

Chapter 5 **Baseline and Natural Conditions in Washington's Mandatory Class I Areas**

This chapter covers the baseline and natural visibility conditions for each of Washington's 8 mandatory Class I Areas including the Uniform Rate of Progress. The Uniform Rate of Progress (URP) is the calculation of the uniform slope, or glide path, of the line between baseline visibility conditions and natural conditions over the 60-year period. The technical basis for this information was produced and compiled by the Western Regional Air Partnership (WRAP) for consistency in planning among western states.

Table 5-1 shows a summary of the baseline conditions, natural conditions, the difference in these two conditions, and what the 2018 target would be for a URP for each of Washington's mandatory Class I Areas. More detailed information on light extinction and Deciviews (dv) for the Most Impaired and Least Impaired Days is found in Appendix E.

Table 5-1 Summary of Baseline Conditions, Natural Conditions, and Difference

Washington's Mandatory Class I Areas	Most Impaired Days				Least Impaired Days		
	2000-04 Baseline [deciviews]	2064 Natural Conditions [deciviews]	Difference [deciviews]	2018 Target Value for a Uniform Rate of Progress [deciview]	2000-04 Baseline [deciview]	2064 Natural Conditions [deciview]	Difference [deciviews]
Olympic National Park	16.74	8.44	8.30	14.81	6.02	2.7	3.32
North Cascades National Park and Glacier Peak Wilderness	16.01	8.39	7.62	14.23	3.37	1.93	1.44
Alpine Lakes Wilderness	17.84	8.43	9.41	15.64	5.5	2.33	3.17
Mount Rainier National Park	18.24	8.54	9.70	15.98	5.47	2.56	3.91
Goat Rocks Wilderness and Mount Adams Wilderness	12.76	8.35	4.41	11.73	1.66	0.82	0.84
Pasayten Wilderness	15.23	8.25	6.98	13.6	2.73	1.16	1.57

5.1 Olympic National Park

Baseline visibility is determined from the from the OLYM1 monitoring site for the Most Impaired and Least Impaired Days for the years 2002 through 2004 as specified in the Regional Haze Rule (RHR) under¹. The baseline visibility for the Olympic National Park is calculated at 6.02 dv for the Least Impaired Days and 16.74 dv for the Most Impaired Days.

Natural visibility represents the visibility conditions that would be experienced in the absence of human-caused impairment. Based on Environmental Protection Agency (EPA) guidance, the natural visibility for Olympic National Park is 2.7 dv for the Least Impaired Days and 8.44 dv for the Most Impaired Days. See Table 5-1 and Figure 5-1.

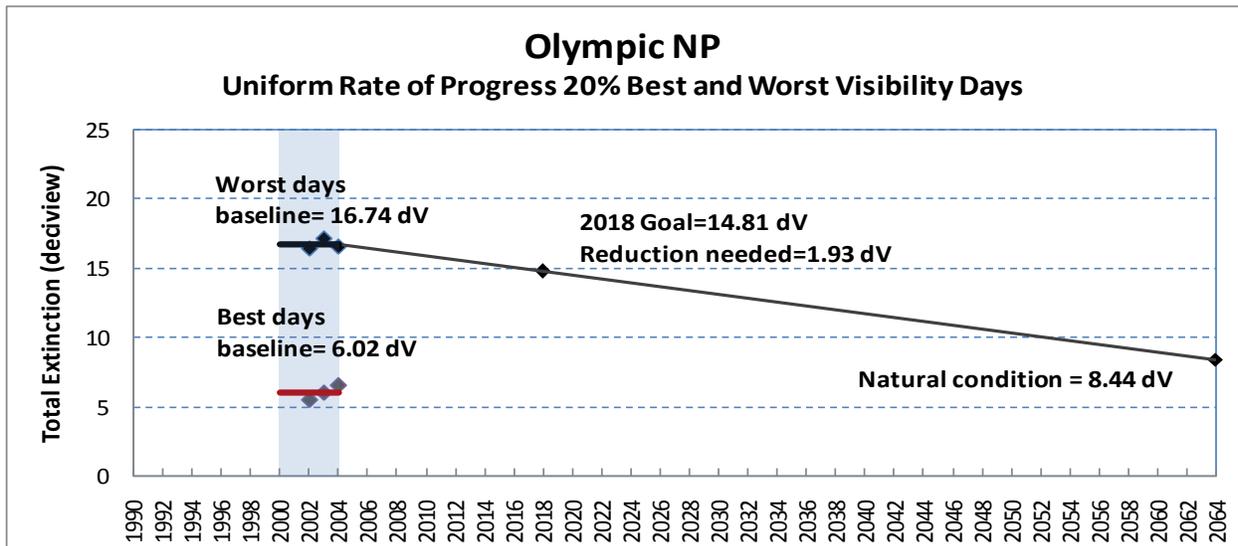


Figure 5-1 Uniform Rate of Progress for Olympic National Park

Figures 5-2 and 5-3 show the annual and average contributions of haze species to light extinction over the baseline period based on data from the OLYM1 Interagency Monitoring of Protected Visual Environments (IMPROVE) monitor site for the Most Impaired and Least Impaired Days, respectively. Overall, the year to year variability of annual Most Impaired and Least Impaired Days light extinction is very small (nearly 3 and 2 Mm^{-1} , respectively). On average, sulfates are the predominant cause (39%) of haze on Most Impaired Days at this site, followed by Organic Compound (OC) (28%) and nitrates (19%). Elemental carbon, coarse mass and sea salt are much less significant and nearly equal contributors to visibility impairment on the Most Impaired Days for the baseline period. Compared to the Most Impaired Days, on the Least Impaired Days the proportional share attributable to sulfates, nitrates, and OC is nearly equal.

¹ 40 CFR §51.308(d)(2)(i)

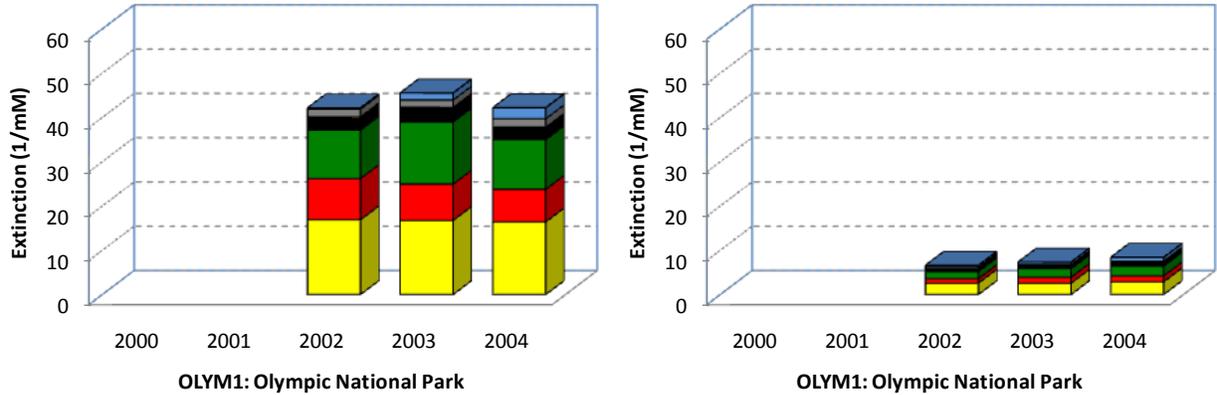


Figure 5-2 Annual Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Olympic National Park

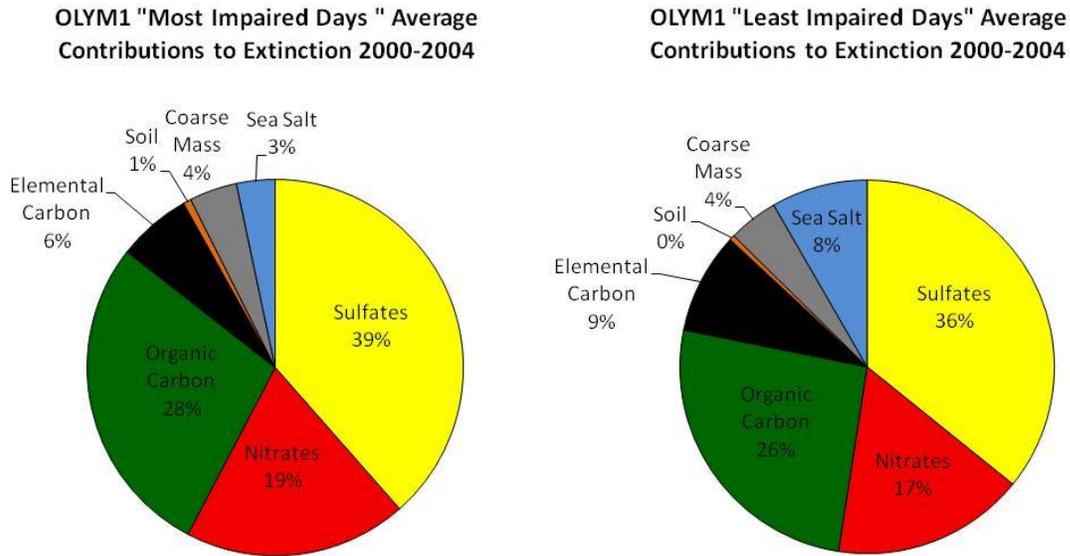


Figure 5-3 Average Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Olympic National Park

Figure 5-4 illustrates monitoring data for all IMPROVE sampled days during the base years (2001-2004). These data are reinterpreted in Figures x through z for major haze species. A clear seasonal variation is observed for sulfates, with increases in summer months. OC and nitrates remain stable for much of the year with year-to-year variability in the late summer or fall throughout the year at this site.

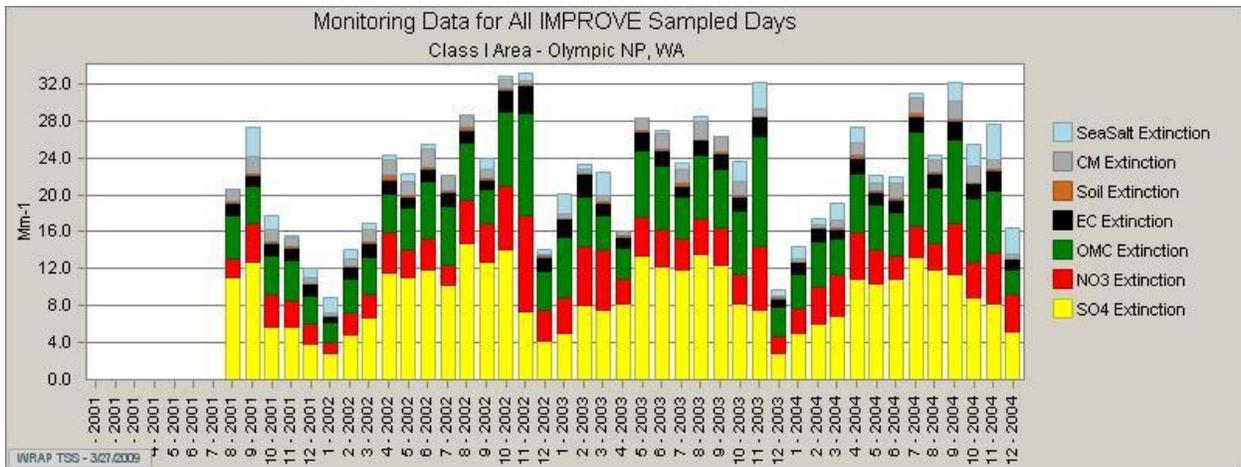


Figure 5-4 Baseline Seasonal Variation in Haze Species at OLYM1 for 2001 through 2004

**OLYM1: SO₄ Seasonal Variation
2001-2004**

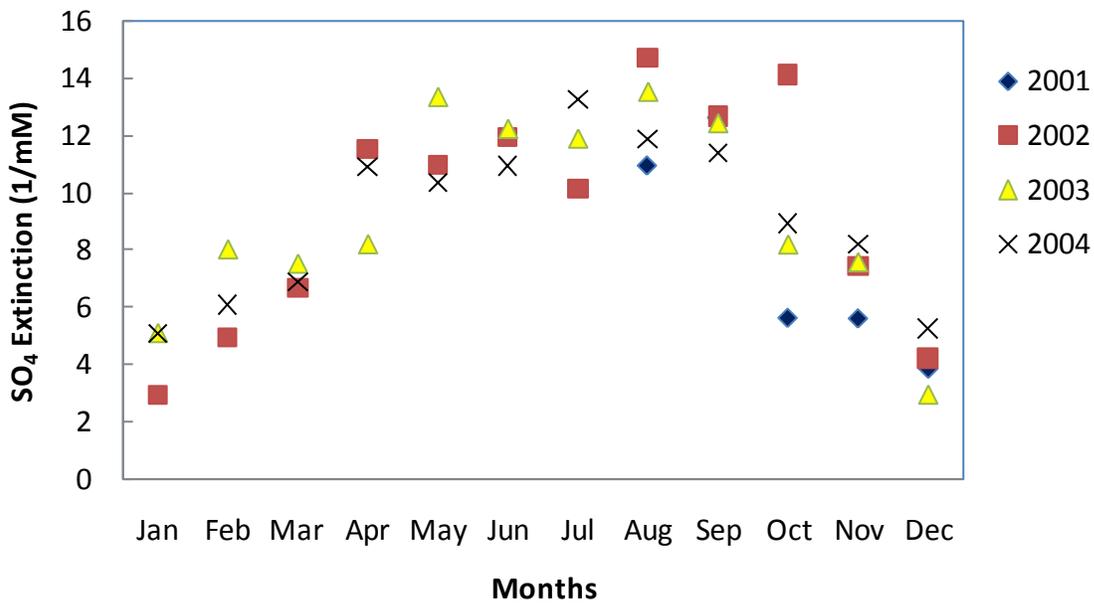


Figure 5-5 Baseline Seasonal Variation by Month for SO₄ at OLYM1

OLYM1: OC Seasonal Variation 2001-2004

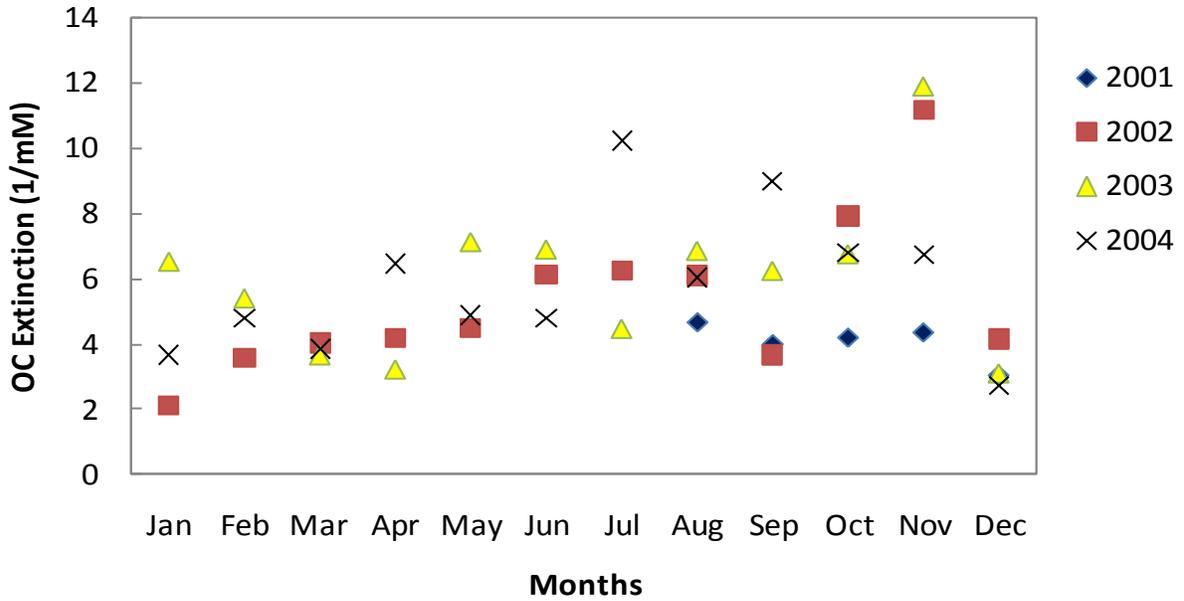


Figure 5-6 Baseline Seasonal Variation by Month for OC at OLYM1

OLYM1: NO₃ Seasonal Variation 2001-2004

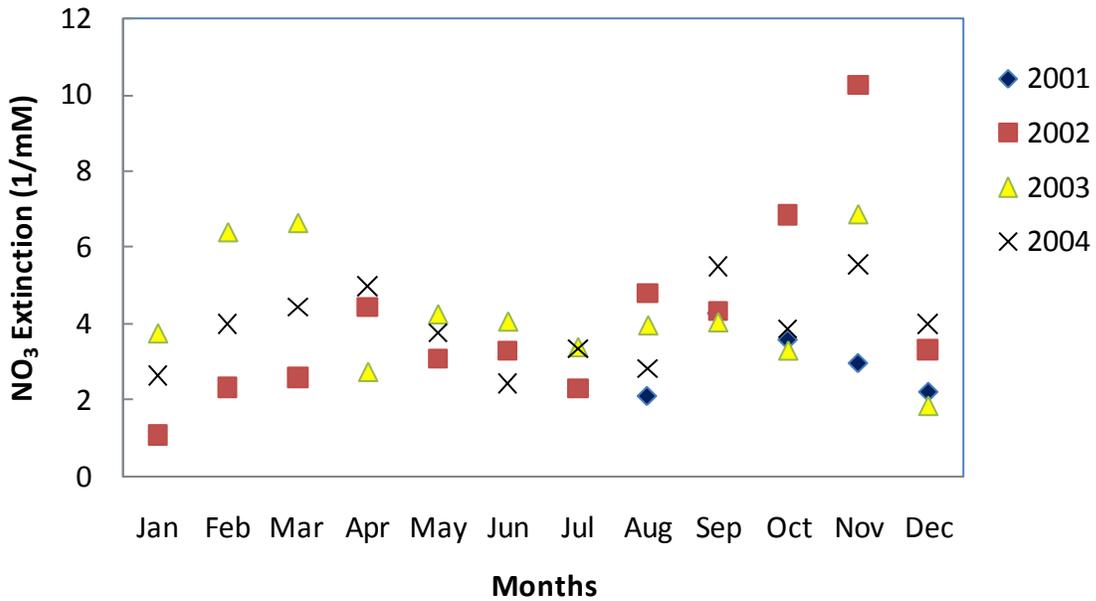


Figure 5-7 Baseline Seasonal Variation by Month for NO₃ at OLYM1

5.2 North Cascades National Park and Glacier Peak Wilderness

For the North Cascades National Park and Glacier Peak Wilderness, baseline visibility is determined from the NOCA1 monitoring site for the Most Impaired Days and Least Impaired Days. Data for years 2001 and 2002 met the data completeness requirements per the EPA document “Guidance for Tracking Progress under the RHR.” Routine data substitutions per this guidance document were made for years 2003 and 2004. After these routine data substitutions were made, the NOCA1 site still failed to meet data completeness requirements for the baseline period. One reason was due to the site being inaccessible from mid-November 2003 to March 2004 due to snow.

WRAP performed additional data substitutions for years 2003 and 2004 to address the data completeness problems for this site. The SNPA1 IMPROVE site was used to complete the data substitution for years 2003 and 2004. The WRAP methods used were similar to methods used at IMPROVE sites with incomplete data records in other Regional Planning Organizations. See Appendix D for additional information on the WRAP data substitutions for the NOCA1 site.

Using the now complete data set for 2001-2004, the baseline visibility for the North Cascades National Park and Glacier Peak Wilderness is calculated at 3.37 dv for the Least Impaired Days and 16.01 dv for the Most Impaired Days.

Natural visibility represents the visibility conditions that would be experienced in the absence of human-caused impairment. The natural visibility for North Cascades National Park and Glacier Peak Wilderness is 1.93 dv for the Least Impaired Days and 8.39 dv for the Most Impaired Days. See Table 5-1 and Figure 5-8.

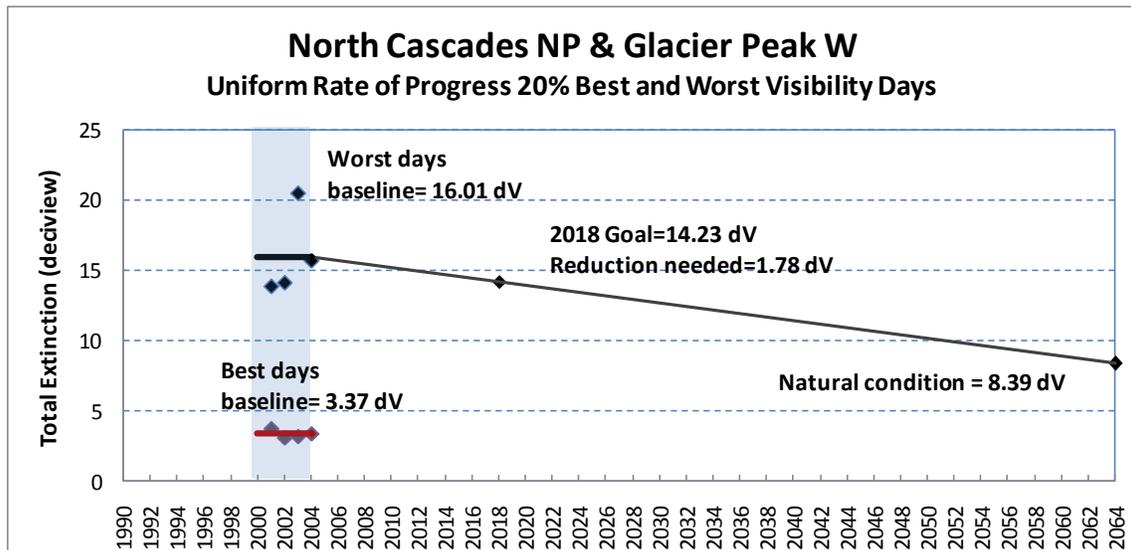


Figure 5-8 Uniform Rate of Progress for North Cascades National Park and Glacier Peak Wilderness

Figures 5-9 and 5-10 show the annual and average contributions of haze species to light extinction over the baseline period based on data from the NOCA1 IMPROVE monitor site for

the Most Impaired (left) and Least Impaired (right) Days, respectively. On average for the years 2001 to 2004, OC is the predominant cause (58%) of haze on the Most Impaired Days at this site. Sulfates (26%) produce the majority of the remaining visibility impairment. Compared to the Most Impaired Days, on the Least Impaired Days sulfates significantly increase their proportional share of the visibility impairment, the proportional share attributable to nitrates increases, OC significantly reduces its share, and elemental carbon stays about the same. The year to year variability of the average of the annual best days light extinction is very small. The principal chemical species that change between the annual average Most Impaired and Least Impaired Days are the OC, nitrates, and sulfates.

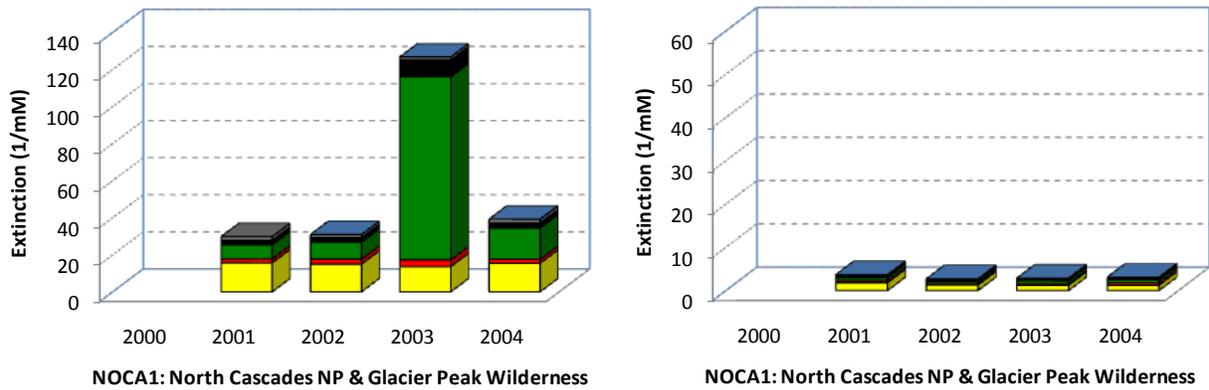


Figure 5-9 Annual Species Contributions to Most Impaired (left) and Least Impaired (right) Days in North Cascades National Park and Glacier Peak Wilderness

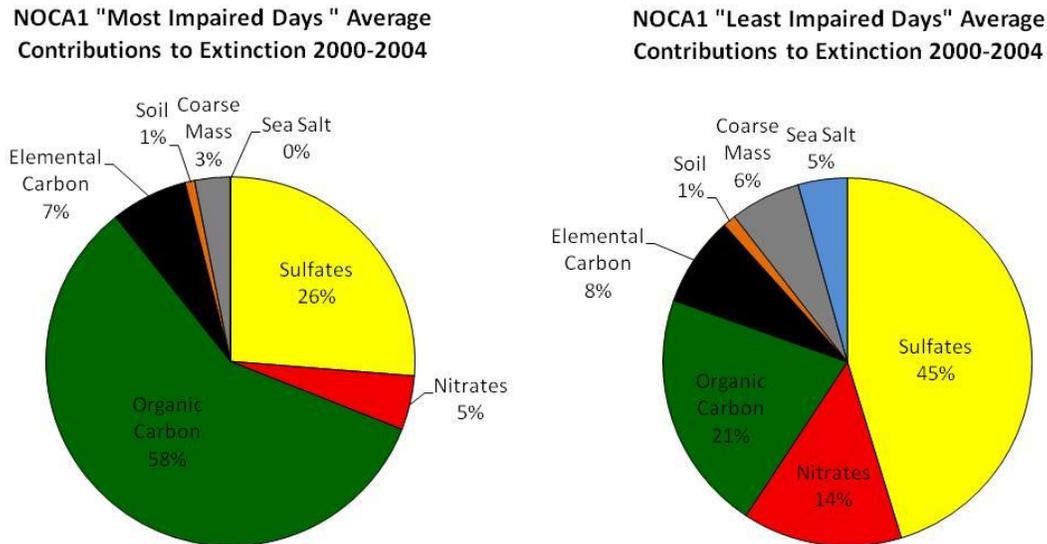


Figure 5-10 Average Species Contributions to Most Impaired (left) and Least Impaired (right) Days in North Cascades National Park and Glacier Peak Wilderness

It is important to point that there is an abrupt emission increase for the Most Impaired Days in 2003, especially for organic and elemental carbon haze species. Figure 5-11 shows what the average contributions of haze species to light extinction on the Most Impaired Days would be at this site if the 2003 data were excluded. In this case, on average sulfates (46%) are the predominant cause of haze on the Most Impaired Days at this site. OC (34%) produces the majority of the remaining visibility impairment. The high levels of OC in September and October 2003 correspond with several large (over 1,000 acres) wildfires that occurred in or near the North Cascades Mountain Range. This will be discussed further in Chapter 8 when sources are discussed.

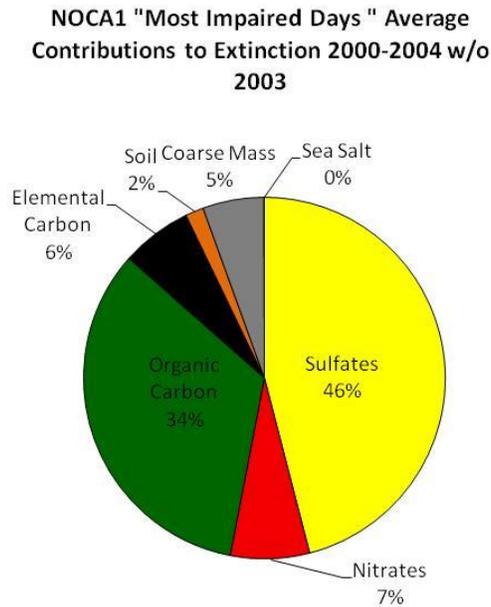


Figure 5-11 Average Species Contributions to Most Impaired and Least Impaired Days in North Cascades National Park and Glacier Peak Wilderness excluding 2003 data

Figure 5-12 illustrates monitoring data for all IMPROVE sampled days during the base years (2000-2004). These data are reinterpreted in Figures x through z for major haze species. A clear seasonal variation is observed for sulfates, OC, nitrates and elemental carbon. Sulfates and nitrates increase in summer months, and organic and elemental carbons increase in late summer and early fall. Some extreme values for elemental carbon and OC have been observed in September and October in 2003 due to natural fires. The highest nitrate levels of the baseline period were observed during the same months.

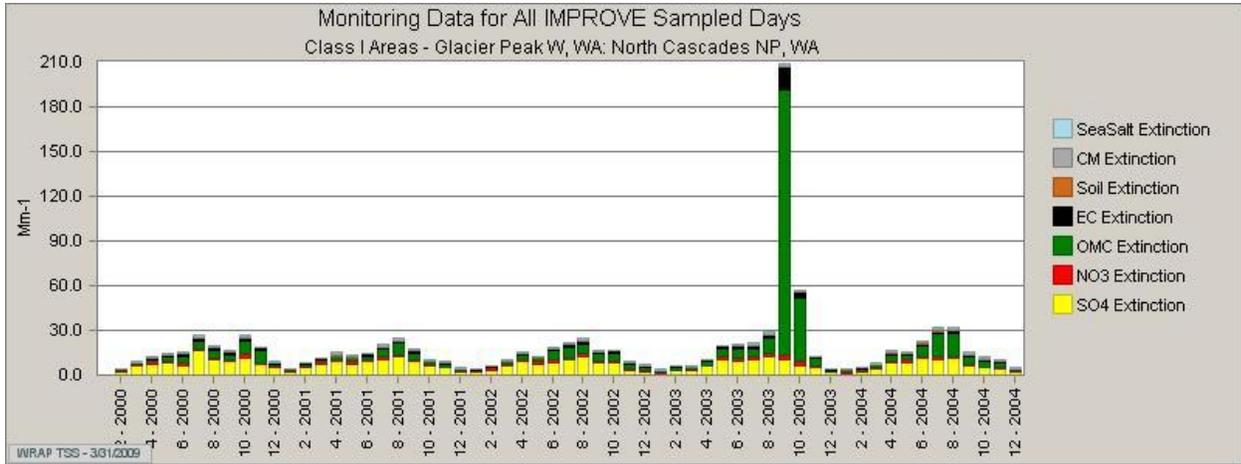


Figure 5-12 Baseline Seasonal Variation in Haze Species at NOCA1 for 2000 through 2004

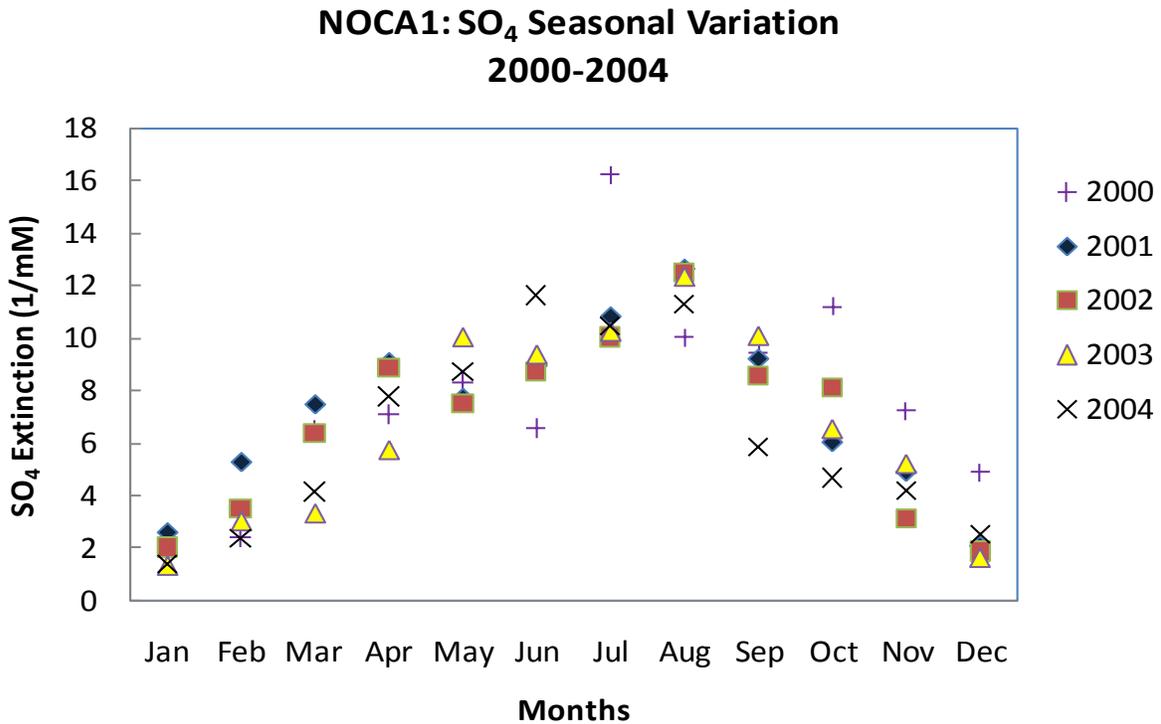


Figure 5-13 Baseline Seasonal Variation by Month for SO₄ at NOCA1

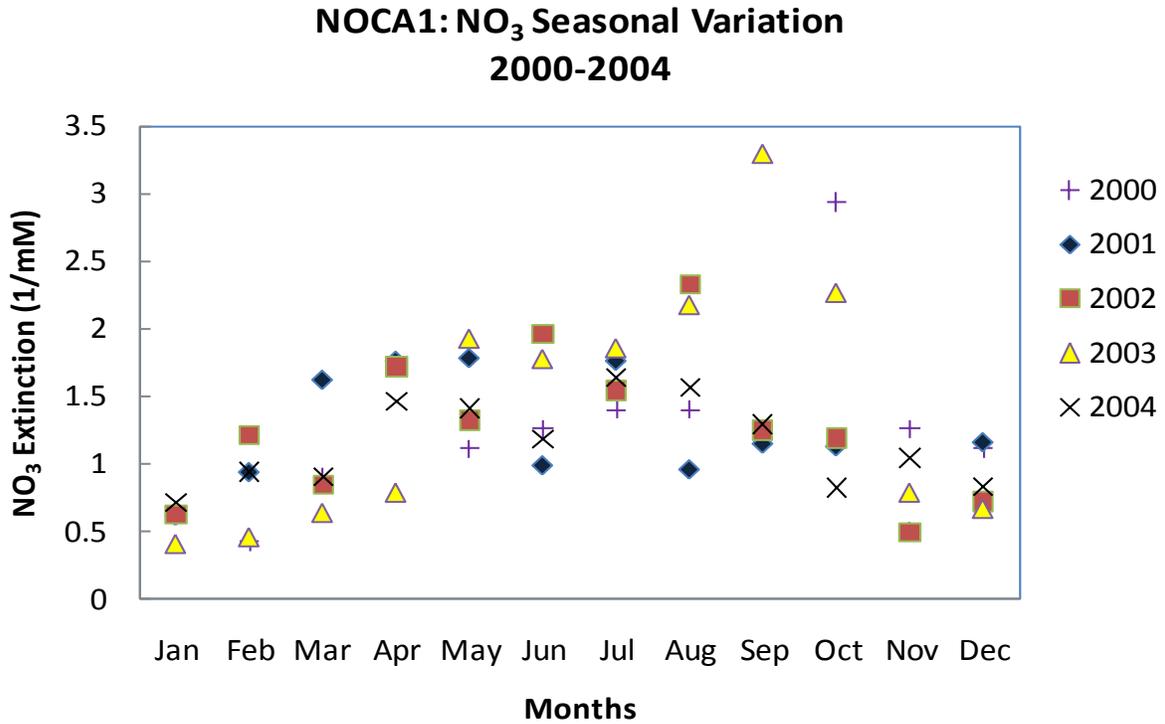


Figure 5-14 Baseline Seasonal Variation by Month for NO₃ at NOCA1

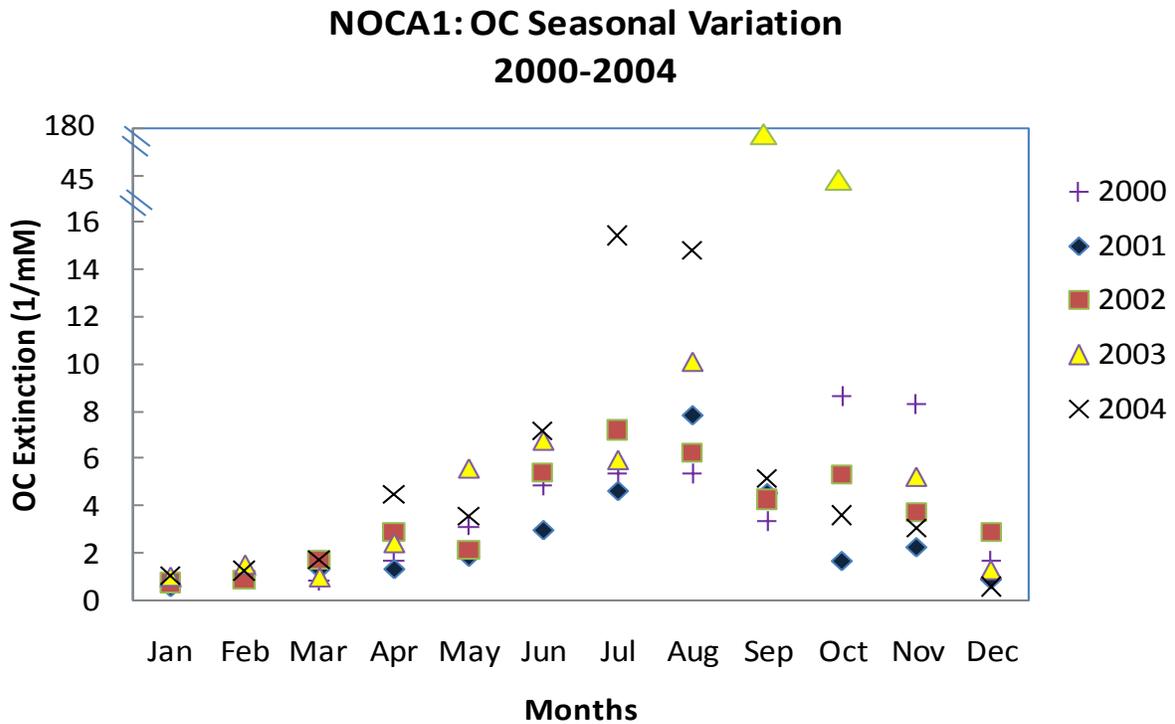


Figure 5-15 Baseline Seasonal Variation by Month for OC at NOCA1

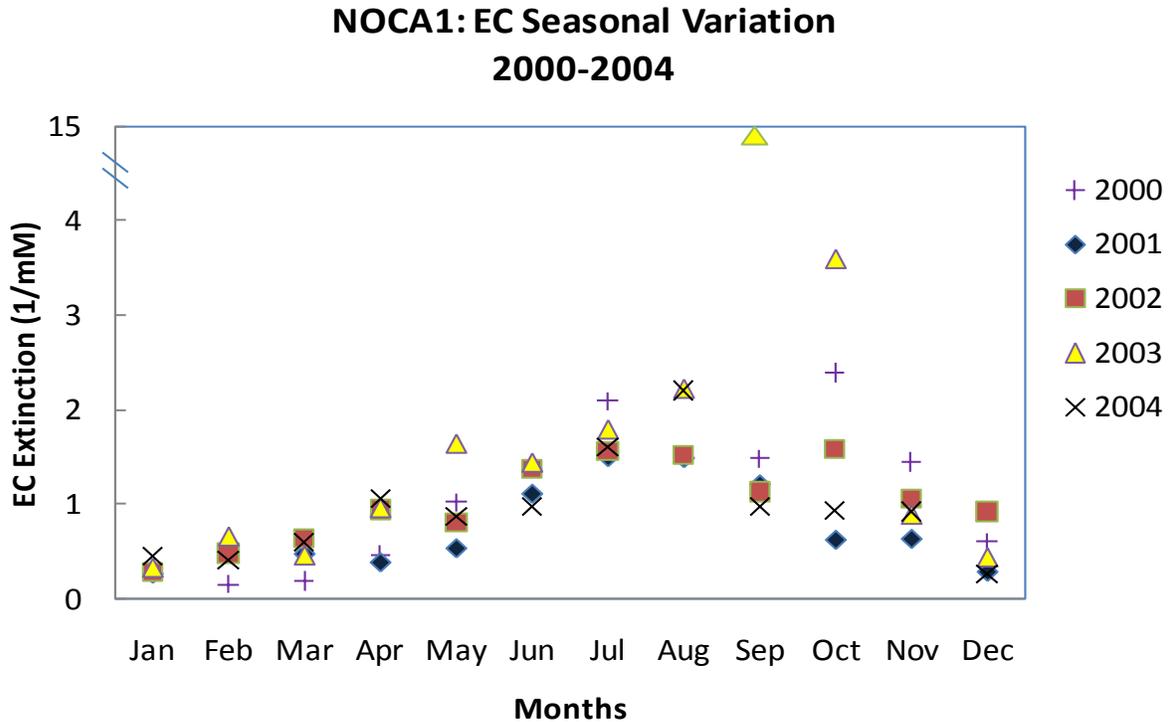


Figure 5-16 Baseline Seasonal Variation by Month for EC at NOCA1

5.3 Alpine Lakes Wilderness

Baseline visibility is determined from the SNPA1 monitoring site for the Most Impaired Days and Least Impaired Days for the years 2001 through 2004 as specified in the RHR under². The baseline visibility for the Alpine Lakes Wilderness is calculated at 5.5 dv for the Least Impaired Days and 17.84 dv for the Most Impaired Days.

Natural visibility represents the visibility conditions that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for Alpine Lakes Wilderness is 2.33 dv for the Least Impaired Days and 8.43 dv for the Most Impaired Days. See Figure 5-17.

² 40 CFR §51.308(d)(2)(i)

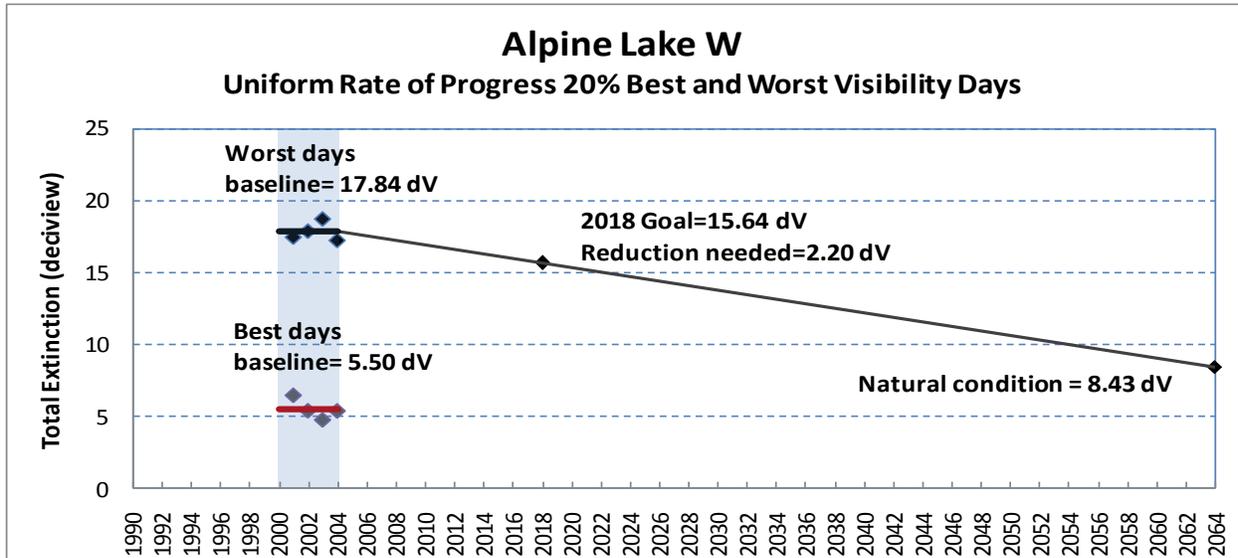


Figure 5-17 Uniform Rate of Progress for Alpine Lakes Wilderness

Figures 5-18 and 5-19 show the annual and average contributions of haze species to light extinction over the baseline period based on data from the SNPA1 IMPROVE monitor site for the Most Impaired (left) and Least Impaired (right) Days, respectively. Overall, the year to year variability of the average of the annual Most Impaired and Least Impaired Days light extinction is small (nearly 10 and 3 Mm^{-1} , respectively). On average, sulfates (34%) and OC (30%) are the predominant cause of haze on the Most Impaired Days at this site. Nitrates (23%) produce the majority of the remaining visibility impairment. Compared to the Most Impaired Days, on the Least Impaired Days sulfates increase their proportional share of the visibility impairment, the proportional share attributable to nitrates remains about the same, OC reduces its share, and elemental carbon becomes relatively significant.

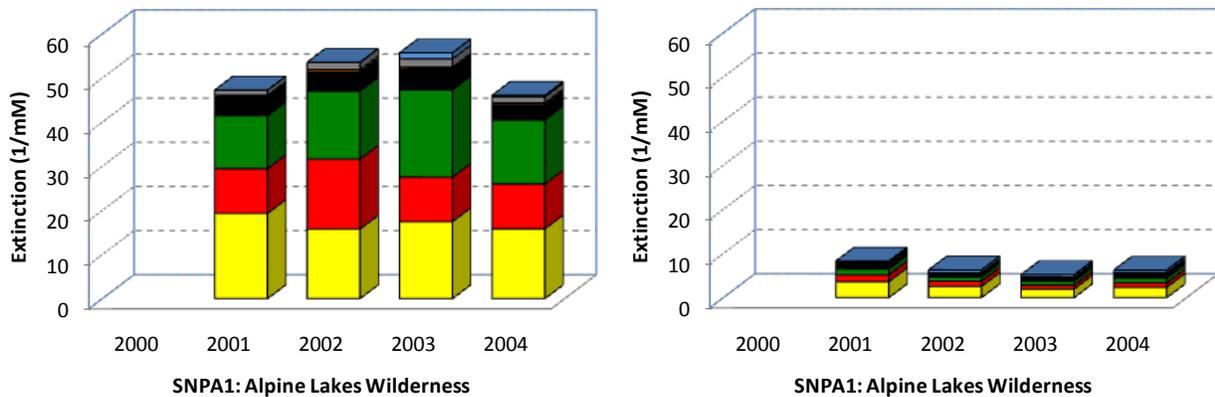


Figure 5-18 Annual Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Alpine Lakes Wilderness

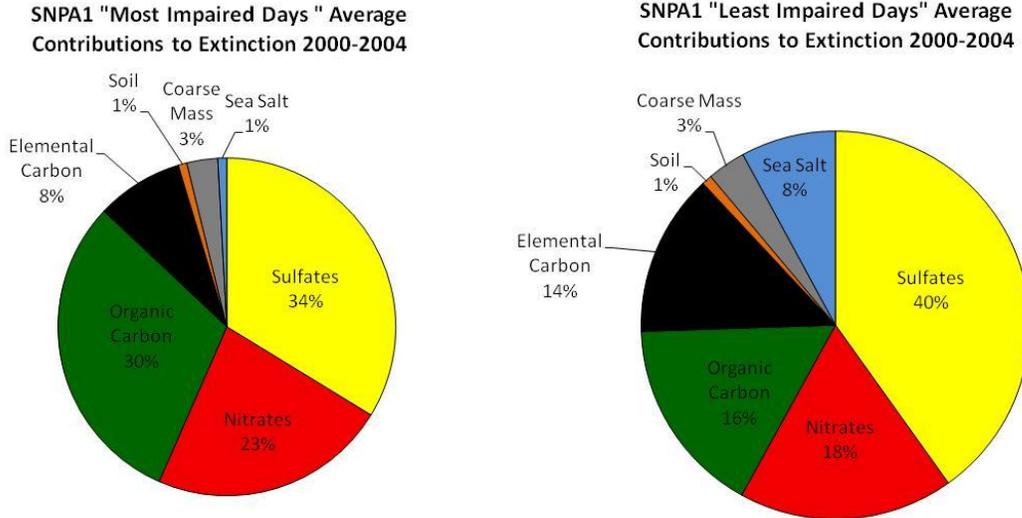


Figure 5-19 Average Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Alpine Lakes Wilderness

Figure 5-20 illustrates monitoring data for all IMPROVE sampled days during the base years (2000-2004). These data are interpreted in Figures x through z for major haze species. A clear seasonal variation is observed for sulfates and OC, both of them increase during summer months. Nitrates remain relatively stable for much of the year with more year-to-year variability in the late fall and winter.

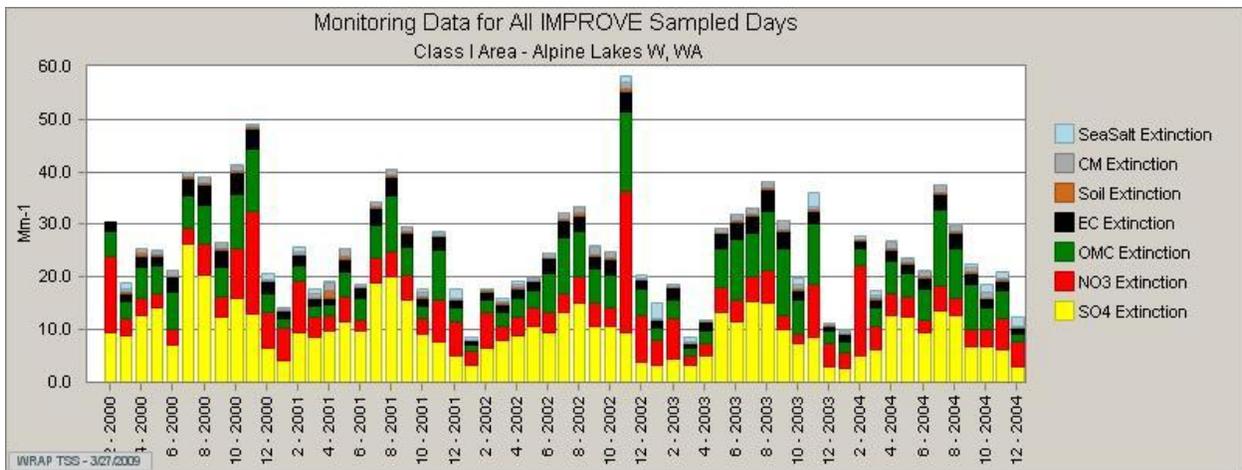


Figure 5-20 Baseline Seasonal Variation in Haze Species at SNPA1 for 2000 through 2004

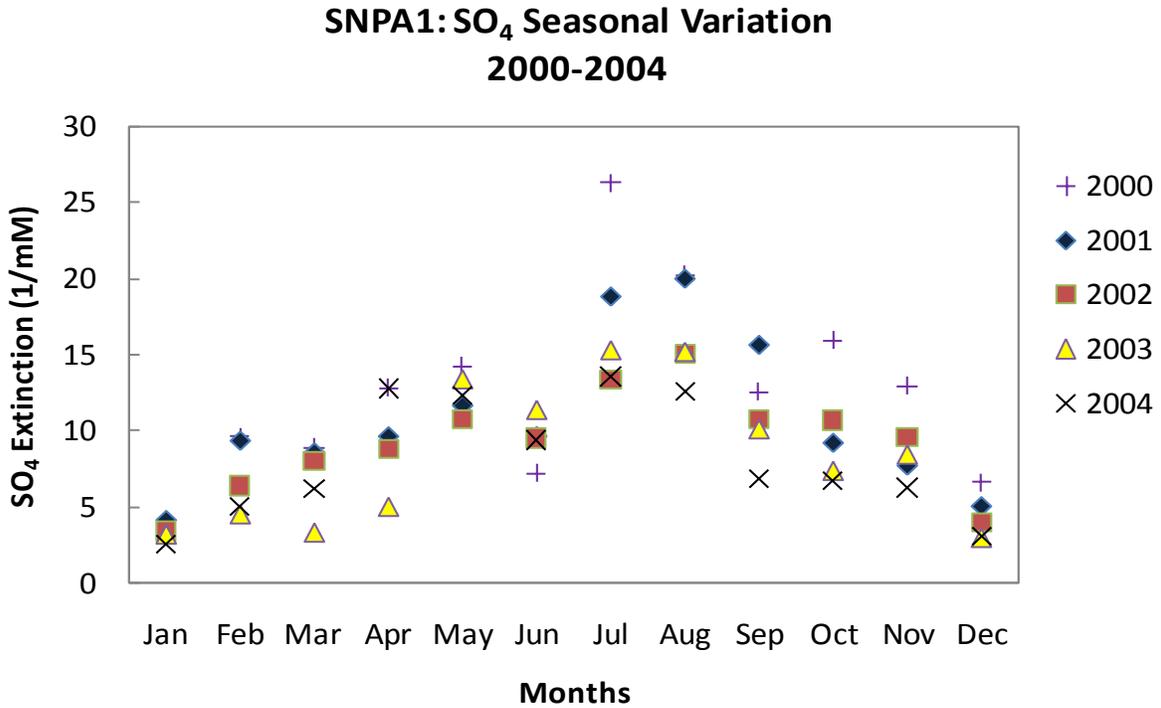


Figure 5-21 Baseline Seasonal Variation by Month for SO₄ at SNPA1

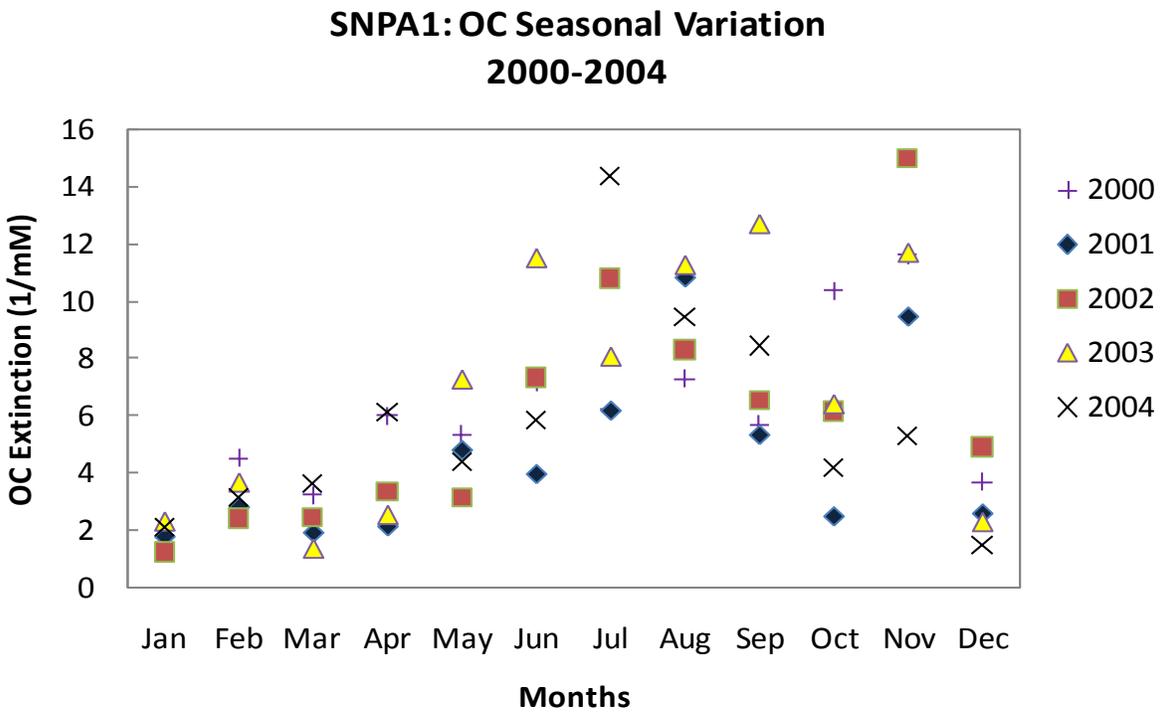


Figure 5-22 Baseline Seasonal Variation by Month for OC at SNPA1

SNPA1: NO₃ Seasonal Variation 2000-2004

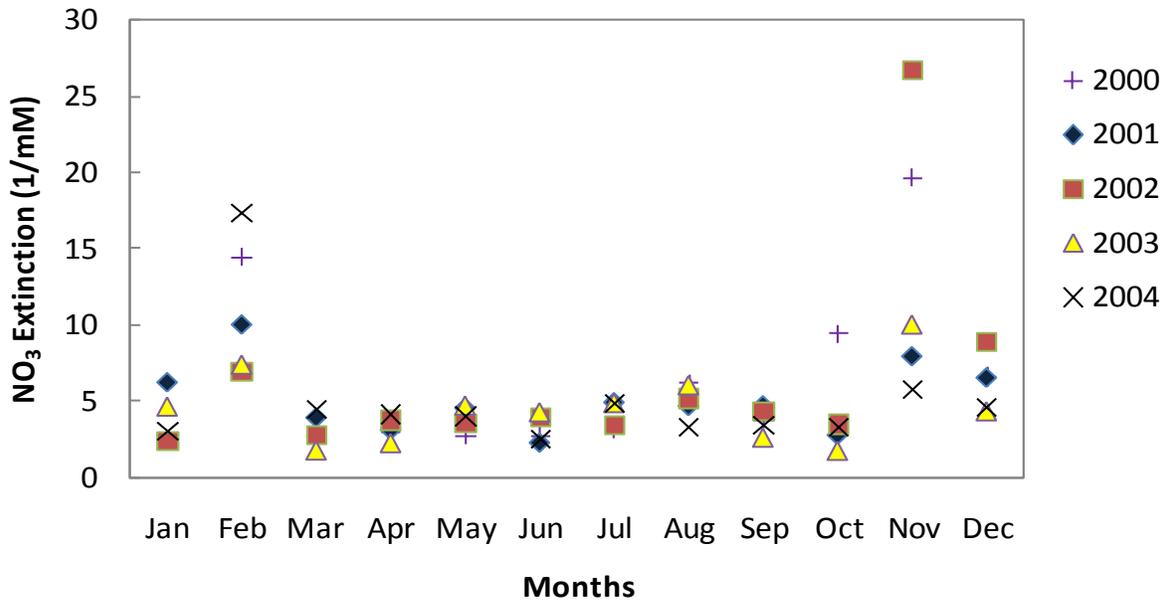


Figure 5-23 Baseline Seasonal Variation by Month for NO₃ at SNPA1

5.4 Mount Rainier National Park

Baseline visibility is determined from the MORA1 monitoring site for the Most Impaired and Least Impaired Days for the years 2000 through 2002 and year 2004 as specified in the RHR under³. The 2003 data from this site did not meet the data completeness requirements for the year and was not used to calculate baseline conditions. The baseline visibility for the Mount Rainier National Park is calculated at 5.47 dv for the Least Impaired Days and 18.24 dv for the Most Impaired Days.

Natural visibility represents the visibility conditions that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for Mount Rainier National Park is 2.56 dv for the Least Impaired Days and 8.54 dv for the Most Impaired Days. See Table 5-1 and Figure 5-24.

³ 40 CFR §51.308(d)(2)(i)

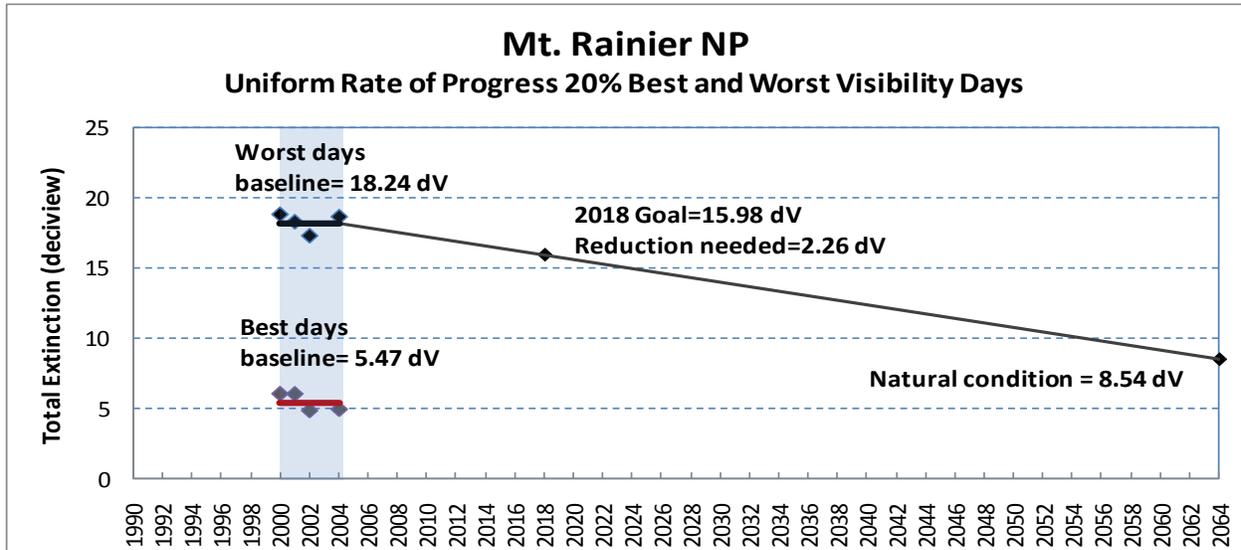


Figure 5-24 Uniform Rate of Progress for Mount Rainier National Park

Figures 5-25 and 5-26 show the annual and average contributions of haze species to light extinction over the baseline period based on data from the MORA1 IMPROVE monitor site for the Most Impaired (left) and Least Impaired (right) Days, respectively. Overall, the variability of annual Most Impaired and Least Impaired Days light extinction is small (about 9 and 2 Mm^{-1} , respectively). On average, sulfates (46%) and OC (29%) are the predominant causes of haze on the Most Impaired Days at this site. Nitrates (10%) and elemental carbon (10%) are much less significant. Compared to the Most Impaired Days, on the Least Impaired Days sulfates decrease their proportional share to 40% and OC reduces to 23%. The proportional contribution of both nitrates and elemental carbon stays the same.

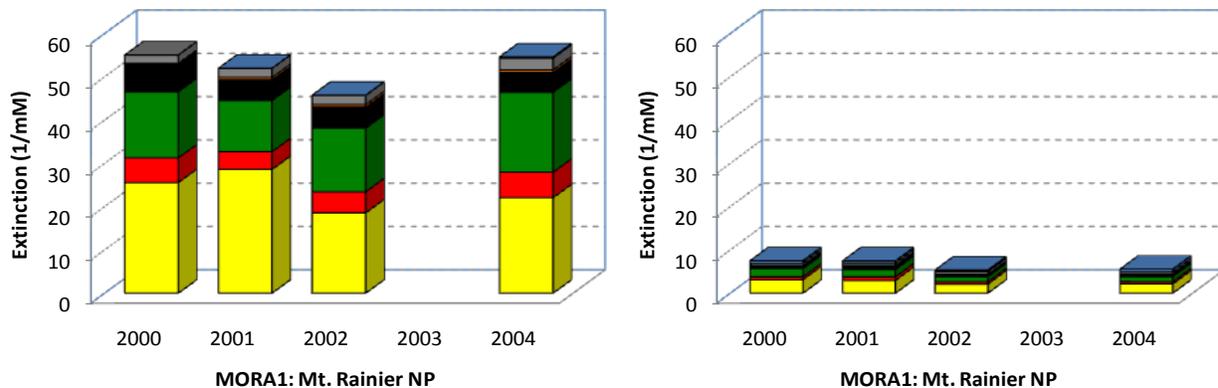


Figure 5-25 Annual Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Mount Rainier National Park

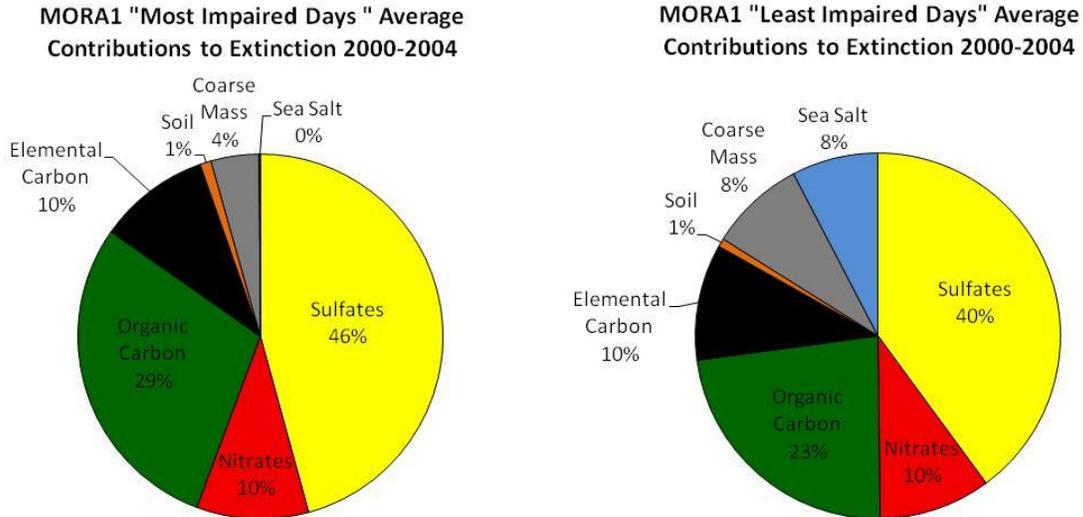


Figure 5-26 Average Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Mount Rainier National Park

Figure 5-27 illustrates monitoring data for all IMPROVE sampled days during the base years (2000-2004). These data are reinterpreted in Figures x through z for major individual haze species. A clear seasonal variation is observed for sulfates, organic aerosols, elemental carbon and nitrates. Sulfates, OCs and elemental carbon increase in summer months, and nitrates decrease in winter months.

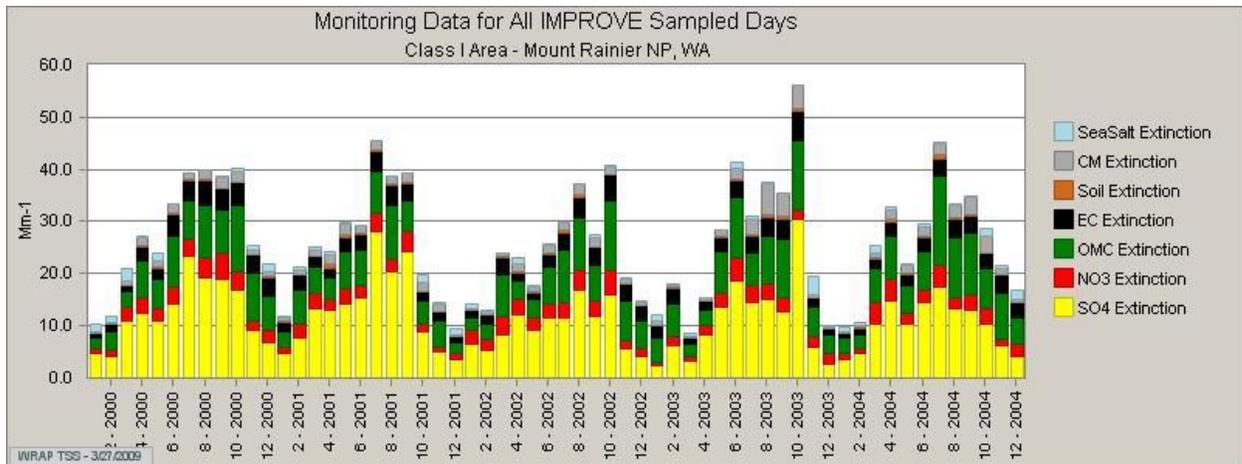


Figure 5-27 Baseline Seasonal Variation in Haze Species at MORA1 for 2000 through 2004

**MORA1: SO₄ Seasonal Variation
2000-2004**

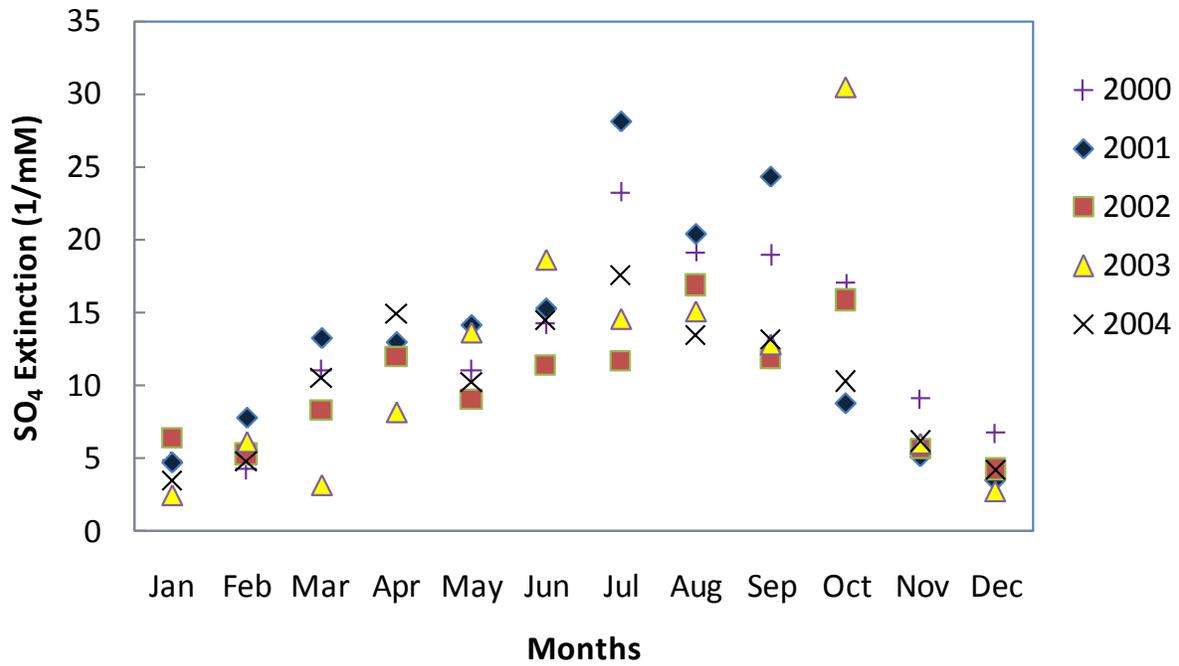


Figure 5-28 Baseline Seasonal Variation by Month for SO₄ at MORA1

**MORA1: OC Seasonal Variation
2000-2004**

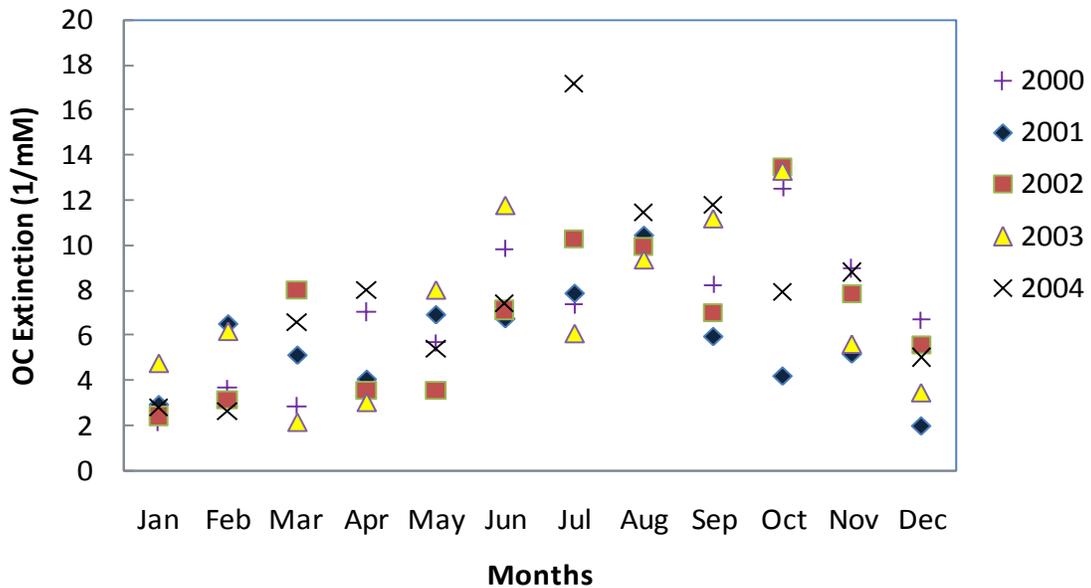


Figure 5-29 Baseline Seasonal Variation by Month for OC at MORA1

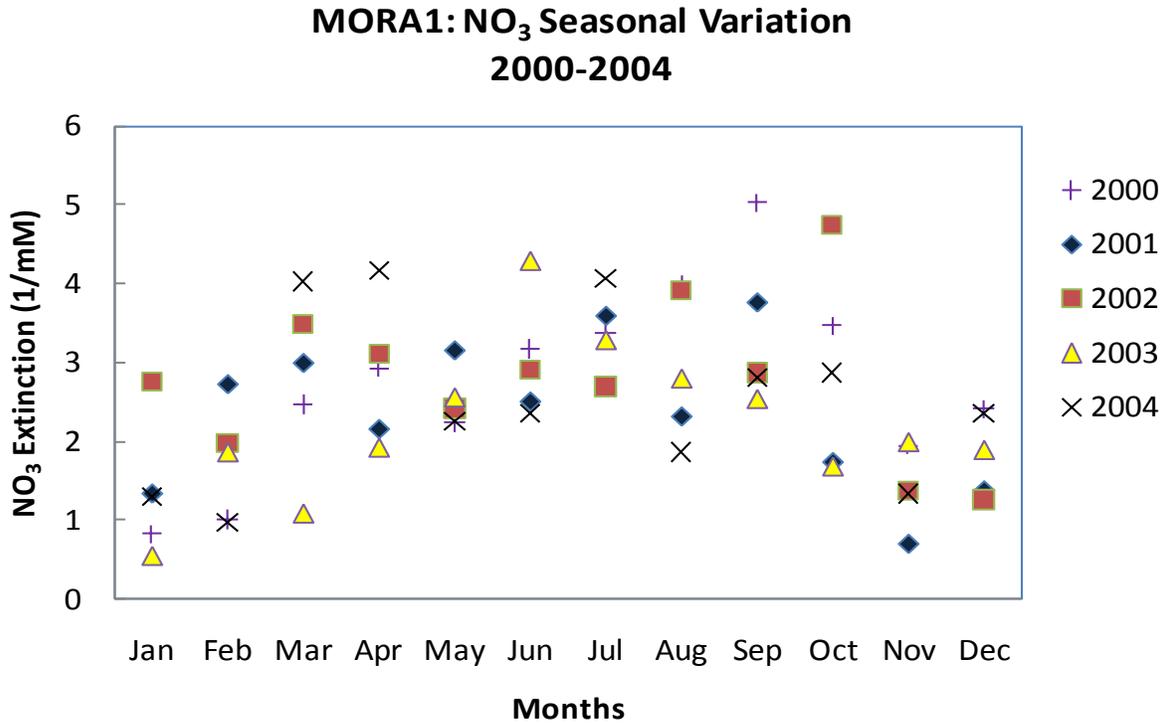


Figure 5-30 Baseline Seasonal Variation by Month for NO₃ at MORA1

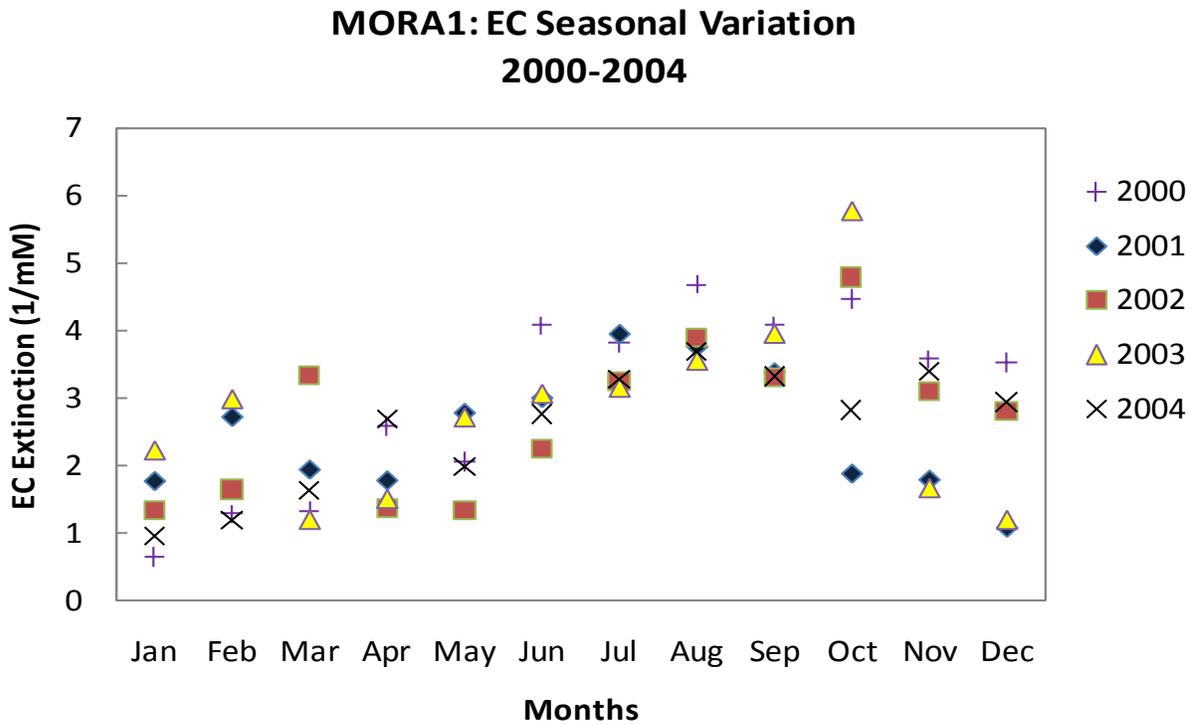


Figure 5-31 Baseline Seasonal Variation by Month for EC at MORA1

5.5 Goat Rocks Wilderness and Mount Adams Wilderness

For the Goat Rocks Wilderness and Mount Adams Wilderness baseline visibility is determined from the WHPA1 monitoring site for the Most Impaired Days and Least Impaired Days for the years 2001 through 2004 as specified in the RHR under⁴. The baseline visibility for the Goat Rocks Wilderness and Mount Adams Wilderness is calculated at 1.66 dv for the Least Impaired Days and 12.76 dv for the Most Impaired Days.

Natural visibility represents the visibility conditions that would be experienced in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for Goat Rocks Wilderness and Mount Adams Wilderness is 0.82 dv for the Least Impaired Days and 8.35 dv for the Most Impaired Days. See Table 5-1 and Figure 5-32.

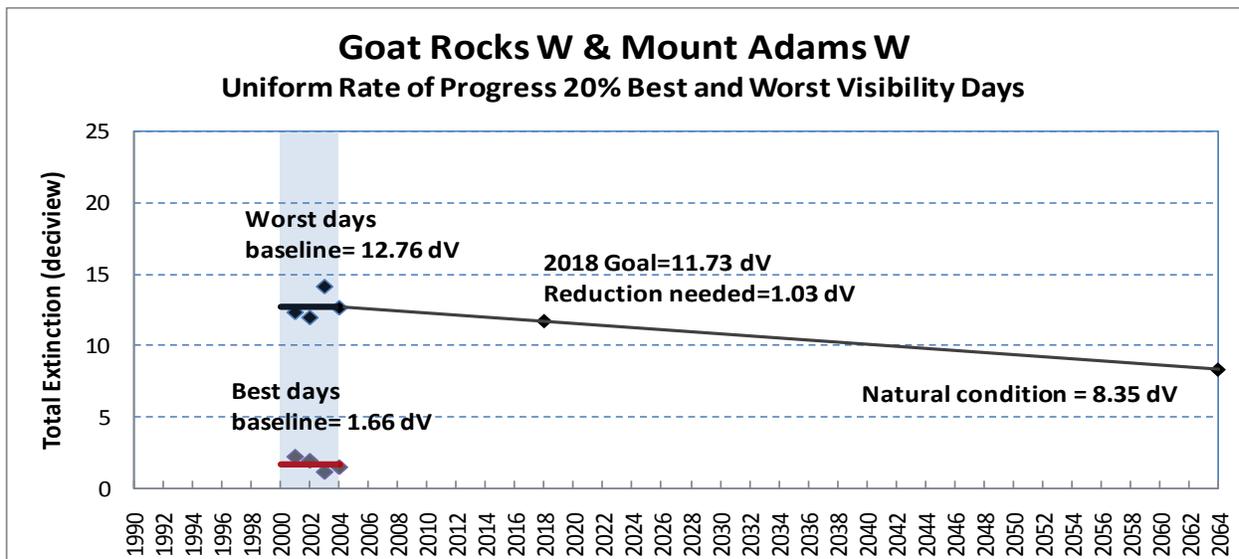


Figure 5-32 Uniform Rate of Progress for Goat Rocks Wilderness and Mount Adams Wilderness

Figures 5-33 and 5-34 show the annual and average contributions of haze species to light extinction over the baseline period based on data from the WHPA1 IMPROVE site for the Most Impaired (left) and Least Impaired (right) Days, respectively. WHPA1 has the lowest light extinction among all Washington Class I areas for both Most Impaired and Least Impaired Days over the baseline period. There are some annual variations over the baseline period but overall, the year to year variability of the average of the annual Most Impaired and Least Impaired Days light extinction is relative small (nearly 10 and 1 Mm^{-1} , respectively). On average, sulfates (37%) and OC (36%) are the predominant causes of haze on the Most Impaired Days at this site. Compared to the Most Impaired Days, on the Least Impaired Days, sulfates increase their proportional share of the visibility impairment and the proportional share attributable to OC significantly decreases. OCs, nitrates, elemental carbon, coarse mass and sea salt are much less significant and contribute about equally to visibility impairment on the worst and the best days.

⁴ 40 CFR §51.308(d)(2)(i)

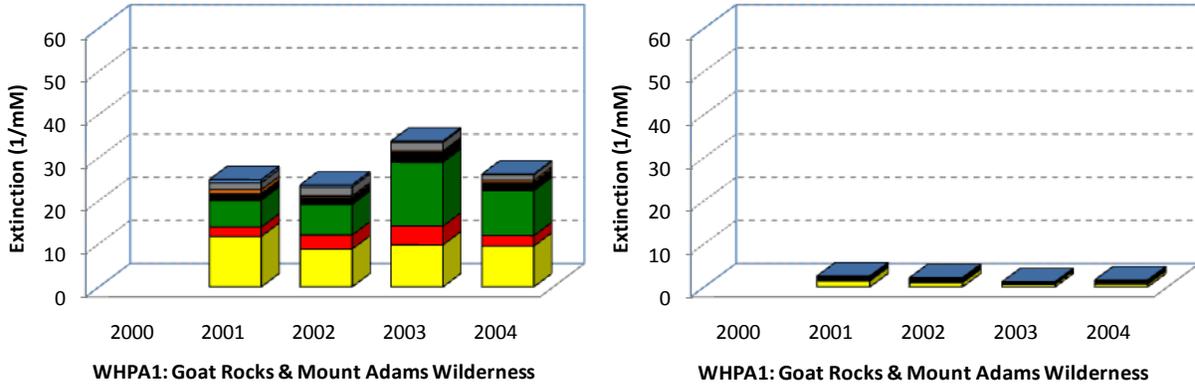


Figure 5-33 Annual Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Goat Rocks Wilderness and Mount Adams Wilderness

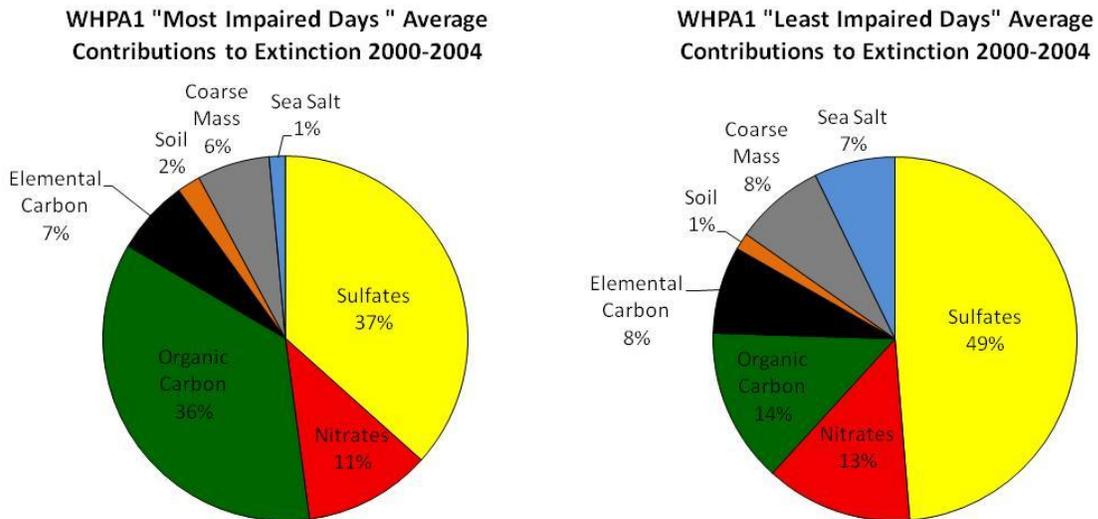


Figure 5-34 Average Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Goat Rocks Wilderness and Mount Adams Wilderness

Figure 5-35 illustrates monitoring data for all IMPROVE sampled days during the base years (2000-2004). These data are interpreted in Figures x through z for major haze species. A clear seasonal variation is observed for sulfates and OCs, both of them increase during summer months. Nitrates remain stable for much of the year with more year-to-year variability in the winter months.

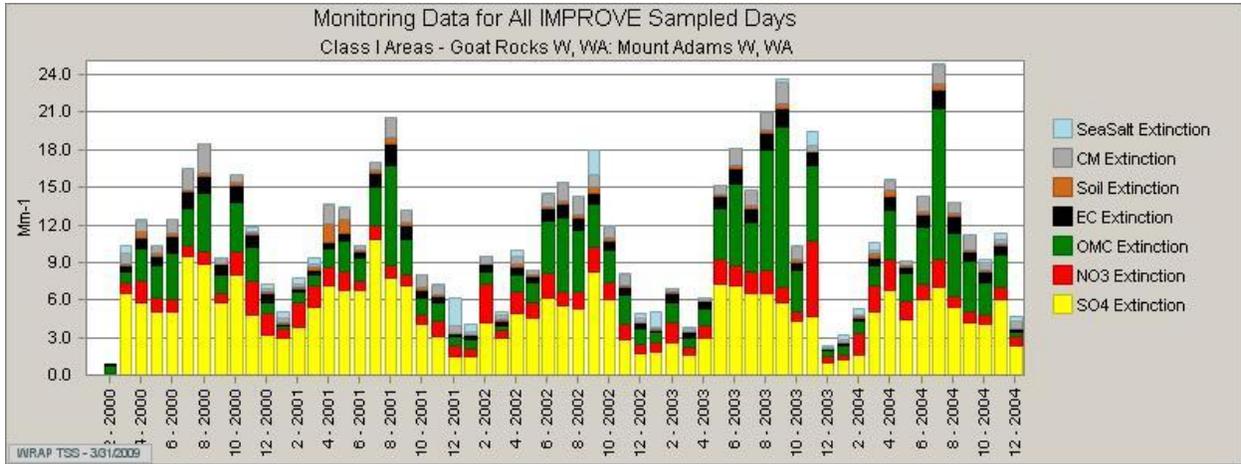


Figure 5-35 Baseline Seasonal Variation in Haze Species at WHPA1 for 2000 through 2004

**WHPA1: SO₄ Seasonal Variation
2000-2004**

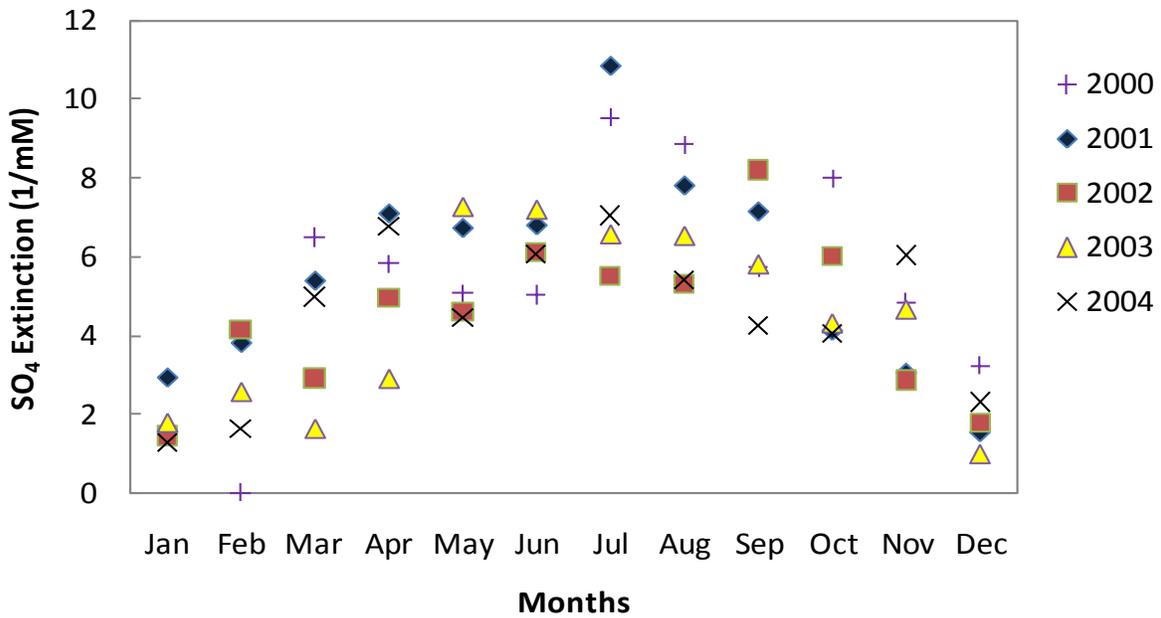


Figure 5-36 Baseline Seasonal Variation by Month for SO₄ at WHPA1

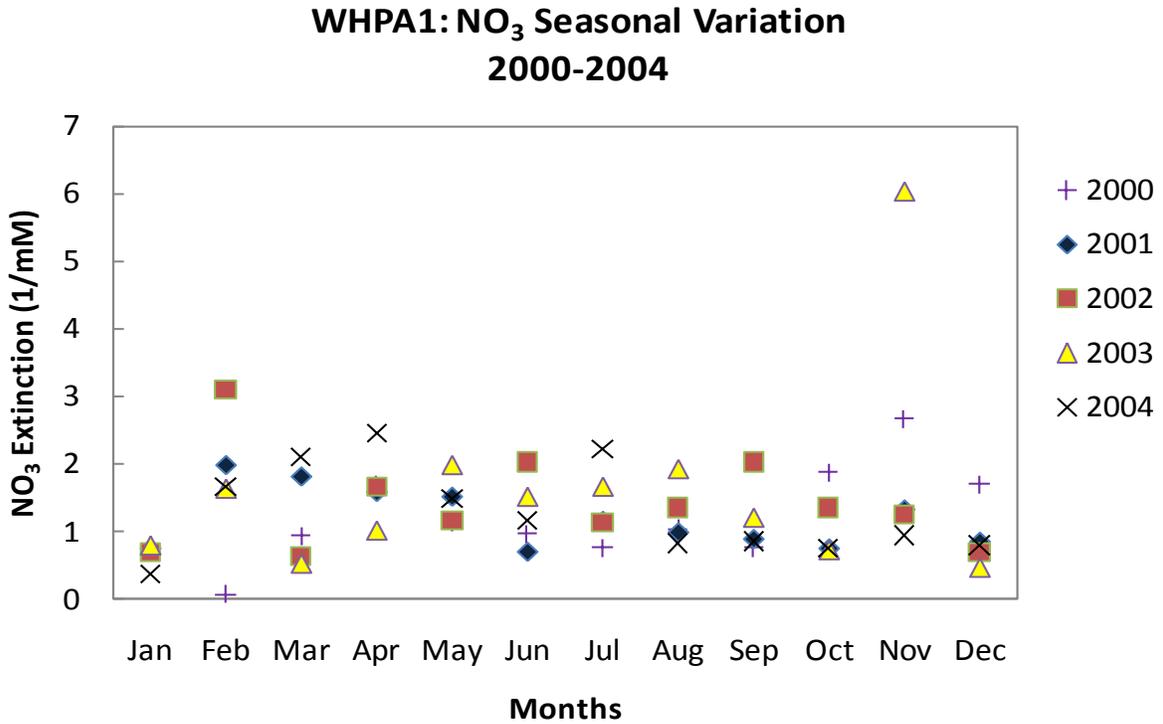


Figure 5-37 Baseline Seasonal Variation by Month for NO₃ at WHPA1

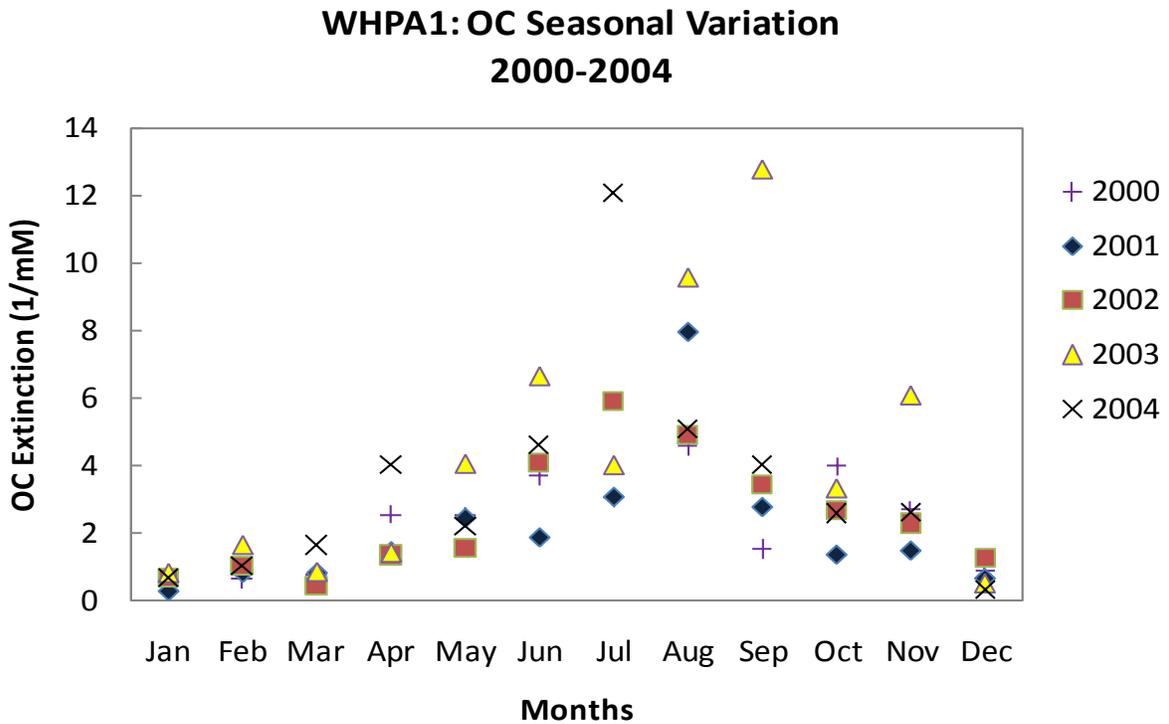


Figure 5-38 Baseline Seasonal Variation by Month for OC at WHPA1

5.6 Pasayten Wilderness

Baseline visibility is determined from the from the PASA1 monitoring site for the Most Impaired and Least Impaired Days for the years 2001 through 2004 as specified in the RHR under⁵. The baseline visibility for the Pasayten Wilderness is calculated at 2.73 dv for the Least Impaired Days and 15.23 dv for the Most Impaired Days.

Natural visibility represents the visibility conditions that would be experiences in the absence of human-caused impairment. Based on EPA guidance, the natural visibility for Pasayten Wilderness is 1.16 dv for the Least Impaired Days and 8.25 dv for the Most Impaired Days. See Table 5-1 and Figure 5-39.

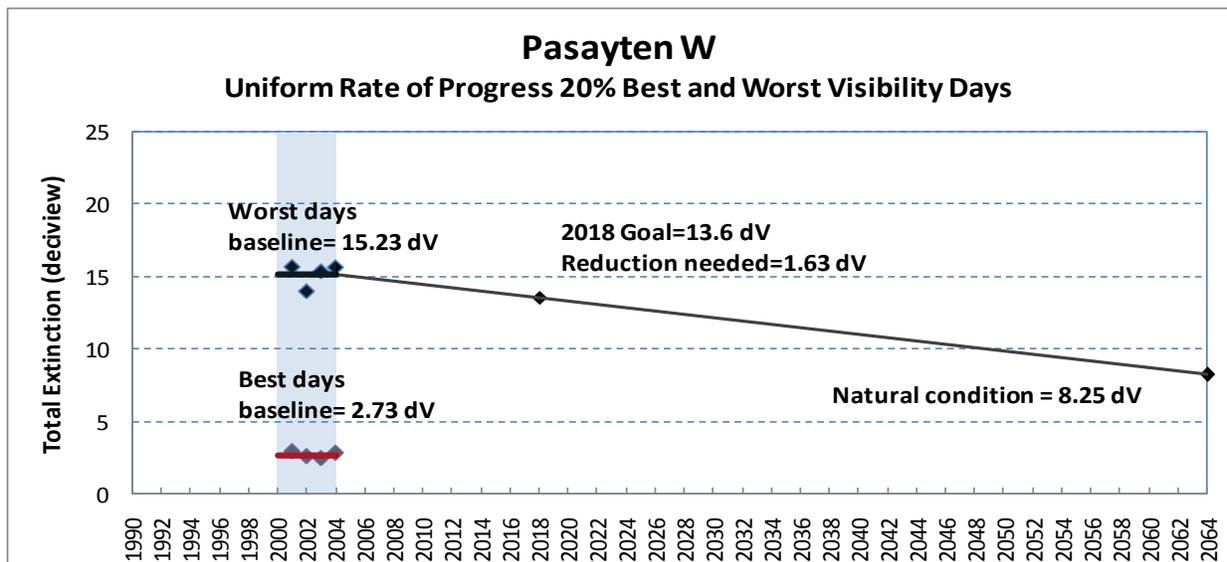


Figure 5-39 Uniform Rate of Progress for Pasayten Wilderness

Figures 5-40 and 5-41 show the annual and average contributions of haze species to light extinction over the baseline period based on data from the PASA1 IMPROVE monitor site for the Most Impaired (left) and Least Impaired (right) Days, respectively. Overall, the year to year variability of the average of the annual Most Impaired and Least Impaired Days light extinction is small (13 Mm^{-1} and 1 Mm^{-1} , respectively). On average, OC (56%) is the predominant cause of haze on the Most Impaired Days at this site. Sulfates (20%) produce the majority of the remaining visibility impairment. Compared to the Most Impaired Days, on the Least Impaired Days sulfates significantly increase their proportional share of the visibility impairment, OC significantly reduces its share, and nitrates increase their share.

⁵ 40 CFR §51.308(d)(2)(i)

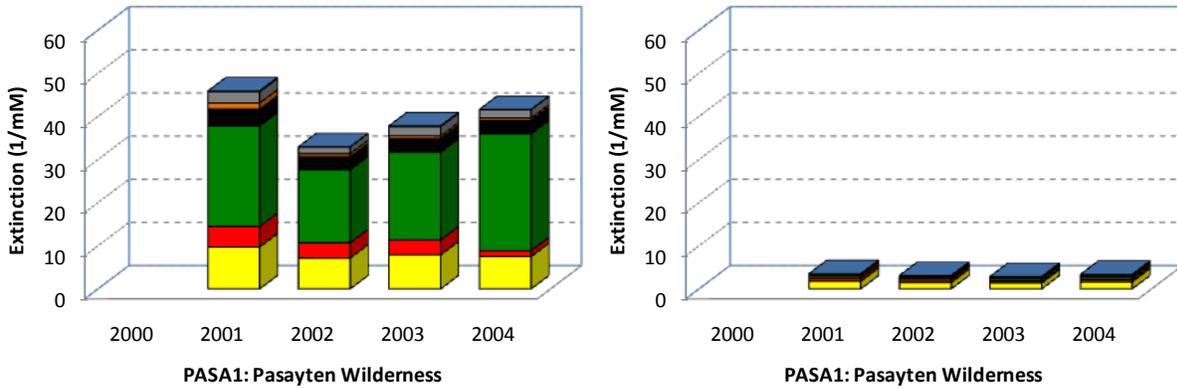


Figure 5-40 Annual Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Pasayten Wilderness

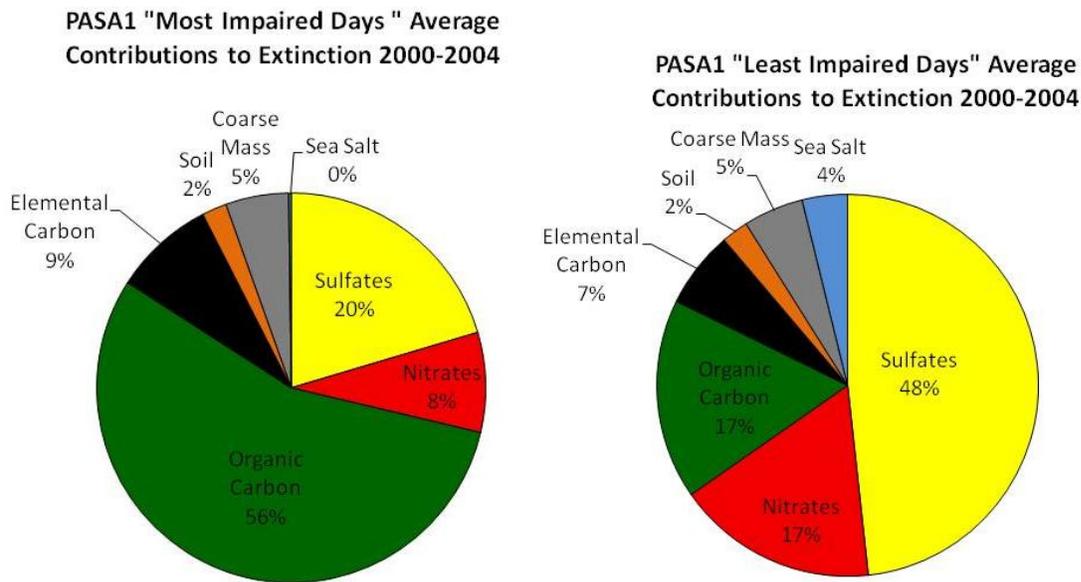


Figure 5-41 Average Species Contributions to Most Impaired (left) and Least Impaired (right) Days in Pasayten Wilderness

Figure 5-42 illustrates monitoring data for all IMPROVE sampled days during the base years (2001-2004). These data are reinterpreted in Figures x through z for major haze species. A clear seasonal variation is observed for OC which increases considerably in summer and fall months. A clear seasonal variation is observed for EC which increases in summer and fall months. A bimodal trend is observed for both SO₄ and NO₃, both of which seem to increase in the spring and fall.

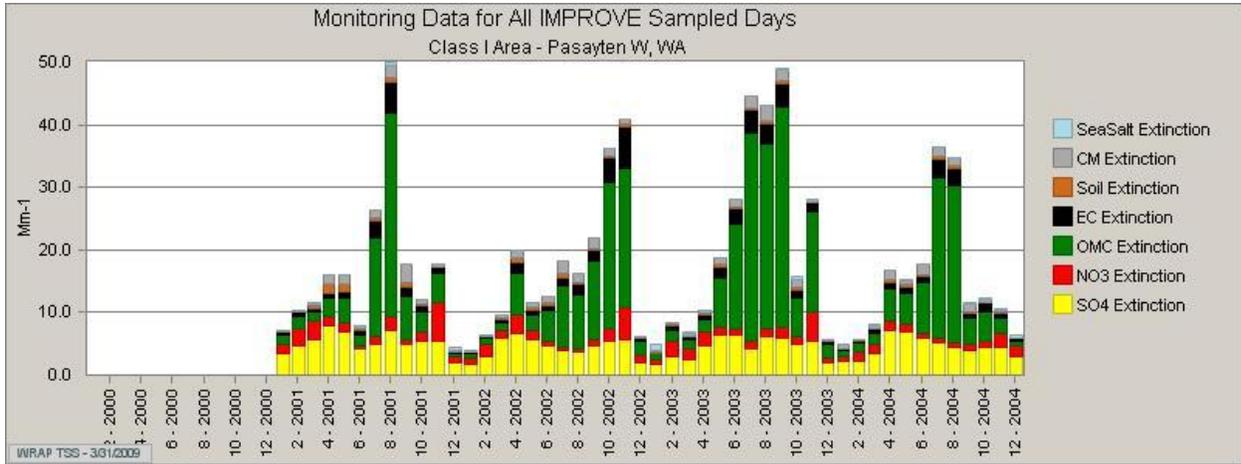


Figure 5-42 Baseline Seasonal Variation in Haze Species at PASA1 for 2001 through 2004

PASA1: SO₄ Seasonal Variation
2001-2004

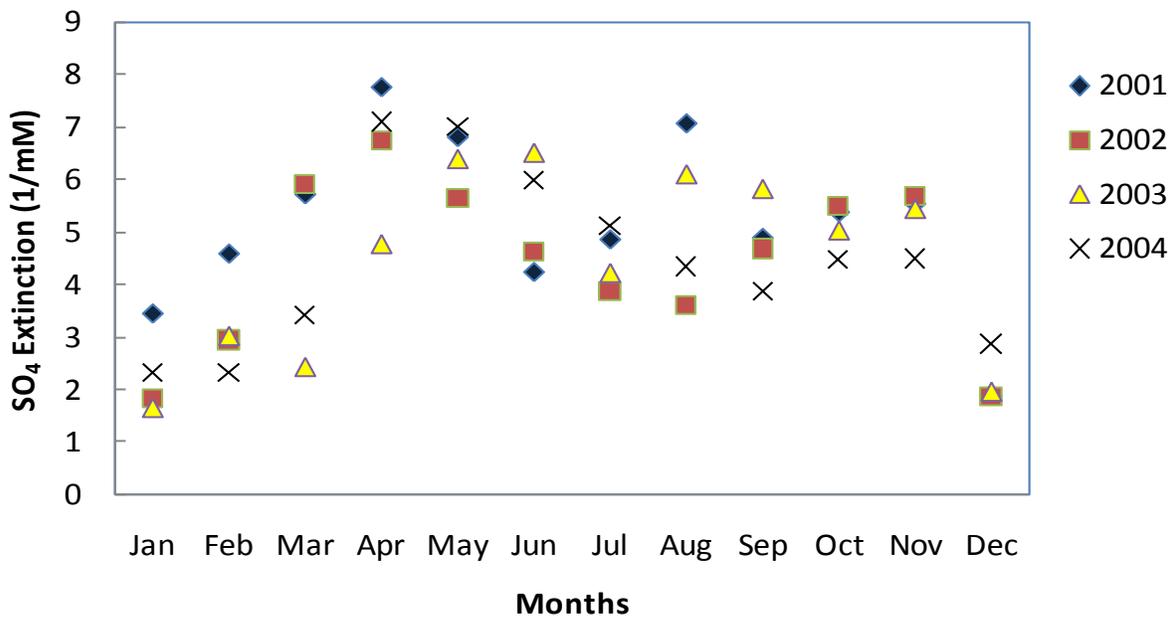


Figure 5-43 Baseline Seasonal Variation by Month for SO₄ at PASA1

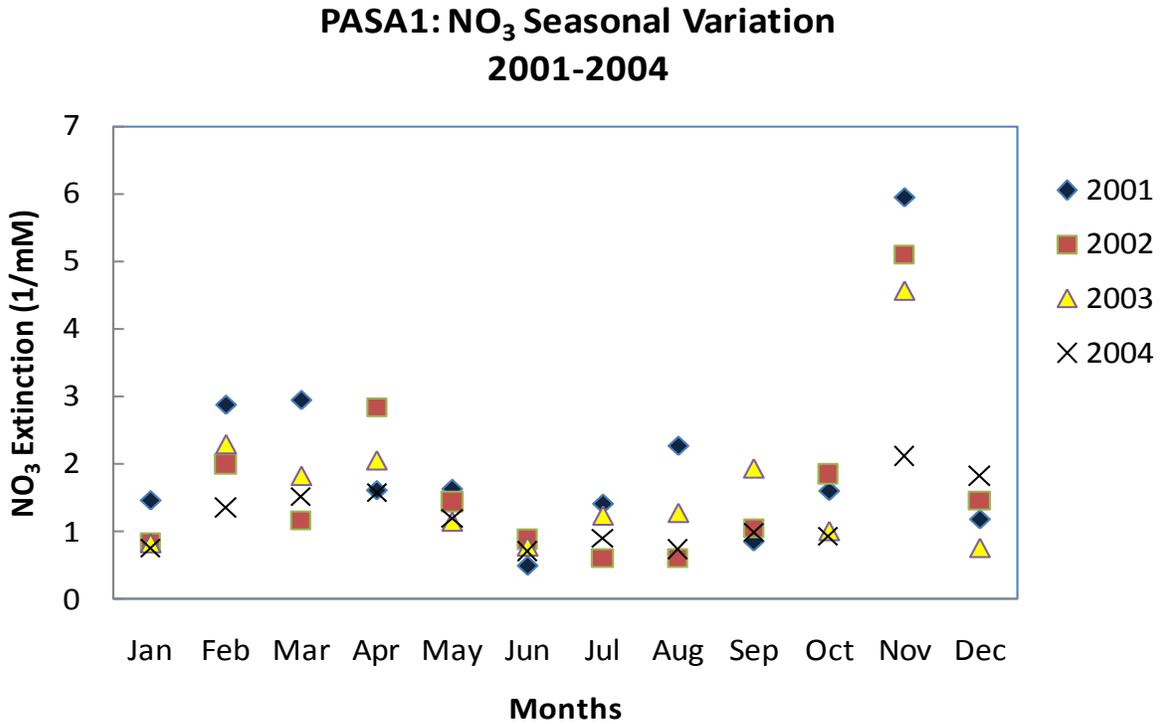


Figure 5-44 Baseline Seasonal Variation by Month for NO₃ at PASA1

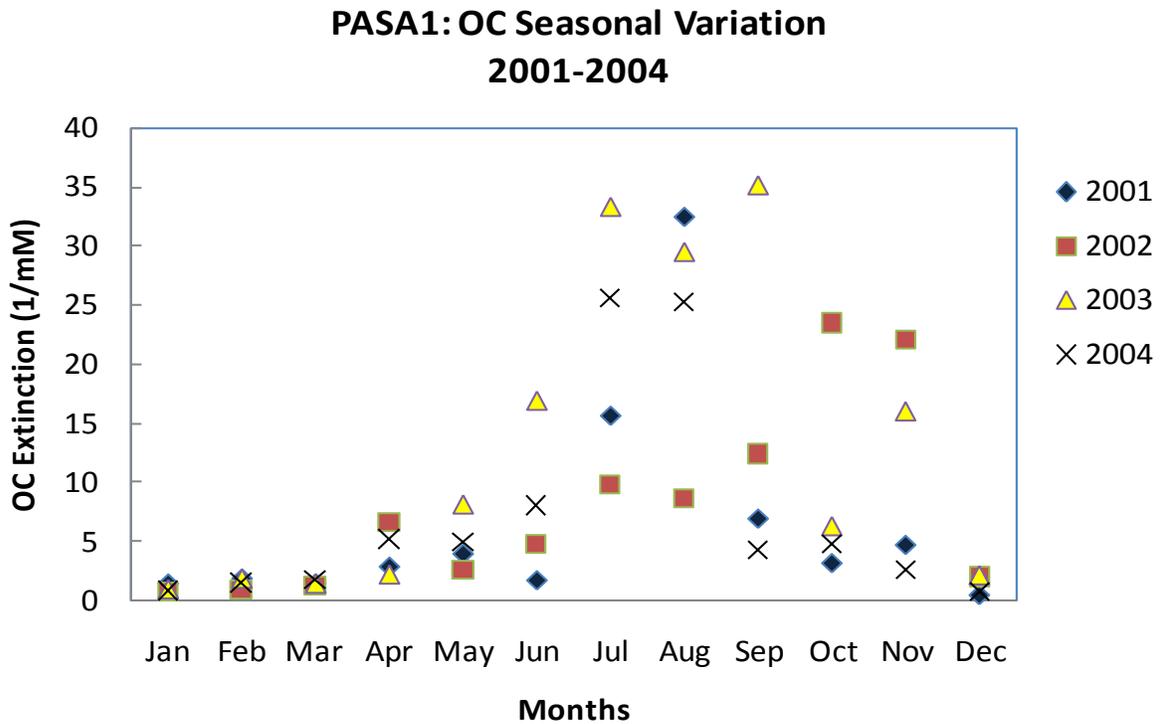


Figure 5-45 Baseline Seasonal Variation by Month for OC at PASA1

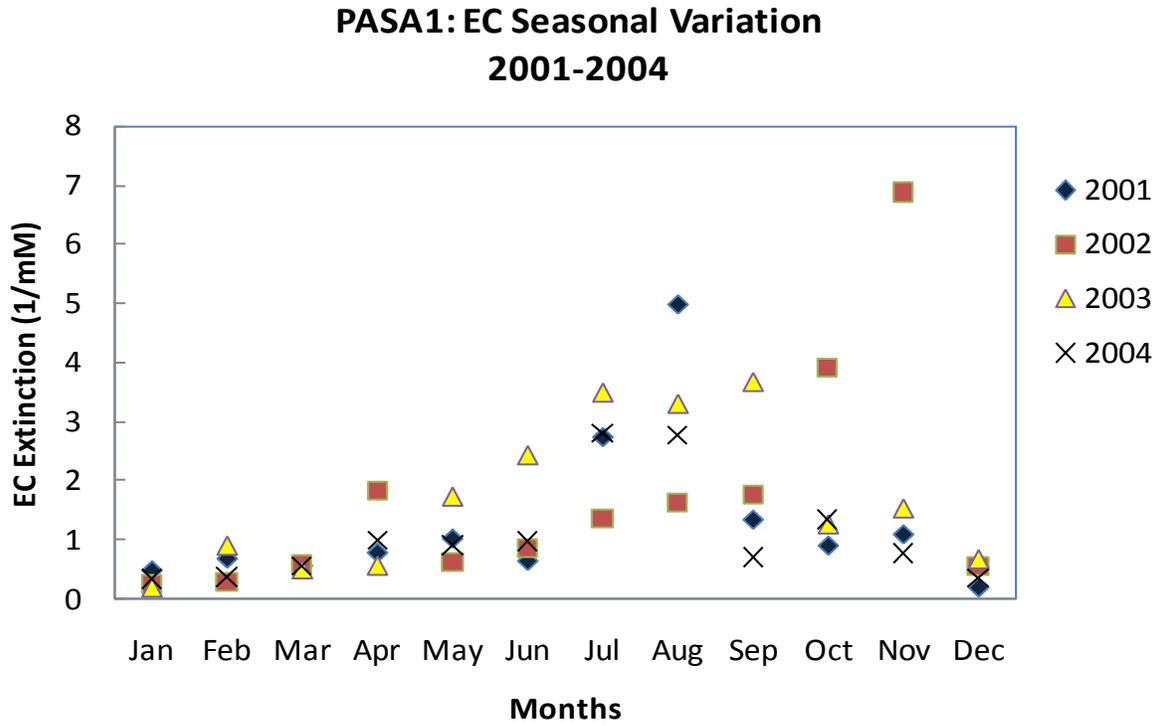


Figure 5-46 Baseline Seasonal Variation by Month for EC at PASA1