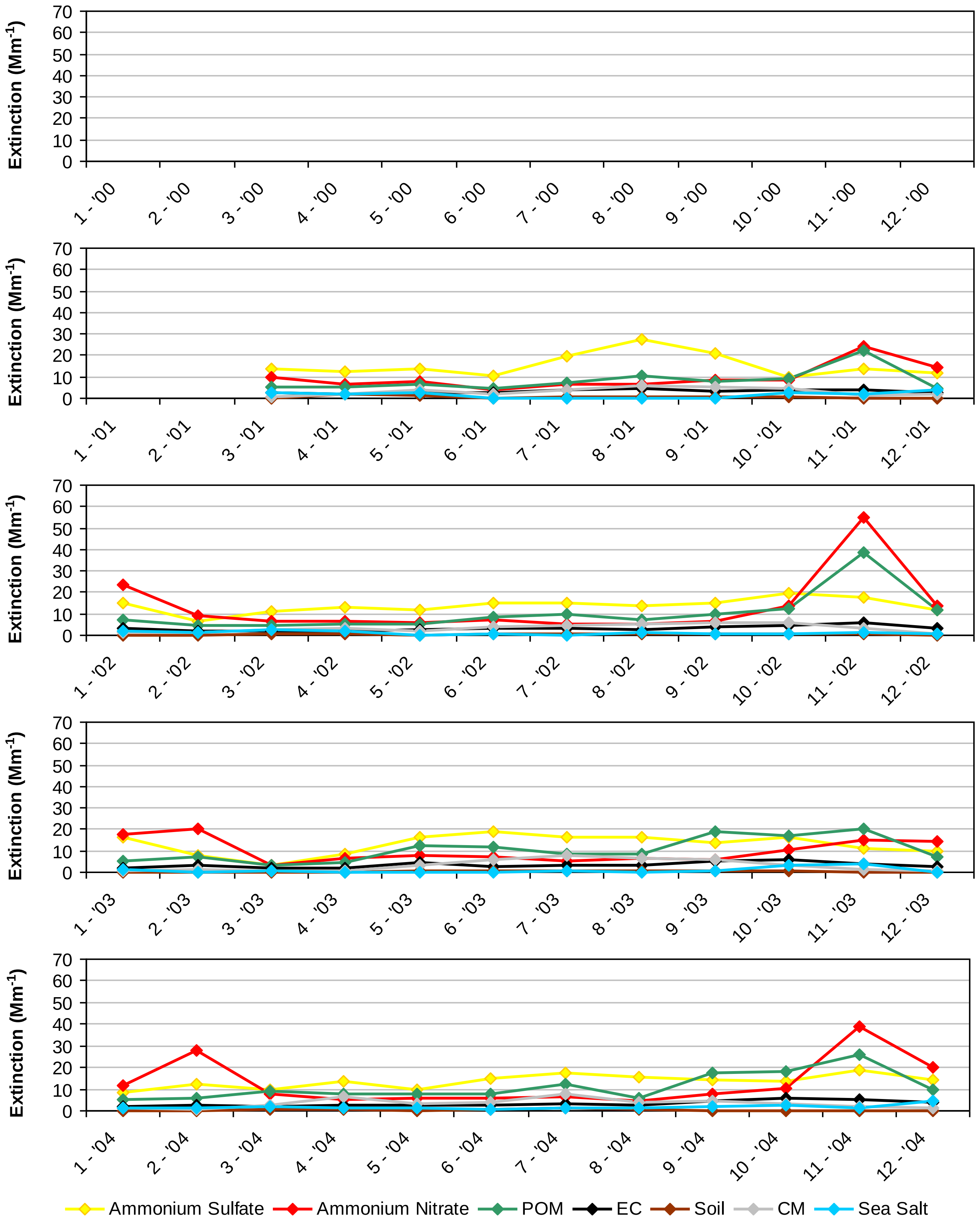
*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.1-4
Columbia River Gorge, WA (COGO1 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 K.1-5
Columbia River Gorge, WA (COGO1 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 K.1-6
Columbia River Gorge, WA (COGO1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days

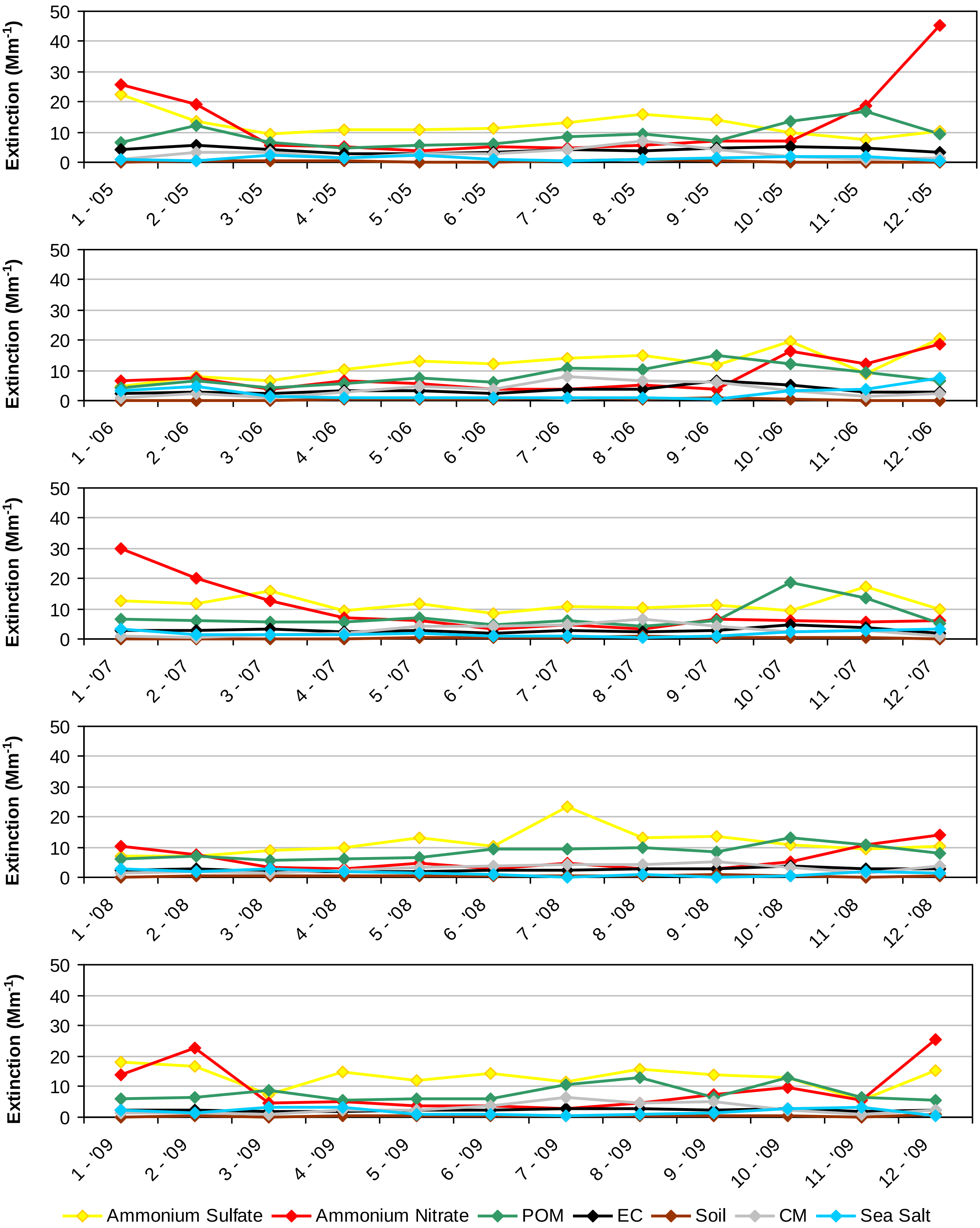
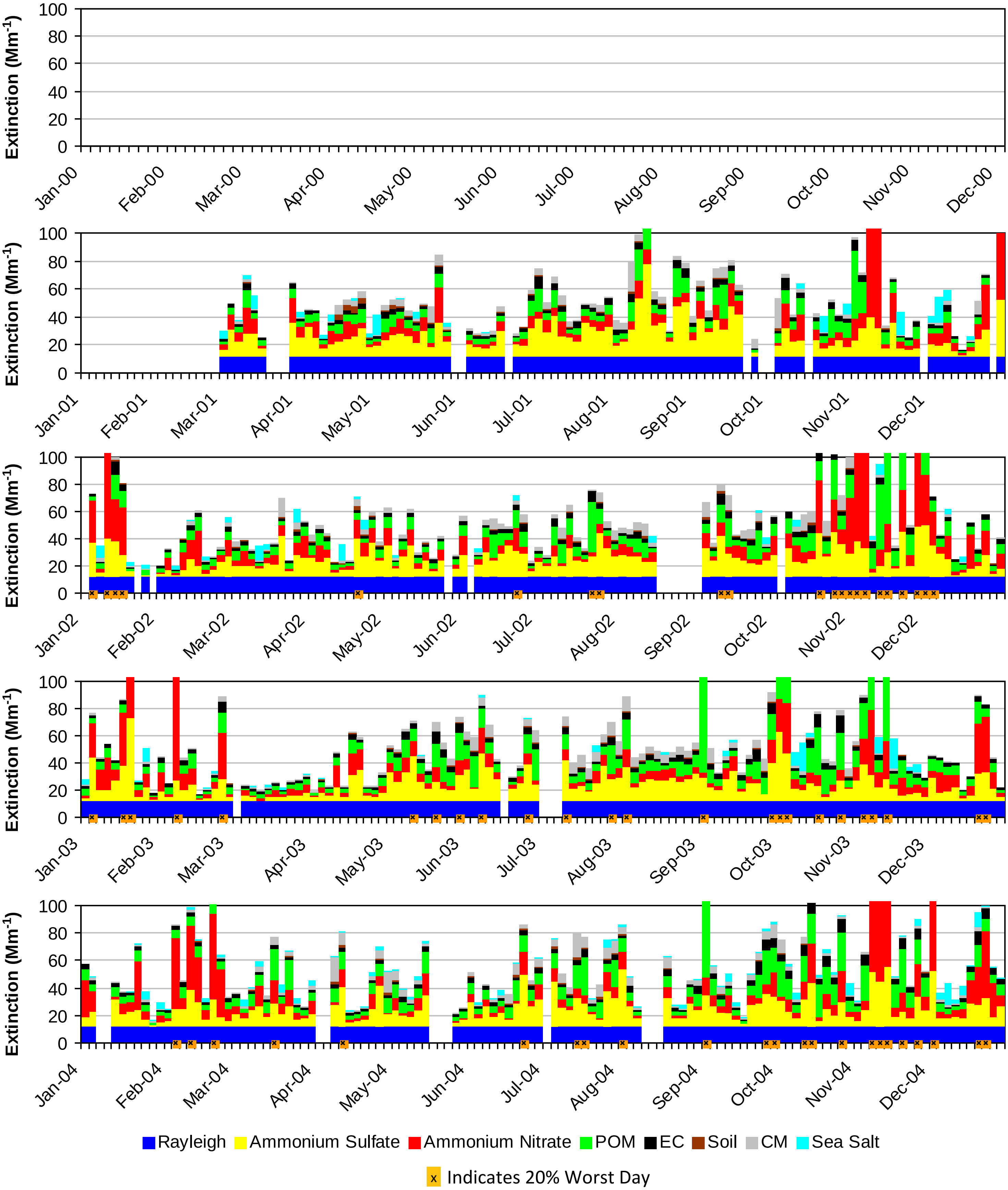
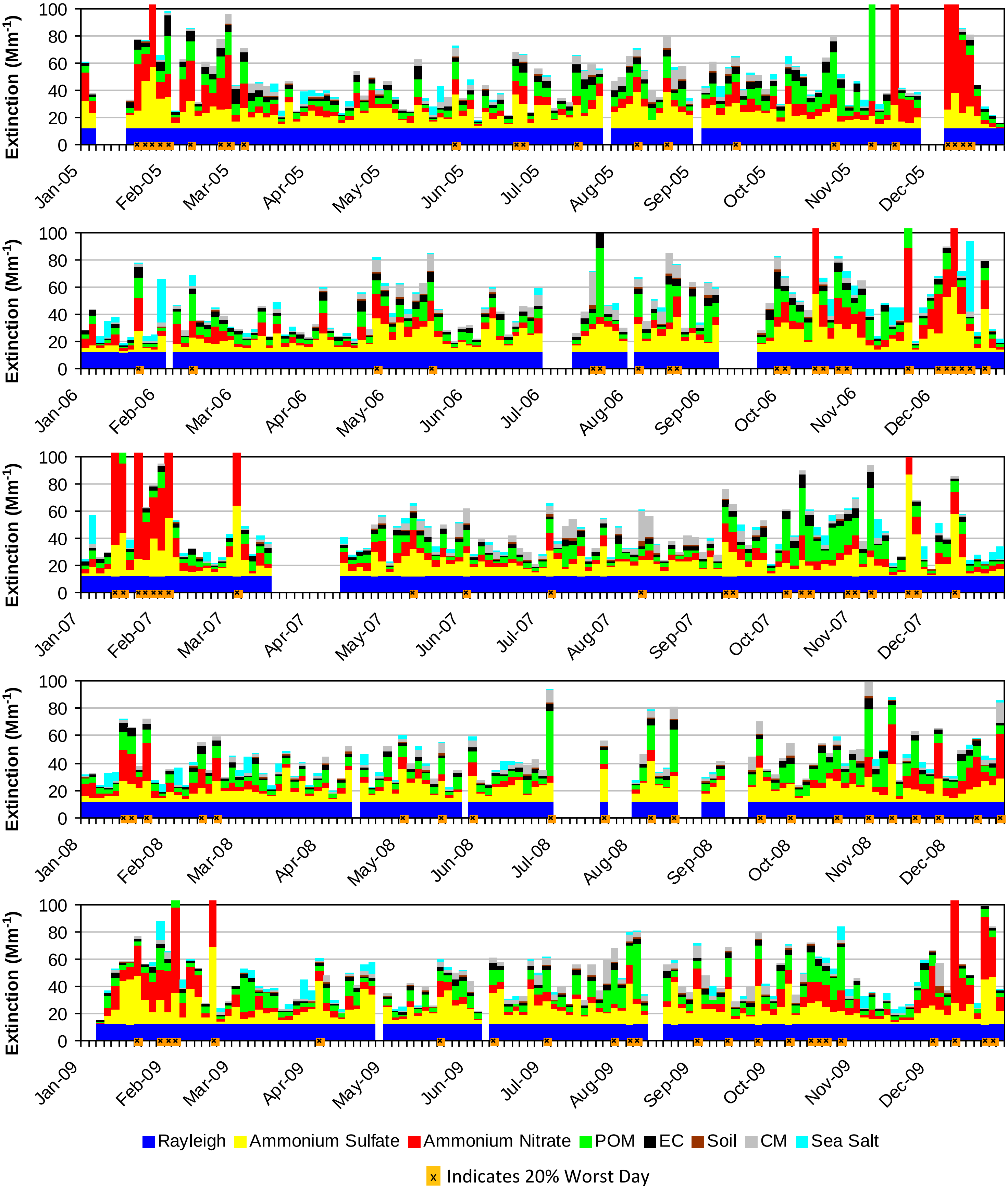


Figure K.1-7
Columbia River Gorge, WA (COGO1 Site)
2000-2004 Progress Period Extinction, All Sampled Days



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

Figure K.1-8
Columbia River Gorge, WA (COGO1 Site)
2005-2009 Progress Period Extinction, All Sampled Days



K.2. COLUMBIA RIVER GORGE (CORI1)

The following tables and figures are presented in this section for the Columbia River Gorge represented by the COGO1 IMPROVE Monitor:

- **Table K.2-1: Annual Averages, 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 K.2-1: Annual and Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

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

- **Figure K.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 K.2-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure K.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 K.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 K.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.

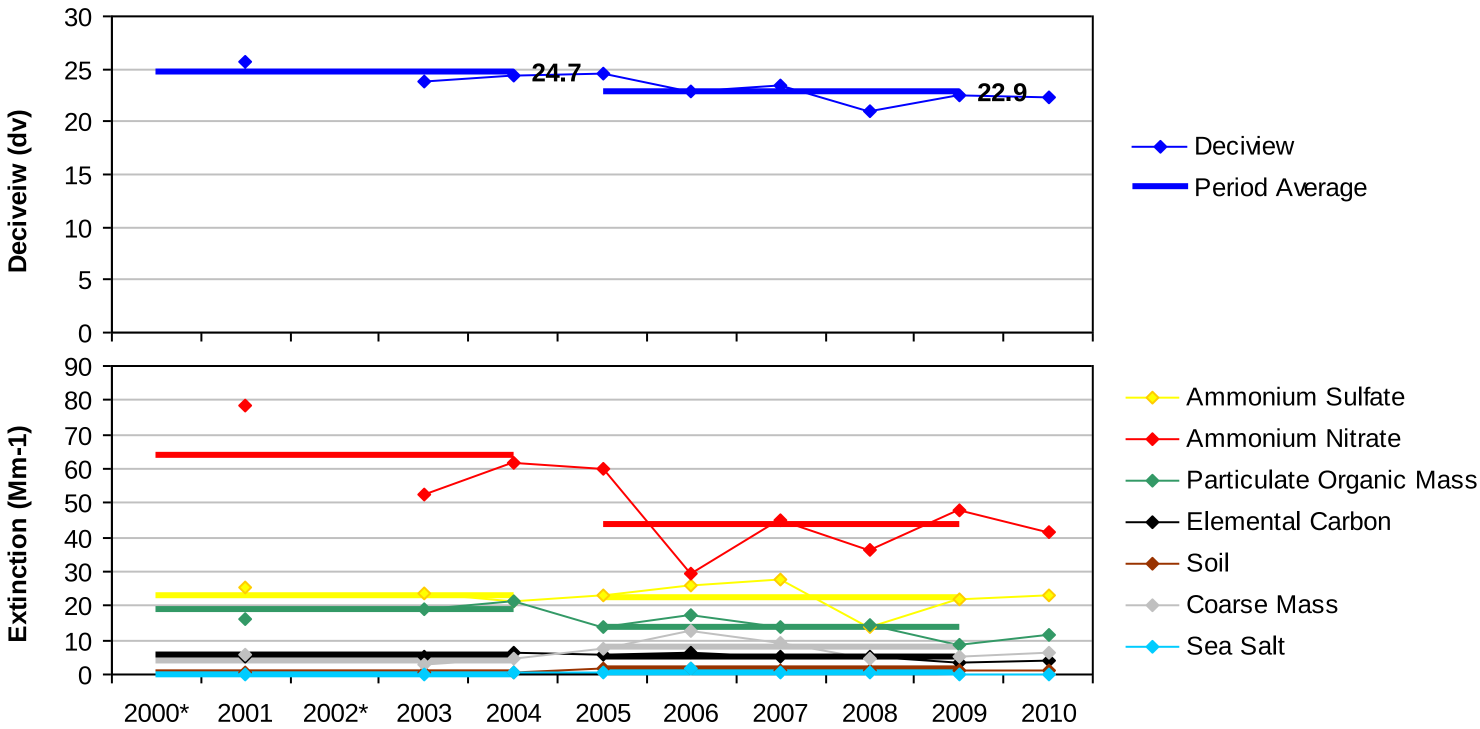
- **Figure K.2-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

Table K.2-1
Columbia River Gorge, WA (CORI1 Site)
Annual Averages, Period Averages and Trends

Group	Baseline Period					Progress Period					2010	2000-2009 Trend Statistics*		Period Averages**			
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009		Slope (change/yr.)	p-value	Baseline (B)	Progress (P)	Difference (P -B)	Percent Change
Deciview (dv)																	
Best 20% Days	---	10.7	---	8.6	9.7	10.7	10.8	10.2	8.7	9.2	9.1	-0.1	0.5	9.6	9.9	0.3	3%
Worst 20% Days	---	25.8	---	23.9	24.4	24.6	22.9	23.4	21.0	22.6	22.3	-0.4	0.0	24.7	22.9	-1.8	-7%
All Days	---	16.6	---	15.3	16.4	16.8	16.1	15.6	14.2	15.1	14.7	-0.2	0.1	16.1	15.5	-0.6	-4%
Total Extinction (Mm-1)																	
Best 20% Days	---	29.2	---	23.7	26.5	29.4	29.5	27.9	24.0	25.4	24.9	-0.2	0.5	26.5	27.3	0.8	3%
Worst 20% Days	---	142.7	---	115.8	129.0	124.7	106.5	114.7	88.3	99.9	99.6	-5.2	0.0	129.2	106.8	-22.4	-17%
All Days	---	63.7	---	54.8	61.5	62.1	56.5	55.3	46.6	51.4	49.8	-1.7	0.0	60.0	54.4	-5.6	-9%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	---	6.3	---	3.6	3.6	5.2	4.1	4.0	3.8	3.9	3.2	-0.1	0.3	4.5	4.2	-0.3	-7%
Worst 20% Days	---	25.1	---	23.5	21.2	23.2	25.8	27.6	14.0	21.9	23.0	-0.3	0.4	23.3	22.5	-0.8	-3%
All Days	---	13.9	---	11.4	11.5	11.3	11.8	10.9	8.8	11.1	9.7	-0.2	0.0	12.3	10.8	-1.5	-12%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	---	2.4	---	2.3	2.2	2.7	2.5	3.2	1.8	2.3	2.2	0.0	0.5	2.3	2.5	0.2	9%
Worst 20% Days	---	78.6	---	52.4	61.7	59.9	29.4	45.2	36.1	47.6	41.4	-4.3	0.1	64.2	43.6	-20.6	-32%
All Days	---	20.0	---	13.8	17.2	16.9	10.1	13.1	11.0	13.2	11.8	-0.9	0.1	17.0	12.9	-4.1	-24%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	---	2.6	---	2.5	2.9	3.0	2.8	2.6	2.7	2.4	2.1	0.0	0.3	2.7	2.7	0.0	0%
Worst 20% Days	---	15.9	---	19.1	21.6	14.0	17.1	13.9	14.5	8.4	11.7	-1.1	0.1	18.9	13.6	-5.3	-28%
All Days	---	8.0	---	10.1	10.5	8.1	8.2	6.8	6.9	6.3	5.8	-0.6	0.1	9.5	7.3	-2.2	-23%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	---	1.4	---	1.5	1.6	1.6	1.8	1.4	1.3	1.3	1.2	0.0	0.3	1.5	1.5	0.0	0%
Worst 20% Days	---	5.0	---	5.2	6.6	5.8	6.1	5.1	5.1	3.5	3.8	-0.2	0.2	5.6	5.1	-0.5	-9%
All Days	---	3.0	---	3.3	3.6	3.5	3.5	2.9	2.8	2.3	2.3	-0.1	0.1	3.3	3.0	-0.3	-9%
Soil Extinction (Mm-1)																	
Best 20% Days	---	0.4	---	0.2	0.3	0.8	0.7	0.3	0.5	0.5	0.4	0.0	0.3	0.3	0.6	0.3	100%
Worst 20% Days	---	0.7	---	0.8	0.6	1.8	1.9	1.2	1.4	1.2	1.1	0.1	0.2	0.7	1.5	0.8	>100%
All Days	---	0.9	---	0.6	0.7	1.7	1.4	0.9	1.2	1.2	0.9	0.1	0.1	0.7	1.3	0.6	86%
Coarse Mass Extinction (Mm-1)																	
Best 20% Days	---	3.1	---	1.4	2.6	3.1	4.0	2.9	1.4	2.1	2.8	-0.1	0.4	2.4	2.7	0.3	13%
Worst 20% Days	---	5.5	---	2.9	4.6	7.6	12.5	9.2	4.6	5.2	6.4	0.4	0.4	4.3	7.8	3.5	81%
All Days	---	5.4	---	2.8	4.7	7.7	7.9	7.7	3.3	4.4	6.4	0.0	0.6	4.3	6.2	1.9	44%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	---	0.9	---	0.2	1.3	1.0	1.6	1.6	0.4	1.1	1.0	0.0	0.2	0.8	1.1	0.3	38%
Worst 20% Days	---	0.0	---	0.0	0.7	0.5	1.7	0.3	0.6	0.1	0.1	0.0	0.3	0.2	0.6	0.4	>100%
All Days	---	0.7	---	0.7	1.2	0.9	1.7	1.1	0.7	0.9	0.9	0.0	0.3	0.8	1.0	0.2	25%

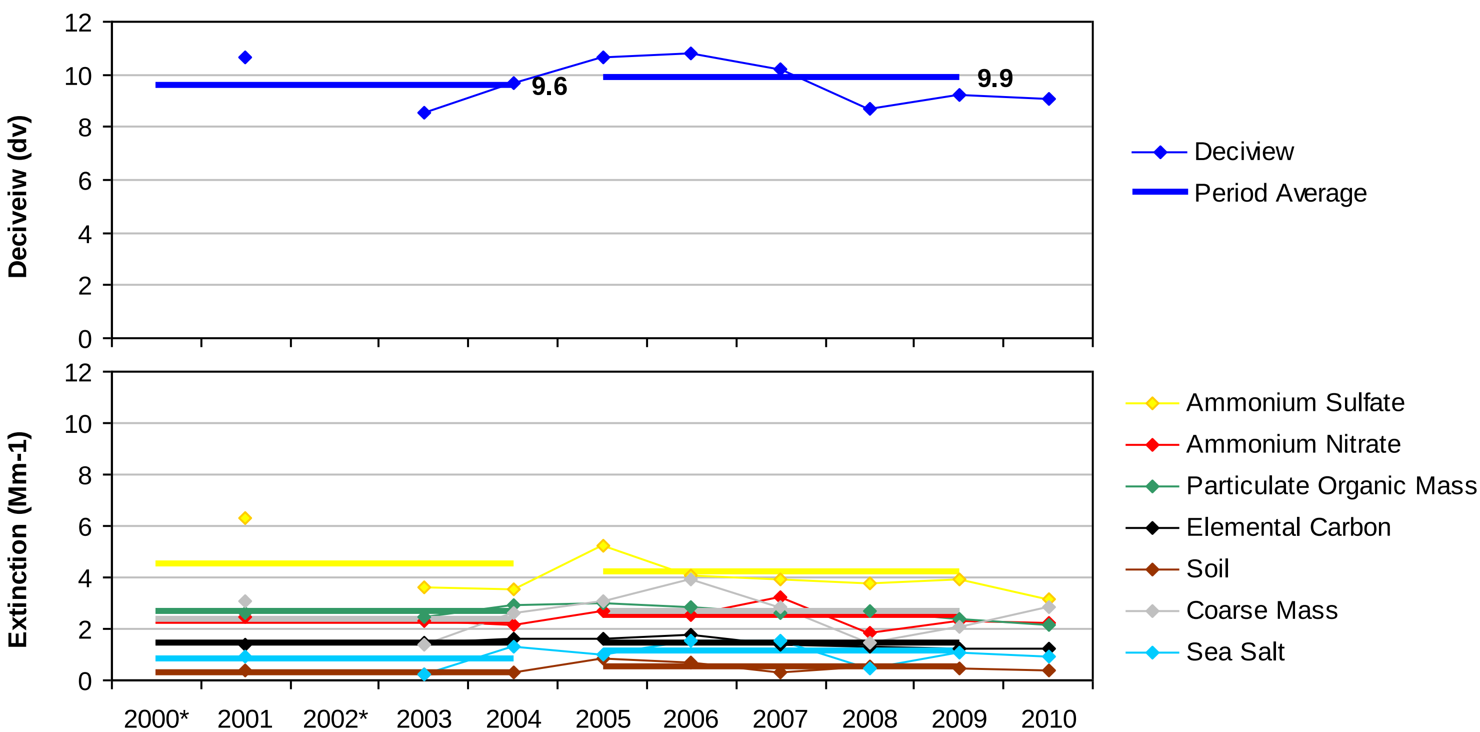
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---"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

Figure K.2-1
Columbia River Gorge, WA (CORI1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days



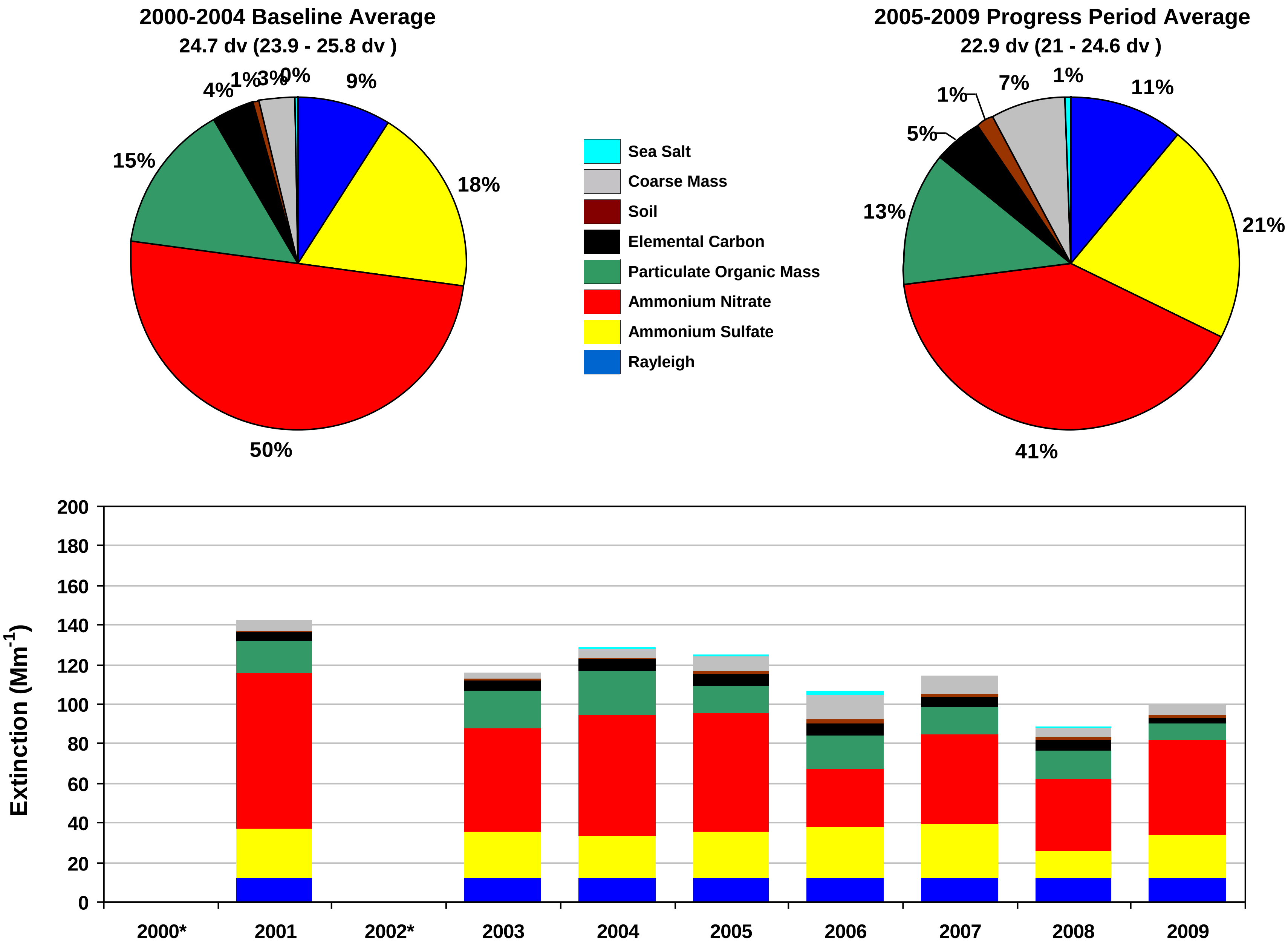
*Missing years did not meet RHR data completeness criteria.

Figure K.2-2
Columbia River Gorge, WA (CORI1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days



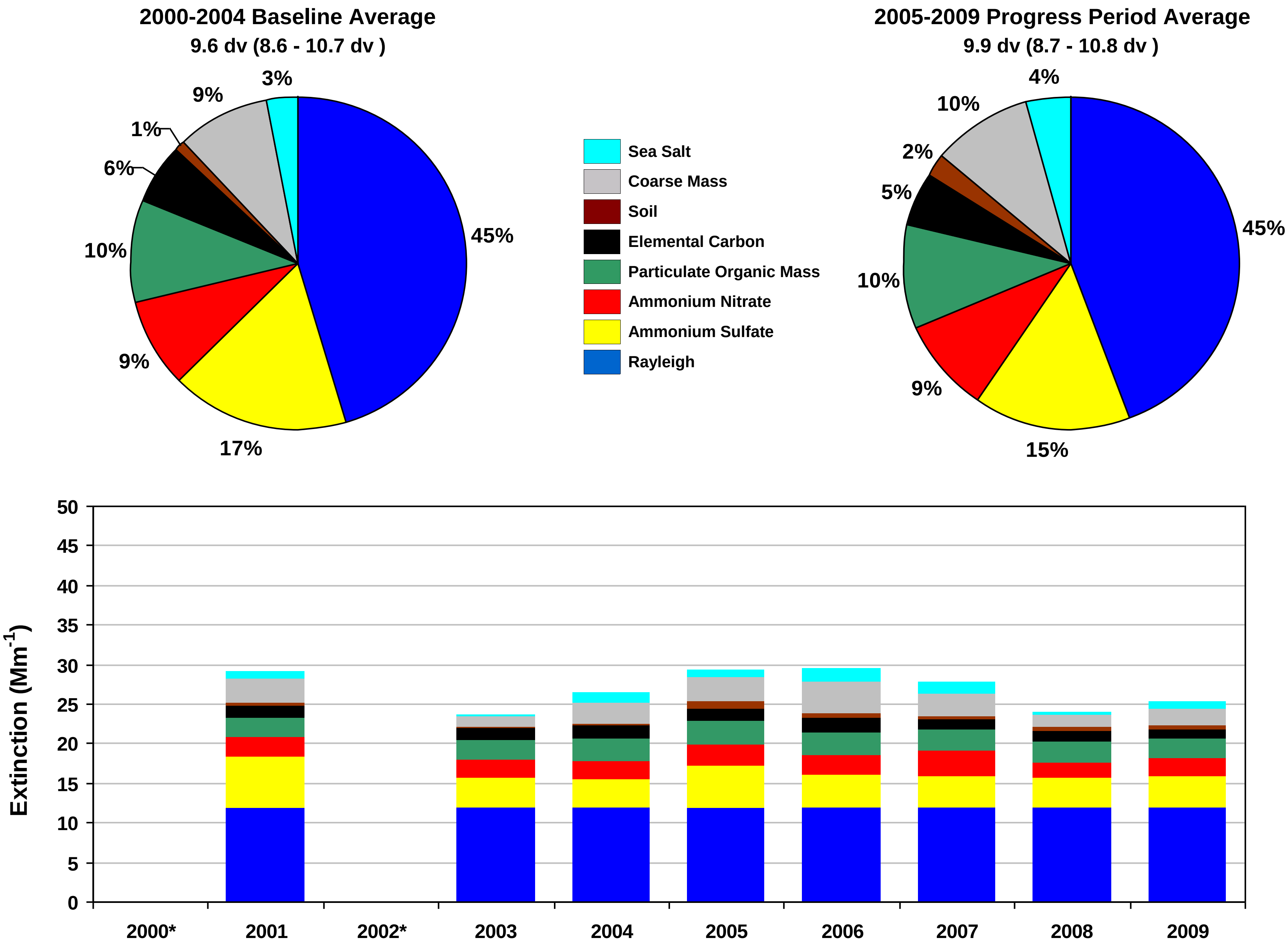
*Missing years did not meet RHR data completeness criteria.

Figure K.2-3
Columbia River Gorge, WA (CORI1 Site)
20% Most Impaired Visibility Days



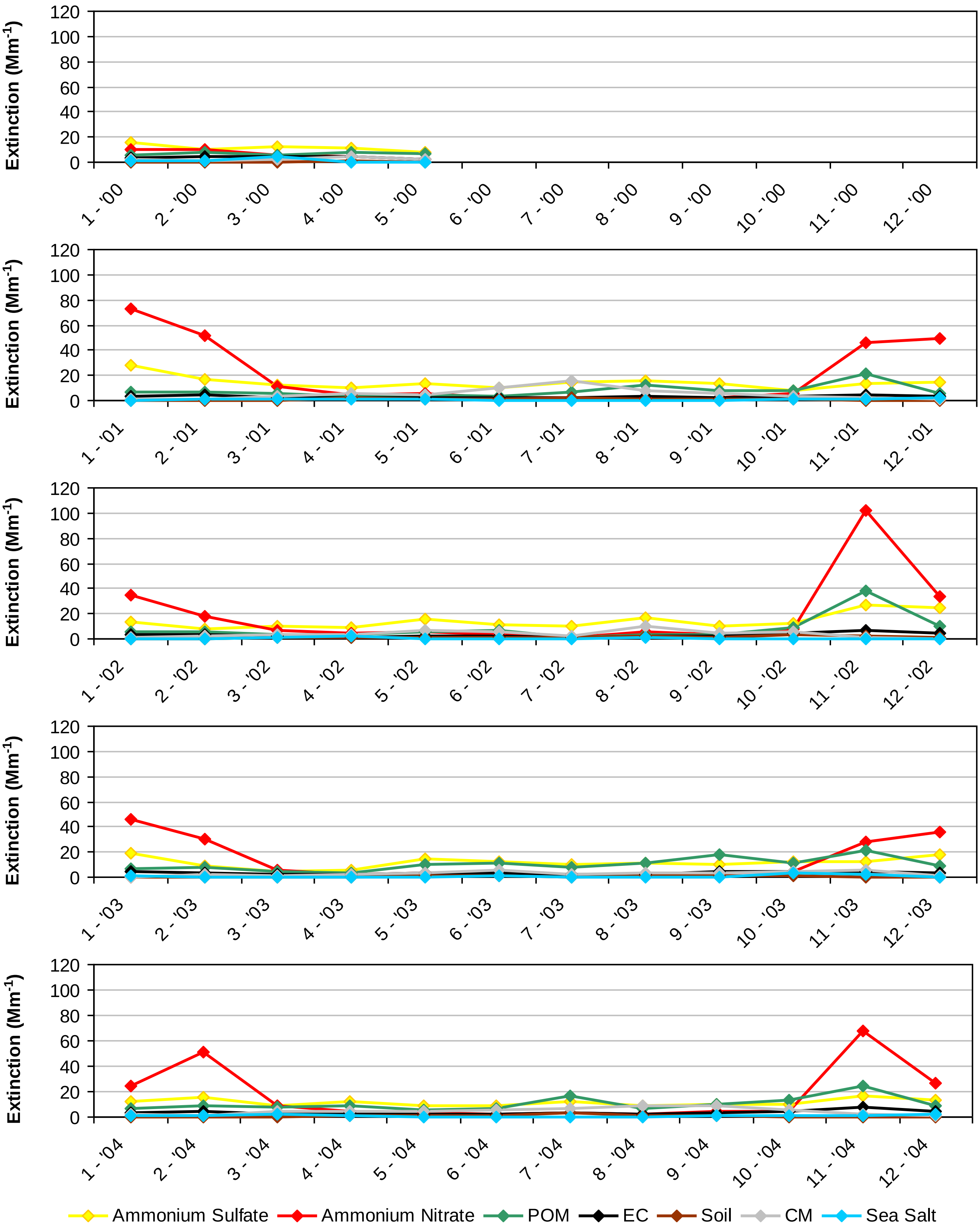
*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.2-4
Columbia River Gorge, WA (CORI1 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 K.2-5
Columbia River Gorge, WA (CORI1 Site)
2000-2004 Monthly Average Aerosol Extinction, All Monitored Days



*Note that monthly averages for the years 2000 and 2002 are shown here, but these years did not meet RHR data completeness criteria.

Figure K.2-6
Columbia River Gorge, WA (CORI1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days

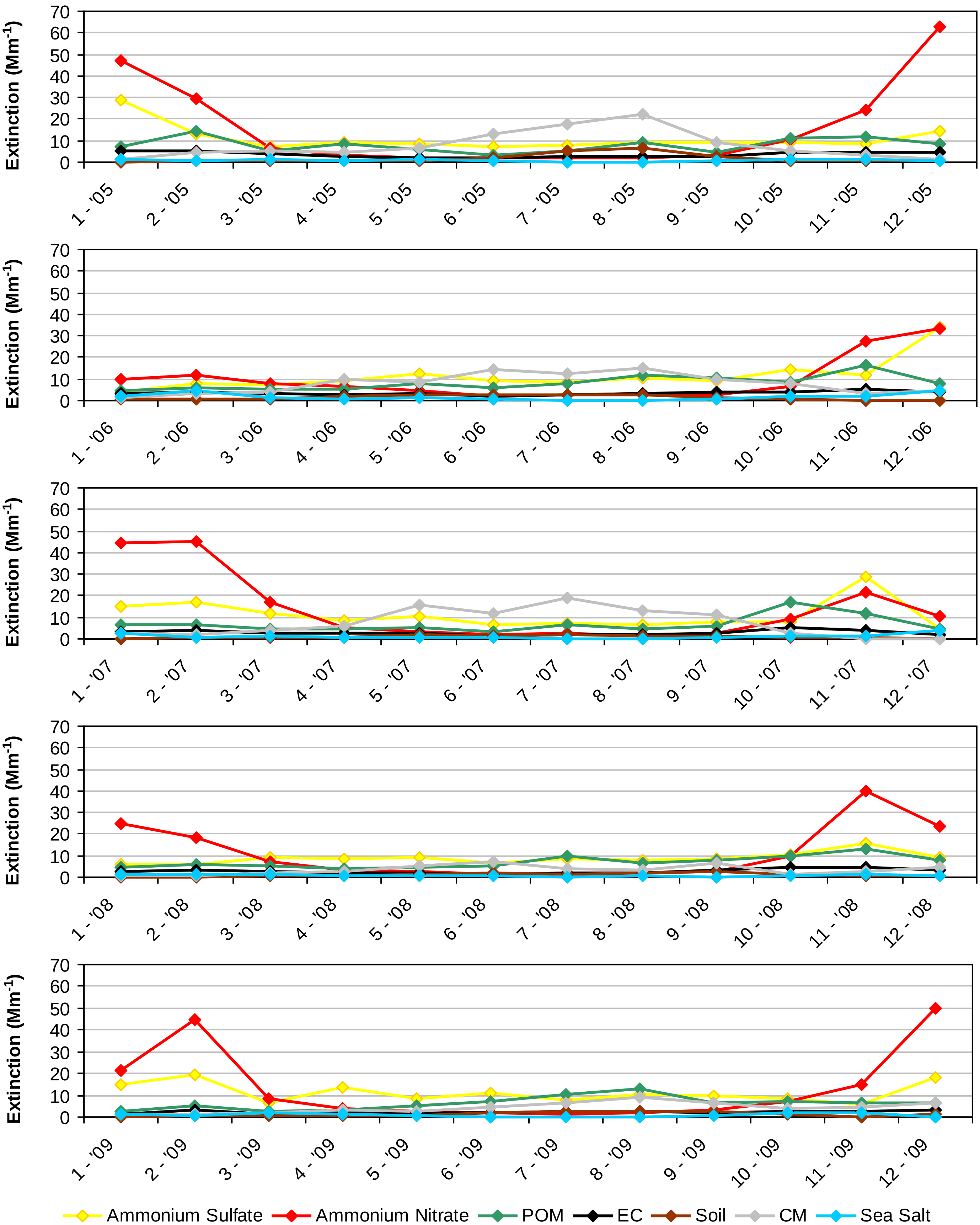
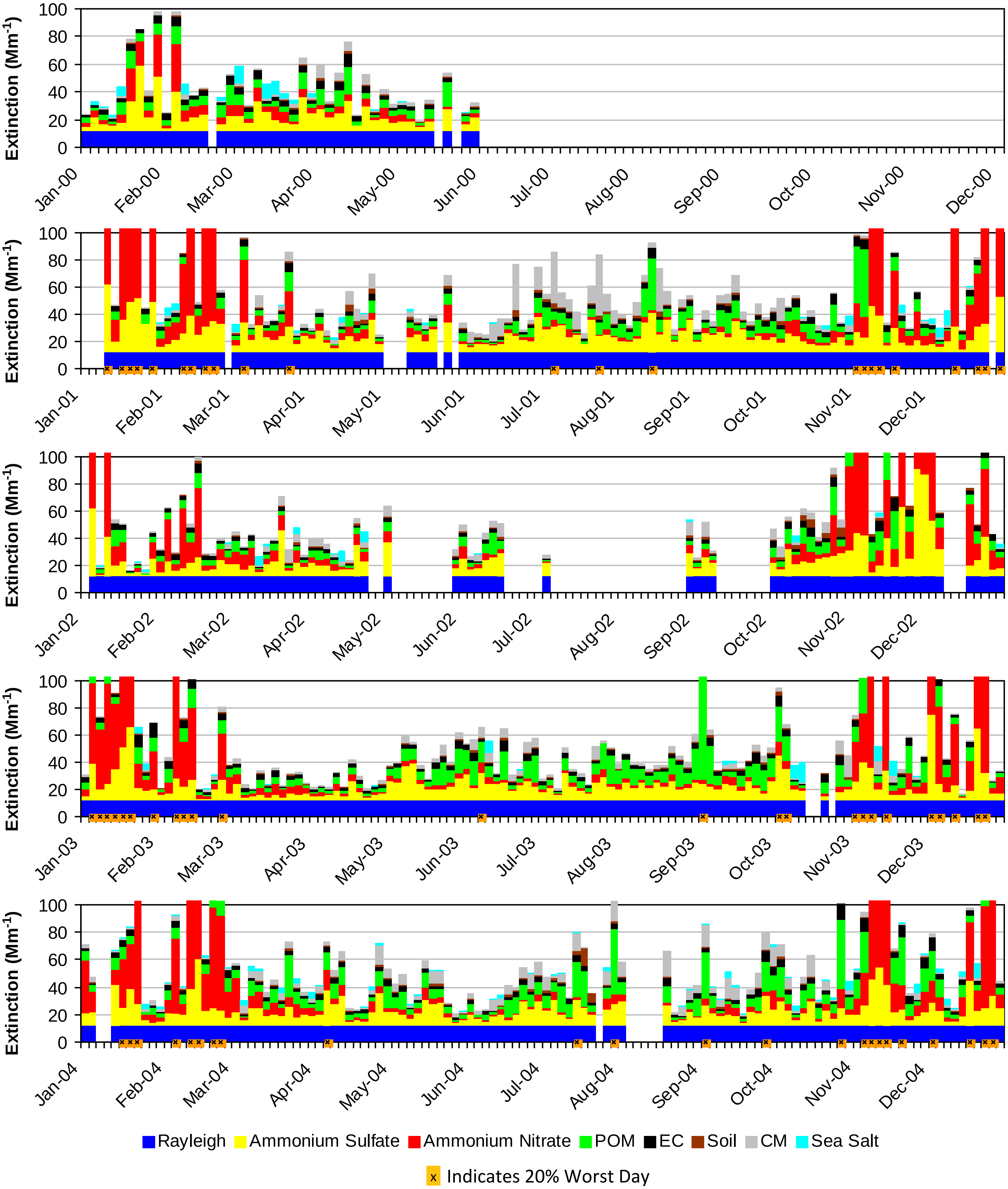
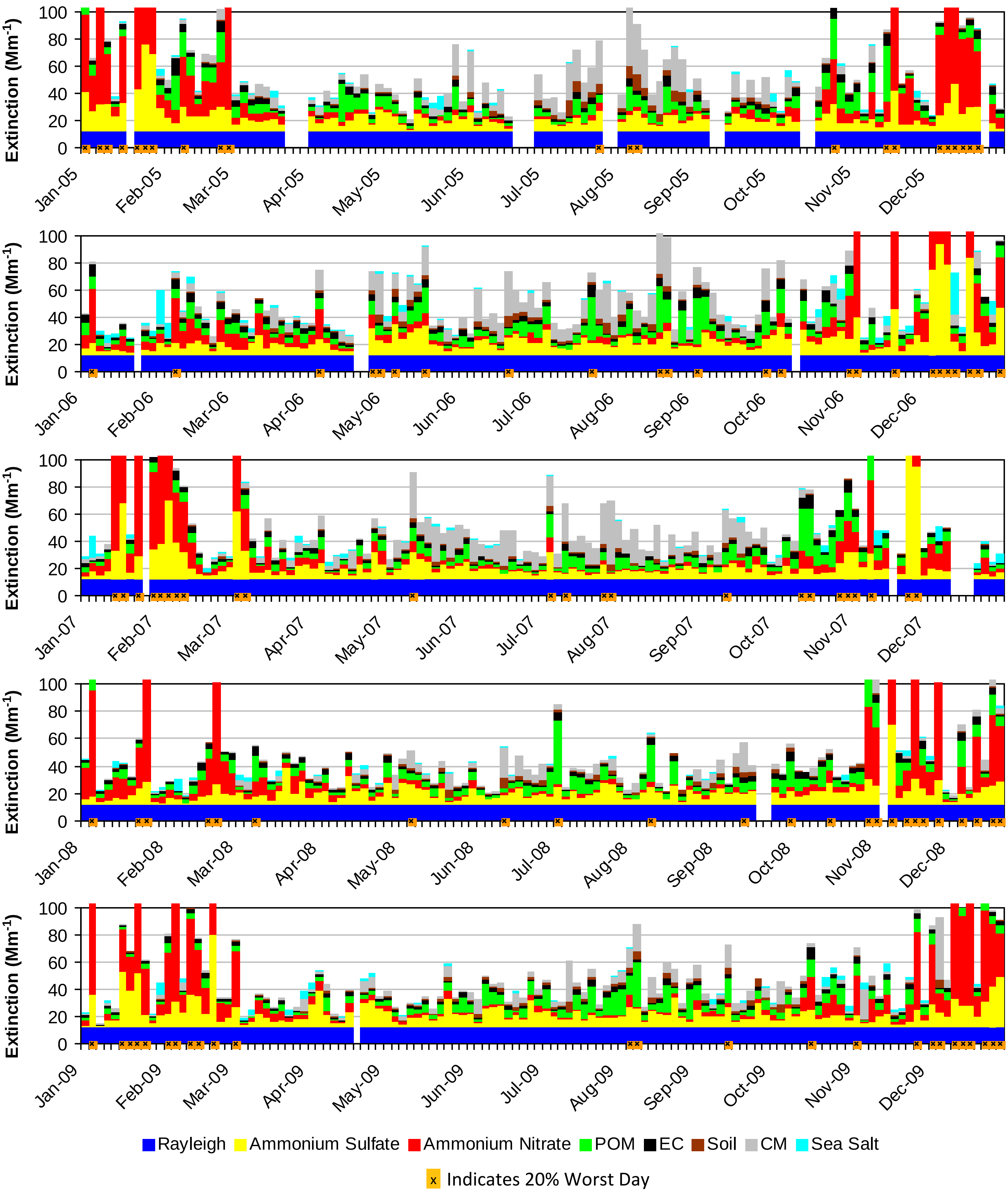


Figure K.2-7
Columbia River Gorge, WA (CORI1 Site)
2000-2004 Progress Period Extinction, All Sampled Days



*Note that daily averages for the years 2000 and 2002 are shown here, but these years did not meet RHR data completeness criteria.

Figure K.2-8
Columbia River Gorge, WA (CORI1 Site)
2005-2009 Progress Period Extinction, All Sampled Days



K.3. CRATER LAKE NP, DIAMOND PEAK WA, GEARHART MOUNTAIN WA, AND MOUNTAIN LAKES WA (CRLA1)

The following tables and figures are presented in this section for the Crater Lake NP, Diamond Peak WA, Gearhart Mountain WA, and Mountain Lakes WA represented by the CRLA1 IMPROVE Monitor:

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

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

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

- **Figure K.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 K.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 K.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.

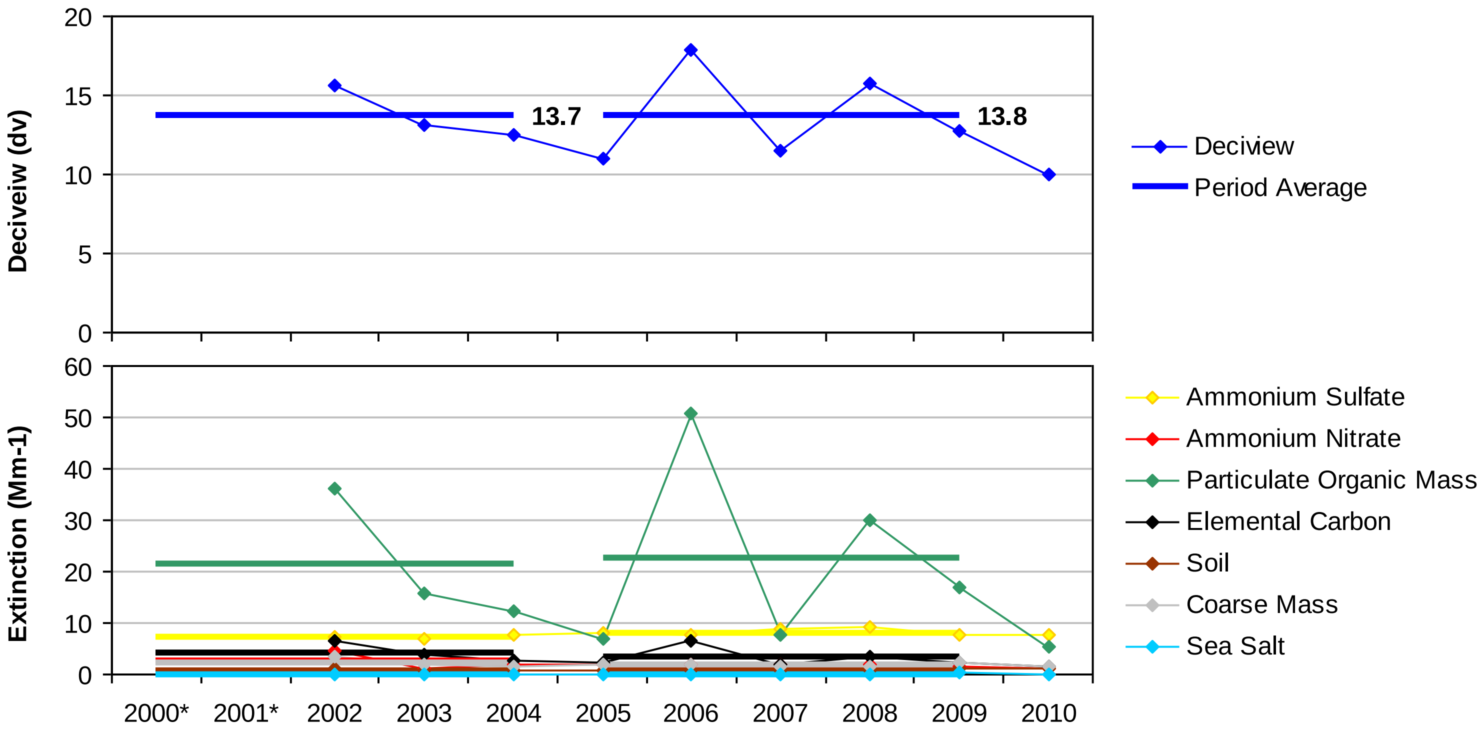
- **Figure K.3-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

Table K.3-1
Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)
Annual Averages, 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	---	---	1.8	1.7	1.6	1.7	1.5	1.4	1.7	1.6	0.9	0.0	0.1	1.7	1.6	-0.1	-6%
Worst 20% Days	---	---	15.6	13.1	12.5	11.1	17.9	11.5	15.8	12.7	9.9	-0.2	0.5	13.7	13.8	0.1	1%
All Days	---	---	7.4	6.8	6.6	6.1	7.8	5.9	7.2	6.4	5.0	-0.1	0.2	6.9	6.7	-0.2	-3%
Total Extinction (Mm-1)																	
Best 20% Days	---	---	12.1	11.8	11.7	12.0	11.7	11.5	11.9	11.8	11.0	0.0	0.1	11.9	11.8	-0.1	-1%
Worst 20% Days	---	---	68.5	39.3	35.9	30.6	78.5	32.1	55.9	41.2	27.6	-1.5	0.5	47.9	47.7	-0.2	0%
All Days	---	---	28.0	21.9	21.0	19.5	30.2	19.3	25.1	21.6	17.4	-0.5	0.3	23.6	23.1	-0.5	-2%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	---	---	1.0	0.9	1.0	1.3	1.2	1.2	1.2	1.0	0.8	0.0	0.5	0.9	1.2	0.3	33%
Worst 20% Days	---	---	7.3	7.0	7.8	8.1	7.6	8.9	9.1	7.5	7.6	0.3	0.1	7.3	8.2	0.9	12%
All Days	---	---	4.0	3.6	3.9	4.3	4.3	4.1	4.8	4.0	3.4	0.1	0.2	3.8	4.3	0.5	13%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	---	---	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.1	0.0	0.3	0.3	0.2	-0.1	-33%
Worst 20% Days	---	---	4.5	1.3	2.0	1.7	1.9	1.8	1.8	1.4	1.2	-0.1	0.2	2.6	1.7	-0.9	-35%
All Days	---	---	1.6	0.9	1.0	0.8	0.9	0.8	0.8	0.7	0.6	-0.1	0.0	1.2	0.8	-0.4	-33%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	---	---	0.7	0.6	0.5	0.6	0.3	0.3	0.4	0.5	0.3	0.0	0.1	0.6	0.4	-0.2	-33%
Worst 20% Days	---	---	36.3	15.7	12.3	6.9	50.9	7.8	30.1	17.0	5.3	-1.3	0.5	21.4	22.5	1.1	5%
All Days	---	---	9.2	5.2	4.3	2.7	12.2	3.0	8.0	5.0	2.2	-0.3	0.4	6.2	6.2	0.0	0%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	---	---	0.7	0.7	0.5	0.4	0.6	0.3	0.5	0.5	0.5	0.0	0.1	0.7	0.5	-0.2	-29%
Worst 20% Days	---	---	6.7	3.7	2.6	2.4	6.4	2.0	3.6	2.5	1.5	-0.2	0.1	4.3	3.4	-0.9	-21%
All Days	---	---	2.2	1.7	1.4	1.3	2.2	1.1	1.3	1.2	0.9	-0.1	0.0	1.8	1.4	-0.4	-22%
Soil Extinction (Mm-1)																	
Best 20% Days	---	---	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.4	0.1	0.1	0.0	0%
Worst 20% Days	---	---	1.0	0.7	0.8	0.6	0.8	0.8	0.7	1.3	1.1	0.0	0.4	0.8	0.9	0.1	13%
All Days	---	---	0.5	0.4	0.4	0.4	0.5	0.3	0.4	0.5	0.5	0.0	0.4	0.4	0.4	0.0	0%
Coarse Mass Extinction (Mm-1)																	
Best 20% Days	---	---	0.2	0.2	0.2	0.1	0.1	0.2	0.3	0.2	0.1	0.0	0.5	0.2	0.2	0.0	0%
Worst 20% Days	---	---	3.6	1.9	1.4	1.8	1.9	1.7	1.5	2.2	1.6	0.0	0.3	2.3	1.8	-0.5	-22%
All Days	---	---	1.3	0.9	0.8	0.9	1.0	0.8	0.8	0.9	0.8	0.0	0.1	1.0	0.8	-0.2	-20%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	---	---	0.3	0.1	0.2	0.2	0.3	0.2	0.2	0.3	0.1	0.0	0.1	0.2	0.2	0.0	0%
Worst 20% Days	---	---	0.1	0.0	0.0	0.1	0.1	0.2	0.1	0.2	0.1	0.0	0.1	0.1	0.1	0.0	0%
All Days	---	---	0.1	0.2	0.2	0.1	0.2	0.2	0.2	0.3	0.2	0.0	0.1	0.2	0.2	0.0	0%

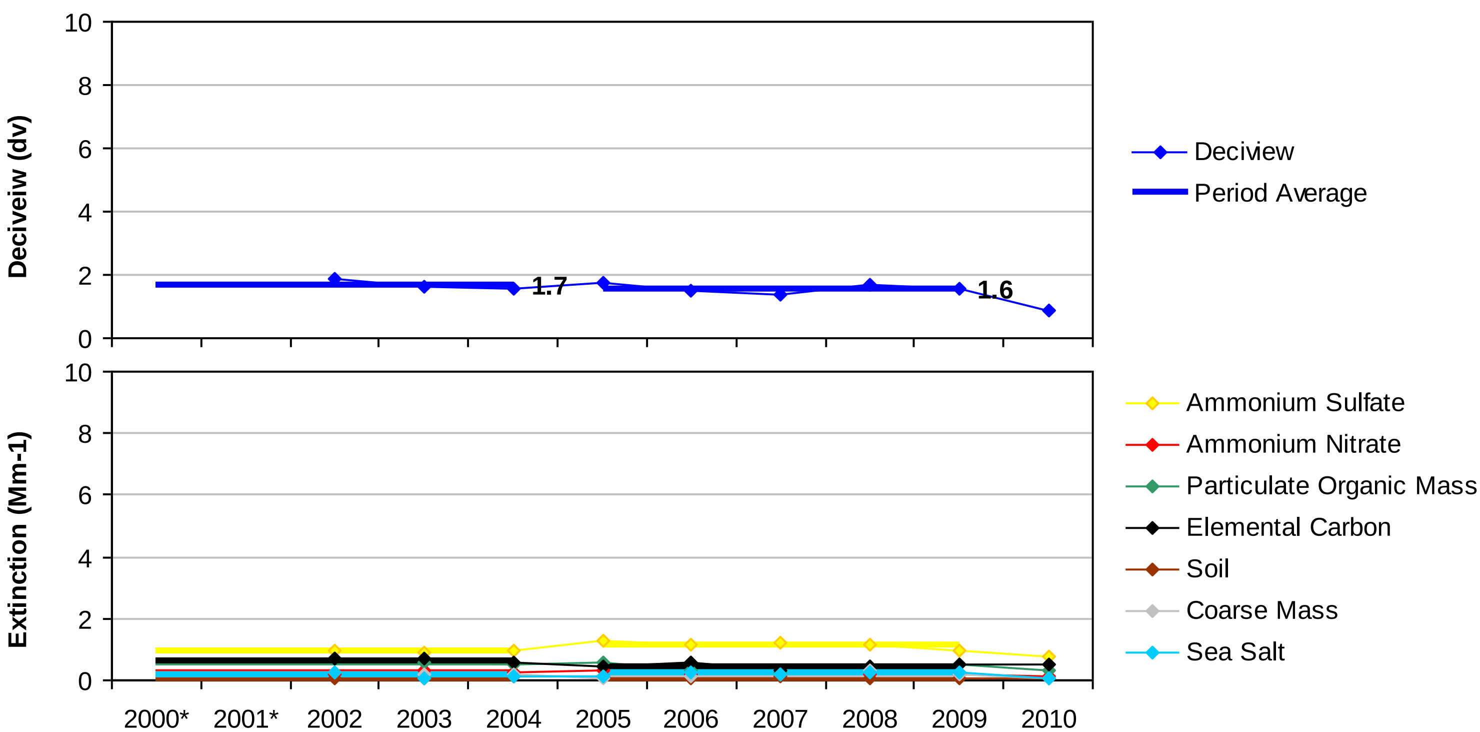
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---"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

Figure K.3-1
Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days



*Missing years did not meet RHR data completeness criteria.

Figure K.3-2
Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days

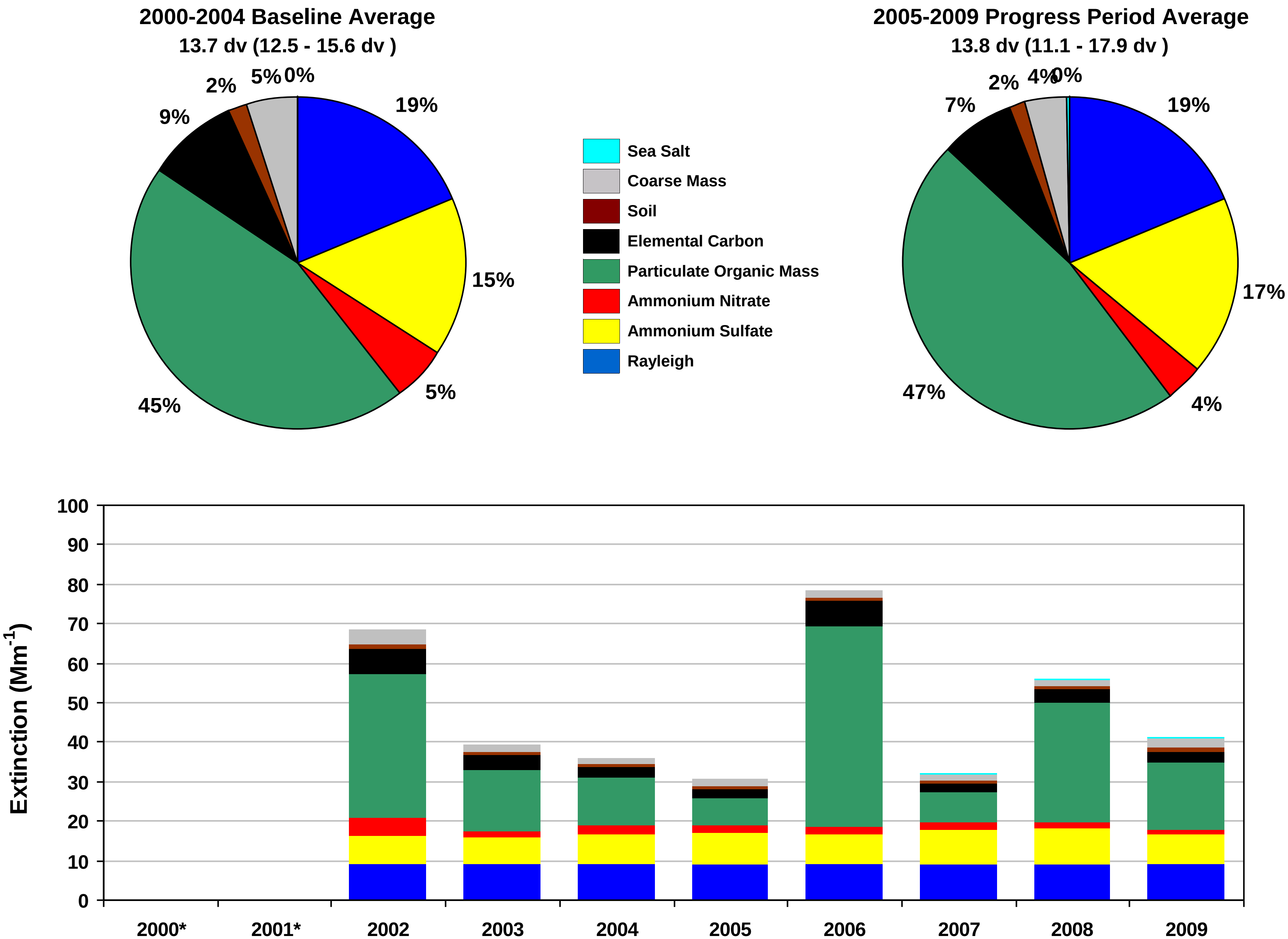


*Missing years did not meet RHR data completeness criteria.

Figure K.3-3

Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)

20% Most Impaired Visibility Days

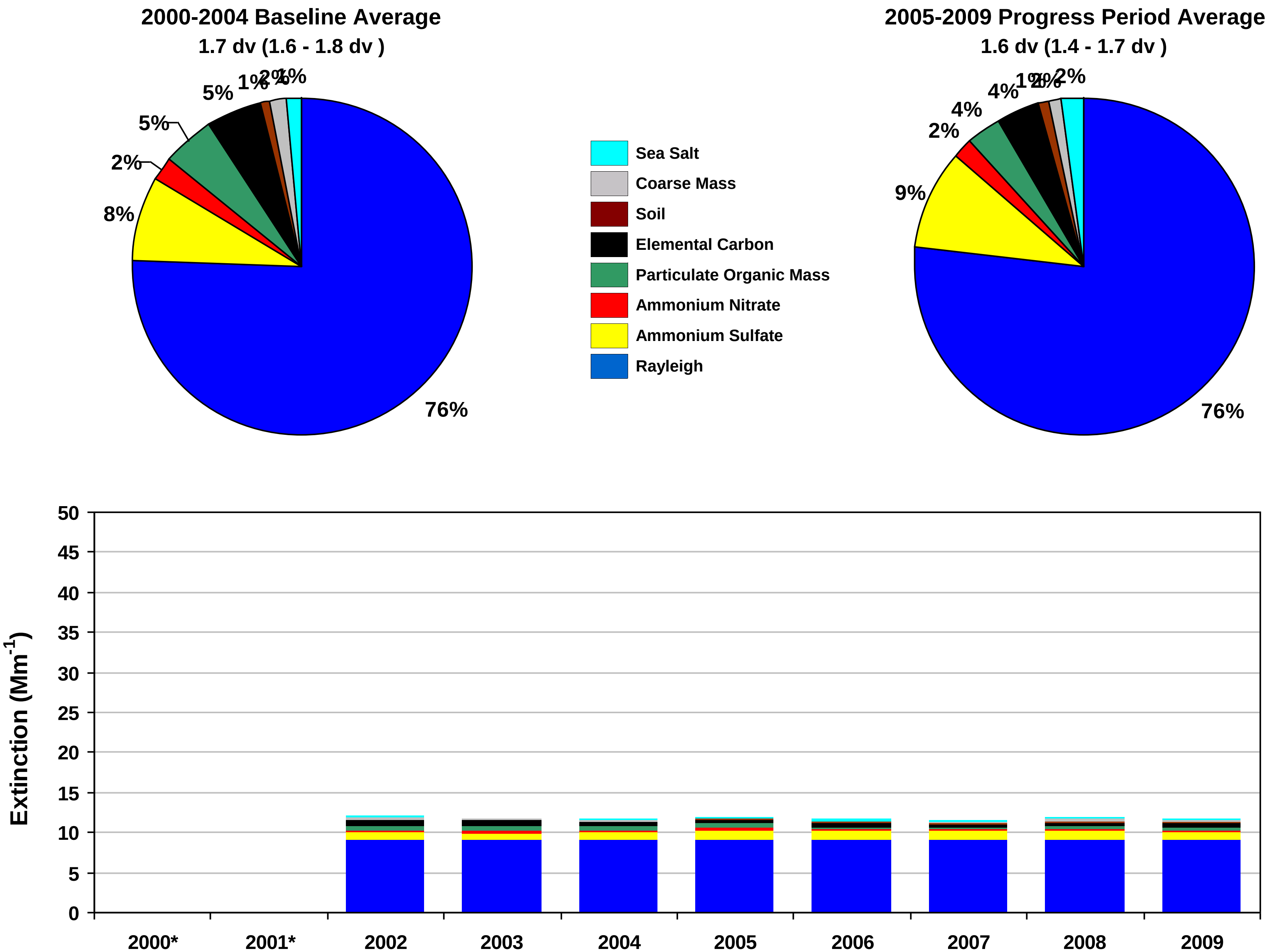


*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.3-4

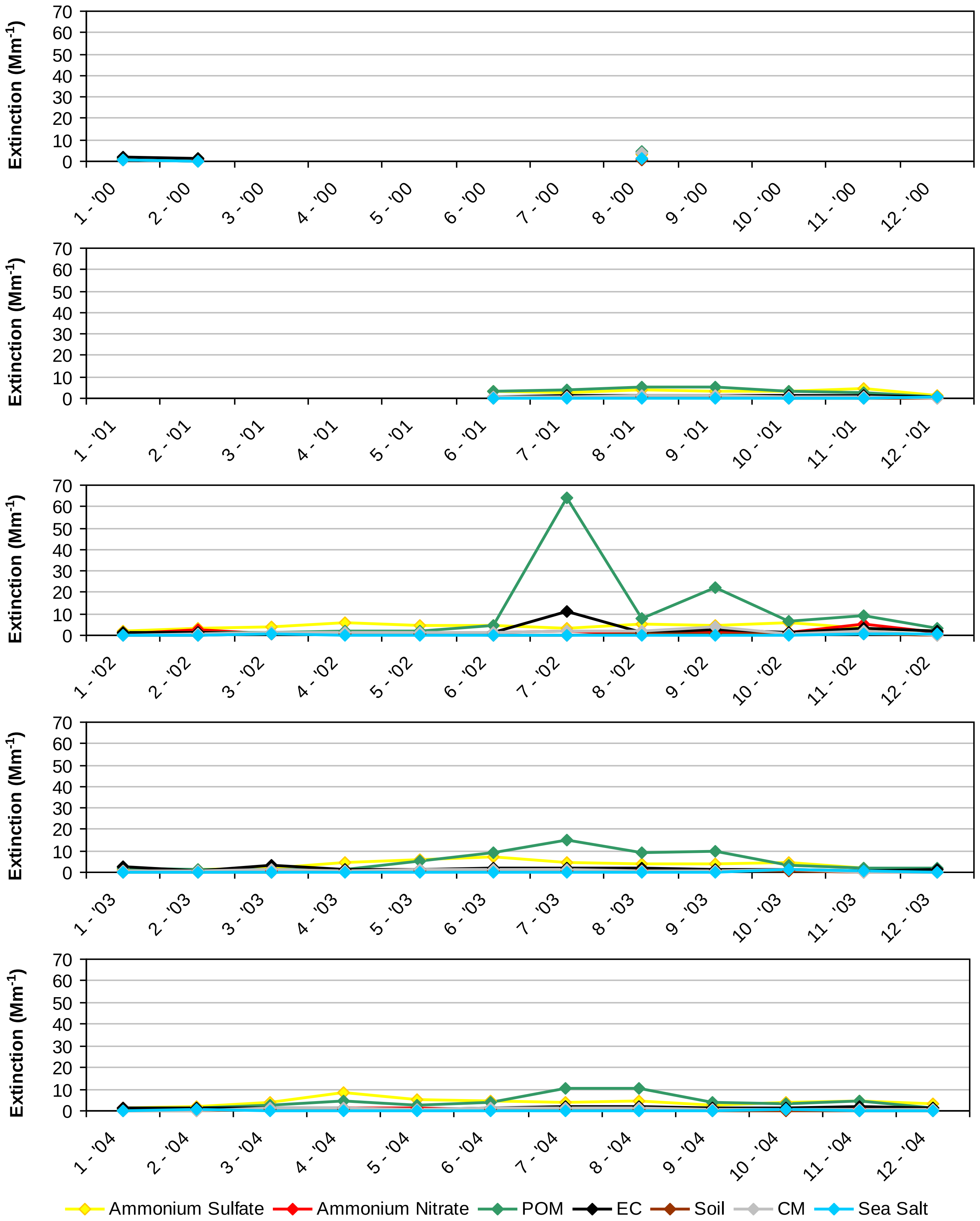
Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)

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 K.3-5
Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 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 K.3-6
Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days

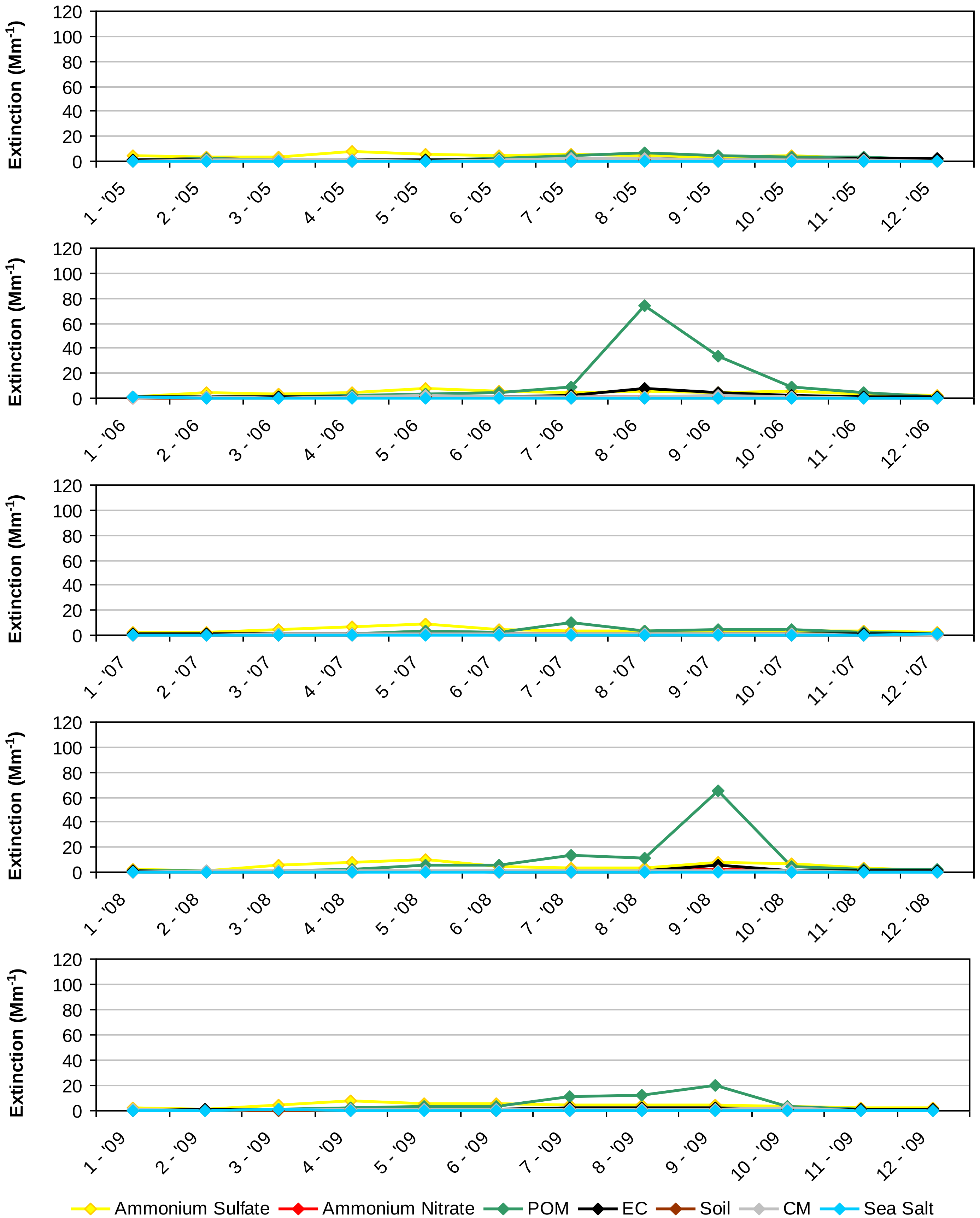
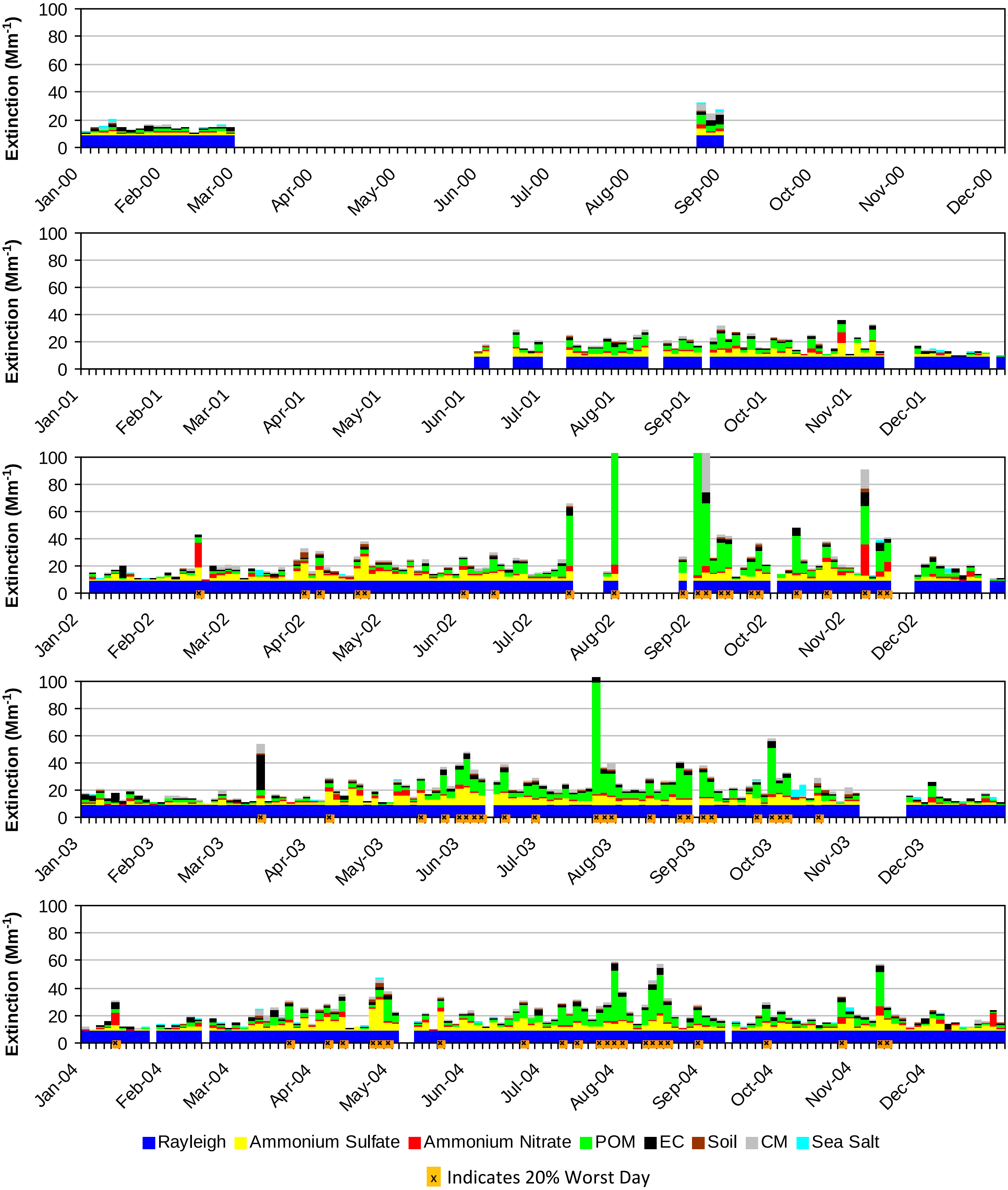


Figure K.3-7
Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)
2000-2004 Progress Period Extinction, All Sampled Days

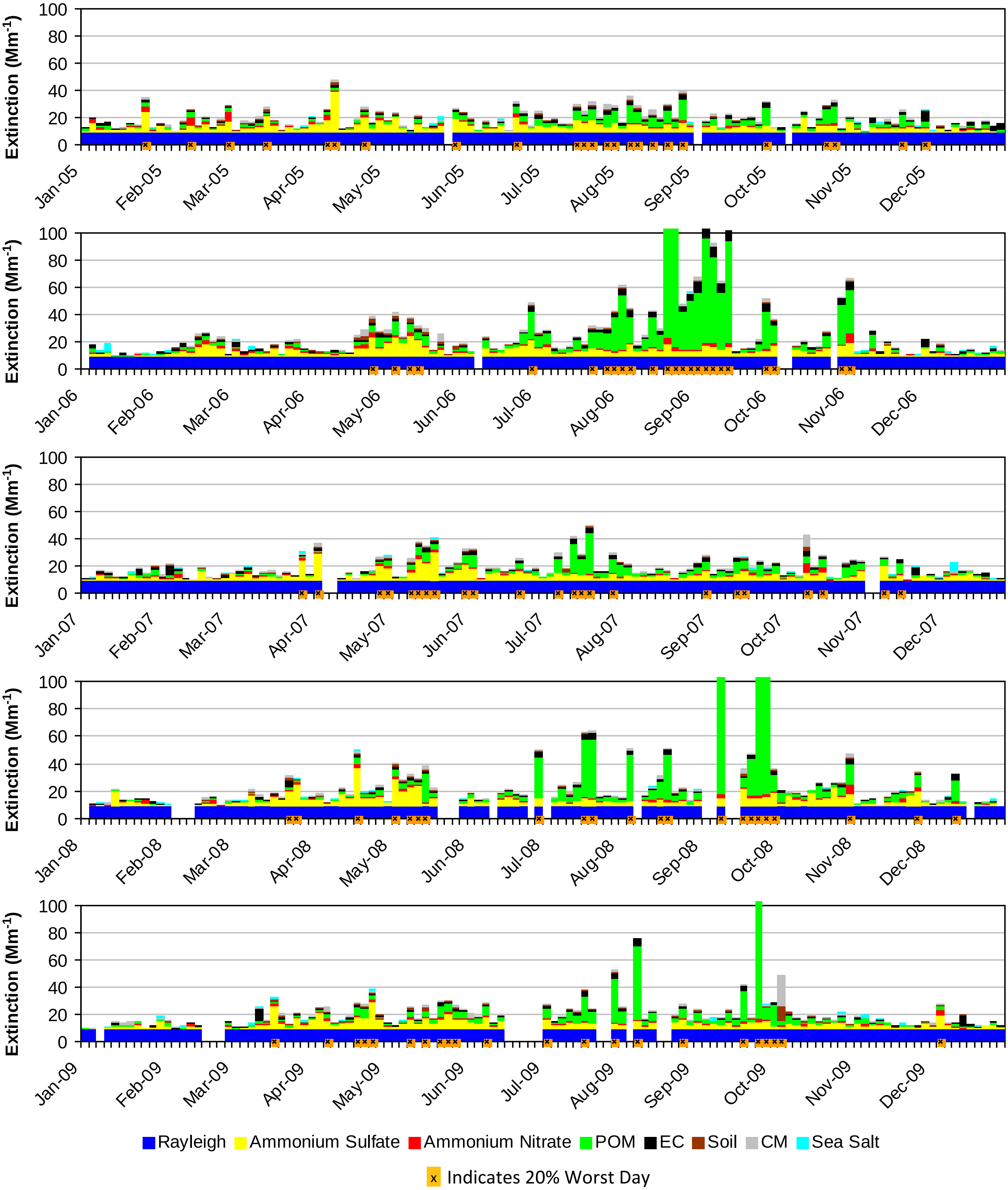


*Note that daily averages for the years 2000 and 2001 are shown here, but these years did not meet RHR data completeness criteria.

Figure K.3-8

Crater Lake NP and Diamond Peak, Gearhart Mountain and Mountain Lakes Was, OR (CRLA1 Site)

2005-2009 Progress Period Extinction, All Sampled Days



K.4. HELLS CANYON WA (HECA1)

The following tables and figures are presented in this section for the Hells Canyon WA represented by the HECA1 IMPROVE Monitor:

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

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

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

- **Figure K.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 K.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 K.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.

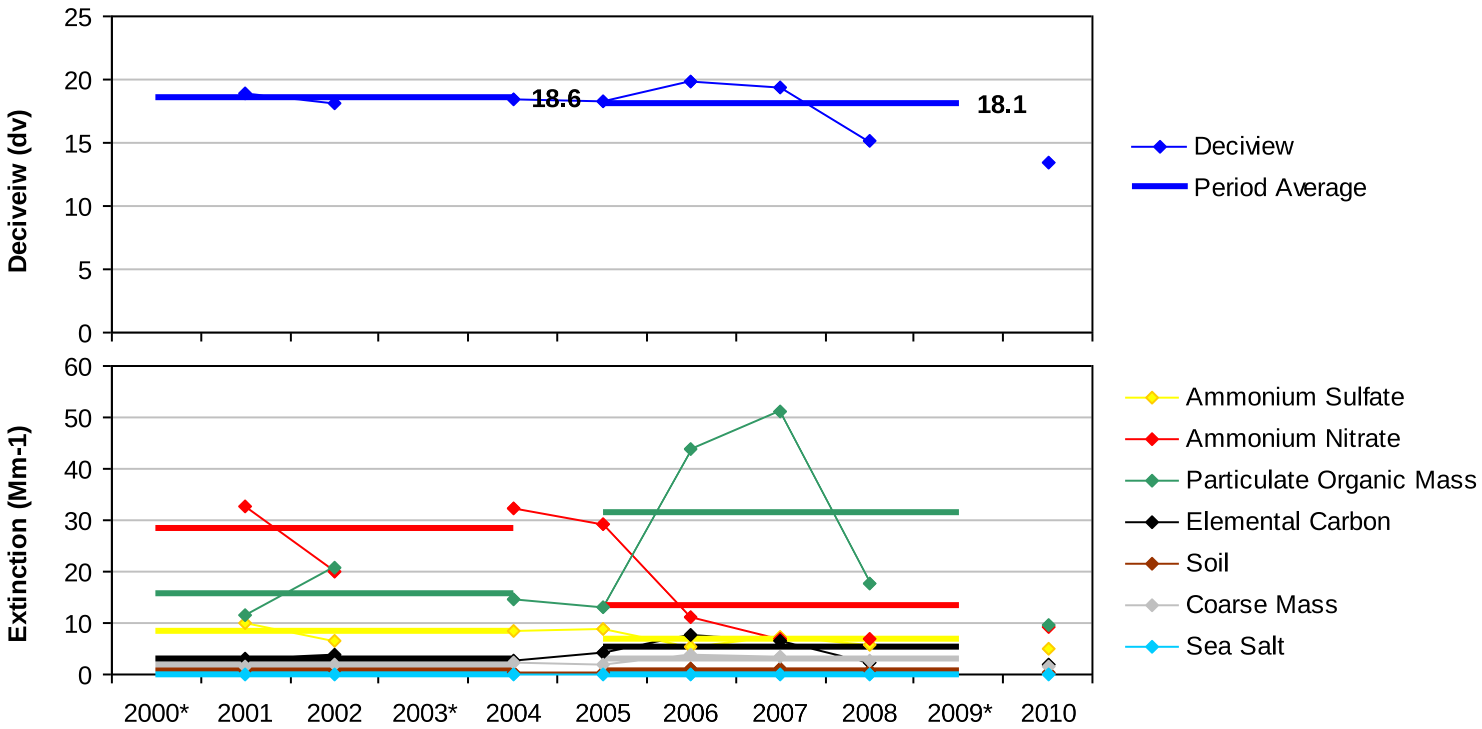
- **Figure K.4-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

Table K.4-1
Hells Canyon WA, OR (HECA1 Site)
Annual Averages, 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	5.8	---	5.2	4.7	4.7	5.2	4.6	---	4.0	-0.1	0.1	5.5	4.8	-0.7	-13%
Worst 20% Days	---	19.0	18.2	---	18.5	18.3	19.8	19.4	15.1	---	13.5	-0.1	0.5	18.6	18.1	-0.5	-3%
All Days	---	10.9	11.0	---	10.7	10.0	10.8	10.8	9.4	---	8.5	-0.1	0.1	10.9	10.3	-0.6	-6%
Total Extinction (Mm-1)																	
Best 20% Days	---	17.4	18.0	---	16.9	16.1	16.1	17.0	15.9	---	15.0	-0.2	0.0	17.4	16.3	-1.1	-6%
Worst 20% Days	---	70.2	64.8	---	72.5	68.7	84.1	87.5	47.2	---	39.1	1.3	0.4	69.1	71.9	2.8	4%
All Days	---	34.3	33.9	---	34.6	32.0	36.7	37.4	27.7	---	24.8	0.1	0.5	34.2	33.4	-0.8	-2%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	---	2.2	1.9	---	1.7	2.0	1.7	2.2	1.8	---	1.3	0.0	0.4	1.9	1.9	0.0	0%
Worst 20% Days	---	9.9	6.6	---	8.6	8.8	5.4	7.3	5.7	---	5.2	-0.4	0.1	8.4	6.8	-1.6	-19%
All Days	---	4.9	3.8	---	4.5	4.5	3.8	4.4	3.9	---	3.5	-0.1	0.3	4.4	4.2	-0.2	-5%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	---	1.0	0.8	---	0.5	0.5	0.7	0.6	0.7	---	0.3	0.0	0.2	0.8	0.6	-0.2	-25%
Worst 20% Days	---	32.9	20.0	---	32.5	29.1	11.2	6.8	6.9	---	9.3	-3.7	0.0	28.5	13.5	-15.0	-53%
All Days	---	8.3	5.7	---	8.2	6.7	3.5	3.0	2.7	---	2.8	-0.8	0.0	7.4	4.0	-3.4	-46%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	---	1.6	2.3	---	2.1	1.4	1.5	1.7	1.4	---	1.1	-0.1	0.1	2.0	1.5	-0.5	-25%
Worst 20% Days	---	11.4	20.7	---	14.7	13.1	43.9	51.0	17.8	---	9.7	1.6	0.1	15.6	31.4	15.8	>100%
All Days	---	6.0	8.9	---	7.1	5.8	13.0	14.1	6.7	---	4.5	0.4	0.3	7.4	9.9	2.5	34%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	---	0.6	0.7	---	0.5	0.5	0.4	0.5	0.3	---	0.3	0.0	0.1	0.6	0.4	-0.2	-33%
Worst 20% Days	---	2.9	3.7	---	2.5	4.3	7.6	6.6	2.5	---	1.9	0.3	0.4	3.1	5.3	2.2	71%
All Days	---	1.5	1.8	---	1.4	1.9	2.5	2.3	1.2	---	1.0	0.1	0.4	1.6	2.0	0.4	25%
Soil Extinction (Mm-1)																	
Best 20% Days	---	0.2	0.3	---	0.2	0.1	0.2	0.2	0.2	---	0.2	0.0	0.1	0.3	0.2	-0.1	-33%
Worst 20% Days	---	0.7	0.7	---	0.6	0.4	1.1	1.2	0.7	---	0.5	0.1	0.3	0.7	0.8	0.1	14%
All Days	---	0.7	0.7	---	0.5	0.4	0.7	0.5	0.5	---	0.4	0.0	0.4	0.6	0.5	-0.1	-17%
Coarse Mass Extinction (Mm-1)																	
Best 20% Days	---	0.7	0.9	---	0.8	0.5	0.4	0.6	0.5	---	0.7	-0.1	0.1	0.8	0.5	-0.3	-38%
Worst 20% Days	---	1.4	2.0	---	2.5	1.8	3.8	3.6	2.6	---	1.5	0.3	0.1	1.9	2.9	1.0	53%
All Days	---	1.8	2.0	---	1.8	1.6	2.0	1.9	1.7	---	1.6	0.0	0.3	1.9	1.8	-0.1	-5%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	---	0.1	0.0	---	0.1	0.1	0.2	0.1	0.1	---	0.0	0.0	0.3	0.1	0.1	0.0	0%
Worst 20% Days	---	0.0	0.0	---	0.1	0.2	0.2	0.1	0.0	---	0.0	0.0	0.2	0.0	0.1	0.1	0%
All Days	---	0.0	0.1	---	0.1	0.1	0.1	0.1	0.1	---	0.0	0.0	0.5	0.1	0.1	0.0	0%

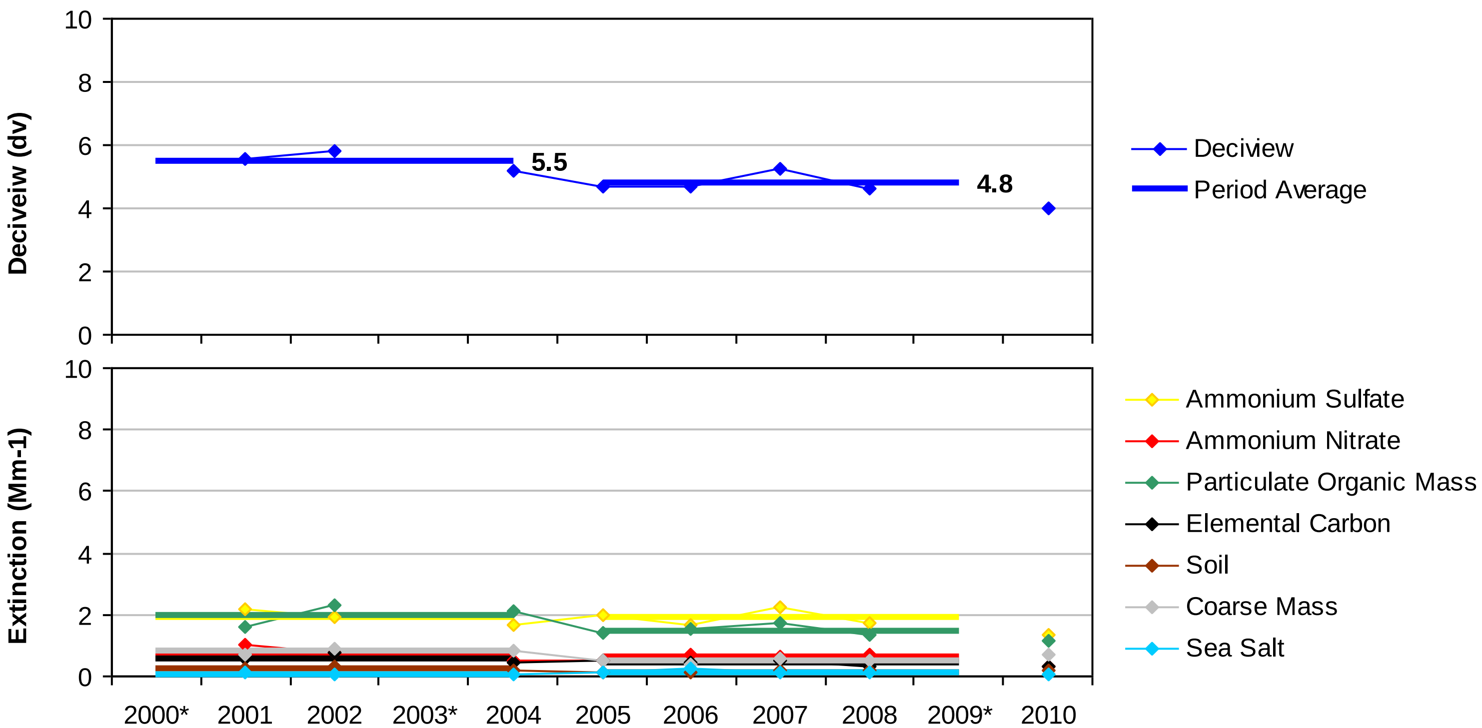
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---"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

Figure K.4-1
Hells Canyon WA, OR (HECA1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days



*Missing years did not meet RHR data completeness criteria.

Figure K.4-2
Hells Canyon WA, OR (HECA1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days

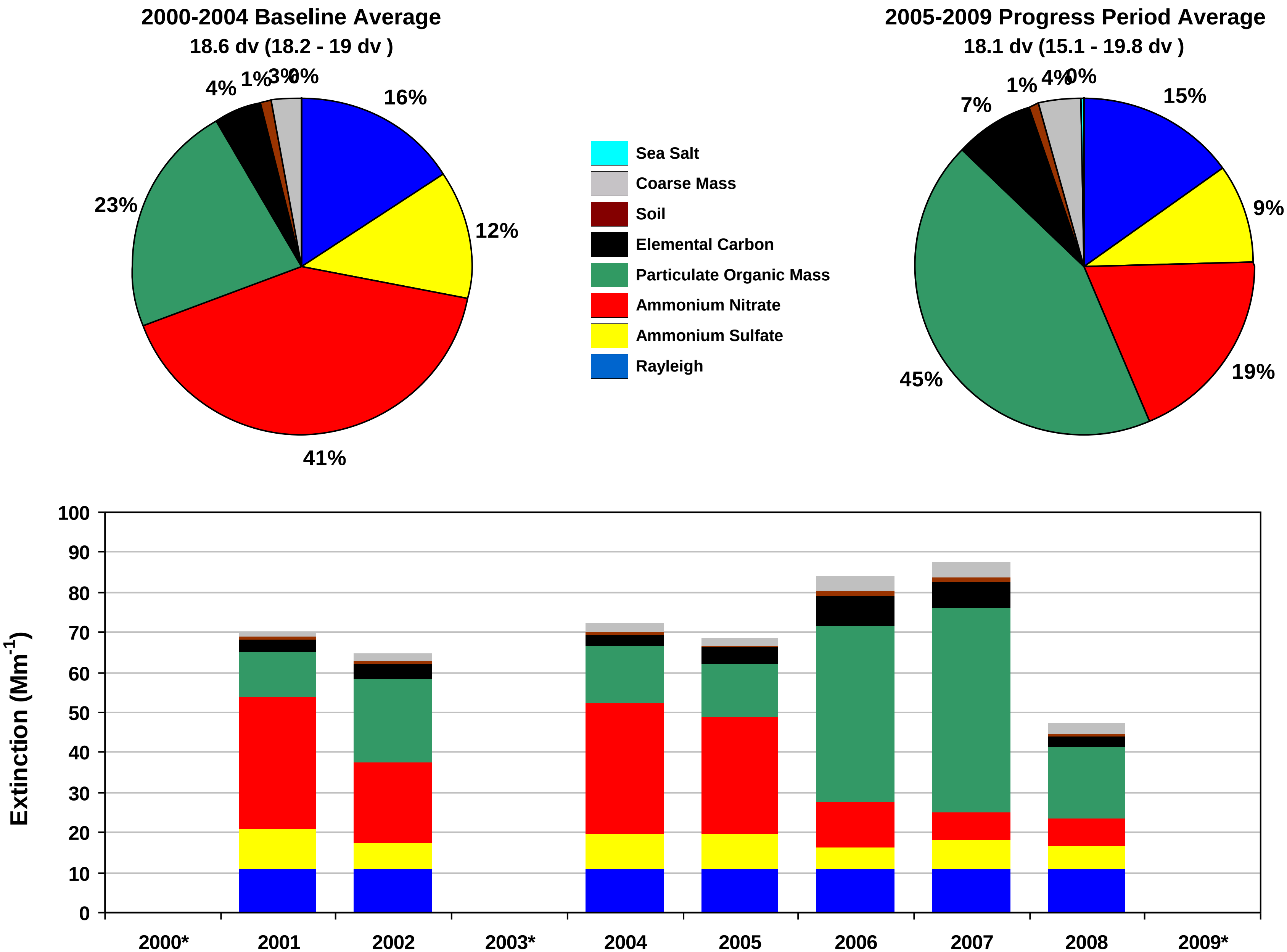


*Missing years did not meet RHR data completeness criteria.

Figure K.4-3

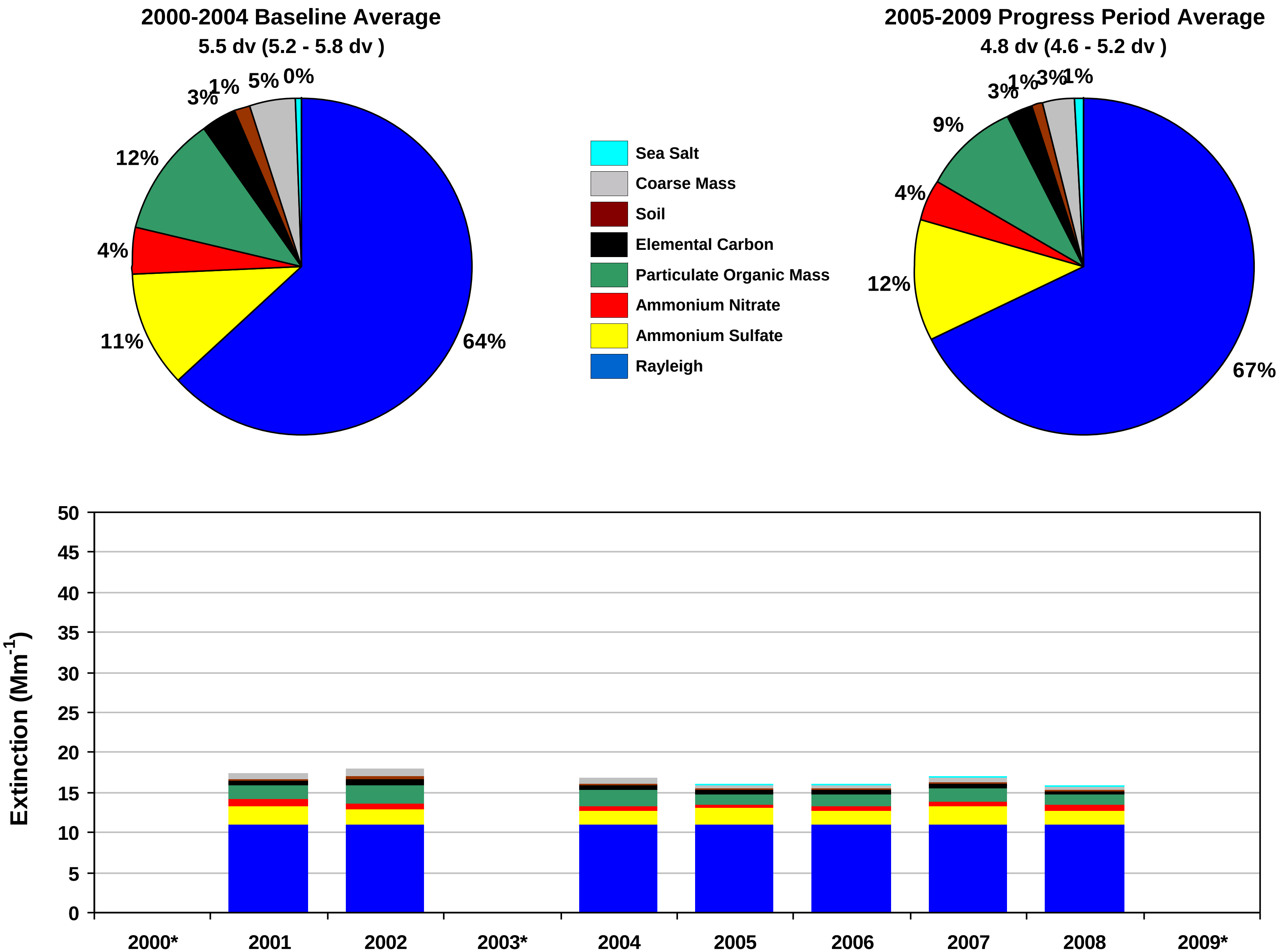
Hells Canyon WA, OR (HECA1 Site)

20% Most Impaired Visibility Days



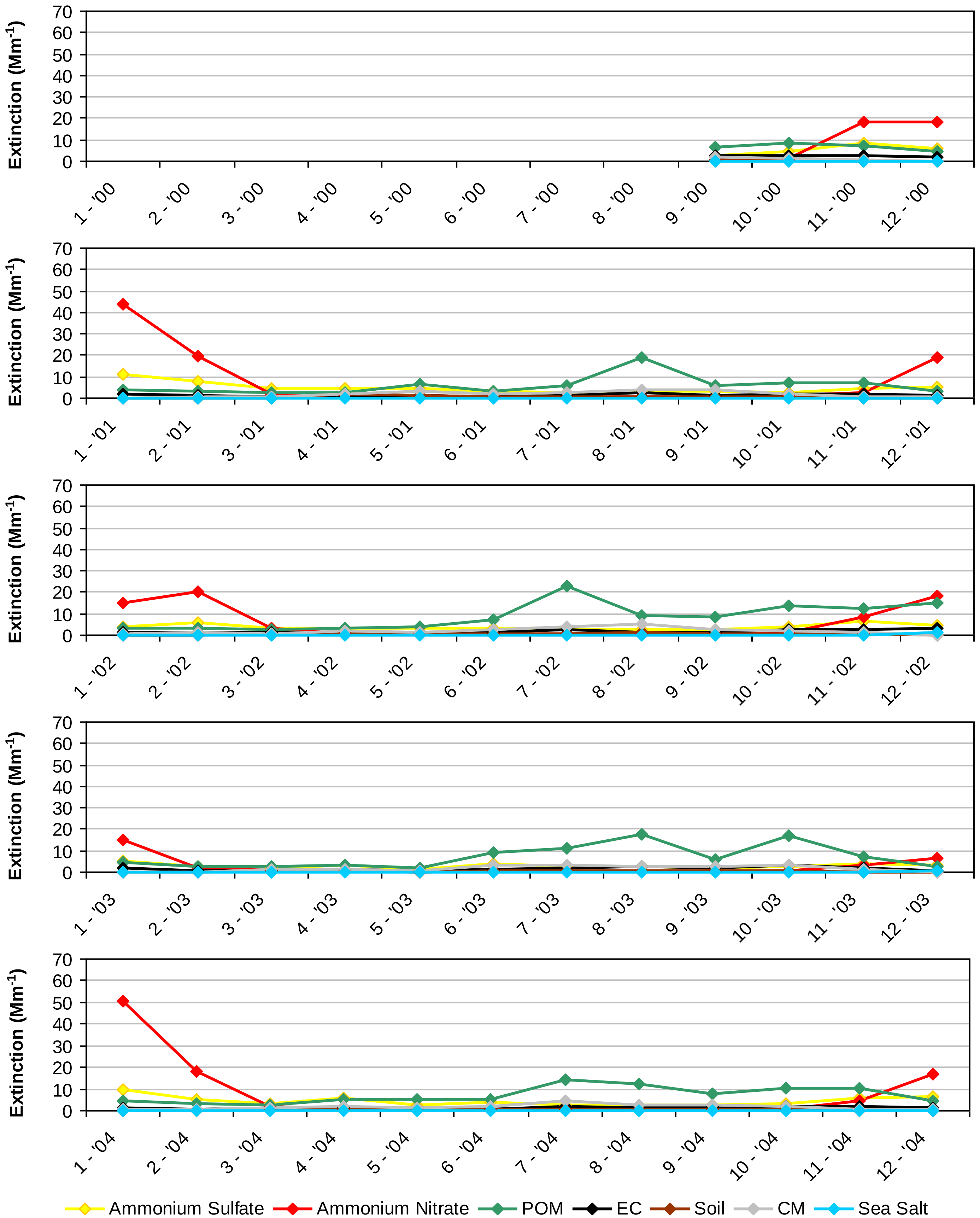
*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.4-4
Hells Canyon WA, OR (HECA1 Site)
20% Least Impaired Visibility Days



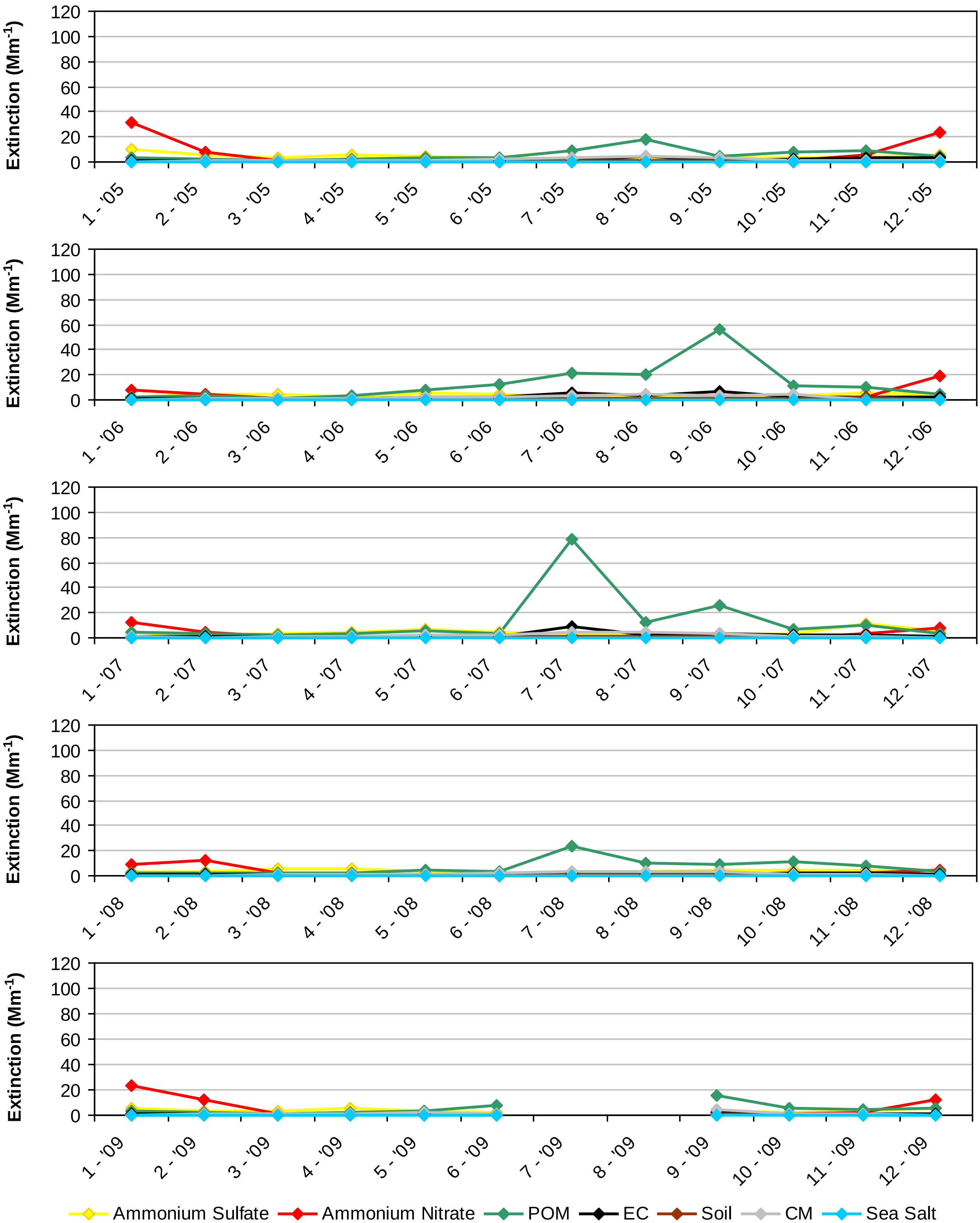
*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.4-5
Hells Canyon WA, OR (HECA1 Site)
2000-2004 Monthly Average Aerosol Extinction, All Monitored Days



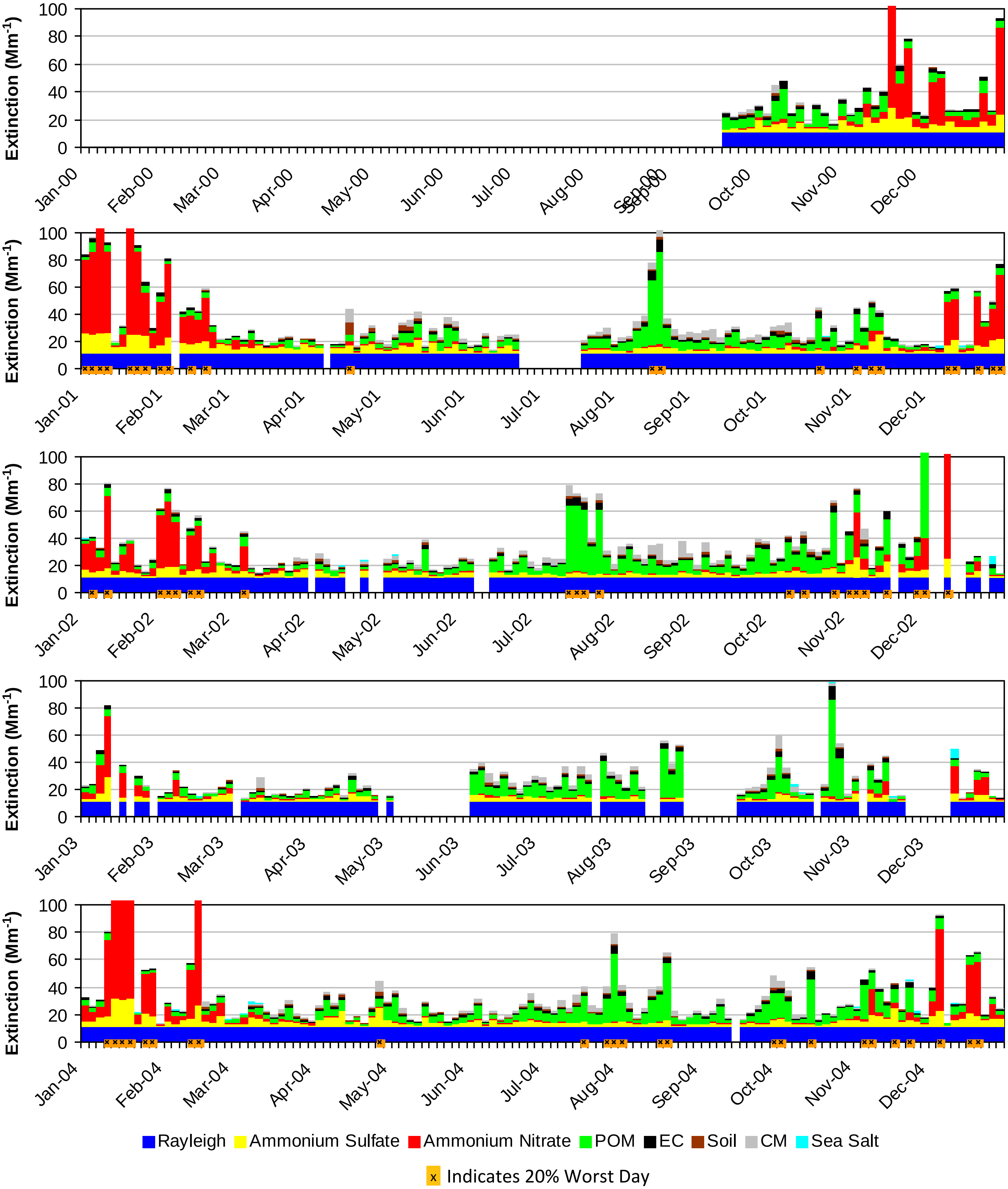
*Note that monthly averages for the years 2000 and 2003 are shown here, but these years did not meet RHR data completeness criteria.

Figure K.4-6
Hells Canyon WA, OR (HECA1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days



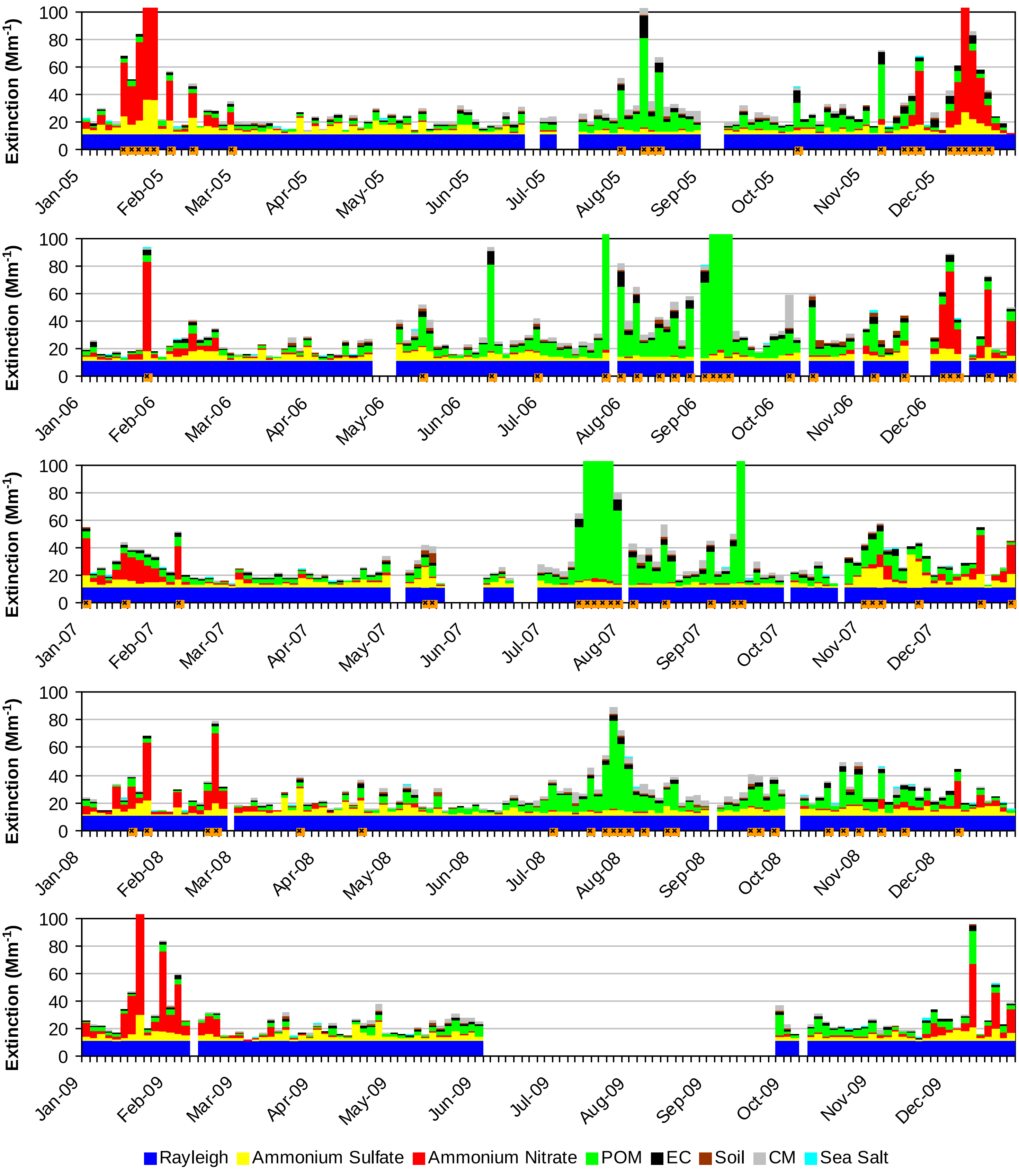
*Note that monthly averages for the year 2009 are shown here, but this year did not meet RHR data completeness criteria.

Figure K.4-7
Hells Canyon WA, OR (HECA1 Site)
2000-2004 Progress Period Extinction, All Sampled Days



*Note that daily averages for the years 2000 and 2003 are shown here, but these years did not meet RHR data completeness criteria.

Figure K.4-8
Hells Canyon WA, OR (HECA1 Site)
2005-2009 Progress Period Extinction, All Sampled Days



*Note that daily averages for the year 2009 are shown here, but this year did not meet RHR data completeness criteria.

K.5. KALMIOPSIS WA (KALM1)

The following tables and figures are presented in this section for the Kalmiopsis WA represented by the KALM1 IMPROVE Monitor:

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

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

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

- **Figure K.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 K.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 K.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.

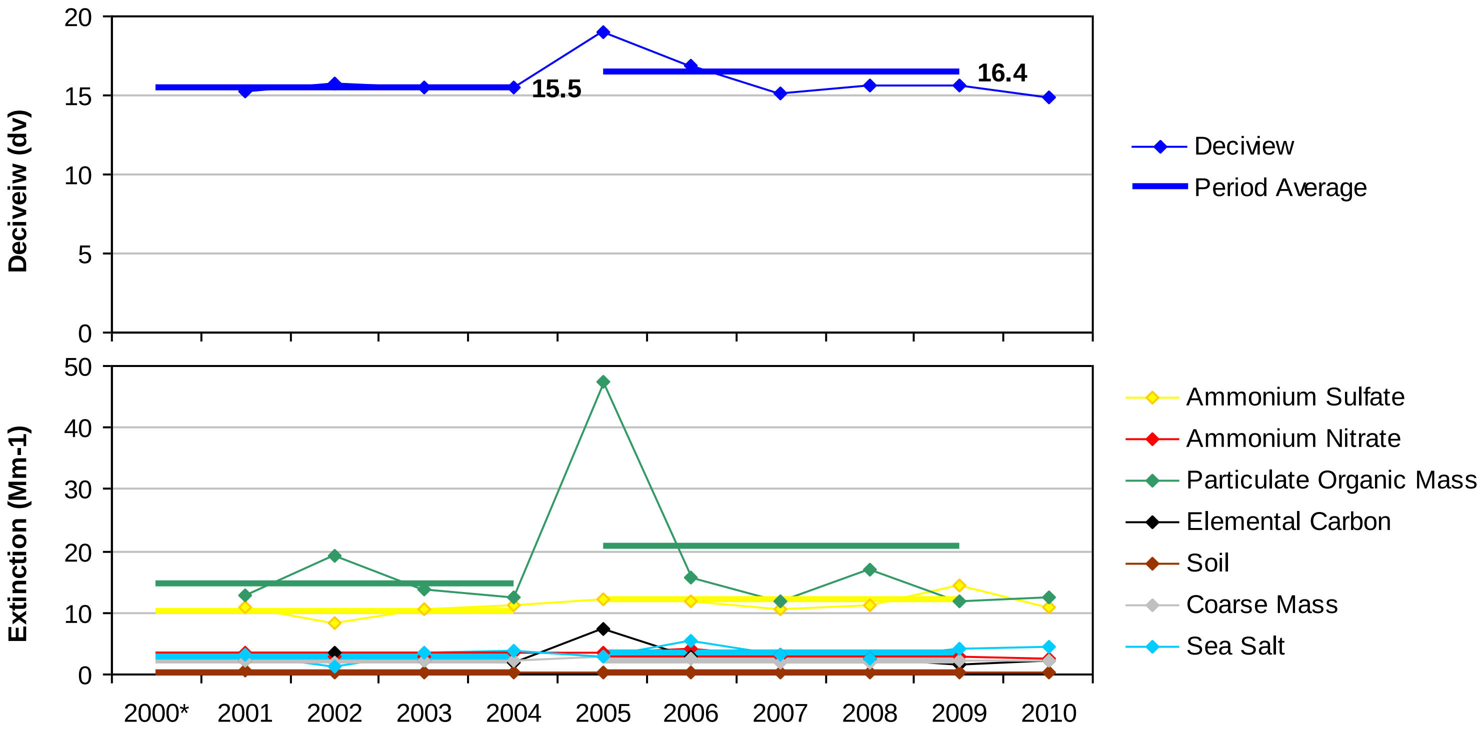
- **Figure K.5-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

Table K.5-1
Kalmiopsis WA, OR (KALM1 Site)
Annual Averages, 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	---	6.3	5.8	6.2	6.7	6.9	5.8	6.3	6.7	6.1	5.8	0.0	0.4	6.3	6.4	0.1	2%
Worst 20% Days	---	15.3	15.8	15.5	15.5	19.0	16.9	15.1	15.6	15.7	14.8	0.0	0.4	15.5	16.4	0.9	6%
All Days	---	10.4	10.8	10.7	11.0	12.0	10.9	10.5	10.8	10.4	9.8	0.0	0.4	10.7	10.9	0.2	2%
Total Extinction (Mm-1)																	
Best 20% Days	---	18.9	17.9	18.7	19.8	20.1	18.0	18.8	19.8	18.4	17.8	0.0	0.5	18.8	19.0	0.2	1%
Worst 20% Days	---	47.5	49.8	47.7	47.4	88.5	54.9	46.0	50.2	49.7	46.9	0.1	0.5	48.1	57.9	9.8	20%
All Days	---	30.2	31.7	30.7	31.7	40.7	32.2	30.1	31.3	30.4	28.7	0.0	0.5	31.0	32.9	1.9	6%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	---	1.9	1.6	1.3	1.5	1.7	1.4	1.9	2.7	1.5	1.2	0.0	0.5	1.6	1.8	0.2	13%
Worst 20% Days	---	11.0	8.4	10.6	11.3	12.1	12.0	10.6	11.2	14.4	10.8	0.4	0.1	10.3	12.1	1.8	18%
All Days	---	6.5	5.5	5.8	6.2	6.8	6.6	6.1	6.4	6.7	5.3	0.1	0.1	6.0	6.5	0.5	8%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	---	0.5	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.3	0.3	0.0	0.2	0.4	0.4	0.0	0%
Worst 20% Days	---	3.4	2.9	2.9	3.5	3.5	4.1	2.8	2.7	2.7	2.7	0.0	0.2	3.2	3.2	0.0	0%
All Days	---	1.7	1.7	1.5	1.6	1.7	1.8	1.6	1.3	1.2	1.2	-0.1	0.1	1.6	1.5	-0.1	-6%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	---	2.4	2.2	3.0	3.5	3.5	2.2	2.3	2.6	2.5	2.5	0.0	0.4	2.7	2.6	-0.1	-4%
Worst 20% Days	---	12.7	19.4	13.8	12.4	47.4	15.7	12.0	17.0	11.8	12.5	-0.1	0.2	14.6	20.8	6.2	43%
All Days	---	5.4	7.9	6.9	6.8	13.8	6.2	5.3	6.9	5.6	5.5	-0.2	0.3	6.8	7.6	0.8	12%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	---	0.8	0.6	0.9	1.1	1.1	0.7	0.7	0.6	0.7	0.6	0.0	0.3	0.8	0.8	0.0	0%
Worst 20% Days	---	2.3	3.5	2.4	1.8	7.3	2.9	3.2	2.4	1.7	2.1	-0.1	0.4	2.5	3.5	1.0	40%
All Days	---	1.3	1.8	1.6	1.4	2.8	1.5	1.4	1.3	1.1	1.1	-0.1	0.1	1.5	1.6	0.1	7%
Soil Extinction (Mm-1)																	
Best 20% Days	---	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0%
Worst 20% Days	---	0.5	0.4	0.3	0.3	0.4	0.4	0.2	0.4	0.4	0.4	0.0	0.4	0.4	0.3	-0.1	-25%
All Days	---	0.3	0.2	0.1	0.2	0.2	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	---	0.7	0.5	0.5	0.5	0.6	0.5	0.6	0.5	0.5	0.4	0.0	0.1	0.6	0.6	0.0	0%
Worst 20% Days	---	2.3	1.9	2.2	2.2	3.0	2.5	2.0	2.0	2.3	2.1	0.0	0.4	2.1	2.4	0.3	14%
All Days	---	1.5	1.3	1.3	1.3	1.6	1.5	1.4	1.2	1.4	1.2	0.0	0.5	1.3	1.4	0.1	8%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	---	0.6	0.7	0.6	0.9	0.7	0.9	0.9	0.9	0.8	0.8	0.0	0.0	0.7	0.8	0.1	14%
Worst 20% Days	---	3.2	1.3	3.5	3.8	2.8	5.3	3.2	2.4	4.3	4.4	0.1	0.2	2.9	3.6	0.7	24%
All Days	---	1.4	1.3	1.5	2.2	1.8	2.5	2.2	2.0	2.1	2.2	0.1	0.1	1.6	2.1	0.5	31%

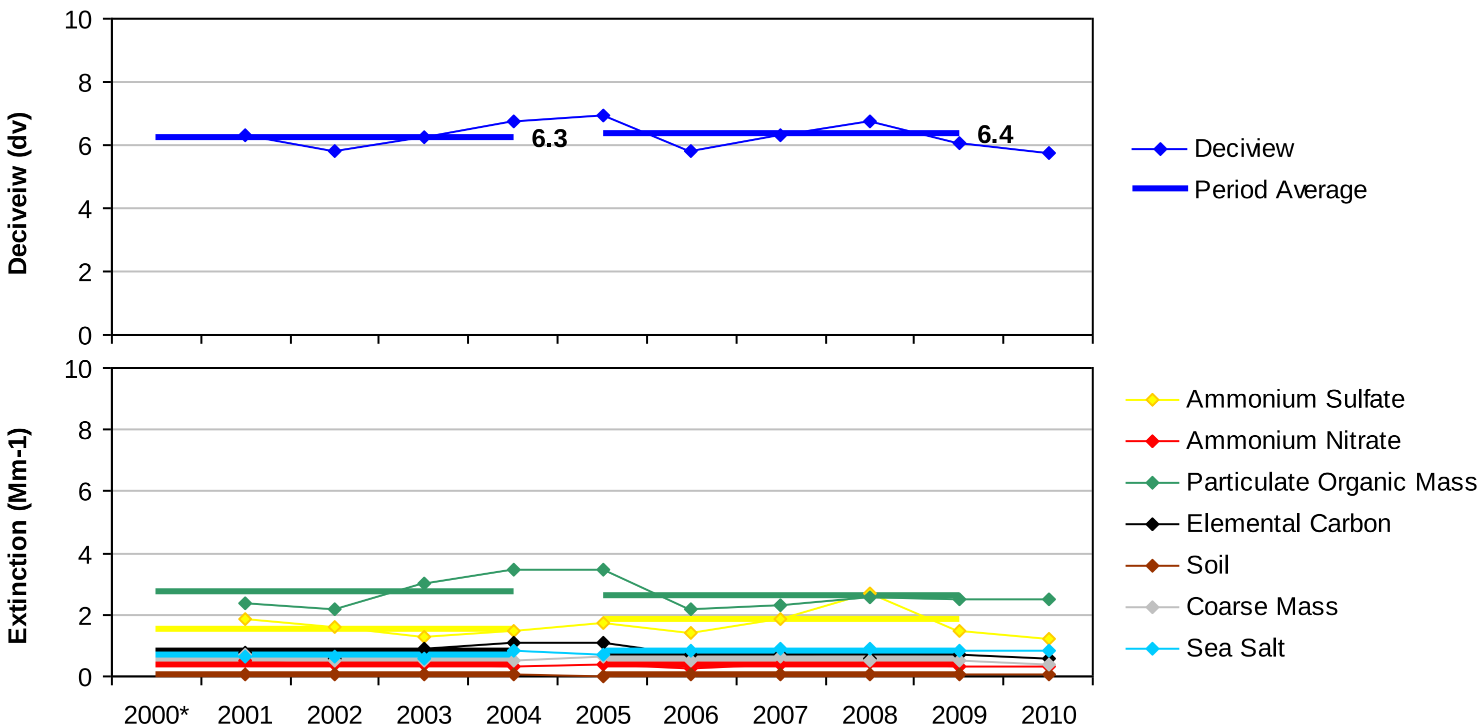
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---"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

Figure K.5-1
Kalmiopsis WA, OR (KALM1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days



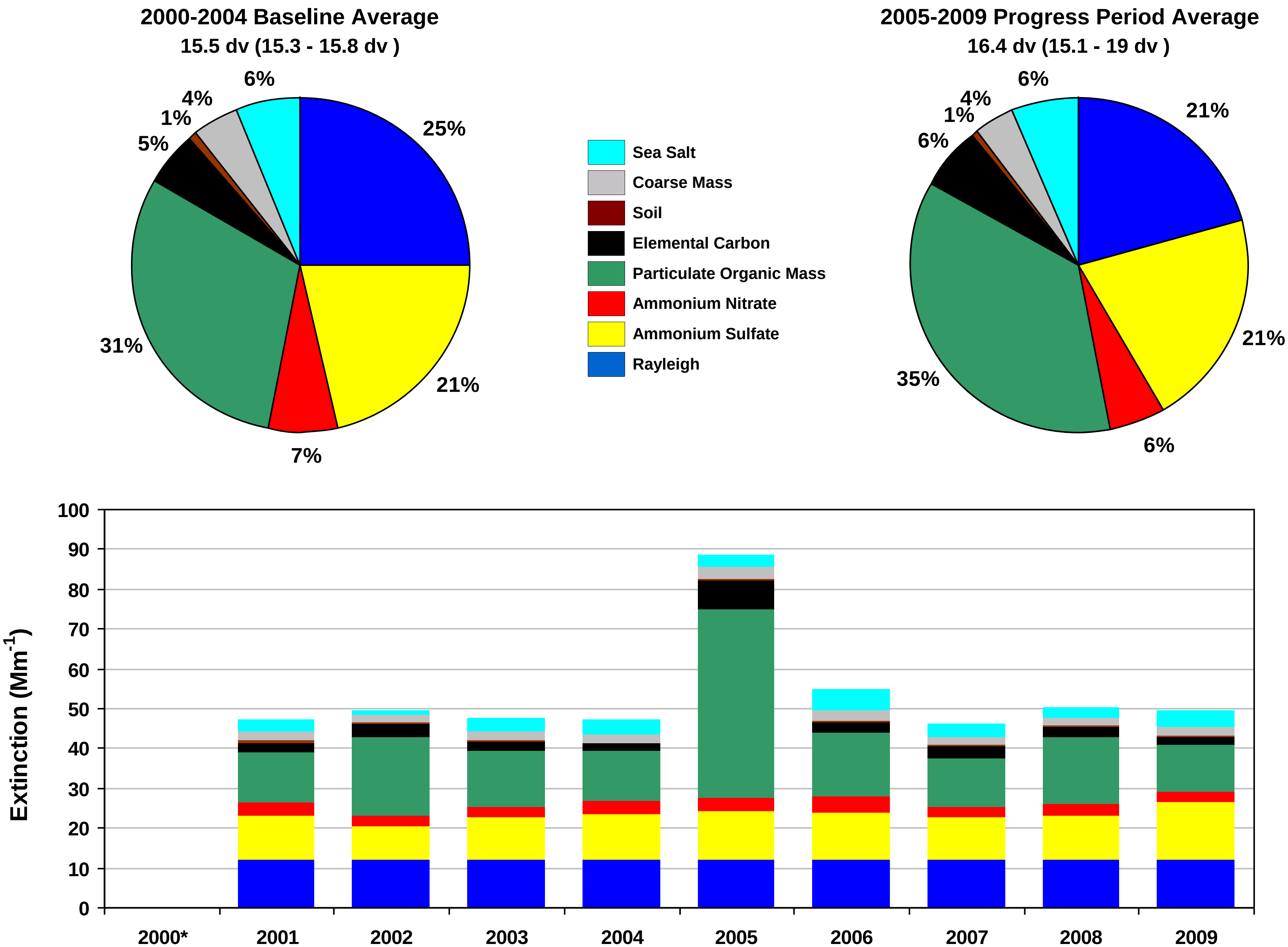
*Missing years did not meet RHR data completeness criteria.

Figure K.5-2
Kalmiopsis WA, OR (KALM1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days



*Missing years did not meet RHR data completeness criteria.

Figure K.5-3
Kalmiopsis WA, OR (KALM1 Site)
20% Most Impaired Visibility Days

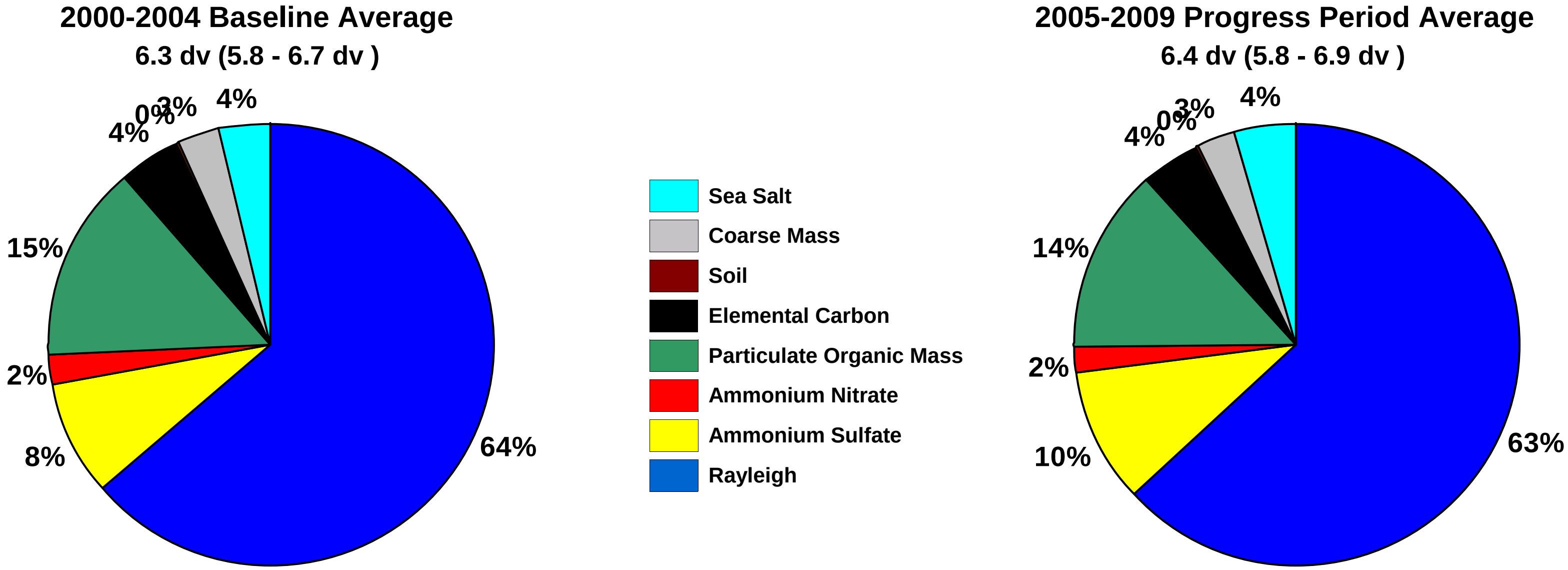


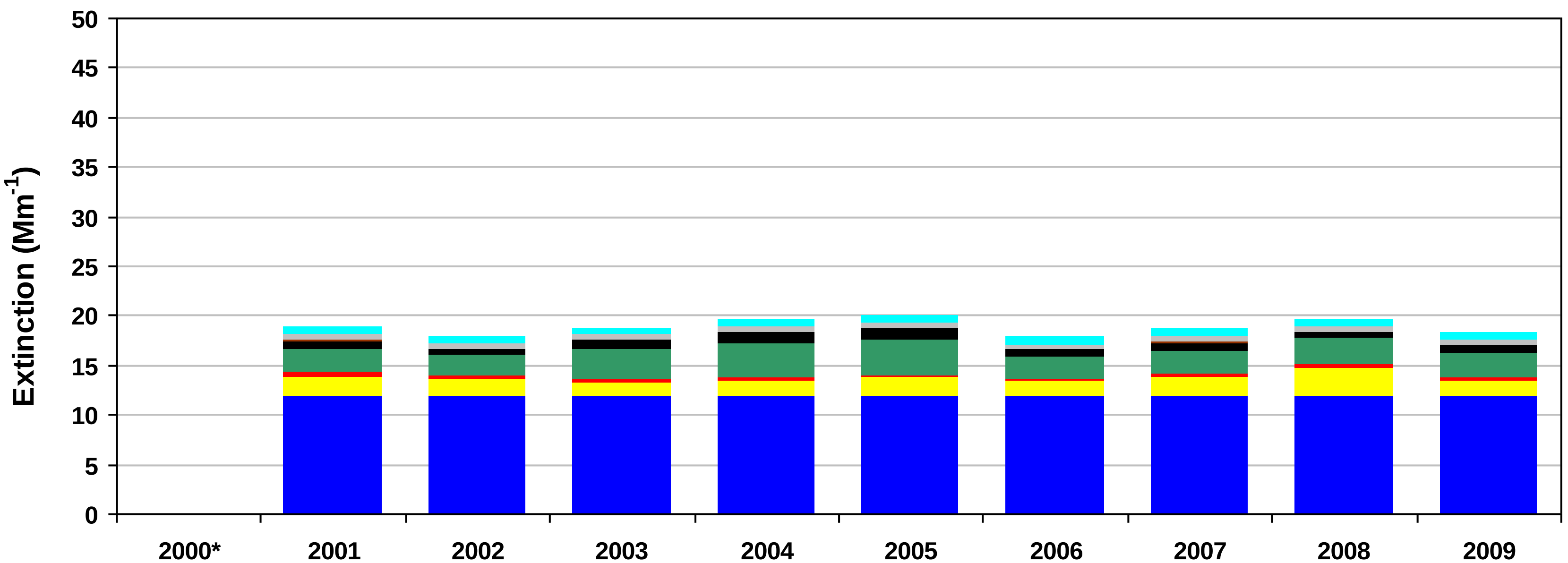
*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.5-4

Kalmiopsis WA, OR (KALM1 Site)

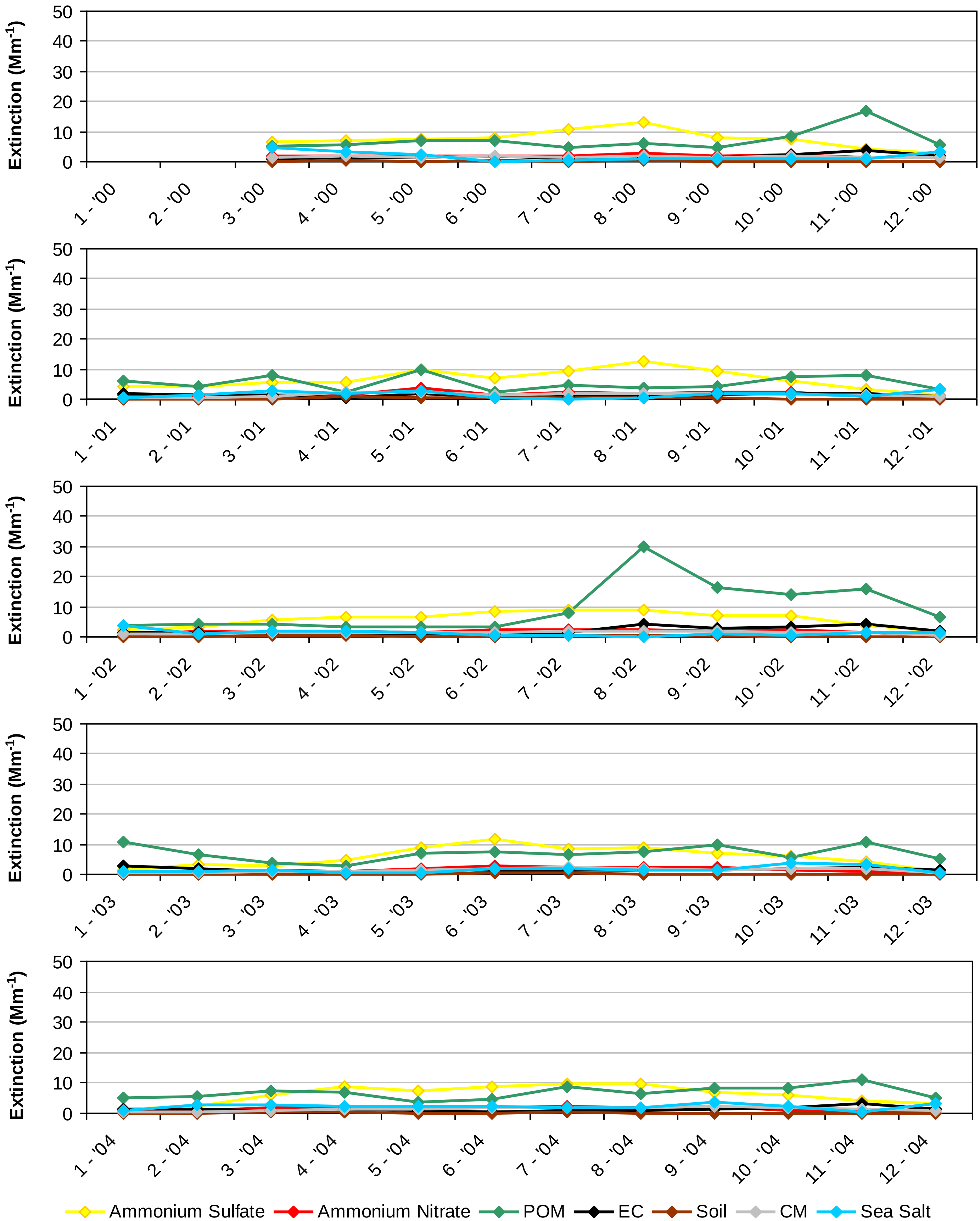
20% Least Impaired Visibility Days





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

Figure K.5-5
Kalmiopsis WA, OR (KALM1 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 K.5-6
Kalmiopsis WA, OR (KALM1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days

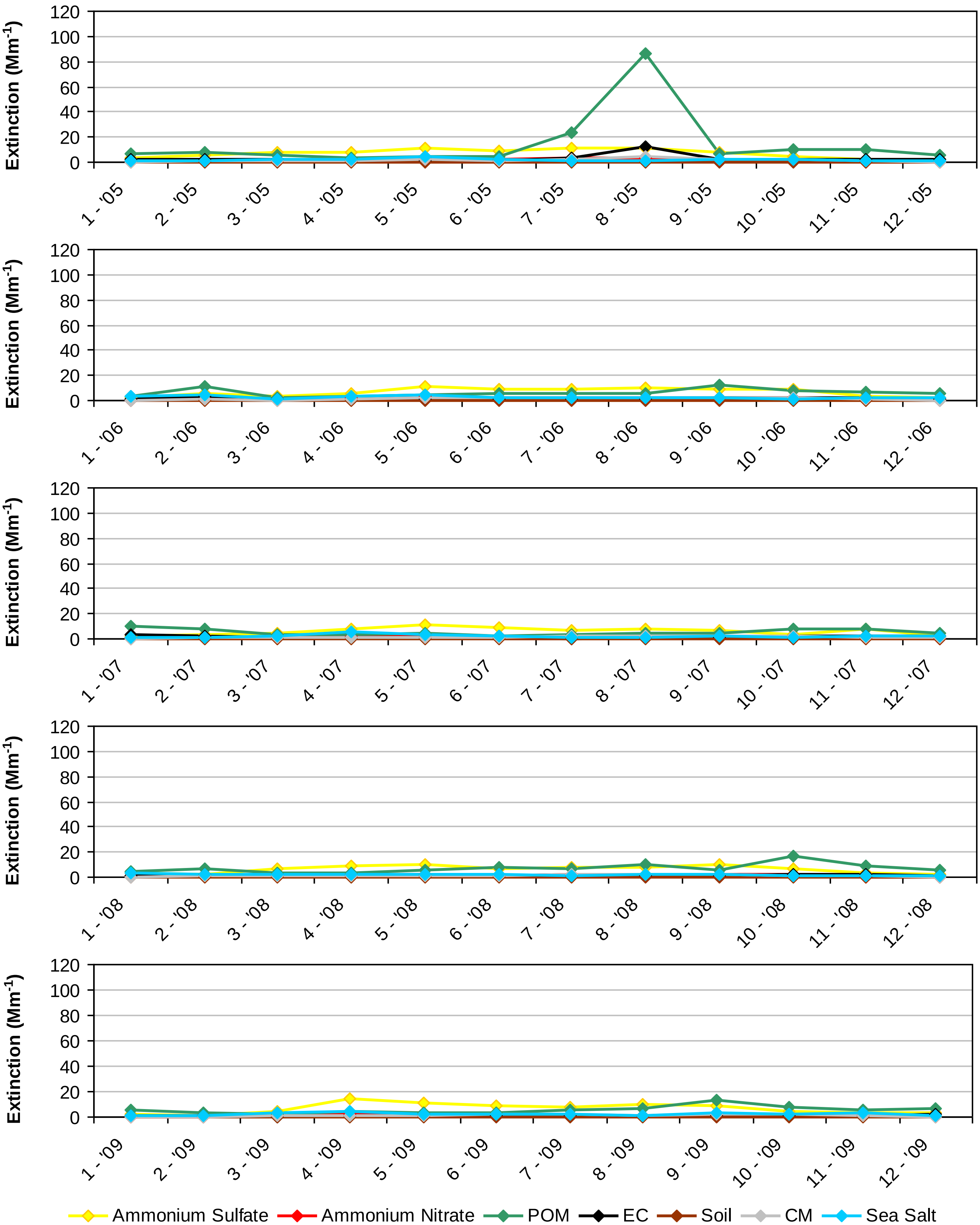
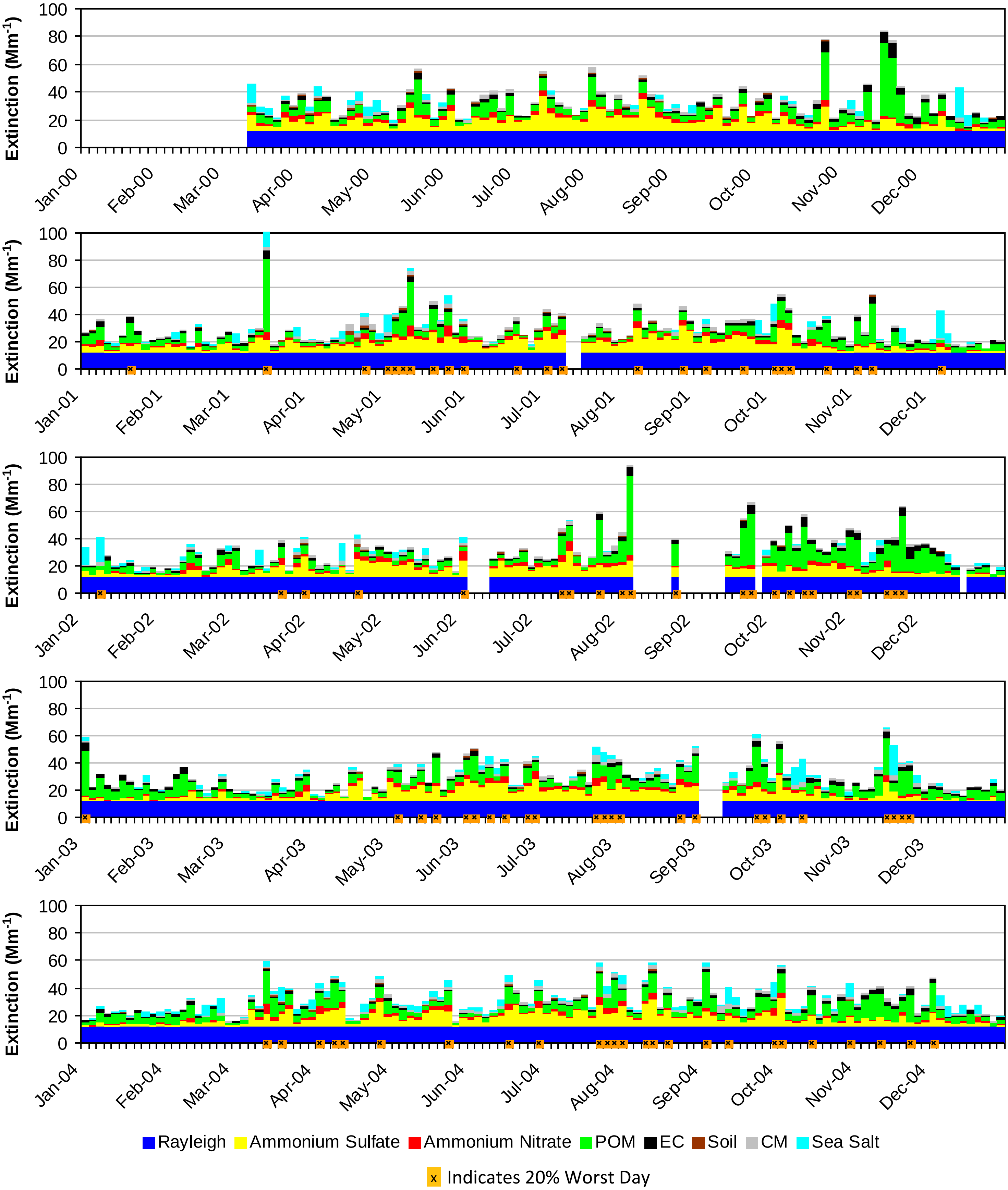
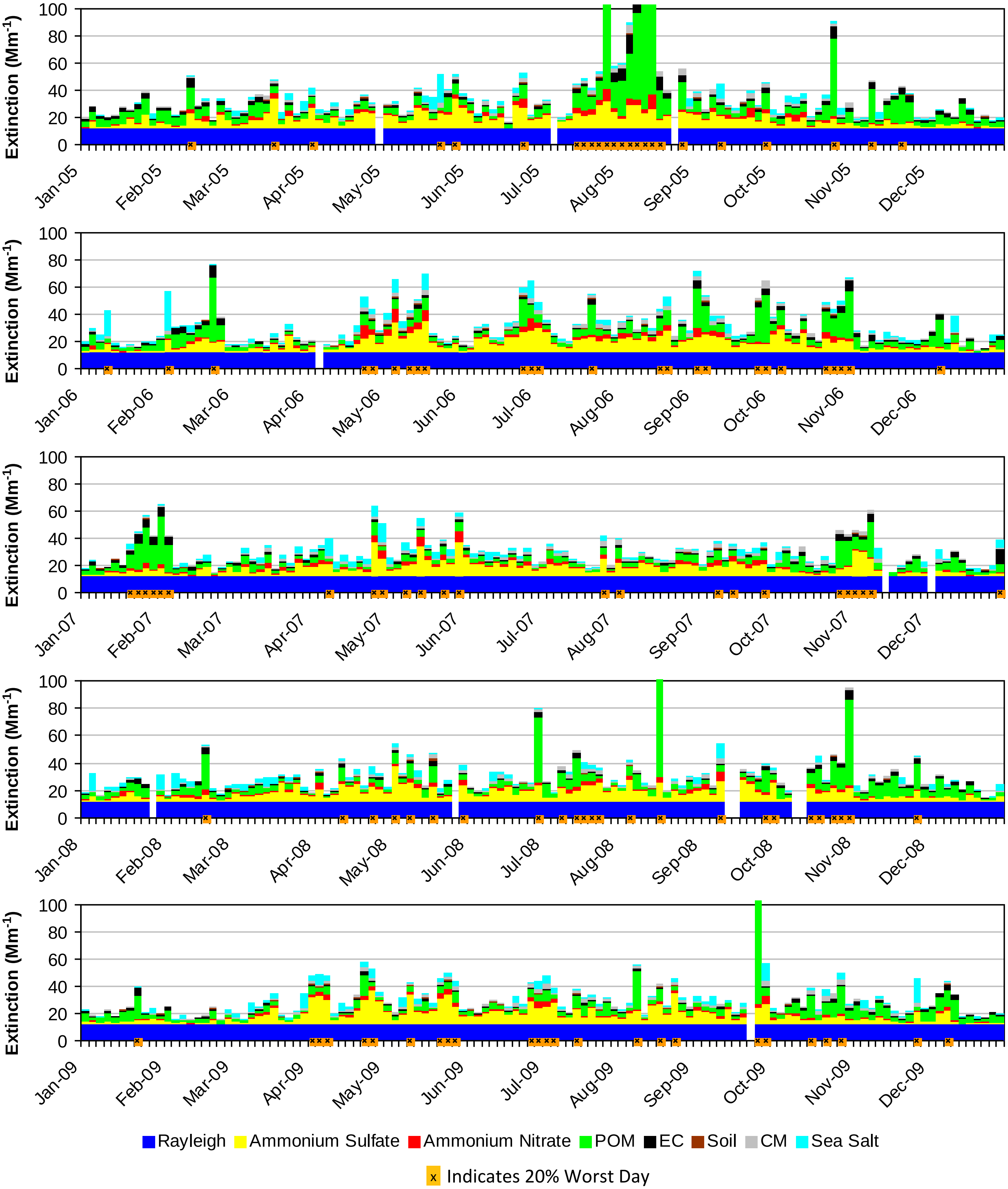


Figure K.5-7
Kalmiopsis WA, OR (KALM1 Site)
2000-2004 Progress Period Extinction, All Sampled Days



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

Figure K.5-8
Kalmiopsis WA, OR (KALM1 Site)
2005-2009 Progress Period Extinction, All Sampled Days



K.6. MOUNT HOOD WA (MOHO1)

The following tables and figures are presented in this section for the Mount Hood WA represented by the MOHO1 IMPROVE Monitor:

- **Table K.6-1: Annual Averages, 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 K.6-1: Annual and Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure K.6-2: Annual and Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure K.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 K.6-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure K.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 K.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 K.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.

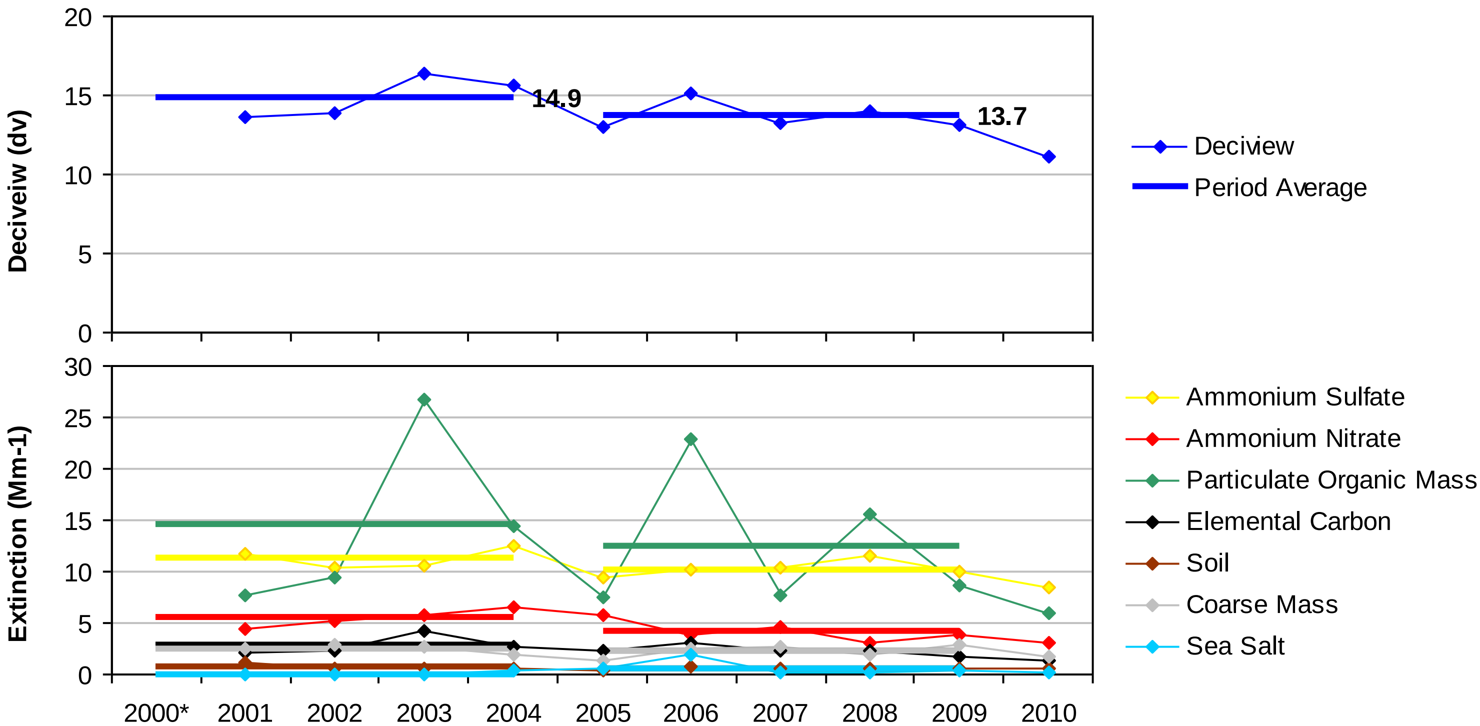
- **Figure K.6-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

Table K.6-1
Mount Hood WA, OR (MOHO1 Site)
Annual Averages, 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	---	3.1	2.3	1.5	1.7	2.0	1.8	1.7	1.7	1.5	0.9	-0.1	0.0	2.2	1.7	-0.5	-23%
Worst 20% Days	---	13.6	13.9	16.4	15.6	12.9	15.2	13.3	14.0	13.2	11.2	-0.1	0.2	14.9	13.7	-1.2	-8%
All Days	---	7.9	7.9	7.8	7.9	7.3	7.5	7.0	7.0	6.8	5.6	-0.2	0.0	7.9	7.1	-0.8	-10%
Total Extinction (Mm-1)																	
Best 20% Days	---	13.7	12.7	11.7	11.9	12.3	12.1	11.9	11.8	11.6	11.0	-0.2	0.0	12.5	11.9	-0.6	-5%
Worst 20% Days	---	39.6	40.7	60.6	49.1	37.2	55.3	38.3	45.4	37.9	31.4	-0.3	0.3	47.5	42.8	-4.7	-10%
All Days	---	23.8	24.1	27.0	25.3	22.5	25.7	22.1	23.2	21.7	18.9	-0.3	0.1	25.1	23.0	-2.1	-8%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	---	1.8	1.2	0.7	0.9	1.2	1.0	0.8	1.0	0.8	0.5	-0.1	0.1	1.2	1.0	-0.2	-17%
Worst 20% Days	---	11.6	10.4	10.7	12.5	9.5	10.1	10.3	11.6	9.9	8.5	-0.1	0.2	11.3	10.3	-1.0	-9%
All Days	---	5.9	5.5	4.8	5.5	5.4	5.1	4.9	5.2	4.8	3.9	-0.1	0.0	5.4	5.1	-0.3	-6%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	---	0.8	0.4	0.3	0.4	0.3	0.2	0.3	0.2	0.2	0.2	0.0	0.0	0.4	0.3	-0.1	-25%
Worst 20% Days	---	4.5	5.2	5.8	6.6	5.7	3.8	4.6	3.1	3.8	3.0	-0.3	0.1	5.5	4.2	-1.3	-24%
All Days	---	2.3	2.3	2.3	2.6	2.2	1.8	2.0	1.4	1.7	1.2	-0.1	0.0	2.4	1.8	-0.6	-25%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	---	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.1	0.1	0.0	0.0	0.2	0.2	0.0	0%
Worst 20% Days	---	7.7	9.5	26.7	14.4	7.5	22.9	7.6	15.6	8.6	5.9	0.0	0.5	14.6	12.4	-2.2	-15%
All Days	---	2.9	3.6	7.0	4.6	2.7	5.7	2.7	4.4	2.8	1.9	0.0	0.4	4.5	3.7	-0.8	-18%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	---	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.2	0.1	-0.1	-50%
Worst 20% Days	---	2.2	2.3	4.3	2.8	2.3	3.2	2.2	2.3	1.8	1.4	0.0	0.3	2.9	2.3	-0.6	-21%
All Days	---	1.0	1.1	1.4	1.1	1.0	1.1	0.9	0.8	0.7	0.5	-0.1	0.0	1.1	0.9	-0.2	-18%
Soil Extinction (Mm-1)																	
Best 20% Days	---	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.4	0.1	0.0	-0.1	-100%
Worst 20% Days	---	1.2	0.6	0.5	0.6	0.3	0.7	0.6	0.7	0.7	0.6	0.0	0.4	0.7	0.6	-0.1	-14%
All Days	---	0.4	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.3	0.2	0.0	0.5	0.3	0.2	-0.1	-33%
Coarse Mass Extinction (Mm-1)																	
Best 20% Days	---	0.1	0.2	0.1	0.0	0.1	0.1	0.2	0.1	0.1	0.1	0.0	0.2	0.1	0.1	0.0	0%
Worst 20% Days	---	2.4	2.8	2.7	2.0	1.3	2.6	2.6	2.0	2.9	1.6	0.0	0.5	2.5	2.3	-0.2	-8%
All Days	---	1.0	1.0	1.0	0.8	0.6	0.8	0.9	0.8	1.0	0.7	0.0	0.3	0.9	0.8	-0.1	-11%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	---	0.4	0.4	0.2	0.2	0.3	0.4	0.3	0.2	0.2	0.1	0.0	0.1	0.3	0.3	0.0	0%
Worst 20% Days	---	0.0	0.0	0.0	0.3	0.6	2.0	0.2	0.1	0.4	0.3	0.0	0.1	0.1	0.7	0.6	>100%
All Days	---	0.3	0.4	0.3	0.5	0.5	0.9	0.5	0.3	0.4	0.4	0.0	0.3	0.4	0.5	0.1	25%

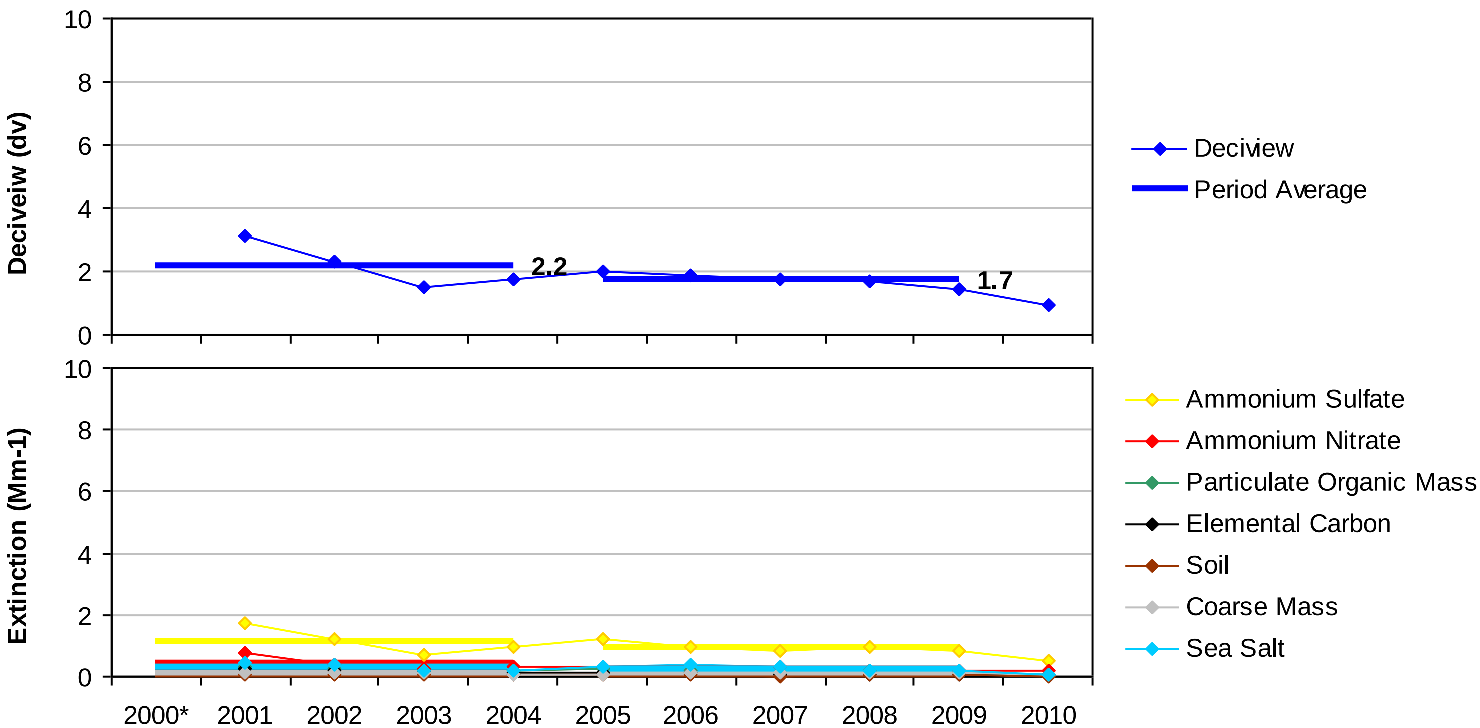
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---"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

Figure K.6-1
Mount Hood WA, OR (MOHO1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days



*Missing years did not meet RHR data completeness criteria.

Figure K.6-2
Mount Hood WA, OR (MOHO1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days

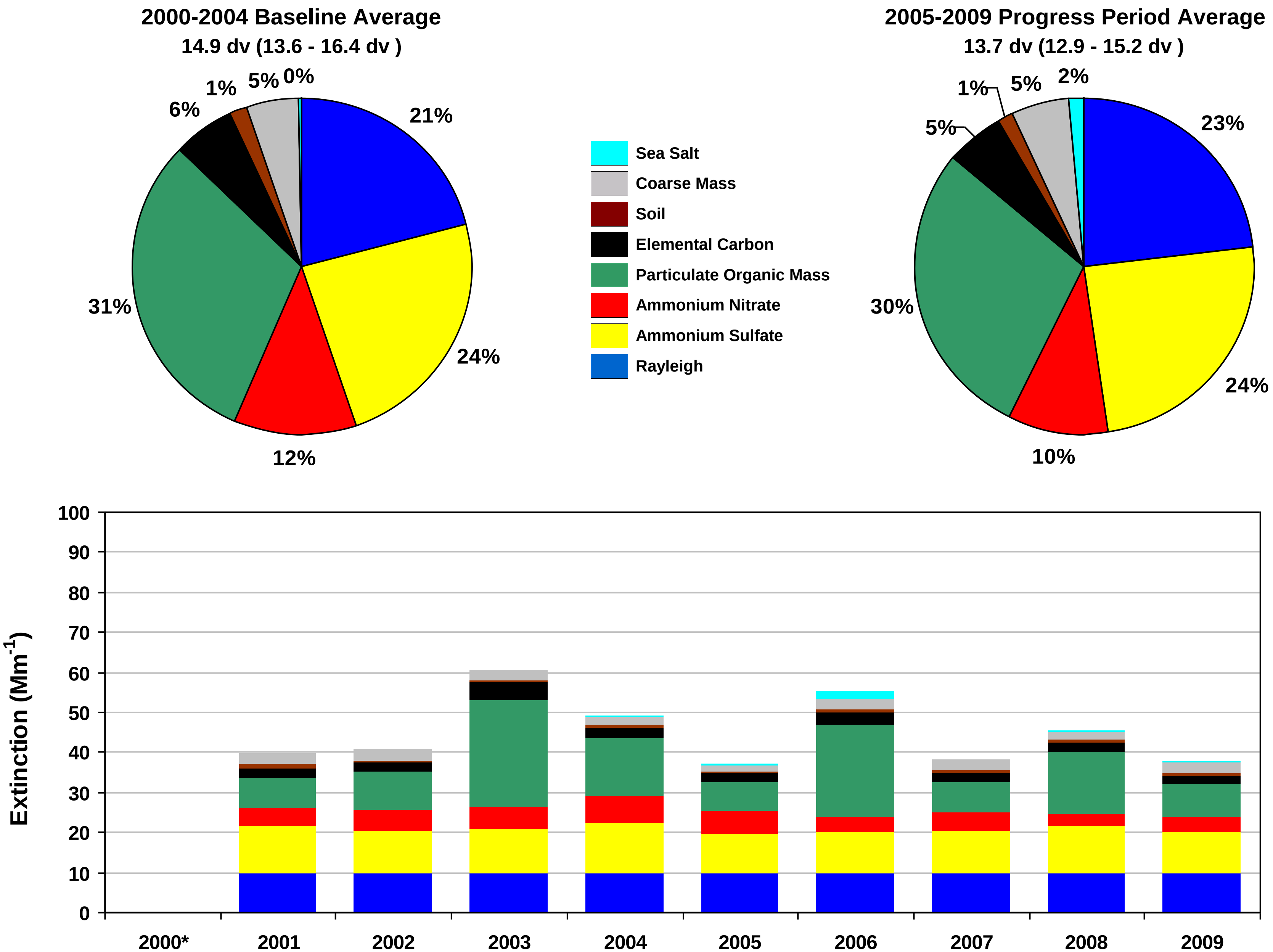


*Missing years did not meet RHR data completeness criteria.

Figure K.6-3

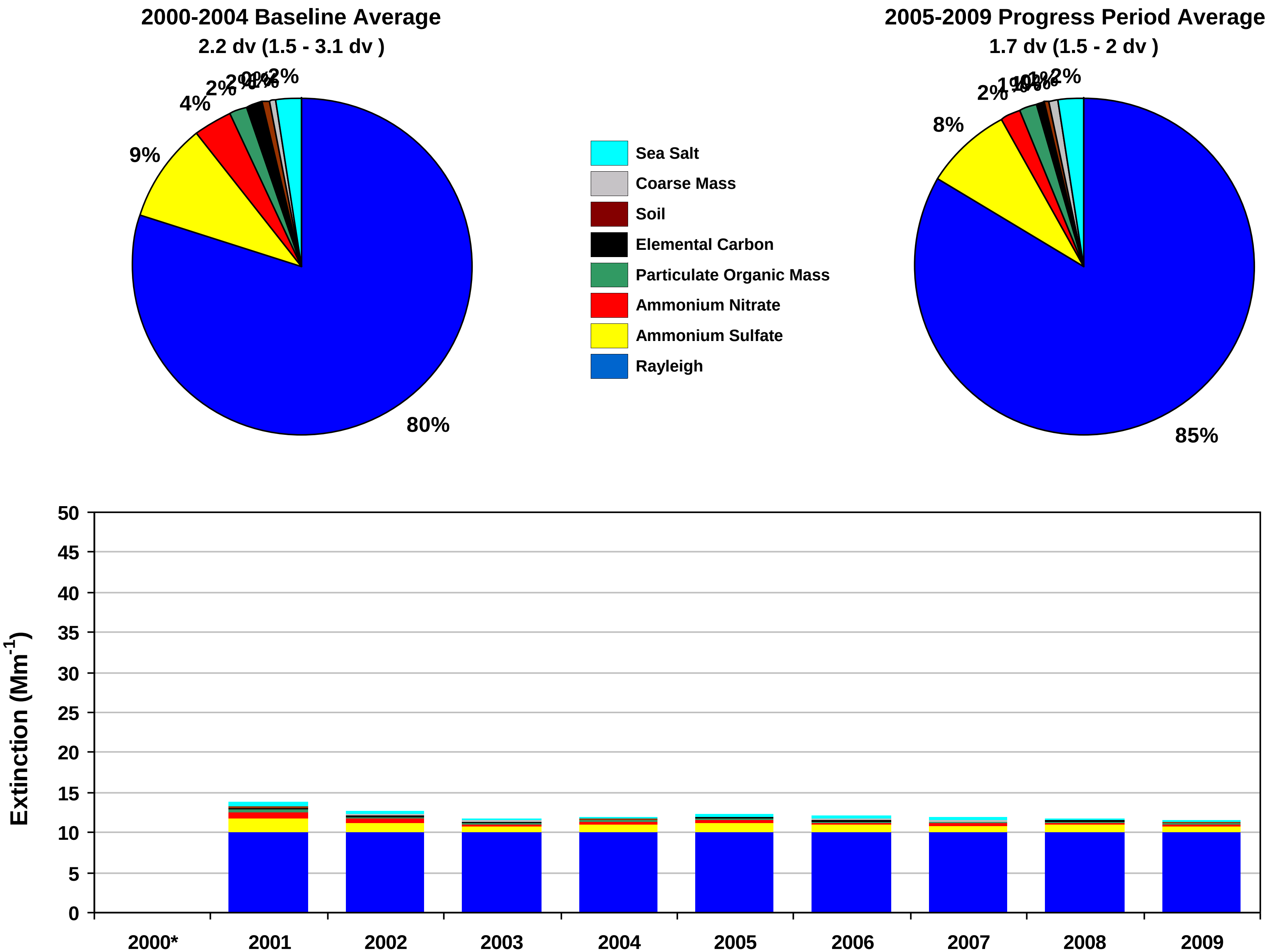
Mount Hood WA, OR (MOHO1 Site)

20% Most Impaired Visibility Days



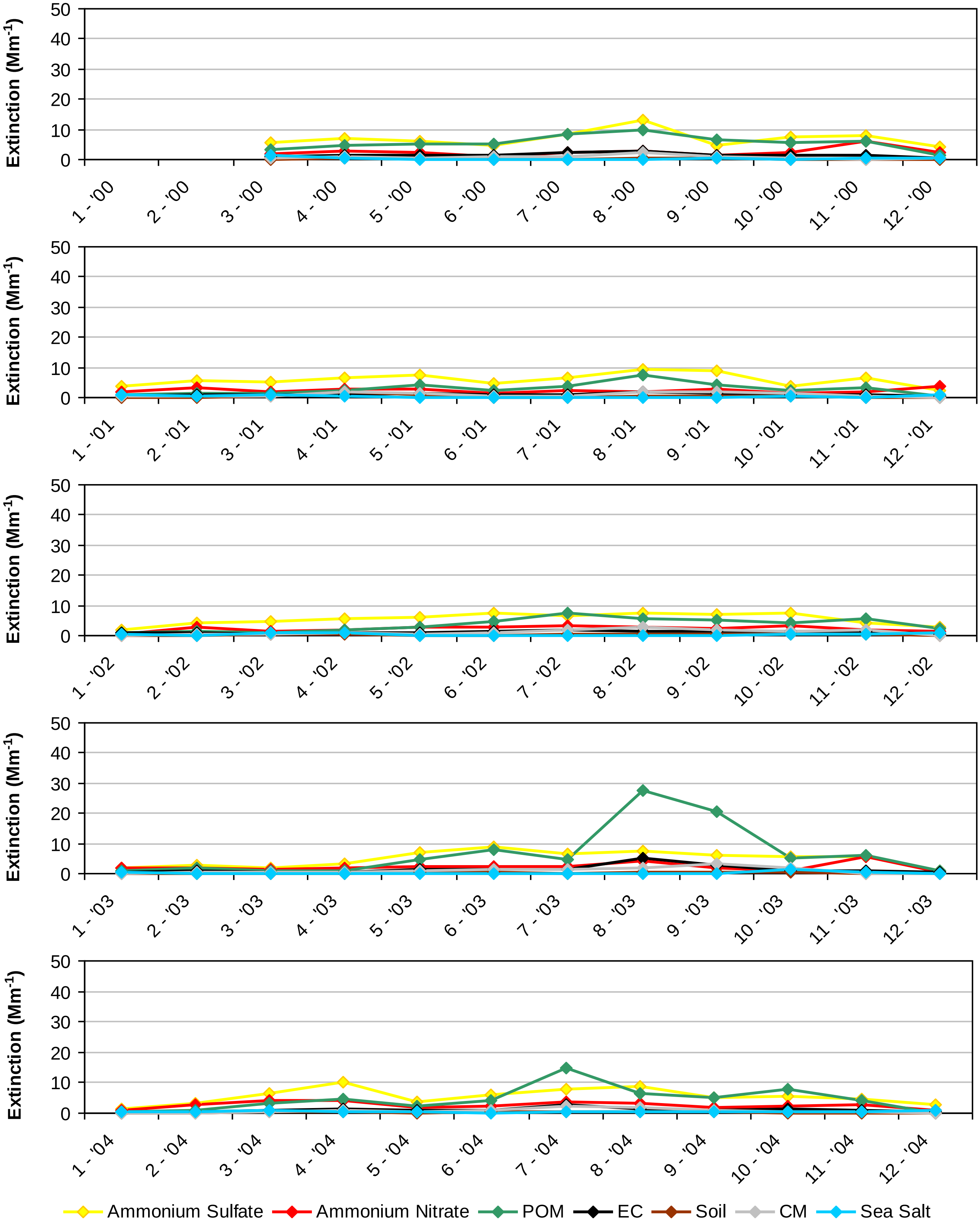
*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.6-4
Mount Hood WA, OR (MOHO1 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 K.6-5
Mount Hood WA, OR (MOHO1 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 K.6-6
Mount Hood WA, OR (MOHO1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days

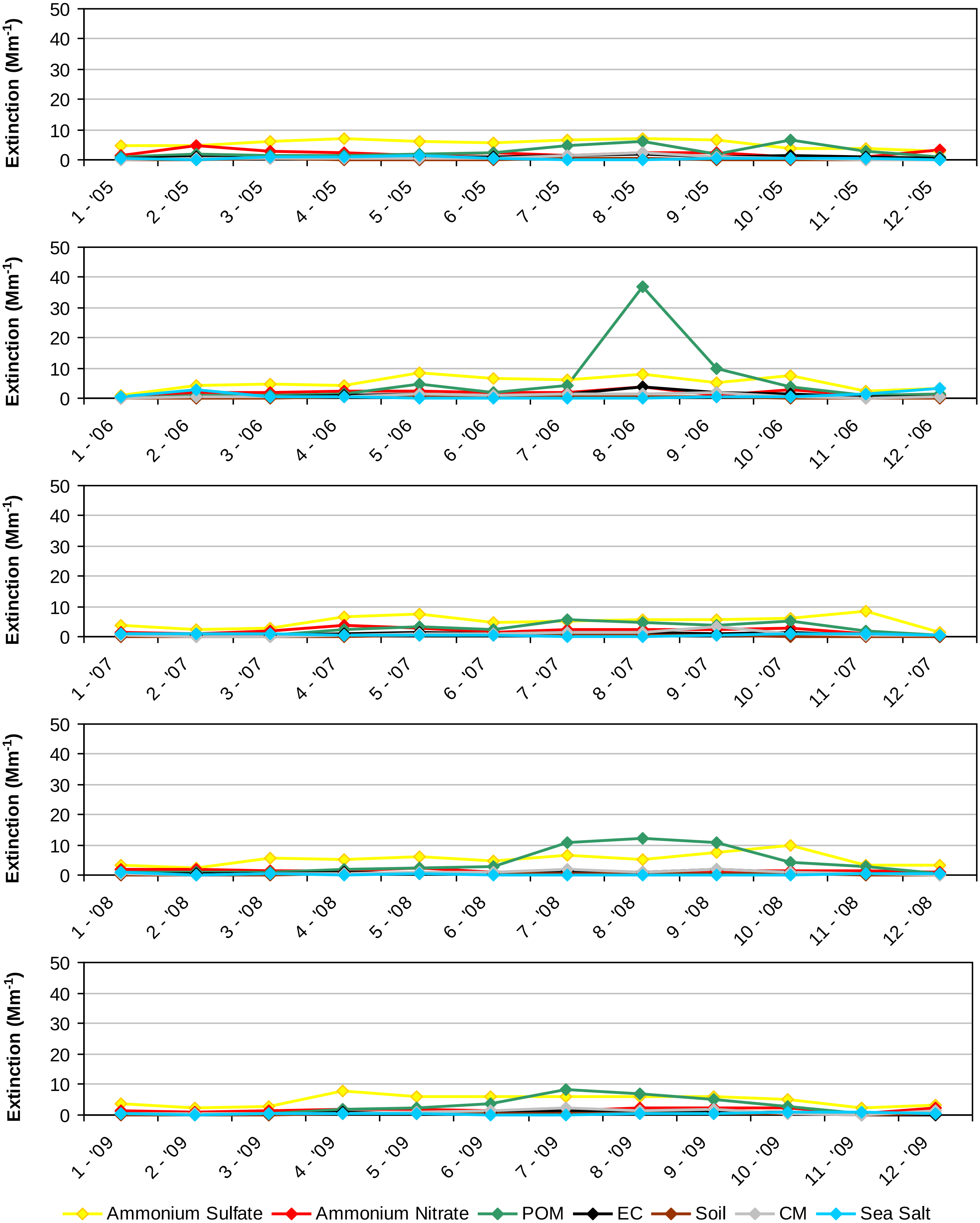
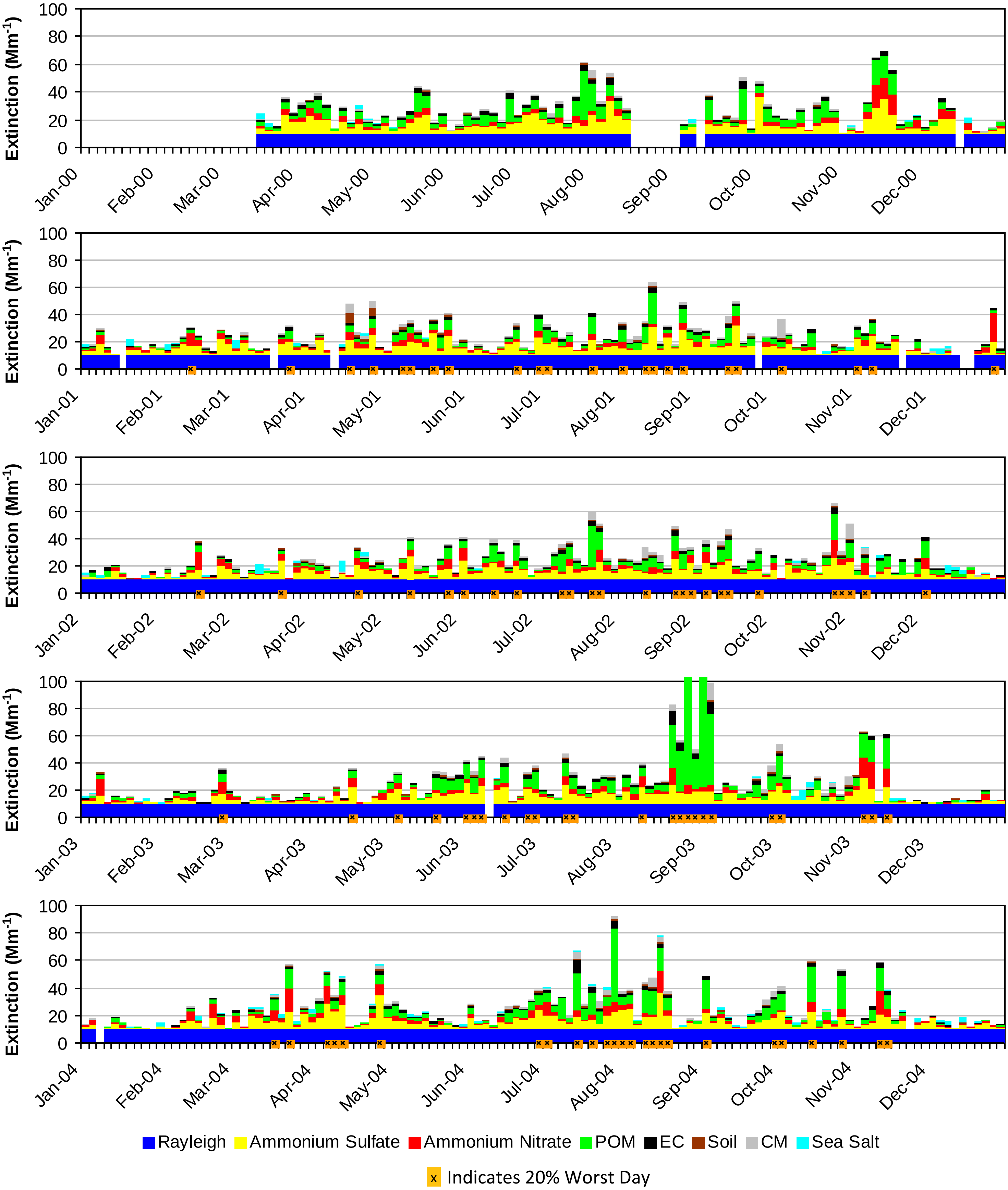
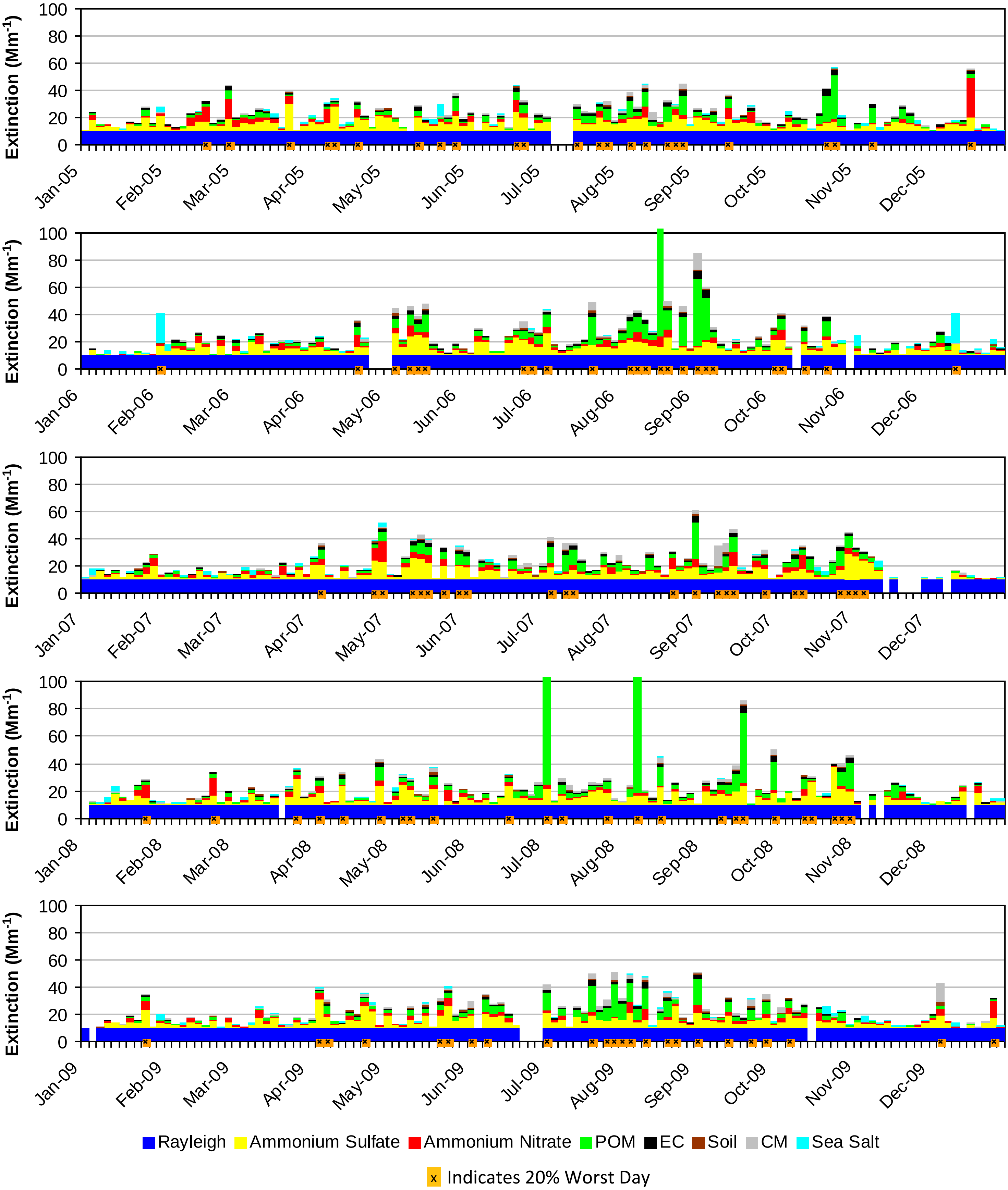


Figure K.6-7
Mount Hood WA, OR (MOHO1 Site)
2000-2004 Progress Period Extinction, All Sampled Days



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

Figure K.6-8
Mount Hood WA, OR (MOHO1 Site)
2005-2009 Progress Period Extinction, All Sampled Days



K.7. EAGLE CAP WA AND STRAWBERRY MOUNTAIN WA (STAR1)

The following tables and figures are presented in this section for the Eagle Cap WA and Strawberry Mountain WA represented by the STAR1 IMPROVE Monitor:

- **Table K.7-1: Annual Averages, 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 K.7-1: Annual and Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure K.7-2: Annual and Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure K.7-3: 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 K.7-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure K.7-5: 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 K.7-6: 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 K.7-7: 2000-2004 Progress Period Extinction, All Sampled Days:** Stacked bar charts depicting daily averages by year and component for the baseline period are presented.

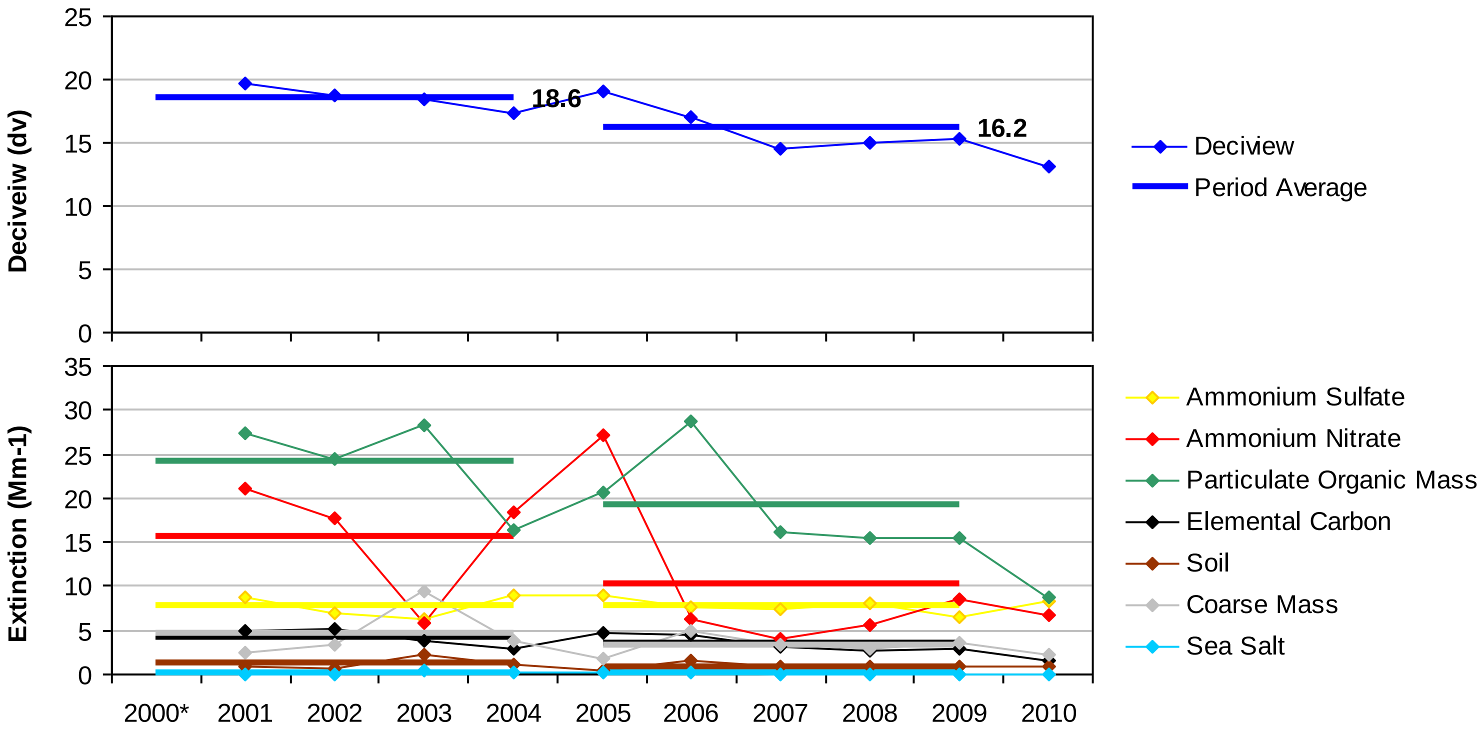
- **Figure K.7-8: 2000-2004 Progress Period Extinction, All Sampled Days**: Stacked bar charts depicting daily averages by year and component for the progress period are presented.

Table K.7-1
Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)
Annual Averages, Period Averages and Trends

Group	Baseline Period					Progress Period					2010	2000-2009 Trend Statistics*		Period Averages**			
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009		Slope (change/yr.)	p-value	Baseline (B)	Progress (P)	Difference (P -B)	Percent Change
Deciview (dv)																	
Best 20% Days	---	5.4	5.5	3.1	3.9	4.0	3.2	3.6	3.7	3.5	2.9	-0.1	0.1	4.5	3.6	-0.9	-20%
Worst 20% Days	---	19.7	18.7	18.5	17.4	19.1	17.1	14.6	15.0	15.3	13.1	-0.6	0.0	18.6	16.2	-2.4	-13%
All Days	---	11.9	11.3	10.1	9.9	10.2	9.3	8.7	8.9	9.1	7.8	-0.4	0.0	10.8	9.2	-1.6	-15%
Total Extinction (Mm-1)																	
Best 20% Days	---	17.3	17.5	13.7	14.9	15.0	13.9	14.4	14.5	14.3	13.5	-0.2	0.1	15.9	14.4	-1.5	-9%
Worst 20% Days	---	75.6	68.4	66.5	61.8	74.2	63.6	45.3	45.6	48.0	38.5	-3.9	0.0	68.1	55.3	-12.8	-19%
All Days	---	38.1	35.1	32.2	31.3	33.3	30.3	26.2	26.6	27.3	23.6	-1.4	0.0	34.2	28.7	-5.5	-16%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	---	2.6	2.4	1.2	1.8	2.0	1.7	1.9	1.9	2.0	1.6	0.0	0.5	2.0	1.9	-0.1	-5%
Worst 20% Days	---	8.7	7.0	6.4	8.9	9.0	7.5	7.5	8.1	6.6	8.3	-0.1	0.4	7.7	7.8	0.1	1%
All Days	---	5.8	5.0	4.1	5.3	5.3	4.9	4.7	5.2	4.9	4.5	0.0	0.2	5.0	5.0	0.0	0%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	---	0.8	0.8	0.5	0.6	0.4	0.5	0.7	0.5	0.6	0.4	0.0	0.3	0.7	0.6	-0.1	-14%
Worst 20% Days	---	21.1	17.7	5.9	18.4	27.1	6.2	4.1	5.7	8.5	6.7	-1.8	0.1	15.8	10.3	-5.5	-35%
All Days	---	5.8	5.4	2.7	5.2	6.8	2.7	2.1	2.3	3.1	2.6	-0.4	0.1	4.8	3.4	-1.4	-29%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	---	2.1	2.3	1.2	1.4	1.2	0.6	0.8	1.1	0.9	0.6	-0.2	0.0	1.7	0.9	-0.8	-47%
Worst 20% Days	---	27.4	24.5	28.3	16.3	20.7	28.7	16.1	15.4	15.5	8.8	-1.5	0.0	24.1	19.3	-4.8	-20%
All Days	---	10.6	9.3	9.5	6.8	7.0	8.0	5.5	5.6	5.7	3.6	-0.6	0.0	9.0	6.4	-2.6	-29%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	---	0.8	0.8	0.3	0.4	0.4	0.3	0.3	0.3	0.2	0.2	-0.1	0.1	0.5	0.3	-0.2	-40%
Worst 20% Days	---	4.8	5.2	3.8	3.0	4.8	4.5	3.2	2.6	2.8	1.7	-0.3	0.0	4.2	3.6	-0.6	-14%
All Days	---	2.5	2.2	1.7	1.5	1.8	1.6	1.3	1.1	1.1	0.8	-0.2	0.0	2.0	1.4	-0.6	-30%
Soil Extinction (Mm-1)																	
Best 20% Days	---	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.0	0%
Worst 20% Days	---	1.0	0.7	2.3	1.1	0.5	1.5	0.9	0.8	1.0	0.8	0.0	0.5	1.3	0.9	-0.4	-31%
All Days	---	0.6	0.6	0.7	0.5	0.4	0.6	0.5	0.5	0.5	0.4	0.0	0.2	0.6	0.5	-0.1	-17%
Coarse Mass Extinction (Mm-1)																	
Best 20% Days	---	0.7	0.8	0.3	0.4	0.6	0.3	0.3	0.4	0.3	0.4	0.0	0.0	0.5	0.4	-0.1	-20%
Worst 20% Days	---	2.6	3.3	9.4	3.8	1.8	5.0	3.5	2.9	3.5	2.2	0.0	0.5	4.8	3.3	-1.5	-31%
All Days	---	2.3	2.5	3.3	1.8	1.8	2.2	1.9	1.7	1.7	1.5	-0.1	0.0	2.5	1.9	-0.6	-24%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	---	0.3	0.2	0.1	0.3	0.2	0.4	0.4	0.2	0.3	0.2	0.0	0.4	0.2	0.3	0.1	50%
Worst 20% Days	---	0.0	0.0	0.4	0.2	0.3	0.1	0.1	0.0	0.1	0.1	0.0	0.5	0.1	0.1	0.0	0%
All Days	---	0.6	0.1	0.2	0.3	0.2	0.3	0.2	0.2	0.2	0.2	0.0	0.4	0.3	0.2	-0.1	-33%

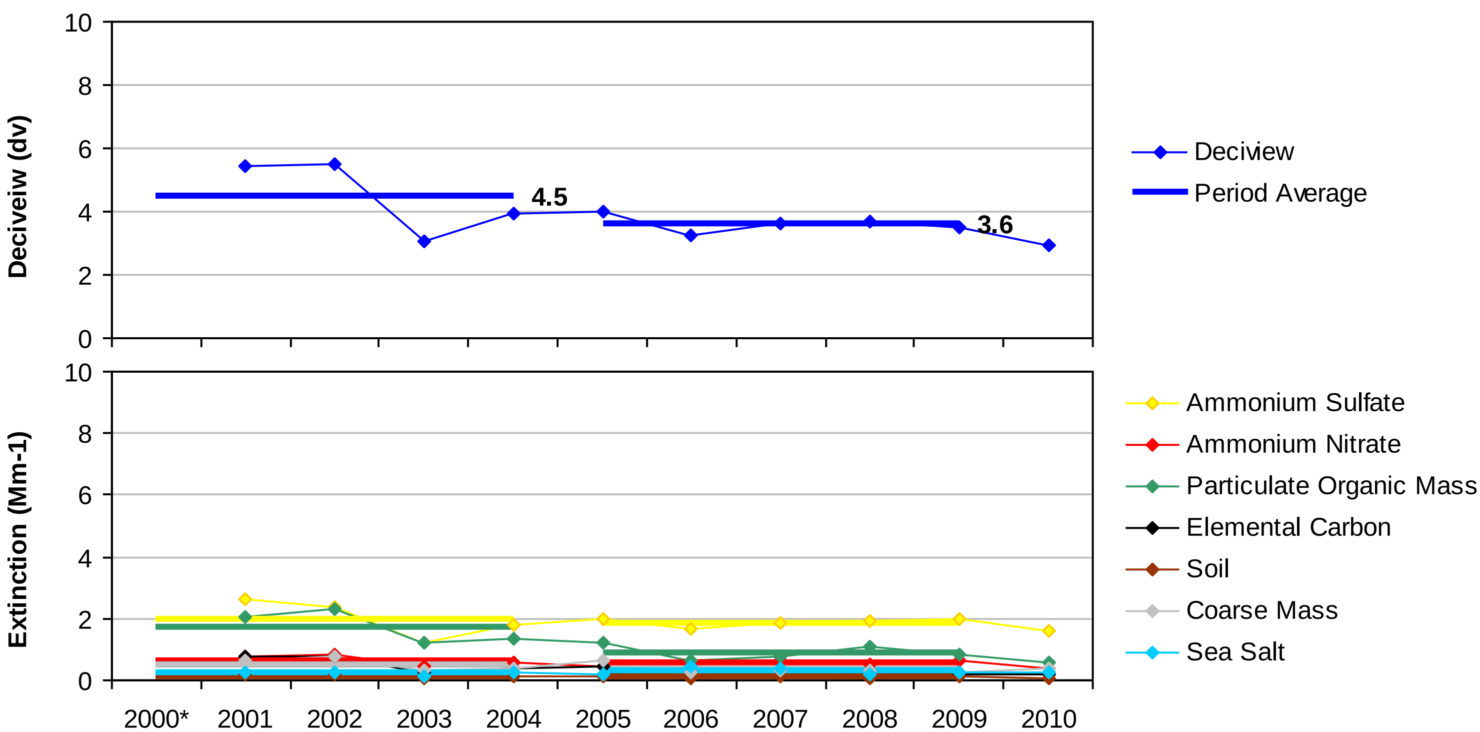
*Values highlighted in blue (red) indicate statistically significant decreasing (increasing) annual trend. Significance is measured at the 85% confidence level (p-value ≤0.15).
**Values highlighted in blue indicate a decrease in the 5-year average, values highlighted in red indicate an increase.
"---"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

Figure K.7-1
Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days



*Missing years did not meet RHR data completeness criteria.

Figure K.7-2
Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days

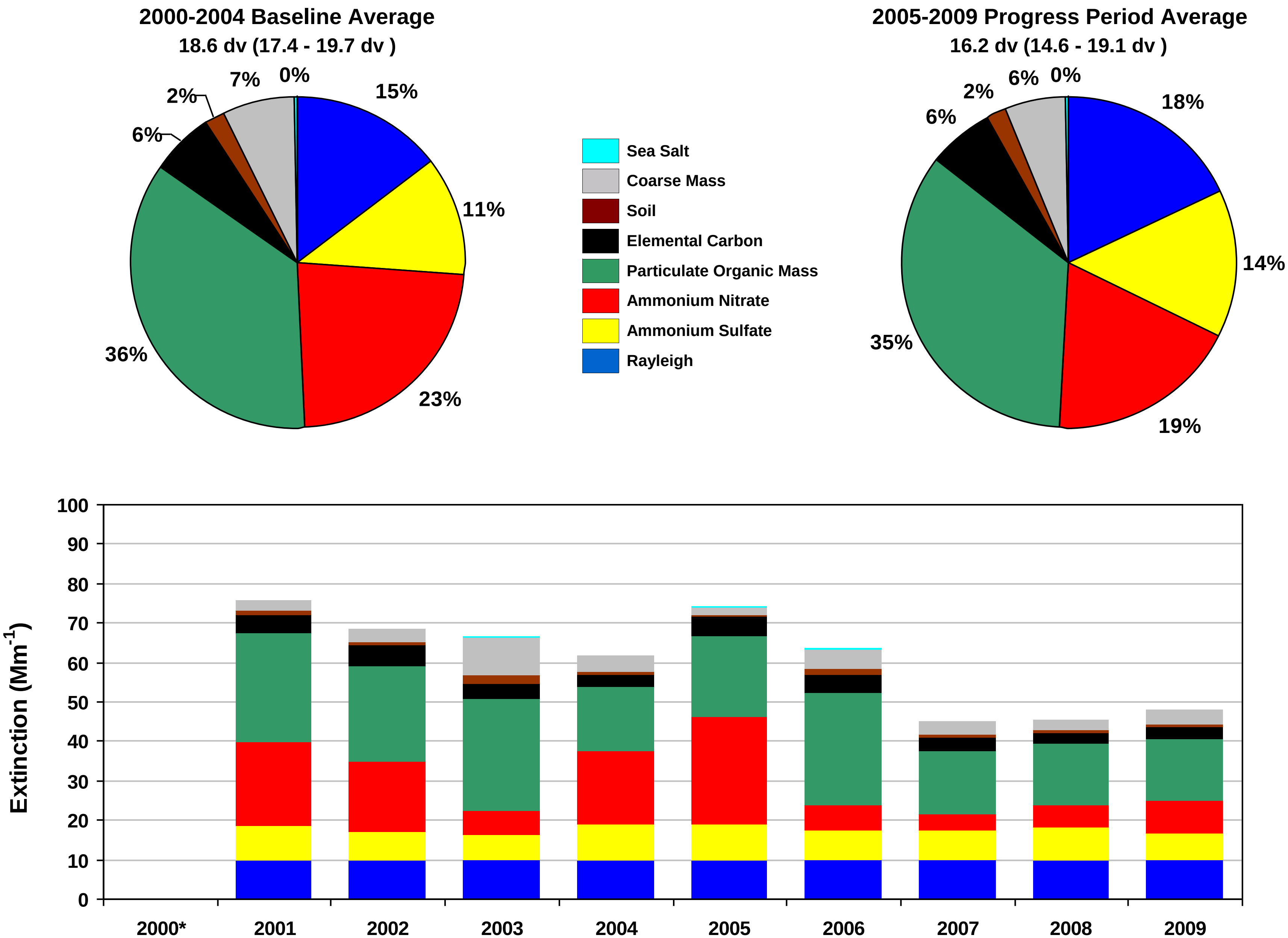


*Missing years did not meet RHR data completeness criteria.

Figure K.7-3

Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)

20% Most Impaired Visibility Days

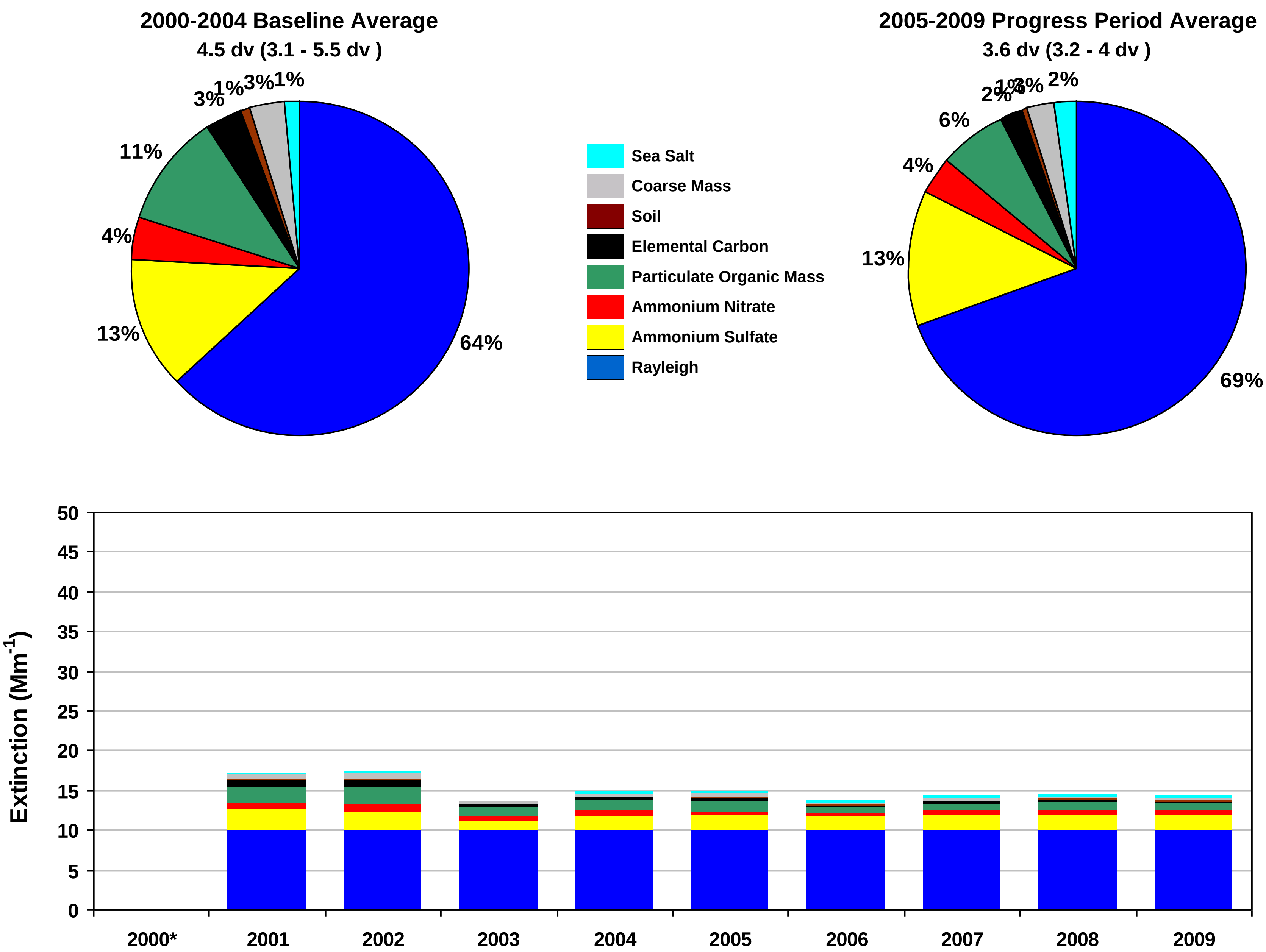


*Missing years did not meet RHR data completeness criteria. Only complete years are included in 5-year average pie charts.

Figure K.7-4

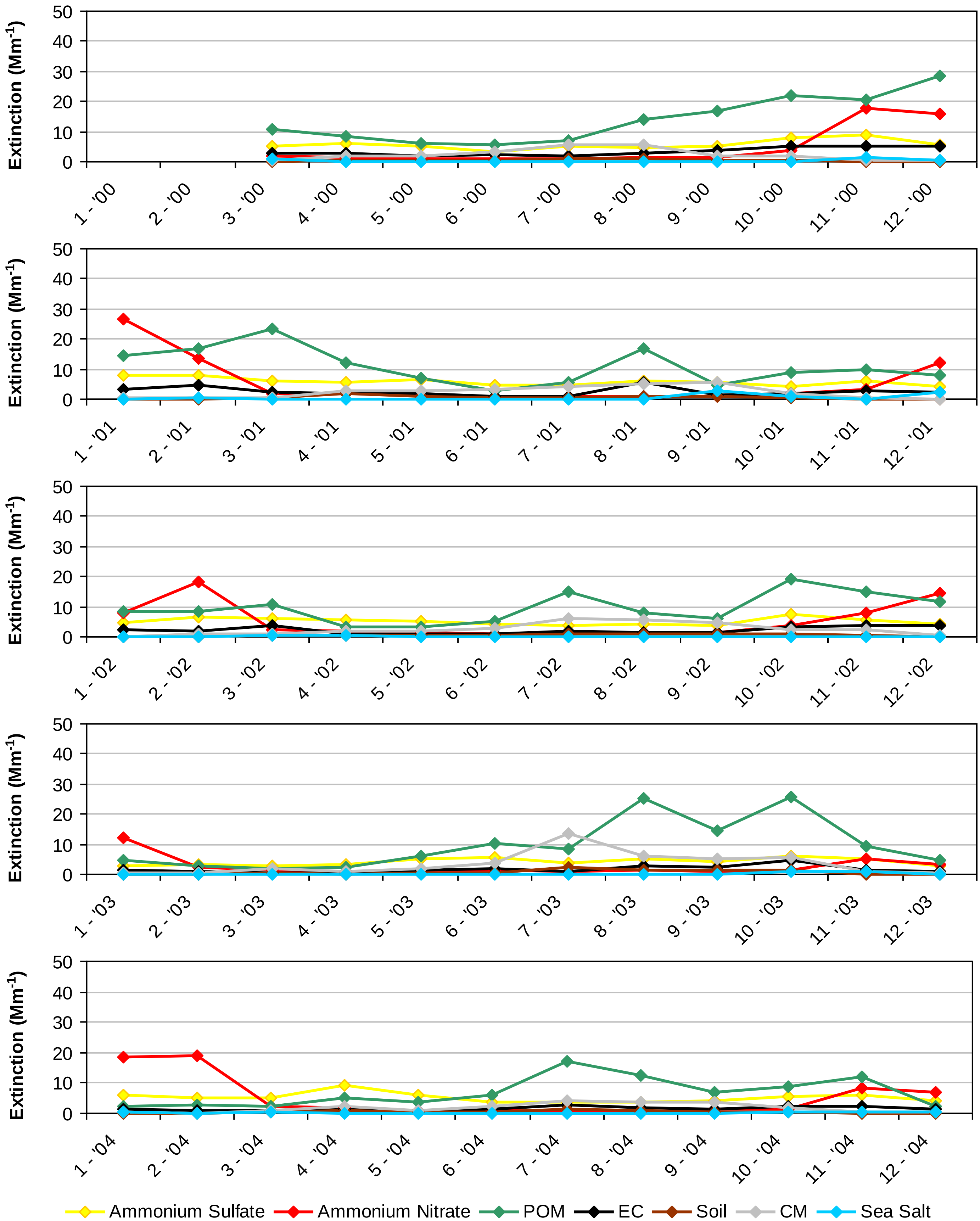
Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)

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 K.7-5
Eagle Cap and Strawberry Mountain Was, OR (STAR1 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 K.7-6
Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days

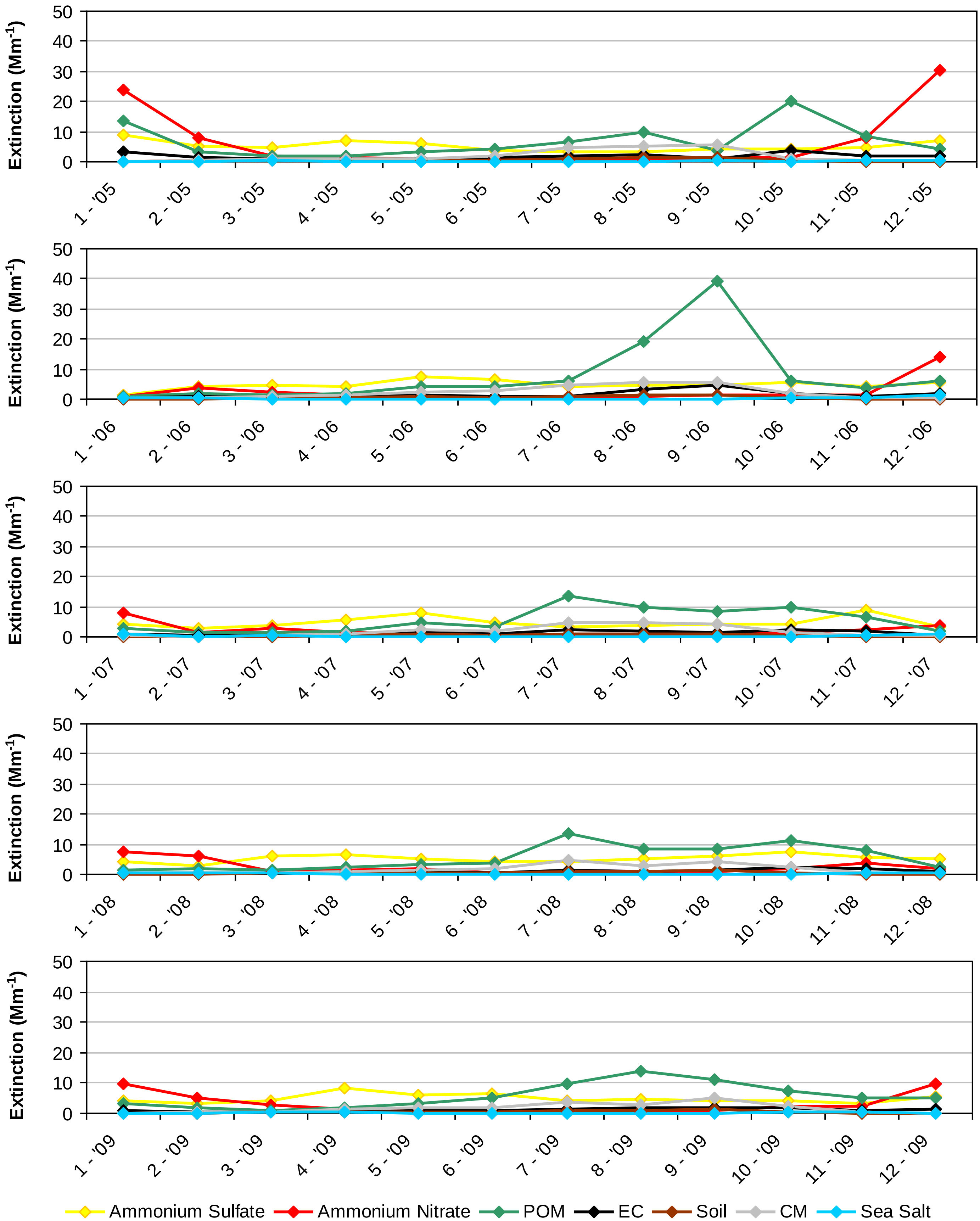
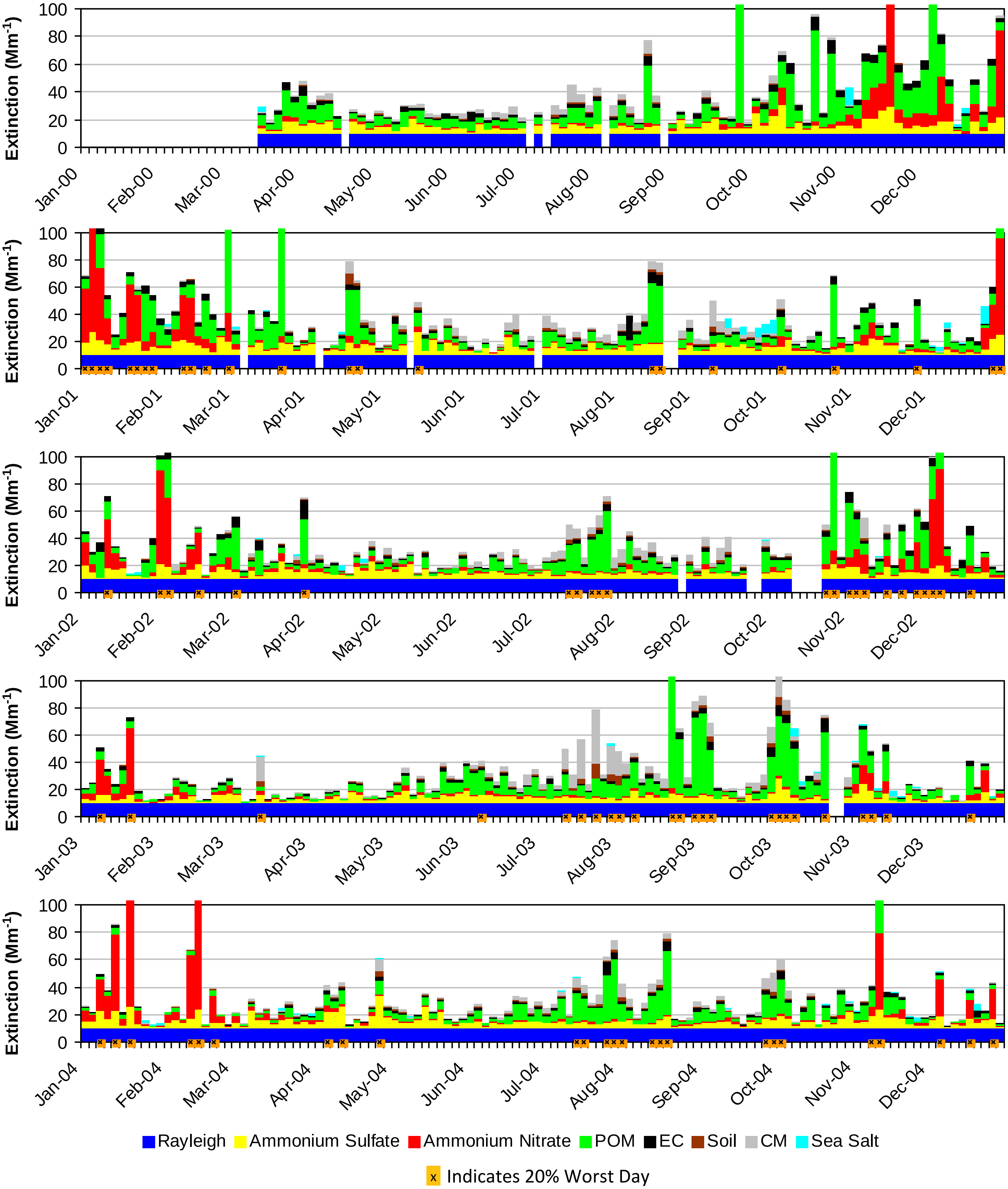
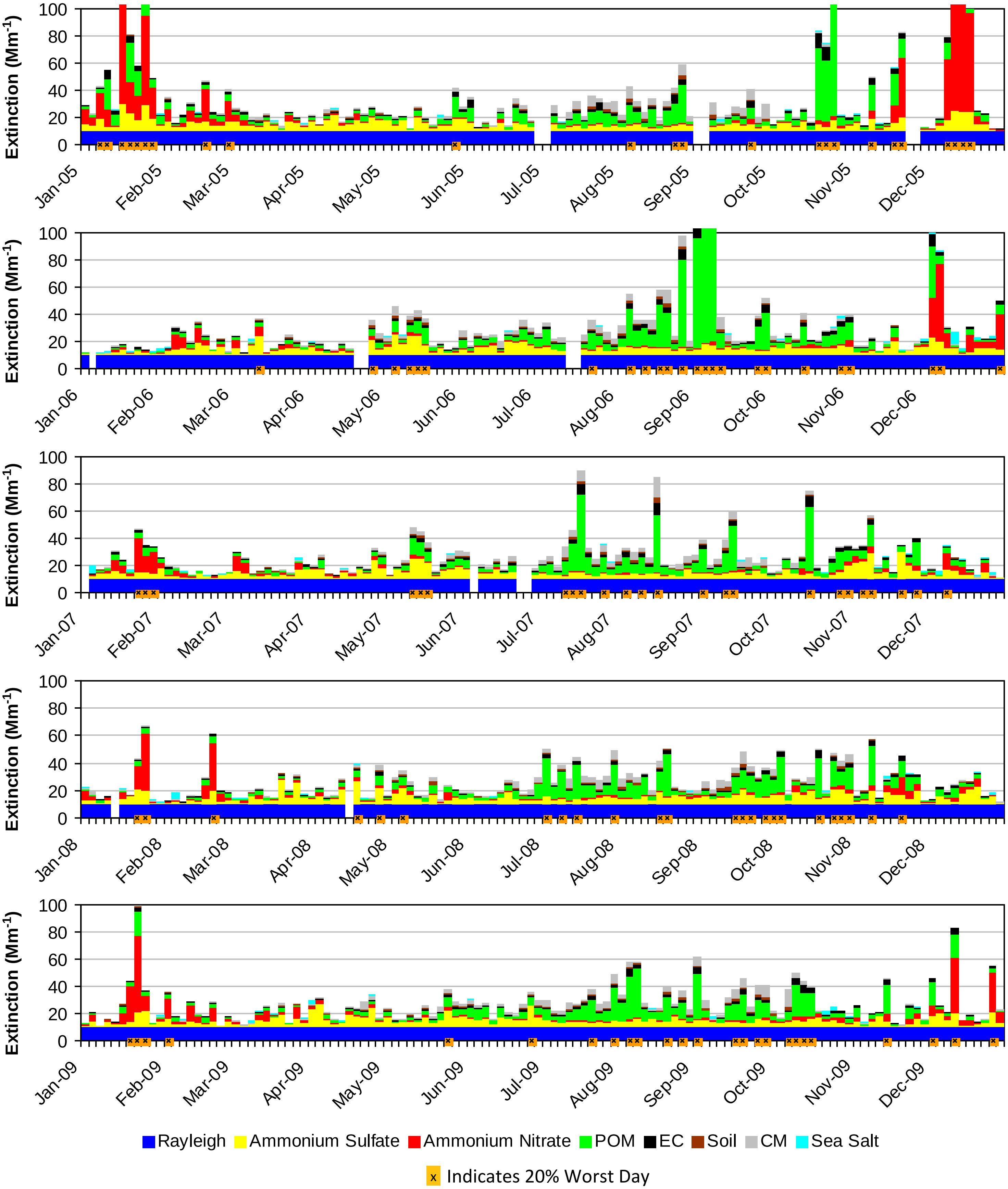


Figure K.7-7
Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)
2000-2004 Progress Period Extinction, All Sampled Days



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

Figure K.7-8
Eagle Cap and Strawberry Mountain Was, OR (STAR1 Site)
2005-2009 Progress Period Extinction, All Sampled Days



K.8. THREE SISTERS WA, MOUNT JEFFERSON WA, AND MOUNT WASHINGTON WA (THSI1)

The following tables and figures are presented in this section for the Three Sisters WA, Mount Jefferson WA, and Mount Washington WA represented by the THSI1 IMPROVE Monitor:

- **Table K.8-1: Annual Averages, 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 K.8-1: Annual and Period Averages for the 20% Most Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure K.8-2: Annual and Period Averages for the 20% Least Impaired Visibility Days:** Line graphs depicting annual and period averages by component are presented.

- **Figure K.8-3: 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 K.8-4: 20% Least Impaired Visibility Days:** Pie charts depicting period averages and stacked bar charts depicting annual averages by component are presented.

- **Figure K.8-5: 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 K.8-6: 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 K.8-7: 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 K.8-8: 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 K.8-1
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
Annual Averages, 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	3.7	3.8	2.8	2.3	2.6	2.9	2.8	2.9	3.3	3.2	2.5	0.0	0.5	3.0	3.0	0.0	0%
Worst 20% Days	14.9	14.1	15.7	16.5	15.5	14.5	17.5	15.1	15.8	18.1	13.6	0.3	0.1	15.3	16.2	0.9	6%
All Days	9.3	8.9	9.4	8.9	8.6	8.5	9.0	8.4	8.8	9.5	7.4	-0.1	0.2	9.0	8.9	-0.1	-1%
Total Extinction (Mm-1)																	
Best 20% Days	14.5	14.7	13.3	12.6	13.0	13.4	13.2	13.4	13.9	13.8	12.8	0.0	0.5	13.6	13.6	0.0	0%
Worst 20% Days	45.1	41.2	50.6	56.3	53.5	43.2	62.1	48.1	52.2	63.7	41.0	1.9	0.1	49.3	53.9	4.6	9%
All Days	27.6	26.2	28.6	28.3	27.5	25.7	29.3	26.0	27.4	30.7	23.1	0.2	0.4	27.6	27.8	0.2	1%
Ammonium Sulfate Extinction (Mm-1)																	
Best 20% Days	1.3	1.7	1.1	0.6	0.9	1.2	1.0	1.0	1.4	1.4	0.9	0.0	0.4	1.1	1.2	0.1	9%
Worst 20% Days	13.4	12.8	11.4	10.7	10.6	10.0	11.5	10.9	12.4	9.3	10.2	-0.3	0.1	11.8	10.8	-1.0	-9%
All Days	6.7	6.8	6.3	5.2	5.5	5.9	5.9	5.5	6.3	5.8	4.7	-0.1	0.2	6.1	5.8	-0.3	-5%
Ammonium Nitrate Extinction (Mm-1)																	
Best 20% Days	0.4	0.6	0.2	0.3	0.2	0.2	0.2	0.3	0.2	0.2	0.2	0.0	0.1	0.3	0.2	-0.1	-33%
Worst 20% Days	3.2	2.1	2.2	3.6	2.4	2.6	2.7	1.9	1.6	2.0	1.7	-0.1	0.1	2.7	2.2	-0.5	-19%
All Days	1.5	1.4	1.4	1.6	1.2	1.2	1.3	1.0	0.9	1.0	0.8	-0.1	0.0	1.4	1.1	-0.3	-21%
Particulate Organic Mass Extinction (Mm-1)																	
Best 20% Days	0.5	0.6	0.5	0.4	0.4	0.3	0.4	0.5	0.6	0.5	0.3	0.0	0.4	0.5	0.4	-0.1	-20%
Worst 20% Days	11.7	9.3	18.7	23.0	22.8	11.7	23.9	15.7	20.4	14.0	9.6	0.6	0.3	17.1	17.1	0.0	0%
All Days	5.0	3.9	6.4	7.0	6.8	4.3	6.8	5.0	6.1	5.0	3.3	0.0	0.5	5.8	5.4	-0.4	-7%
Elemental Carbon Extinction (Mm-1)																	
Best 20% Days	0.4	0.2	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2	0.1	0.0	0.1	0.2	0.2	0.0	0%
Worst 20% Days	3.2	2.4	3.7	3.6	3.1	3.5	4.5	2.9	3.2	2.6	1.9	-0.1	0.4	3.2	3.3	0.1	3%
All Days	1.6	1.2	1.5	1.4	1.3	1.5	1.5	1.1	1.2	1.1	0.8	0.0	0.0	1.4	1.3	-0.1	-7%
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	0.0	0.0	0.2	0.0	0.0	0.0	0%
Worst 20% Days	0.4	0.9	0.7	0.6	0.5	0.7	1.1	0.7	0.7	3.9	1.2	0.0	0.1	0.6	1.4	0.8	>100%
All Days	0.2	0.4	0.3	0.2	0.2	0.2	0.4	0.3	0.3	1.1	0.4	0.0	0.1	0.3	0.5	0.2	67%
Coarse Mass Extinction (Mm-1)																	
Best 20% Days	0.5	0.3	0.1	0.1	0.1	0.2	0.1	0.2	0.2	0.1	0.1	0.0	0.4	0.2	0.2	0.0	0%
Worst 20% Days	2.2	2.3	2.8	3.5	2.8	3.8	6.3	4.8	2.8	20.3	5.1	0.4	0.0	2.7	7.6	4.9	>100%
All Days	1.2	1.1	1.4	1.4	1.2	1.3	1.9	1.7	1.3	5.3	1.6	0.1	0.0	1.3	2.3	1.0	77%
Sea Salt Extinction (Mm-1)																	
Best 20% Days	0.4	0.3	0.2	0.0	0.3	0.3	0.3	0.3	0.3	0.3	0.1	0.0	0.5	0.2	0.3	0.1	50%
Worst 20% Days	0.0	0.5	0.0	0.3	0.2	0.1	0.9	0.2	0.2	0.5	0.4	0.0	0.2	0.2	0.4	0.2	100%
All Days	0.4	0.4	0.3	0.4	0.3	0.3	0.5	0.4	0.4	0.5	0.4	0.0	0.2	0.4	0.4	0.0	0%

*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 K.8-1
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
Annual and Period Averages Averages
20% Most Impaired Visibility Days

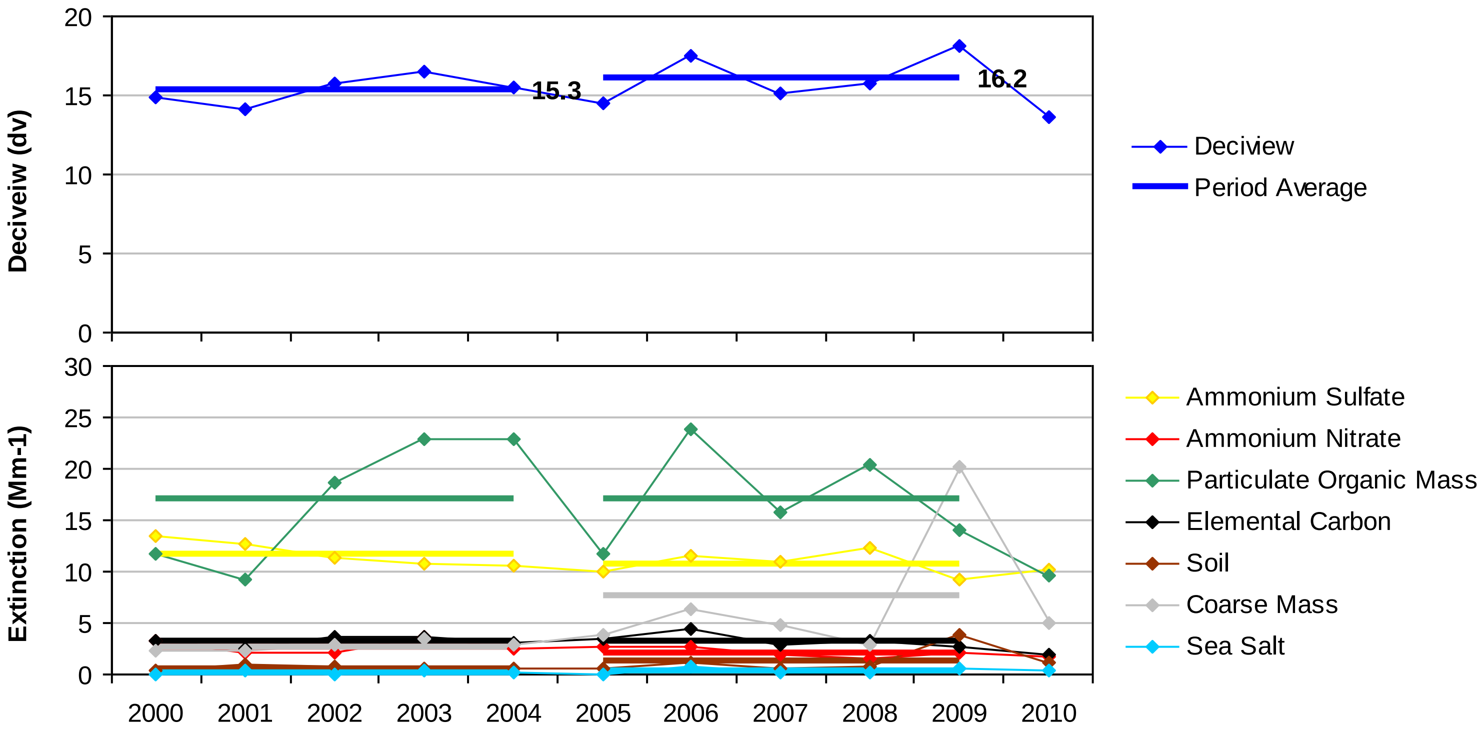


Figure K.8-2
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
Annual and Period Averages
20% Least Impaired Visibility Days

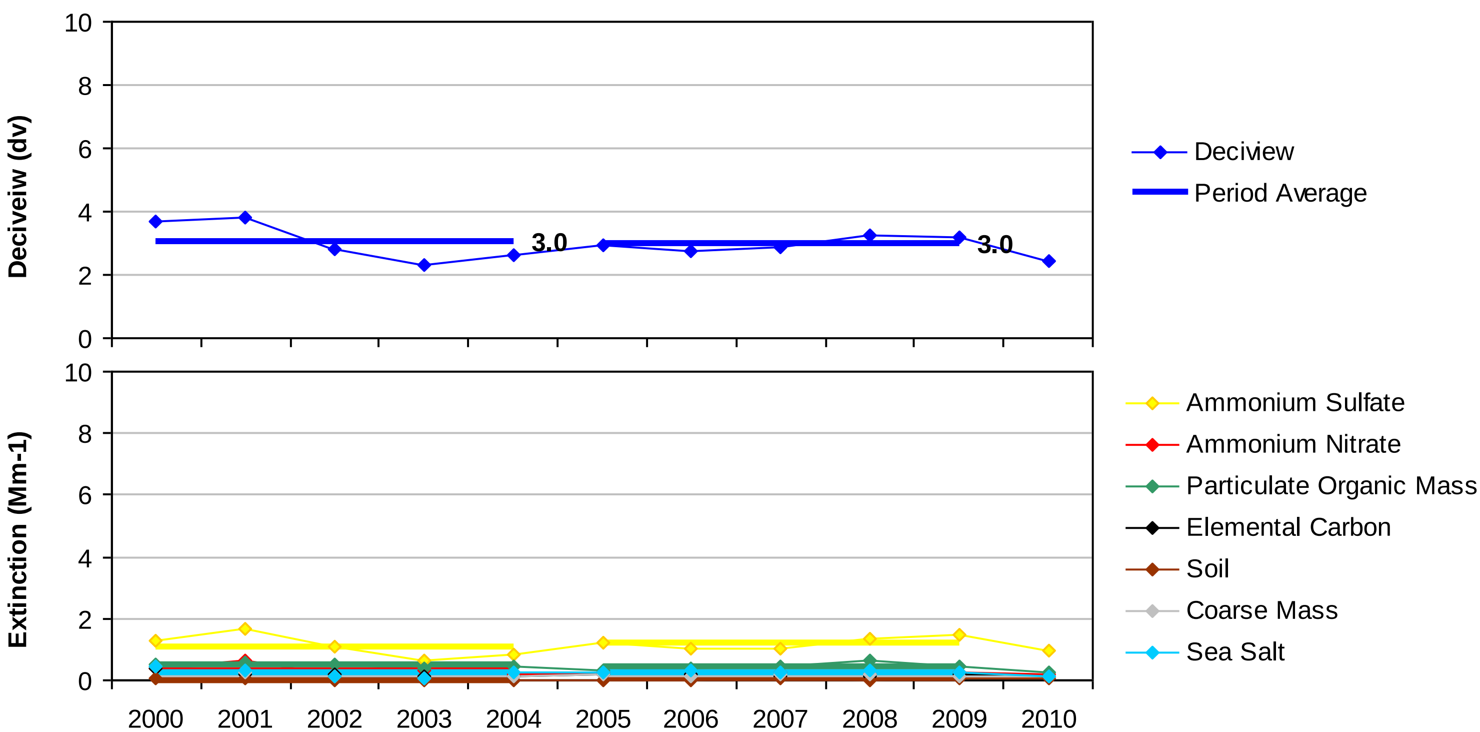
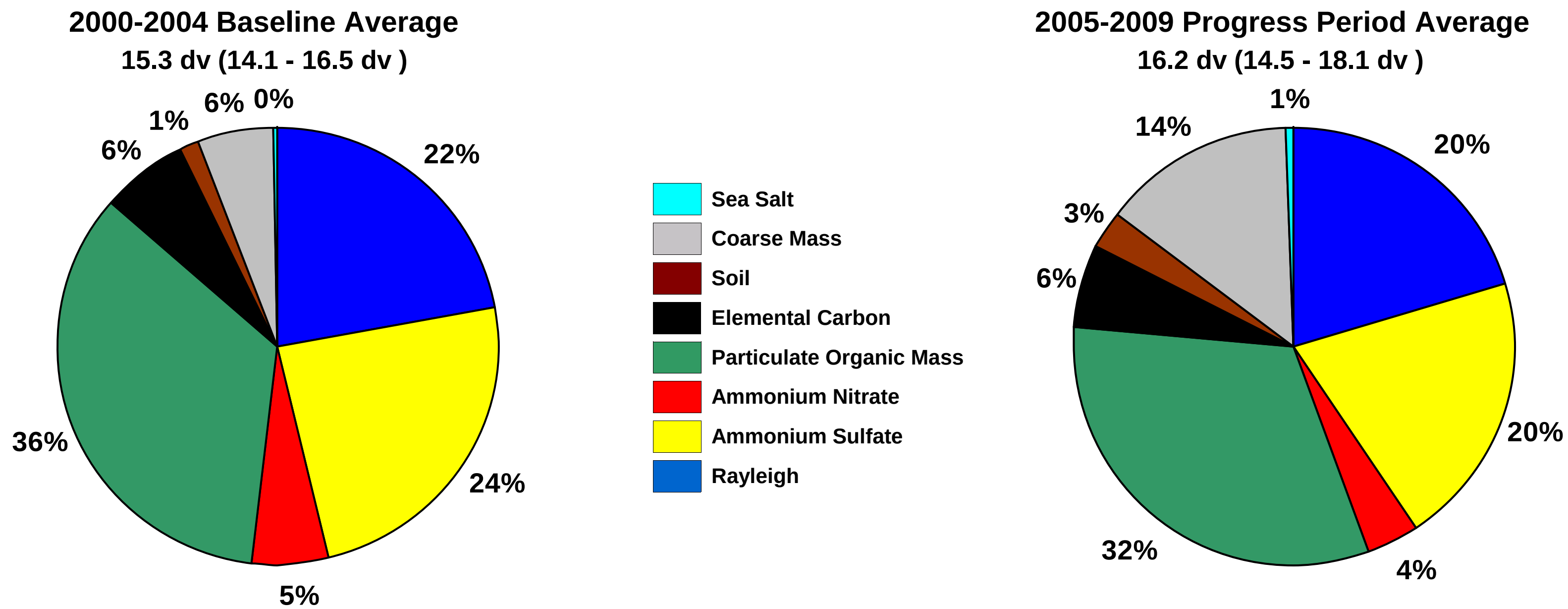


Figure K.8-3
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
20% Most Impaired Visibility Days



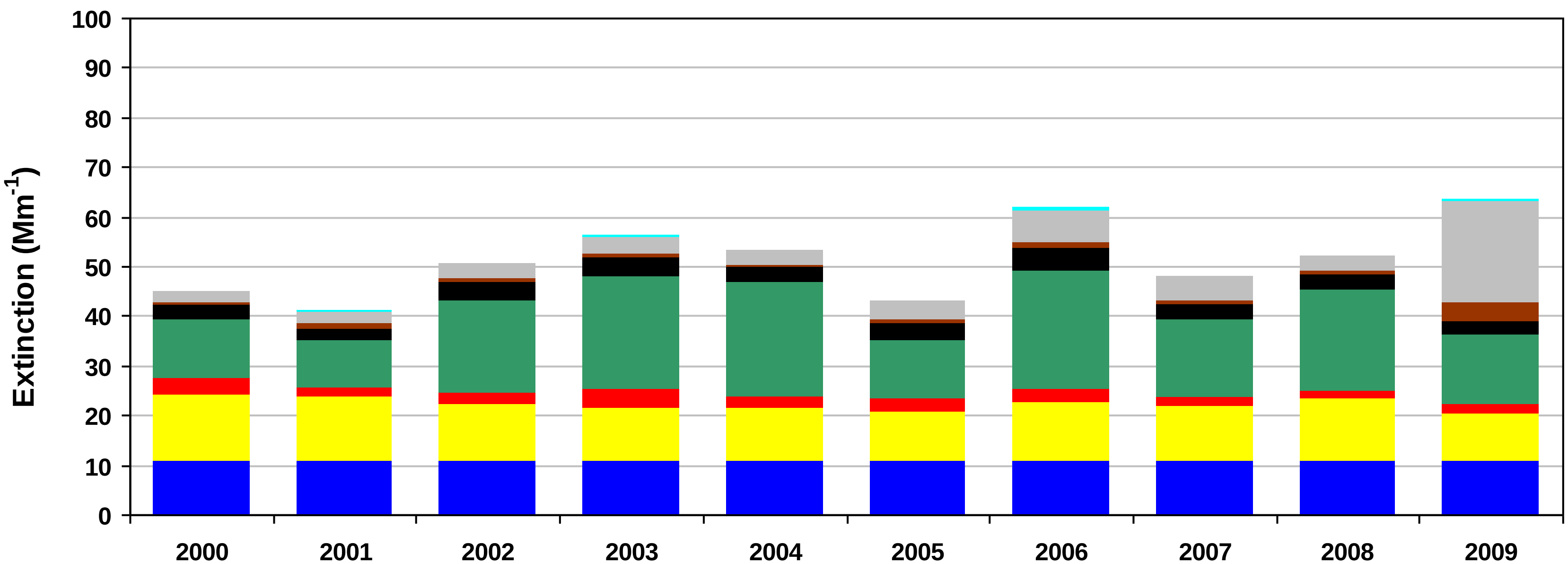


Figure K.8-4

Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)

20% Least Impaired Visibility Days

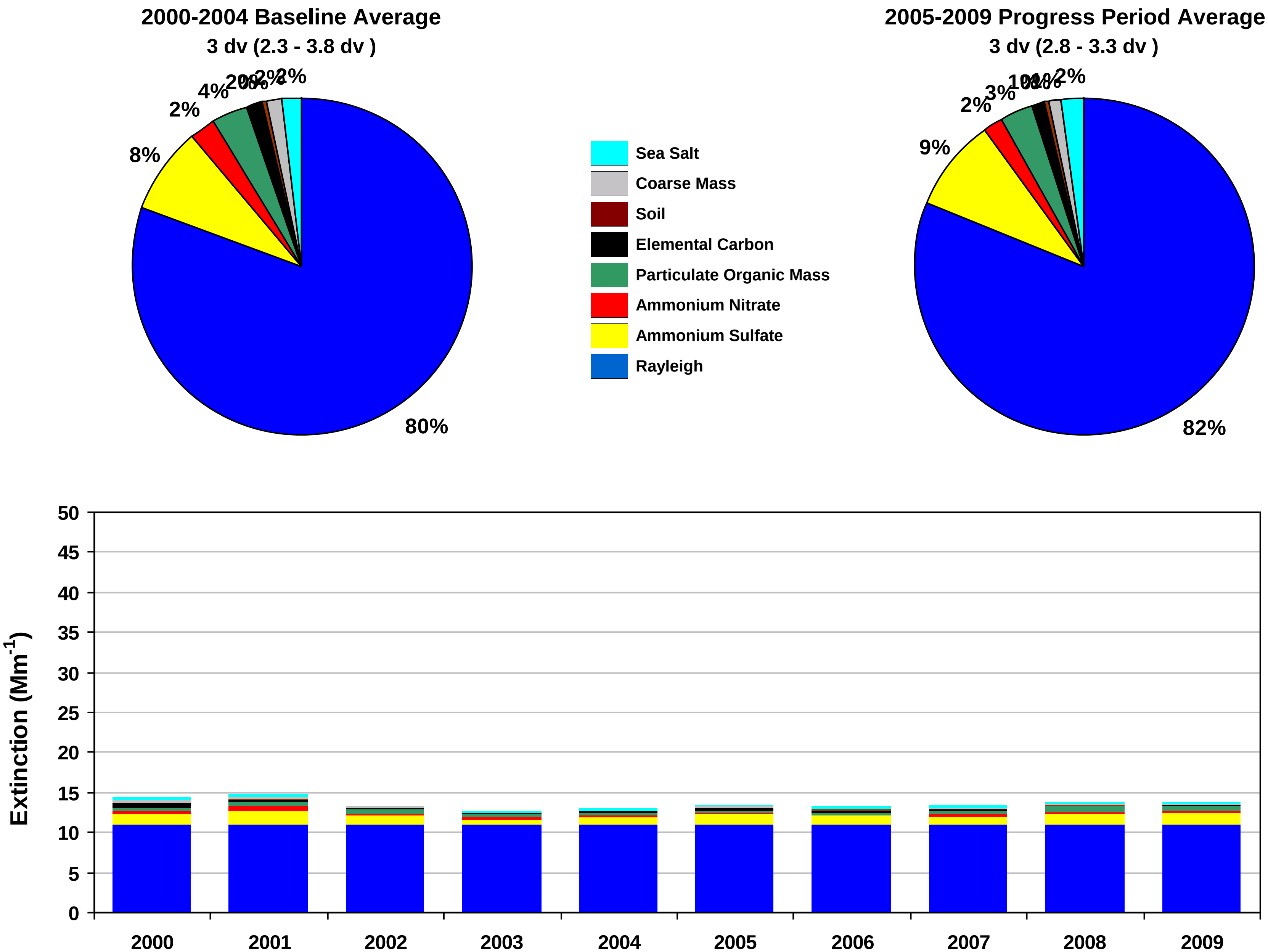


Figure K.8-5
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
2000-2004 Monthly Average Aerosol Extinction, All Monitored Days

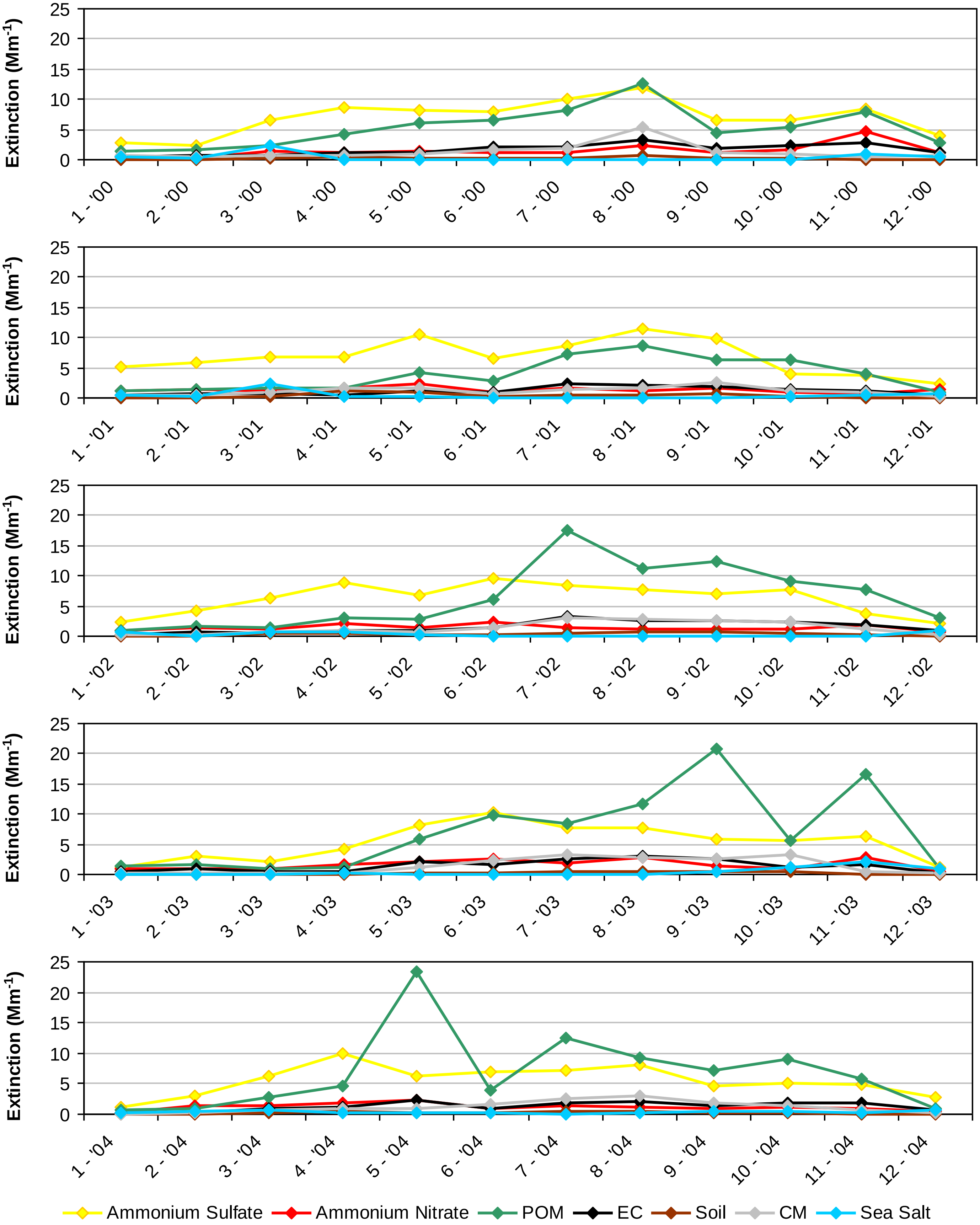


Figure K.8-6
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
2005-2009 Monthly Average Aerosol Extinction, All Monitored Days

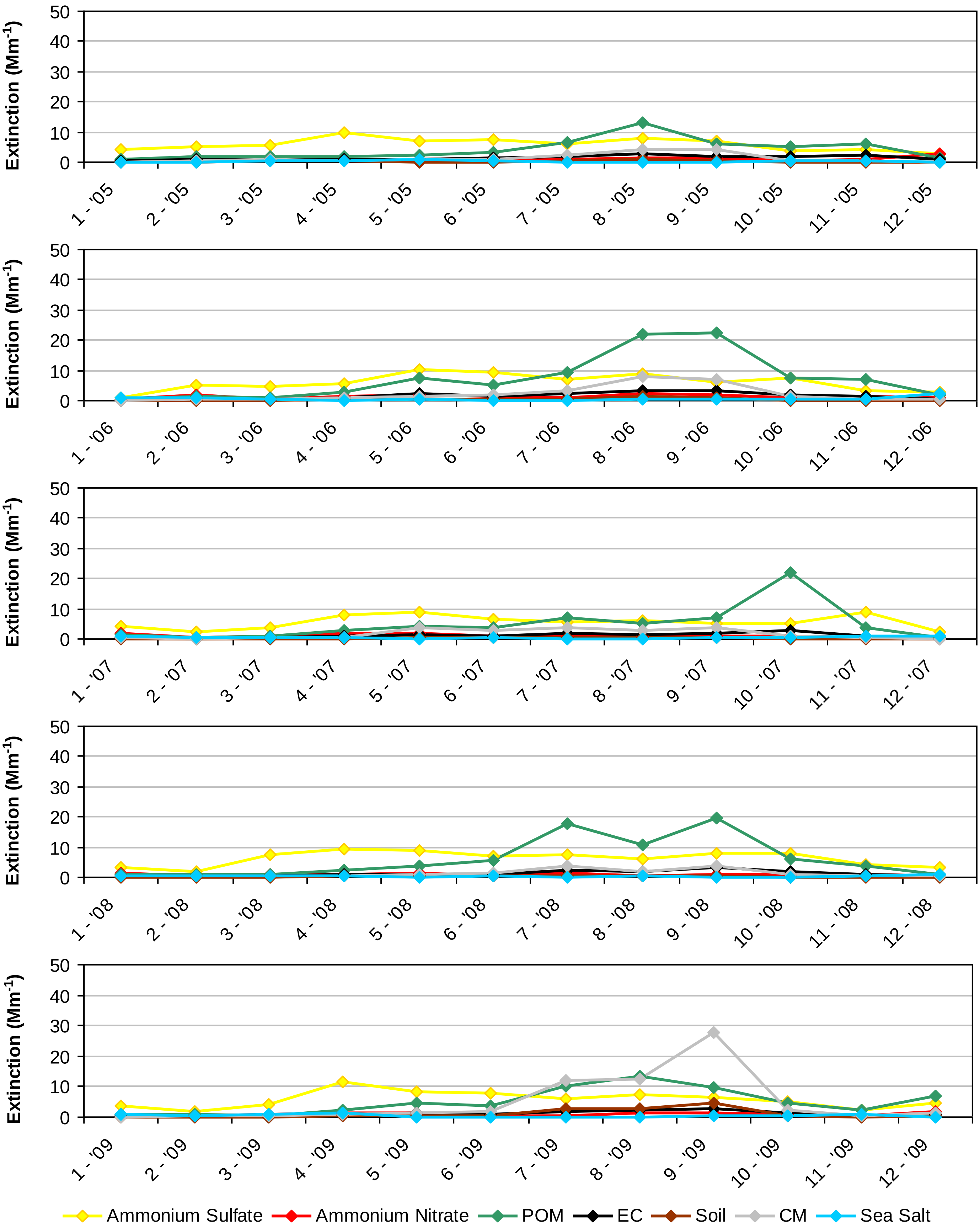


Figure K.8-7
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
2000-2004 Progress Period Extinction, All Sampled Days

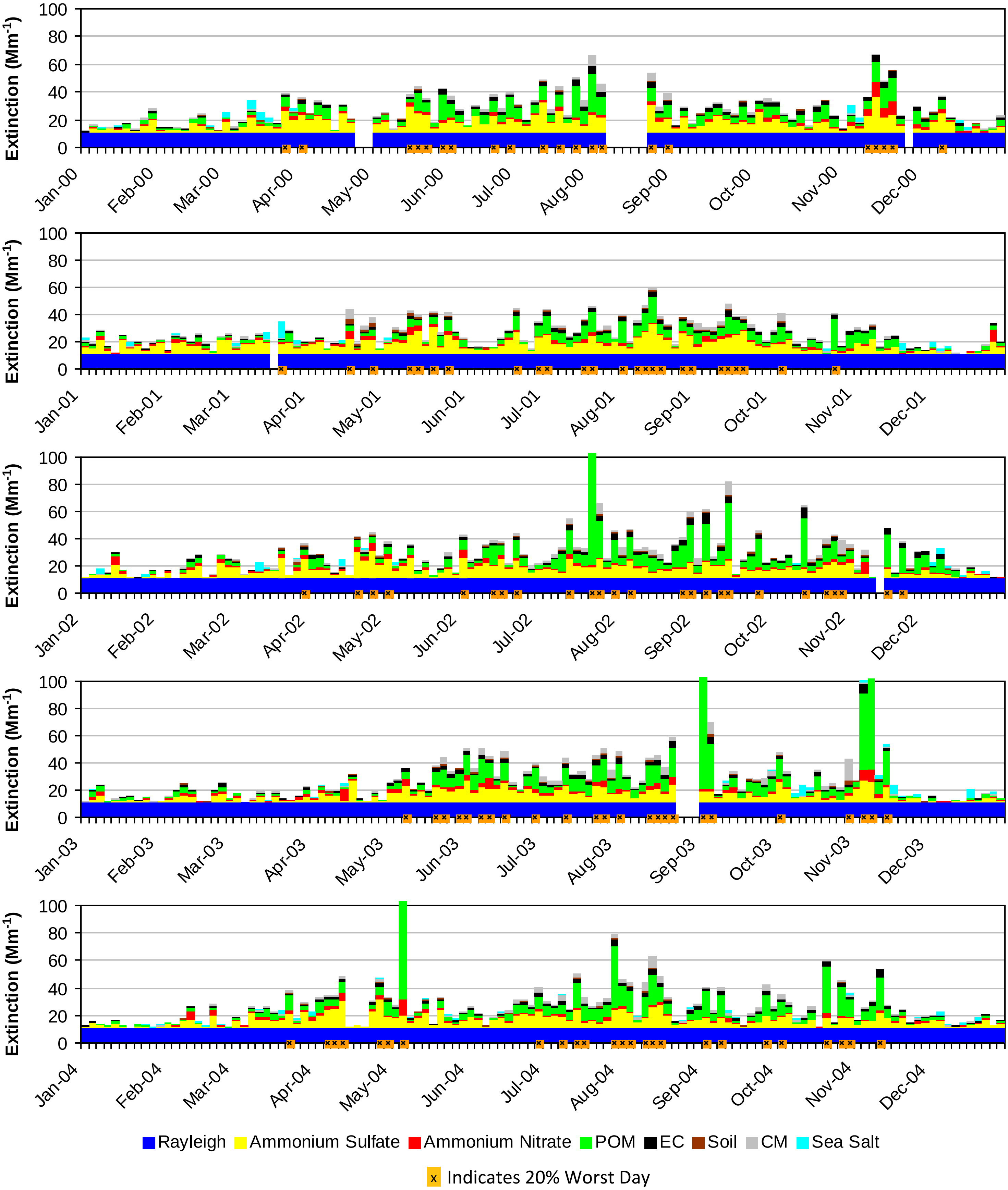


Figure K.8-8
Three Sisters, Mount Jefferson and Mount Washington Was, OR (THSI1 Site)
2005-2009 Progress Period Extinction, All Sampled Days