Mid-Atlantic/Northeast U.S. Visibility Data 2004-2017

(2nd RH SIP Metrics)

Prepared by
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for the
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MANE - VU
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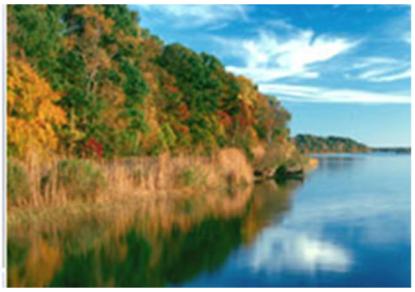

Acknowledgments

This document is a companion technical document to go with the following report: *Tracking Visibility Progress 2004-2017 (1st RH SIP Metrics) – December 2018 Update* (MANE-VU 2018).

We could not have completed this work without the IMPROVE (Interagency Monitoring of Protected Visual Environments) program and long-term commitment of the National Park Service and other state and federal partners to maintain visibility networks and the Federal Land Manager Environmental Database (FED). FED is hosted at the Colorado State University's Cooperative Institute for Research in the Atmosphere (CIRA). IMPROVE is a collaborative association of state, tribal, and federal agencies, and international partners. US Environmental Protection Agency is the primary funding source, with contracting and research support from the National Park Service. The Air Quality Group at the University of California, Davis is the central analytical laboratory, with ion analysis provided by Research Triangle Institute, and carbon analysis provided by Desert Research Institute.

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Executive Summary

This technical document fulfills U.S. Environmental Protection Agency's (USEPA's) Regional Haze Rule (RHR) 51.308(f)(1) provision for the second implementation period (2018-28) to determine baseline, current and natural visibility conditions for the 20 percent most impaired days and the 20 percent clearest days, for each in-state and out-of-state Class I area for states in the Mid-Atlantic/Northeast Visibility Union (MANE-VU) region.

Visibility trends analyses in this document used USEPA recommended metrics in the December 2018 guidance (U.S. EPA 2018) at IMPROVE (Interagency Monitoring of Protected Visual Environments) monitoring sites at federal Class I areas in and adjacent to the MANE-VU region that are subject to USEPA's RHR. Visibility trends analyses were also calculated for IMPROVE Protocol monitoring sites in and adjacent to the MANE-VU region. For visibility trends at IMPROVE Protocol monitoring sites April 2018 natural conditions updates received from Scott Copeland were used.

This technical document provides an analysis of visibility data collected at the IMPROVE monitoring sites, starting in the baseline period of 2000-2004 through 2013-2017, the most recent five-year period with available data. The results of this analysis show the following:

- There continue to be definite downward trends in overall haze levels at all Class I areas in and adjacent to the MANE-VU region and at IMPROVE Protocol monitoring sites.

- Based on rolling-five year averages demonstrating progress since the 2000-2004 baseline period, all MANE-VU and nearby Class I area visibility conditions are currently better than the 2028 uniform rate of progress (URP) visibility condition for the 20 percent most impaired visibility days and below baseline conditions for the 20 percent clearest days.

- Further progress is needed to achieve modeled 2028 reasonable progress goals (RPGs) at all MANE-VU and nearby Class I areas.

- Trends are mainly driven by large reductions in sulfate light extinction, and to a lesser extent, nitrate light extinction.

- Levels of organic carbon mass (OCM) and light absorbing carbon (LAC) appear to be approaching natural background levels at most of the MANE-VU Class I areas.

- The percent contribution of nitrate light extinction has been significantly increasing at some of the MANE-VU Class I areas not just due to lower sulfate contributions but due to more winter days and fewer summer days in the mix of 20 percent most impaired days.

1. INTRODUCTION

1.1. Background

Haze, or reduced visibility, occurs when ambient particulate matter and gases scatter or absorb light ("light extinction") that would otherwise reach an observer. Particles responsible for regional haze are produced naturally, from windblown dust, forest fires, and aerosolized sea salt; and by human-caused pollution from vehicles, power plants, and other combustion and dust-generating activities. Haze-forming particles can also cause serious health effects in the lungs and cardiopulmonary system, potentially leading to premature death. In addition, some particle species contribute to acidic deposition and other environmental harms.

In 1999, the US Environmental Protection Agency (USEPA) issued a rule under Section 169A of the Clean Air Act (Visibility Protection for the Federal Class I Areas) to address human-caused regional haze: Regional Haze Rule (RHR) [64 FR 35614 (July 1, 1999)]. The RHR is designed to improve visibility at certain national parks and wilderness areas (Class I areas) on the 20 percent haziest ('worst') days while not exacerbating haze on the 20 percent clearest ('best') days. The RHR requires states to submit state implementation plans (SIPs) to USEPA every ten years, setting interim progress goals and strategies consistent with the long-term national visibility goal of achieving natural conditions at Class I areas by 2064. States submitted their first haze SIPs to USEPA beginning in 2008. States additionally are required to track their progress against their historic baseline period[1] in achieving reductions in regional haze, submitting reports every five years, and to adjust their emissions management strategies accordingly.

In 2017, USEPA finalized revisions to the 1999 RHR [82 FR 3078 (January 10, 2017)] that will now require states to track progress of visibility for the 20 percent 'most impaired' days due to anthropogenic emissions instead of 20 percent worst visibility days as was done for the first planning period. The method for tracking progress for the 20 percent clearest days will not change from the first planning period. USEPA has recommended metrics for determining 20 percent most impaired days in a December 2018 guidance (U.S. EPA 2018). MANE-VU states have since decided to use those recommended metrics for the second implementation period. All analyses in this document use the most recent (20% most impaired natural conditions were updated in 2018) recommended metrics.

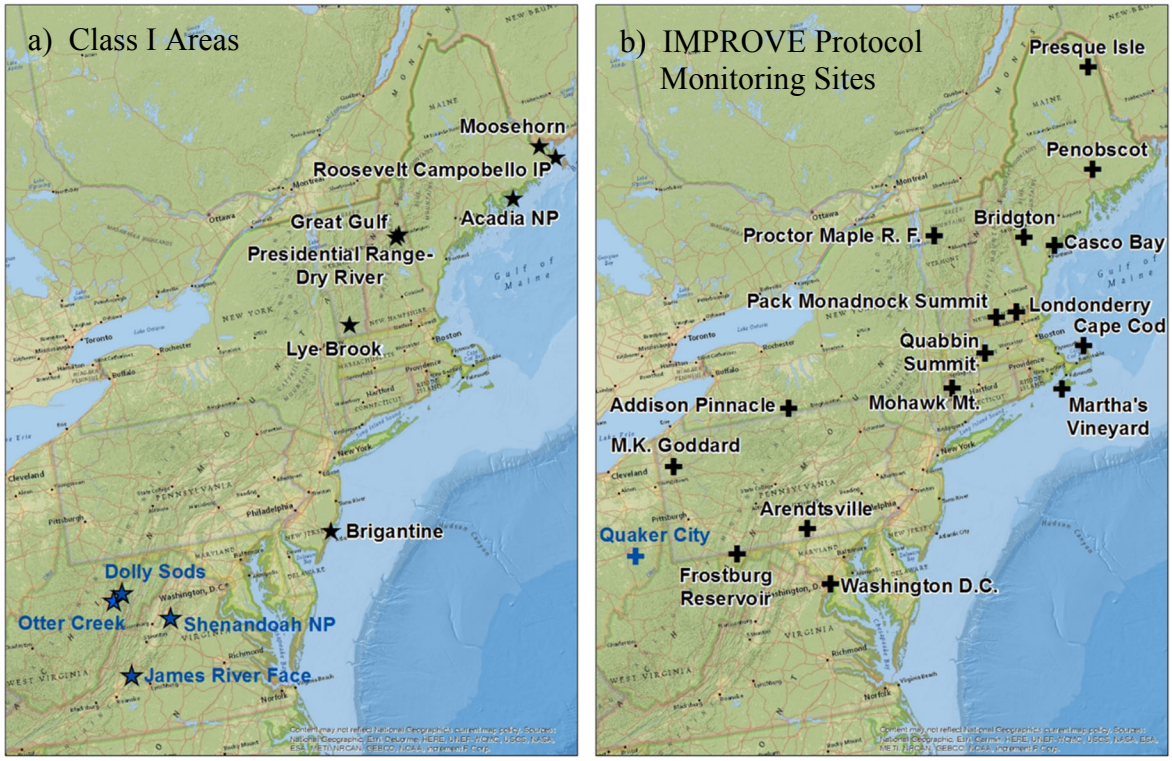
The Mid-Atlantic/Northeast Visibility Union (MANE-VU) was formed to support visibility planning efforts in the mid-Atlantic and northeastern portion of the country, and includes the members listed in Table 1-1. The seven Class I areas in the MANE-VU region (black text) and four Class I areas adjacent to the MANE-VU region (blue text) are shown in Figure 1-1(a). This document also includes analyses for IMPROVE Protocol monitoring sites with at least 6-years of available data (see Figure 1-1(b)), with sixteen monitors in the MANE-VU region (black text) and one adjacent to the MANE-VU region (blue text)). The purpose of this report is to support MANE-VU states to meet USEPA's RHR 51.308(f)(1) provision for the second implementation period (2018-28) to determine baseline, current and natural visibility conditions for the 20 percent most impaired days and the 20 percent clearest days, for each in-state and out-of-state Class I area for states in the Mid-Atlantic/Northeast Visibility Union (MANE-VU) region.

[1] The title of this and earlier trends reports use 2004 as the base year because the trend is based on rolling averages of 5-year periods, and 2004 was the end of the initial 5-year period used as the baseline.

Table 1-1. Members of the Mid-Atlantic/Northeast Visibility Union (MANE-VU)

Connecticut	Pennsylvania
Delaware	Penobscot Indian Nation
District of Columbia	Rhode Island
Maine	St. Regis Mohawk Tribe
Maryland	Vermont
Massachusetts	National Park Service
New Hampshire	U.S. EPA
New Jersey	U.S. Fish and Wildlife Service
New York	U.S. Forest Service

Figure 1-1. Class I Areas and IMPROVE Protocol Monitoring Sites In and Adjacent to the MANE-VU Region



While this report provides readers with a basic background on regional haze, it does not include in-depth discussions of topics covered in previous reports. For a broader understanding of these topics, readers can visit USEPA's regional haze website: https://www.epa.gov/visibility, the IMPROVE technical documentation website: http://vista.cira.colostate.edu/improve/, the Publications section of the MANE-VU website: http://www.otcair.org/manevu/document.asp?Fview=Reports, the MARAMA regional haze website: http://www.marama.org/technical-center/regional-haze-planning and the NESCAUM regional haze documents archive, located at the following web address: http://www.nescaum.org/topics/regional-haze

In the NESCAUM documents archive, readers may find the following of particular interest in understanding regional haze in the MANE-VU region:

- Regional Haze and Visibility in the Northeast and Mid-Atlantic States (2001)

- 2002: A Year in Review (2004)
- Contributions to Regional Haze in the Northeast and Mid-Atlantic United States (2006)
- Public Health Benefits of Reducing Ground-level Ozone and Fine Particulate Matter in the Northeast U.S. (2008)
- MANE-VU Modeling for Reasonable Progress Goals (2008)
- 2018 Visibility Projections (2008)
- Tracking Visibility Progress, 2004-2008 (2010)
- Contribution of Non-Sulfate Aerosols to MANE-VU Regional Haze (2012)
- The Nature of the Fine Particle and Regional Haze Air Quality Problems in the MANE-VU Region: A Conceptual Description (Updated July 31, 2012)
- Tracking Visibility Progress 2004-2011 (Updated (May 24, 2013)

2. Visibility Metrics

IMPROVE is a collaborative association of state, tribal, and federal agencies, and international partners. USEPA is the primary funding source, with contracting and research support from the National Park Service. The Air Quality Group at the University of California, Davis is the central analytical laboratory, with ion analysis provided by Research Triangle Institute, and carbon analysis provided by Desert Research Institute. IMPROVE was initially established as a national visibility network in 1985, and consisted of 30 monitoring sites primarily located in national parks, 20 of which began operation in 1987. IMPROVE has operated many sites within the MANE-VU and nearby regions with some sites (Acadia and Shenandoah National Parks) with data available since 1988. For this report, only available data for the period 2000-17 were analyzed. Table 2-1 lists all IMPROVE monitoring sites in the MANE-VU and nearby regions used in this report. Other IMPROVE Protocol monitoring sites [BALT (Baltimore, Maryland), COHI (Connecticut Hills, New York), NEYO (IS52 in New York City) and OLTO (Old Town, Maine)] in the MANE-VU region were not included primarily because less than six years of valid data were available and no impairment statistics were therefore calculated for those sites.

Table 2-1. IMPROVE Monitoring Sites

Site Code	Class I Area or IMPROVE Protocol Site Name	State	Latitude	Longitude	Elevation (m AMSL)	Start Date	End Date
MANE-VU Class I Areas							
ACAD	Acadia National Park	ME	44.3771	-68.261	157	3/1988	Active
BRIG	Brigantine Wilderness	NJ	39.465	-74.4492	5	9/1991	Active
GRGU	Great Gulf Wilderness	NH	44.3082	-71.2177	453	6/1995	Active
LYBR	Lye Brook Wilderness	VT	43.1482	-73.1268	1015	9/1991	9/2012
LYEB	Lye Brook Wilderness	VT	42.9561	-72.9098	882	1/2012	Active
MOOS	Moosehorn Wilderness	ME	45.1259	-67.2661	77	12/1994	Active
Nearby Class I Areas							
DOSO	Dolly Sods Wilderness	WV	39.1053	-79.4261	1182	9/1991	Active
SHEN	Shenandoah National Park	VA	38.5229	-78.4348	1079	3/1988	Active
JARI	James River Face Wilderness	VA	37.6266	-79.5125	289	6/2000	Active
MANE-VU IMPROVE Protocol Sites							
ADPI	Addison Pinnacle	NY	42.0912	-77.2099	512	4/2001	6/2010
AREN	Arendtsville	PA	39.9232	-77.3079	267	4/2001	12/2010
BRMA	Bridgton	ME	44.1074	-70.7292	233	3/2001	12/2015
CABA	Casco Bay	ME	43.8325	-70.0644	26	3/2001	Active
CACO	Cape Cod	MA	41.9758	-70.0242	49	4/2001	Active
FRRE	Frostburg Reservoir	MD	39.7058	-79.0122	767	4/2004	Active
LOND	Londonderry	NH	42.8624	-71.3801	124	1/2011	Active
MAVI	Martha's Vineyard	MA	41.3309	-70.7846	2	1/2003	Active
MKGO	M.K. Goddard	PA	41.4269	-80.1453	379	4/2001	12/2010
MOMO	Mohawk Mt.	CT	41.8214	-73.2973	521	9/2001	Active
PACK	Pack Monadnock Summit	NH	42.8619	-71.8786	695	10/2007	Active
PENO	Penobscot Nation	ME	44.948	-68.6479	45	1/2006	Active
PMRF	Proctor Maple R. F.	VT	44.5284	-72.8688	401	12/1993	Active
PRIS	Presque Isle	ME	46.6964	-68.0333	165	3/2001	Active
QURE	Quabbin Summit	MA	42.2985	-72.3346	317	3/2001	12/2015
WASH	Washington D.C.	DC	38.8762	-77.0344	15	3/1988	12/2014
Nearby IMPROVE Protocol Site							
QUCI	Quaker City	OH	39.9428	-81.3378	366	5/2001	Active

Figure 1-1(a) shows Class I areas in the MANE-VU and nearby regions. Monitoring data for the LYBR (2000-11) and LYEB (2012-17) sites at the Lye Brook Wilderness Class I area were merged with a new LYBR_RHTS site code. The Roosevelt Campobello International Park, Presidential Range-Dry River and Otter Creek Class I areas do not have an IMPROVE monitor. For those Class I sites without an IMPROVE monitor, monitoring data from a nearby representative Class I area was used to track visibility conditions. In addition to sites that are used to represent Class I areas, IMPROVE Protocol sites are in operation to provide expanded spatial coverage for the network. Protocol sites are separately sponsored by state, regional, tribal, and national organizations and use the same instrumentation, monitoring, and analysis protocols as IMPROVE. Figure 1-1(b) shows the IMPROVE Protocol sites in the MANE-VU and nearby regions with at least six years of valid data. Monitoring data and visibility metrics used for both the first and second implementation planning period are available on the Federal Land Manager Environmental Data Base (FED) website that is hosted at the Colorado State University's Cooperative Institute for Research in the Atmosphere (CIRA).

2.1. IMPROVE Equation

MANE-VU states have agreed to use the revised IMPROVE equation (Pitchford et al., 2007) to calculate, from monitoring data, light extinction contributions from individual particle components for the first and second implementation period. The equation to estimate light extinction (b_{ext}) from the referenced literature is summarized below.

$$b_{ext} \approx 2.2 \times f_S(RH) \times [\textit{Small Ammonium Sulfate}] + 4.8 \times f_L(RH) \times [\textit{Large Ammonium Sulfate}]$$

$$+ 2.4 \times f_S(RH) \times [\textit{Small Ammonium Nitrate}] + 5.1 \times f_L(RH) \times [\textit{Large Ammonium Nitrate}]$$

$$+ 2.8 \times [\textit{Small Organic Mass}] + 6.1 \times [\textit{Large Organic Mass}]$$

$$+ 10 \times [\textit{Elemental Carbon}]$$

$$+ 1 \times [\textit{Fine Soil}]$$

$$+ 1.7 \times f_{SS}(RH) \times [\textit{Sea Salt}]$$

$$+ 0.6 \times [\textit{Coarse Mass}]$$

$$+ \textit{Rayleigh Scattering}\ (\textit{Site Specific})$$

$$+ 0.33\ (\textit{Mm}^{-1}\textit{/ppb}) \times [\textit{Nitrogen Dioxide (ppb)}]$$

Light extinction and Rayleigh scattering units are inverse megameters (Mm^{-1}), concentrations shown in brackets units are microgram per cubic meter ($\mu g/m^3$), and the water growth terms, f(RH), do not have units. The nitrogen dioxide (NO_2) light absorption term will not be used for MANE-VU and nearby region sites due to no NO_2 concentration data being available at those sites. The organic compound mass (OM) to organic carbon mass (OC) ratio is 1.8 (OM=1.8*OC). Sulfate, nitrate and organics are split into small and large modes based

on their mass. For masses less than 20 μg/m^3, the fraction in the large mode is estimated by dividing the total concentration of the component by 20 μg/m^3 with the remaining in the small mode. If the total concentration of a component exceeds 20 μg/m^3, all of it is assumed to be in the large mode. The small and large modes of sulfate and nitrate have associated hygroscopicities, f_S(RH) and f_L(RH), respectively, while f_{SS}(RH) is for sea salt.

To convert light extinction to a haze index with units of deciviews (dv) the following equation is used:

$$\text{Haze index (dv)} = 10(\ln(b_{ext}/10)$$

Not all visibility metrics used by MANE-VU states for the first implementation period can be used for the second implementation period. Recent amendments to the Regional Haze rule (USEPA, 2017) allow states to use the same metrics for the 20 percent clearest days however baseline and current haze metrics for the 20 percent most impaired days must now be calculated for the 20 percent most anthropogenically impaired days. USEPA has recommended metrics for determining 20 percent most impaired days in Chapter 2 of the December 2018 guidance (U.S. EPA 2018). MANE-VU states have agreed to use the recommended metrics for the second implementation period.

For all analyses in this report, the latest available (11/3/2018) data was downloaded from the Federal Land Manager Environmental Data Base (FED) website including daily calculated light extinction, deciview values (using the revised (new) IMPROVE algorithm including patched data) and other metrics needed in the determination of 20 percent clearest days and 20 percent most impaired days for 2000 through 2017. Natural conditions for 20 percent clearest days (IMPROVE Natural Haze Levels II version 2) were also downloaded from the FED website. Natural conditions for 20 percent most impaired days for Class I areas were from USEPA's guidance (U.S. EPA 2018) and for IMPROVE Protocol sites were downloaded from Scott Copeland's (USDA Forest Service Air Data Analyst) Google Drive that will eventually be available on the IMPROVE website (http://vista.cira.colostate.edu/Improve/rhr-summary-data/).

2.2. Natural Visibility Metrics

Even in the absence of emissions from human activities, some level of light extinction occurs from natural causes. This "natural haze" represents the best expectation for long-term progress at Class I areas, and is the goal for these areas by 2064.

For the first SIP planning period ending in 2018, USEPA has guidance (U.S. EPA 2003a) for calculating natural haze levels based on measurements of particulate species at Class I areas during a baseline period. States combine measurements of several parameters to calculate a "Haze Index" in deciview (dv) units based on estimates of light extinction. A fuller explanation of tracking progress procedures is presented in a 2003 USEPA guidance document for tracking progress (U.S. EPA 2003b). For the current SIP planning period ending in 2028, the December 2018 guidance (U.S. EPA 2018) contains final recommendations on methods for selecting 20 percent most impaired days to track visibility and determining natural visibility conditions.

Natural haze levels are calculated for both 20 percent clearest days and 20 percent most

impaired days, because changing natural processes lead to variability in natural visibility. MANE-VU states have agreed for the second implementation planning period to use 20 percent clearest days natural levels (IMPROVE Natural Haze Levels II version 2 (4/18/2018 update)) and derived 20 percent most impaired days natural levels in USEPA's recent guidance (U.S.EPA 2018). Note: For IMPROVE Protocol sites, 20 percent most impaired days metrics were calculated if at least 6-years of data is available. Natural visibility levels for 20 percent clearest days for Class I and IMPROVE Protocol monitoring sites in the MANE-VU and adjacent Class I areas are presented in Table 2-2.

Table 2-2. 20 Percent Clearest Days Natural Conditions for Class I and IMPROVE Protocol Sites In and Adjacent to the MANE-VU Region

Site Code	Deciview (dv)	Extinction (Mm-1)						
		Sulfate	Nitrate	Organic Mass Carbon	Light Absorbing Carbon	Coarse Mass	Sea Salt	Soil
MANE-VU Class I Areas								
ACAD	4.66	0.75945	0.27297	2.00049	0.08352	0.56367	0.18629	0.10431
BRIG	5.52	0.88119	0.35236	2.54476	0.11958	1.03972	0.22229	0.24231
GRGU	3.73	0.6705	0.35433	1.61155	0.08198	0.63134	0.10698	0.09615
LYBR_RHTS	2.79	0.39477	0.25933	1.02682	0.05891	0.3773	0.04617	0.08571
MOOS	5.02	0.83994	0.32516	2.24568	0.12446	0.75137	0.16123	0.11956
Nearby Class I Areas								
DOSO	3.64	0.79949	0.38313	2.35139	0.10451	0.57496	0.06985	0.16779
SHEN	3.15	0.55701	0.5537	1.63632	0.08378	0.71779	0.07105	0.14487
JARI	4.39	0.81288	0.46888	2.07294	0.09621	0.83206	0.06385	0.19781
MANE-VU IMPROVE Protocol Sites								
ADPI	4.12	0.66484	0.37501	2.05769	0.08995	0.61837	0.19171	0.12611
AREN	4.24	0.69604	0.28666	2.04036	0.09179	0.82225	0.17024	0.19266
BRMA	4.65	0.74476	0.30023	1.84437	0.07813	0.65535	0.21168	0.10856
CABA	4.83	0.72653	0.22981	1.99149	0.07961	0.86898	0.17602	0.16803
CACO	5.95	0.78033	0.43355	2.55505	0.11739	1.03772	1.1255	0.14441
FRRE	*	*	*	*	*	*	*	*
LOND	*	*	*	*	*	*	*	*
MAVI	*	*	*	*	*	*	*	*
MKGO	4.52	0.79382	0.4743	2.13868	0.08989	0.87227	0.20685	0.19927
MOMO	3.67	0.64117	0.28174	1.6037	0.07982	0.55116	0.15415	0.15967
PACK	*	*	*	*	*	*	*	*
PENO	*	*	*	*	*	*	*	*
PMRF	3.86	0.57006	0.24555	2.04162	0.08695	0.55555	0.14592	0.08835
PRIS	4.91	0.71974	0.26817	2.04509	0.11767	0.80764	0.20499	0.20713
QURE	3.92	0.62331	0.21697	1.8398	0.08	0.72058	0.2309	0.11885
WASH	5.52	0.86507	0.39121	2.34693	0.12815	1.19015	0.1747	0.28916
Nearby IMPROVE Protocol Site								
QUCI	4.96	0.76891	0.58488	2.66763	0.11451	0.97224	0.12414	0.22298

Data Source: IMPROVE Natural Haze Levels II version 2 revised 4/2018.

** Natural haze values are not calculated for areas without 2000-04 baseline monitoring data or nearby representative IMPROVE site values. Visibility for the Presidential Range/Dry River Wilderness Area, Roosevelt Campobello International Park and Otter Creek Wilderness are represented by the IMPROVE monitors for Great Gulf, Moosehorn and Dolly Sods, respectively.*

In USEPA's guidance (U.S.EPA 2018), to calculate 20 percent most impaired days haze index levels, there are more natural conditions metrics needed to complete the calculations.

The guidance uses 2000-14 data to determine extinction levels for episodic (e3) carbon and dust and natural extinction (NC-II (group 100)) levels for sulfate, nitrate, organic carbon, elemental carbon, fine soil and coarse mass. The RHR does not require Protocol sites to establish Reasonable Progress Goals (RPGs) however, e3 and NC-II (Group 100) extinction metrics are needed to calculate daily extinction levels for Protocol sites. For IMPROVE Protocol sites, e3 and NC-II (group 100) levels were determined if there were at least six years of valid data available (not in USEPA's guidance), but in the latest available dataset). Derived e3 and NC-II (group 100) extinction levels for all MANE-VU and nearby Class I areas and IMPROVE Protocol sites are listed in Table 2-3.

Table 2-3. Derived Episodic (e3) and Natural Conditions for Class I and IMPROVE Protocol Sites In and Adjacent to the MANE-VU Region

	e3 (Mm-1)		Natural Extinction# (Mm-1)					
Site Code*	**Episodic Carbon**	**Episodic Dust**	**Sulfate**	**Nitrate**	**Organic Carbon Mass**	**Light Absorbing Carbon**	**Soil**	**Coarse Mass**
MANE-VU Class I Areas								
ACAD	10.4378	3.1113	2.0363	0.9343	5.4325	0.2	0.2471	1.2827
BRIG	20.1488	9.0660	1.8029	0.816	6.0084	0.2	0.4716	1.8
GRGU	12.0692	3.2331	1.8347	0.8186	5.567	0.2	0.2457	1.5891
LYBR_RHTS	11.4447	2.7527	1.7712	0.7975	5.4171	0.2	0.2788	1.0723
MOOS	11.1330	2.5361	1.9045	0.8729	5.7791	0.2	0.2322	1.5336
Nearby Class I Areas								
DOSO	13.5680	3.3964	1.8867	0.8223	5.7402	0.2	0.4263	1.3147
SHEN	15.0649	3.9163	1.8229	0.7919	5.9617	0.2	0.4086	1.7282
JARI	26.2695	3.1277	1.7784	0.7976	5.778	0.2	0.4811	1.8
MANE-VU IMPROVE Protocol Sites								
ADPI	14.7429	3.7018	1.8253	0.831	5.9314	0.2	0.3975	1.549
AREN	22.1288	5.5557	1.7191	0.7791	5.9076	0.2	0.4789	1.8
BRMA	12.9354	2.5205	1.7926	0.8172	5.8414	0.2	0.2715	1.2729
CABA	18.8995	3.7792	1.716	0.7939	6.077	0.2	0.3216	1.7607
CACO	12.3454	4.9296	1.7068	0.781	6.1061	0.2	0.3218	1.8
FRRE	15.5627	4.5041	1.8621	0.8229	5.7261	0.2	0.4569	1.8
LOND	20.8544	4.3866	1.7467	0.8	5.7654	0.2	0.2257	1.7957
MAVI	12.1914	6.1637	1.7205	0.7844	5.2648	0.2	0.2764	1.8
MKGO	29.7707	4.6911	1.9607	0.8908	5.7383	0.2	0.4603	1.8
MOMO	15.2014	3.0276	1.7634	0.8035	5.9778	0.2	0.3958	1.4881
PACK	12.2389	3.0465	1.7673	0.8033	4.7403	0.2	0.2291	1.3534
PENO	24.0194	4.6536	1.7964	0.8277	5.968	0.2	0.4273	1.8
PMRF	13.6972	2.8846	1.8026	0.7977	5.859	0.2	0.2827	1.2673
PRIS	16.5454	7.7134	1.8395	0.8387	5.8599	0.2	0.4977	1.8
QURE	17.0224	3.1362	1.7471	0.7909	6.0623	0.2	0.3684	1.612
WASH	30.7359	6.0138	1.6829	0.7746	5.7776	0.2	0.5	1.8
Nearby IMPROVE Protocol Site								
QUCI	16.6611	5.5218	1.8759	0.8474	5.716	0.2	0.4863	1.8

Data Source: 4/18/2018 IMPROVE Scott Copeland analyses.

** Visibility for the Presidential Range/Dry River Wilderness Area, Roosevelt Campobello International Park and Otter Creek Wilderness are represented by the IMPROVE monitors for Great Gulf, Moosehorn and Dolly Sods, respectively.*

 # NC-II group 100 (all days)

Per USEPA guidance (U.S. EPA 2018), other metrics needed to calculate natural (2064) deciview conditions for the 20 percent most impaired days include routine and episodic extinction levels. Table 2-4 shows the derived natural routine and episodic extinction levels and the final derived natural deciview levels for all MANE-VU and nearby Class I areas and IMPROVE Protocol sites.

Table 2-4. 20 Percent Most Impaired Days Natural Conditions for Class I and IMPROVE Protocol Sites In and Adjacent to the MANE-VU Region

	Derived	Routine Extinction (Mm-1)							Episodic Extinction (Mm-1)			
*Site Code	Natural Deciview (dv)	Sulfate	Nitrate	Organic Mass Carbon	Light Absorbing Carbon	Coarse Mass	Sea Salt	Soil	Organic Mass Carbon	Light Absorbing Carbon	Soil	Coarse Mass
MANE-VU Class I Areas												
ACAD	10.39	5.1175	1.6277	5.6360	0.3380	1.3768	0.7729	0.2956	1.6565	0.5697	0.0344	0.1524
BRIG	10.69	3.8942	1.2362	7.6682	0.2715	1.6738	0.6474	0.5512	1.4028	0.4589	0.03185	0.6245
GRGU	9.78	4.7633	1.0910	6.3521	0.3246	1.7437	0.1250	0.2874	1.5992	0.4368	0.04945	0.3252
LYBR_RHTS	10.23	5.0789	1.5029	6.2665	0.3585	1.3849	0.1696	0.3718	2.0890	0.7162	0.05726	0.2790
MOOS	9.97	4.5533	1.3701	5.9657	0.2973	1.3099	0.6348	0.2540	1.3176	0.3889	0.02590	0.1756
Nearby Class I Areas												
DOSO	8.92	4.5298	0.5180	6.4247	0.2408	1.3164	0.1054	0.5489	1.0187	0.3089	0.02662	0.1035
SHEN	9.52	4.3316	0.7659	7.1543	0.2747	1.8253	0.1984	0.4892	1.2562	0.3918	0.04123	0.1493
JARI	9.48	3.7839	0.6902	6.7212	0.2382	1.9211	0.2135	0.4907	0.6677	0.2056	0.09505	0.3829
MANE-VU IMPROVE Protocol Sites												
ADPI	10.42	4.7220	0.8251	7.4748	0.2714	1.7974	0.1578	0.5529	1.7669	0.6780	0.0489	0.2140
AREN	10.21	3.8251	1.2034	7.4267	0.2650	1.9386	0.7328	0.6255	1.091	0.3558	0.0513	0.1001
BRMA	10.48	4.4763	1.3448	7.1338	0.3071	1.2586	0.2395	0.3210	1.8101	0.6668	0.0397	0.2045
CABA	10.92	4.1006	1.4187	7.9470	0.3006	1.8830	1.0112	0.3323	1.35793	0.4878	0.0317	0.1794
CACO	10.99	4.1921	1.2320	6.9421	0.3463	1.7536	1.3381	0.4324	1.9780	0.6533	0.0247	0.1827
FRRE	9.61	4.0681	0.8415	6.9409	0.2376	1.9048	0.1062	0.50446	0.70806	0.2479	0.0233	0.1177
LOND	10.42	3.3990	1.6528	8.1077	0.3008	1.8477	0.5493	0.26986	0.5266	0.2031	0.0092	0.06975
MAVI	11.11	4.2506	1.2866	6.5935	0.3293	1.7417	2.2100	0.42526	1.9370	0.5912	0.0192	0.3782
MKGO	10.14	4.6101	1.2542	7.3093	0.2657	2.0255	0.3597	0.65516	0.4333	0.1622	0.0238	0.1025
MOMO	10.89	4.5339	1.3822	8.1762	0.3159	1.6452	0.36867	0.4494	2.4354	0.7666	0.0509	0.2310
PACK	9.54	4.3531	1.4767	6.4355	0.3332	1.4194	0.13337	0.2991	0.9303	0.2470	0.0294	0.1937
PENO	10.39	4.0052	1.3697	7.9636	0.2728	1.8929	0.59697	0.3338	0.4559	0.1696	0.0212	0.2215
PMRF	10.29	4.8478	1.4611	7.4530	0.3167	1.3712	0.15187	0.3693	1.66481	0.5119	0.0263	0.0966
PRIS	10.24	4.2283	1.4418	7.3429	0.2697	1.6331	0.36187	0.4082	1.04401	0.2928	0.0072	0.0545
QURE	10.82	4.4568	1.3448	8.7951	0.3063	1.4839	0.2320	0.4521	2.00641	0.6778	0.0315	0.1298
WASH	9.85	3.3677	0.9889	6.3488	0.2263	1.7631	0.5898	0.5945	1.0051	0.4926	0.0439	0.1362
Nearby IMPROVE Protocol Site												
QUCI	9.78	4.1367	1.0508	6.6407	0.2452	1.7736	0.2626	0.5642	0.9193	0.3992	0.0378	0.1986

Data Source: 4/18/2018 IMPROVE Scott Copeland analyses.

** Visibility for the Presidential Range/Dry River Wilderness Area, Roosevelt Campobello International Park and Otter Creek Wilderness are represented by the IMPROVE monitors for Great Gulf, Moosehorn and Dolly Sods, respectively.*

2.3. Baseline, Current and Reasonable Progress Goal Visibility Metrics

The RHR requires states to evaluate current regional haze conditions at Class I areas subject to the rule relative to conditions during a historic baseline period. The historic baseline period is the five-year period from 2000 through 2004 and current five-year period is 2013 through 2017. Reasonable progress goals (RPGs) were established for the first implementation planning period for reduction of regional haze through 2018 for each Class I area and were established through 2028 in the second implementation planning period. States with Class I areas, in consultation with other states and federal land managers set 2028 RPGs (MANE-VU 2018a) for the 20 percent most impaired days and for the 20 percent clearest days as shown in Figure 2-5. Comparison between the five-year average Haze Index in 2028 (average of the 2024-2028 annual Haze Index values) and the baseline Haze Index will determine if states have met 2028 RPGs. The RPGs are designed to at least ensure no degradation from the baseline period for 20 percent clearest days visibility and achievement of reasonable progress toward natural conditions for 20 percent most impaired days visibility.

Haze indexes for baseline and current 20 percent clearest days are five-year averages of each year's average 20 percent lowest daily haze index values. Results for each Class I area in the MANE-VU and nearby regions are in Table 2-5. For all Class I areas, current haze indexes for the 20 percent clearest days are below baseline levels showing no degradation.

Haze indexes for baseline and current 20 percent most impaired days are determined by starting with calculating daily haze index values and calculating anthropogenic impairment levels as specified in Chapter 2 of the guidance (U.S. EPA 2018). The resulting impairment values are then sorted to determine the 20 percent most impaired days for each 'baseline' and 'current' year. The final 'baseline' and 'current' haze index calculation is a five-year average of each year's average 20 percent most impaired days daily haze index values. Results for each Class I area in the MANE-VU and nearby regions are in Table 2-5. The uniform rate of progress (URP) levels for 2017 and 2028 plus 2028 RPGs for each Class I area are also included in Table 2-5. Constant annual incremental improvement in the Haze Index (dv) such that natural conditions will be reached by 2064 is termed a "uniform rate of progress (URP)" (also referred to as the glide path). Results show that all Class I areas in the MANE-VU and nearby regions are currently between 3.94 dv and 6.47 dv below 2017 URP levels and between 0.88 dv and 3.76 dv below 2028 URP levels. Results also show that Class I areas in the MANE-VU region need between 0.42 dv and 1.89 dv improvements to reach the respective modeled 2028 RPGs and Class I areas in Virginia and West Virginia need between 2.84 dv and 3.53 dv improvements to reach the respective modeled 2028 RPGs.

Appendix B contains 20 percent clearest days and 20 percent most impaired days annual and 5-year rolling average haze indexes for all MANE-VU and nearby region Class I and IMPROVE Protocol sites.

Table 2-5. Baseline, Current and Reasonable Progress Goal Haze Index Levels for Class I Areas In or Adjacent to the MANE-VU Region

Class I Area	IMPROVE SITE DATA CODE(S)	State	CLEAREST DAYS			MOST IMPAIRED DAYS				
			Baseline (2000-04) (dv)	Current (2013-17) (dv)	RPG^ (2028) (dv)	Baseline (2000-04) (dv)	Current (2013-17) (dv)	URP* 2017 (dv)	URP* 2028 (dv)	RPG^ (2028) (dv)
Acadia National Park	ACAD	ME	8.78	6.52	6.33	22.01	14.89	19.50	17.36	13.35
Moosehorn Wilderness Area Roosevelt Campobello International Park	MOOS	ME NB	9.16	6.59	6.45	20.66	13.54	18.34	16.38	13.12
Great Gulf Wilderness Area Presidential Range/Dry River Wilderness Area	GRGU	NH	7.66	5.20	5.06	21.93	13.31	19.29	17.07	12.00
Lye Brook Wilderness Area	LYBR_RHTS	VT	6.37	5.15	3.86	23.57	15.30	20.68	18.23	13.68
Brigantine Wilderness Area	BRIG	NJ	14.33	11.48	10.47	27.43	19.86	23.80	20.74	17.97
Dolly Sods Wilderness Area† Otter Creek Wilderness Area†	DOSO	WV	12.28	7.29	7.27	28.29	17.95	24.09	20.54	15.09
James River Face Area†	JARI	VA	14.21	9.69	9.36	28.08	18.15	24.05	20.64	15.31
Shenandoah National Park†	SHEN	VA	10.93	7.14	6.83	28.32	17.78	24.25	20.80	14.25

† *Class I area adjacent to the MANE-VU region;*
* *Uniform Rate of Progress;*
^ *Modeled Reasonable Progress Goal (MANE-VU 2018a)*

2.4. Visibility Metrics Trend Plots

Figure 2-1 through Figure 2-8 present annual and 5-year average haze indexes on the 20 percent clearest days and 20 percent most impaired days at MANE-VU and adjacent Class I areas between 2000 and 2017 in the context of long term visibility goals. Table A-1 through Table A-5 in Appendix A present haze index trends numerically. Table A-6 through Table A-11 in Appendix A presents haze index trends numerically for all IMPROVE Protocol sites in and adjacent to the MANE-VU Region. URPs and RPGs shown in the figures are the long-term visibility goals for each Class I area.

These figures show that haze levels on the 20 percent clearest and 20 percent most impaired days from 2000 through 2017 have dropped across the entire region. In 2016 and 2017, most of the areas experienced significantly lower levels of haze on both 20 percent clearest and 20 percent most impaired days as compared to any other years. The grey region in the figures denotes the range of 20 percent clearest to 20 percent most impaired haze levels expected to occur under natural conditions. Thus, the URP line intersects with the highest portion of the grey area in 2064 for most sites. For the Brigantine, Dolly Sods and James River Face Wilderness Areas, whose haze levels on the 20 percent clearest days during the 2000 to 2004 baseline period were higher than estimated natural conditions on the 20 percent most impaired days, the no degradation line (representing the long-term clearest-day goal) is higher than the URP at dates approaching 2064. This nonsensical situation by 2064 is an artifact of technical guidance and only represents stated haze level goals, not anticipated results.

Figure 2-1. Visibility Metrics Levels at Acadia National Park

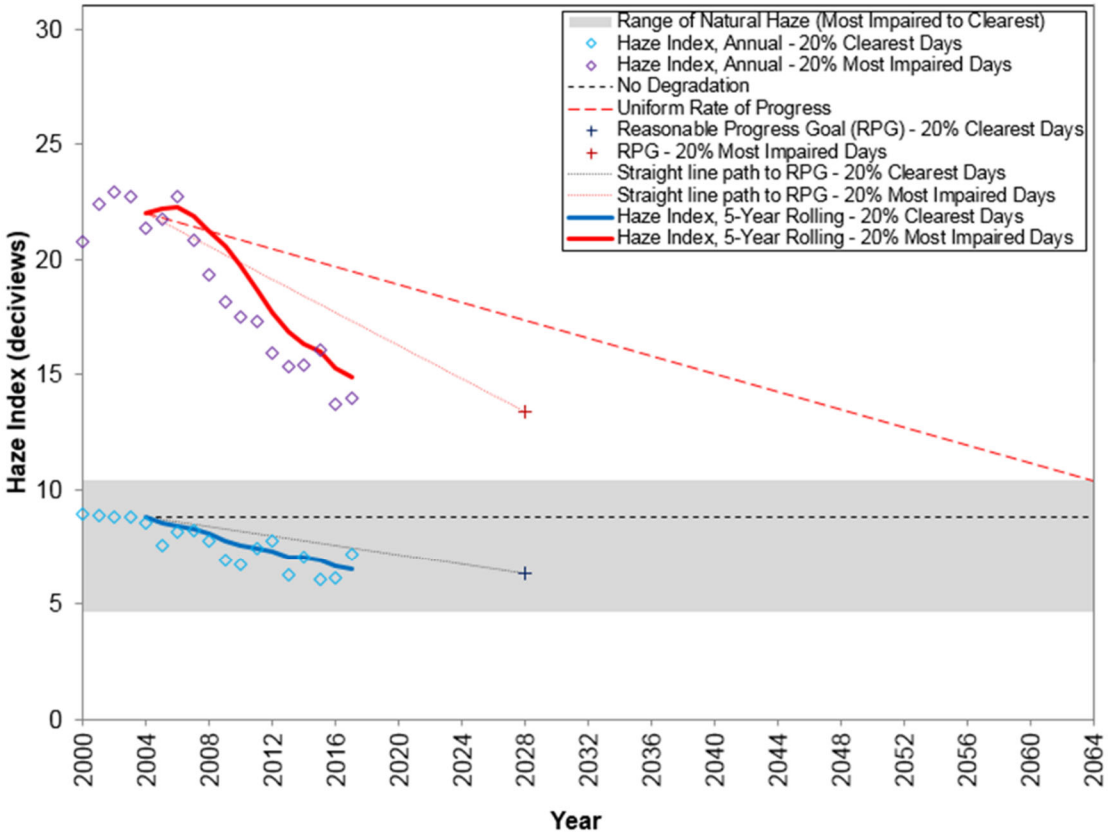


Figure 2-2. Visibility Metrics Levels at Moosehorn Wilderness Area

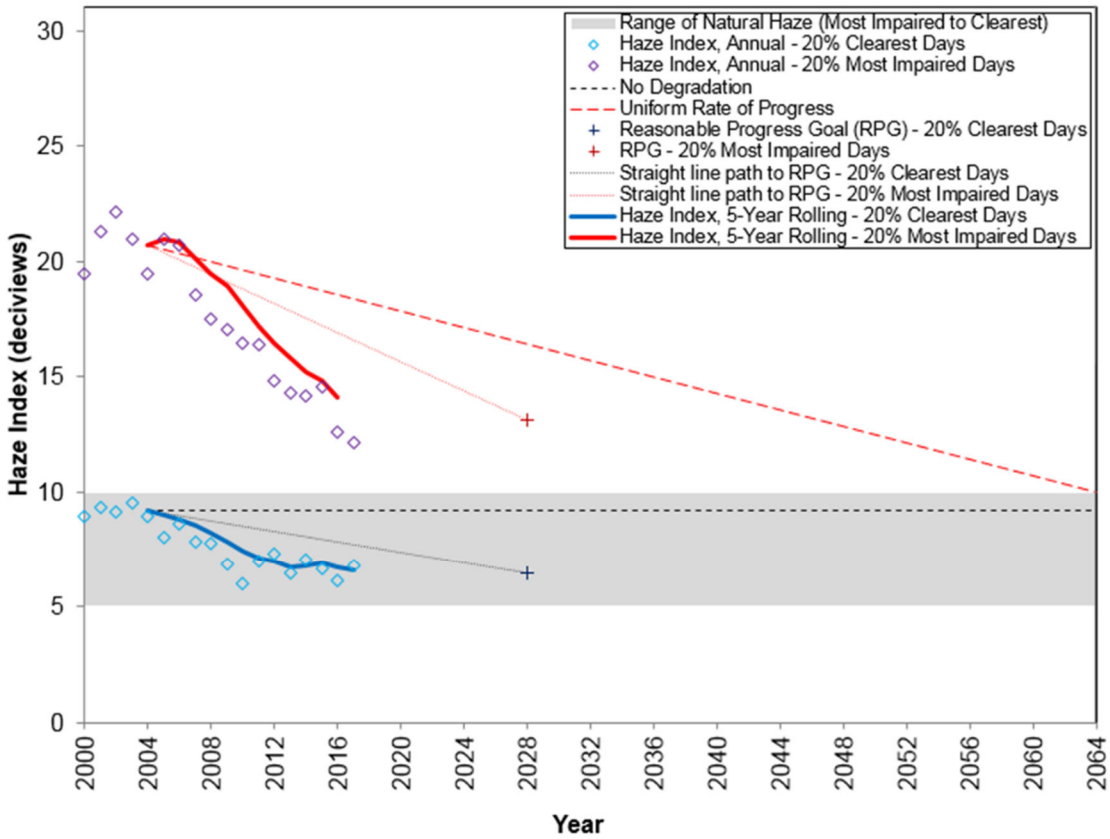


Figure 2-3. Visibility Metrics Levels at Great Gulf Wilderness Area

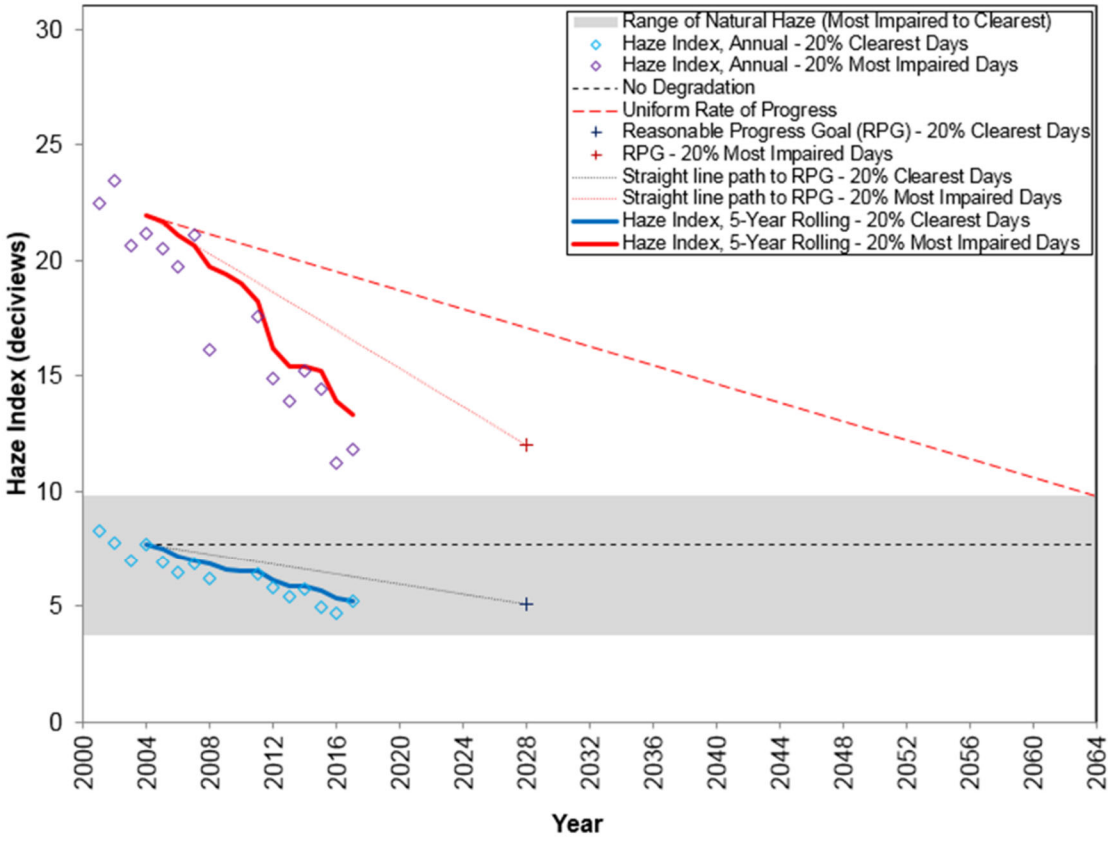


Figure 2-4. Visibility Metrics Levels at Lye Brook Wilderness Area

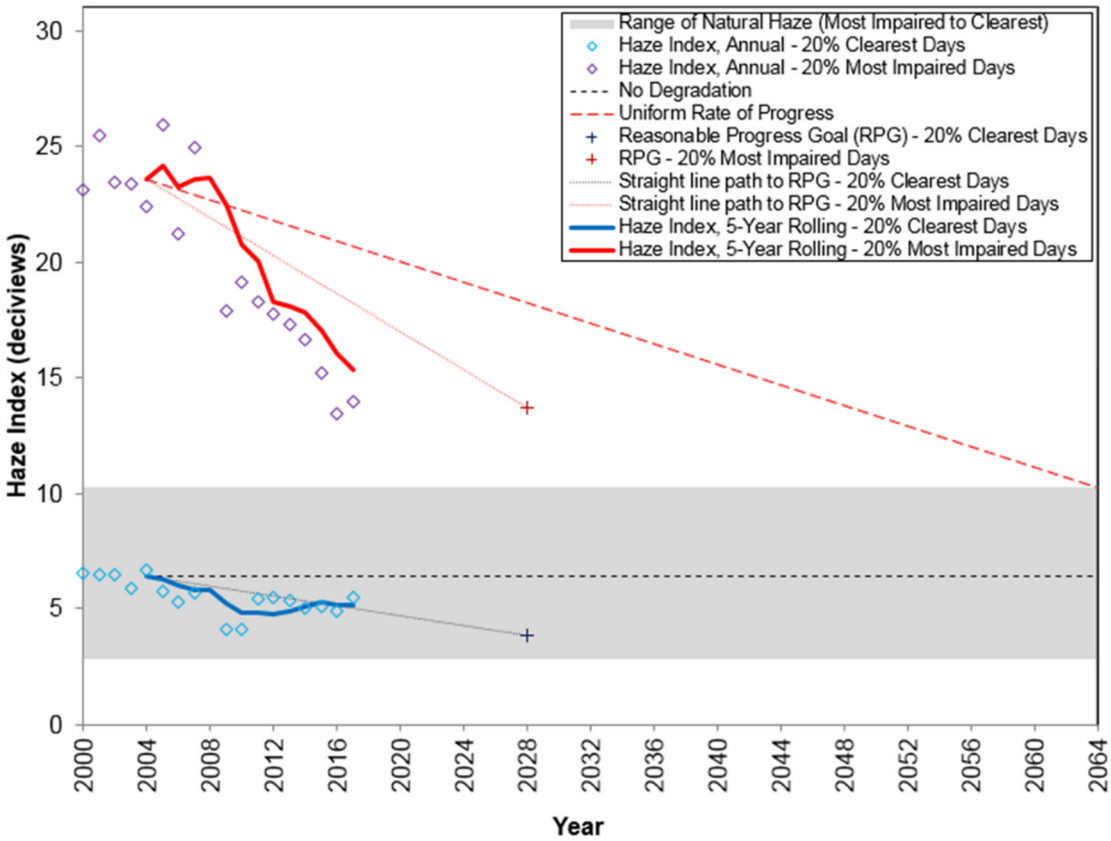


Figure 2-5. Visibility Metrics Levels at Brigantine Wilderness Area

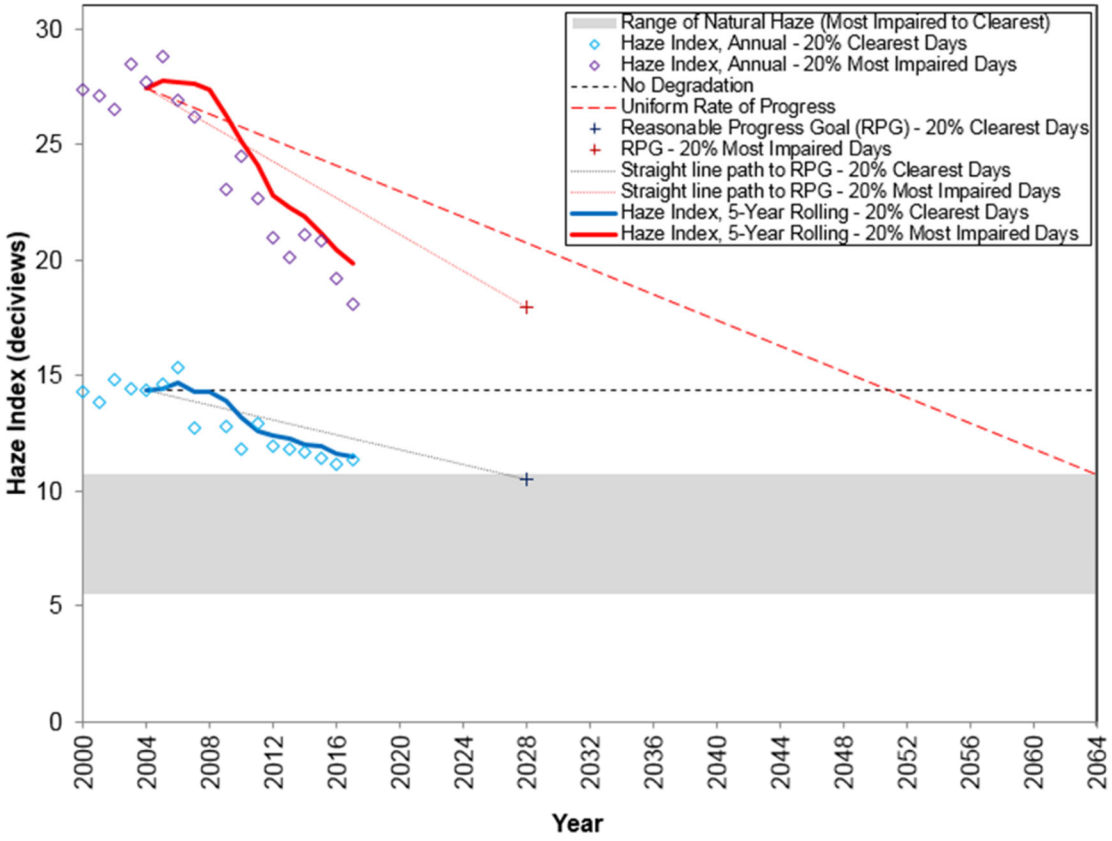


Figure 2-6. Visibility Metrics Levels at Dolly Sods Wilderness Area

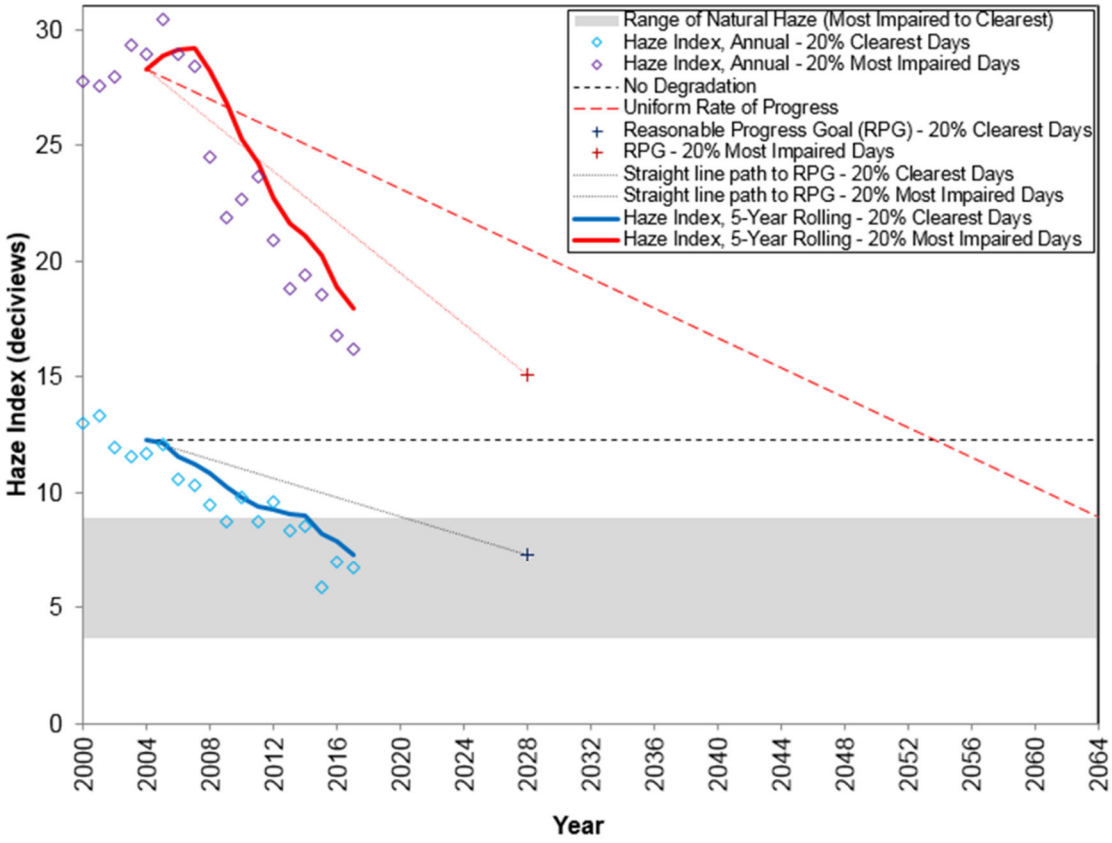


Figure 2-7. Visibility Metrics Levels at Shenandoah National Park

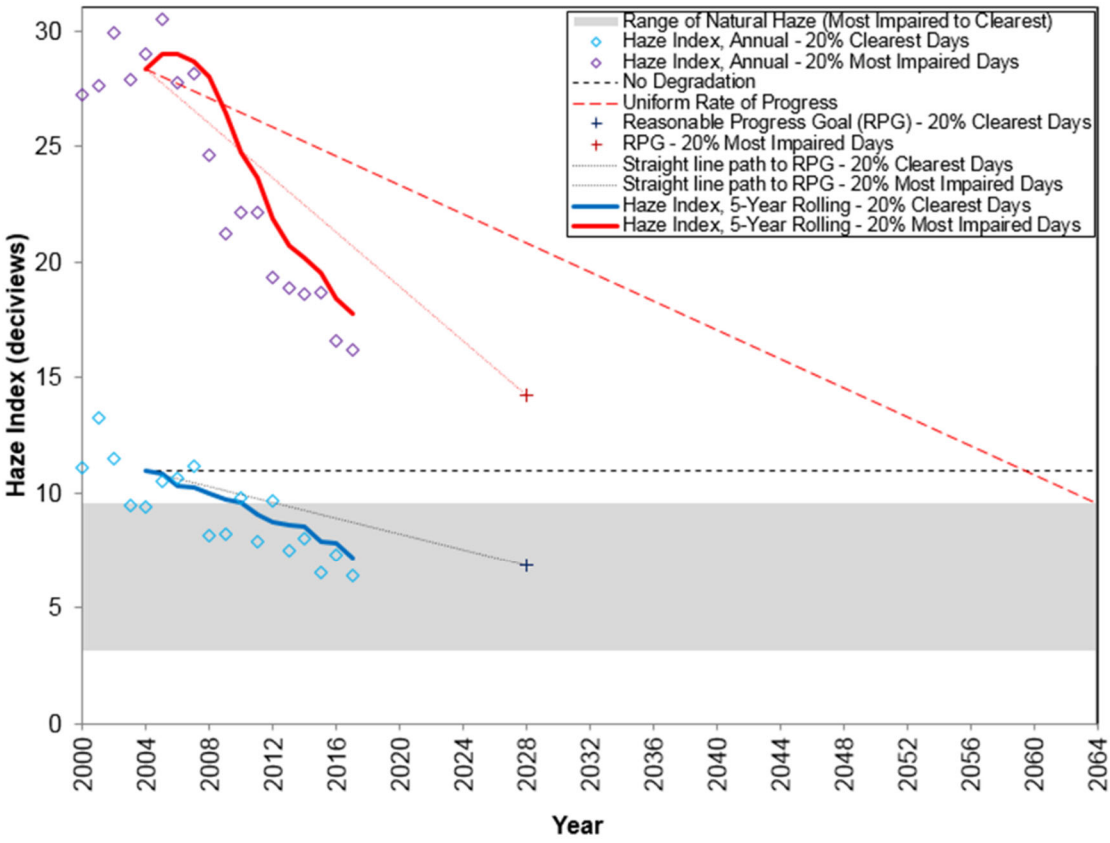
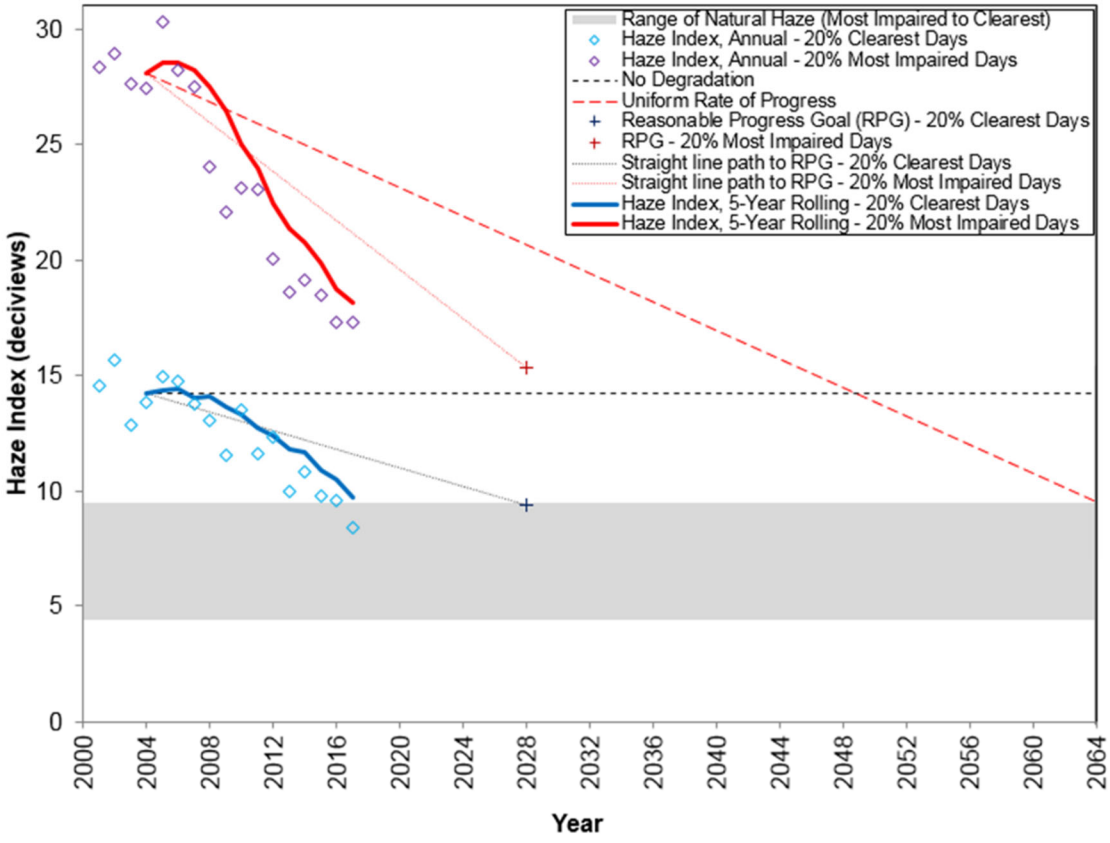


Figure 2-8. Visibility Metrics Levels at James River Face Wilderness



3. Visibility Species Light Extinction Trends

In addition to analyzing trends in overall visibility changes at IMPROVE monitoring locations in the region, data for changes in individual PM species (constituents) contributions to visibility impairment were also examined. Both natural and anthropogenic species contributions will be included in the analyses. Rayleigh, sea salt and soil species are natural components of visibility. Sulfate, nitrate, organic carbon mass, light absorbing carbon (elemental carbon) and coarse mass species in the analyses are both natural and anthropogenic components of visibility. Table B-1 through Table B-28 in Appendix B present species contributions numerically for all Class I and IMPROVE Protocol sites in and adjacent to the MANE-VU region. Note that data for individual species in Appendix B are light extinction (units = inverse megameters (Mm^{-1})).

Analyses of visibility by species helped policy decision makers determine what control strategies to consider for the second regional haze implementation planning period. The first set of analysis plots in Figure 3-1 through Figure 3-8 show 5-year baseline period vs. 5-year current period species average percent contributions for both 20 percent clearest and 20 percent most impaired days. Results clearly show a significant reduction in contributions at all Class I areas from sulfates for the 20 percent most impaired days with varying levels of increases for other species. Examples of increases include percent contribution from nitrates increasing at the Brigantine Wilderness and Lye Brook Wilderness Class I areas from 8% to 22% and from 7% to 15%, respectively.

Current and baseline 5-year average light extinction levels for the 20 percent best (see Figure 3-9(a)) and 20 percent worst (see Figure 3-9(b)) visibility days for all Class I IMPROVE sites are shown side by side. This is just another way to show reductions in the region and shows that reductions were primarily due to sulfate reductions with nitrate and OCM reductions more evident during the 20 percent best days. As was mentioned before, because more winter days are in the current 20 percent worst days mix, the relative contribution of nitrates increased from the baseline especially at the Brigantine Wilderness Class I area.

The second set of analysis plots in Figure 3-10 to Figure 3-17 show individual species relative contributions [haze index∗(species light extinction/total light extinction) (units = deciview (dv))] as stacked bar charts for sulfate, nitrate, organic carbon mass (OCM), light absorbing carbon (EC or LAC), soil, coarse mass, sea salt, and Rayleigh extinction levels on 20 percent clearest days (“a” plot) and 20 percent most impaired days (“b” plot). The total of the stacked bars represents annual Haze Index values, and are marked by circles connected by a thin black line. The thick black line represents five-year back annual averages from 2004 to 2017. Two dashed lines descend from the 2004 five-year back average (i.e., the baseline value): the red dashed line represents the URP glide path to the 2064 natural visibility goal and the black dashed line represents the glide path to the modeled 2028 RPG. These figures confirm that large reductions in overall Haze Index values on the 20 percent most impaired days are primarily due to decreases in sulfate visibility impacts at MANE-VU and other nearby Class I areas. Significant decreases in sulfate contributions started in 2007 at Maine’s Class I areas and in 2008 at all other Class I areas analyzed. As the sulfate contributions declined, relative nitrate contributions have started to increase at many sites, especially at the Brigantine Wilderness monitoring site. This increase is primarily due to having more winter days in the 20 percent most impaired days mix (MANE-VU 2016) during recent years. During the winter, relative nitrate contributions are much higher than during the

summer (more discussion of winter nitrates is located at the end of this section). Steady decreases in sulfate and nitrate contributions have reduced overall haze levels on the least impaired days. These decreases on the least impaired days started to occur after 2004 at most of the studied areas. Sulfate remains the most significant contributor to light extinction at all Class I areas on the most impaired days in and adjacent to the MANE-VU region, followed by nitrate and OCM. For the most part, light extinction from soil and sea salt, which help indicate the extent to which natural haze processes contribute to overall haze levels, are insignificant when compared to extinction from sulfate and nitrate. Based on these figures, continued progress in sulfate and nitrate levels appears to be driving the trend in overall improvement in 20 percent most impaired days and 20 percent clearest days haze level reductions.

To examine the individual species trends more closely, the range of individual light extinction on 20 percent clearest days and 20 percent most impaired days from 2000 through 2017 at the Class I areas were plotted against the estimated light extinction under natural conditions in the third set of analysis plots. See Table 2-2 for 20% clearest days natural extinction levels and Table 2-4 for 20% most impaired days routine and episodic natural extinction levels). Figure 3-18 through Figure 3-25 show the range of light extinction levels at MANE-VU and nearby Class I areas as compared to natural light extinction for selected species. IMPROVE Protocol sites are excluded from this analysis for simplicity and light extinction from soil and sea salt are excluded from this analysis as those contributions are small and are primarily natural. Estimated natural light extinction is represented in each chart by a purple line for 20 percent most impaired days and by a red line for 20 percent clearest days. For the carbonaceous species, OCM and LAC, the green band is observed OCM and the dark grey band is observed LAC. Note that the observations do not represent the range of the highest and lowest 20 percent light extinction levels for those species; rather, they represent the range of species light extinction levels on the 20 percent clearest and 20 percent most impaired visibility days.

It is clear from these charts that levels of extinction from sulfate have dropped significantly since the baseline period at all Class I areas, although remaining at levels much higher than the estimated natural range at all sites. Extinction due to nitrate is closer to natural levels than sulfates and is approaching natural levels on the clearest days, however, the range of nitrate extinction has expanded in recent years with the highest levels at southern Class I areas greater than the baseline period. At the Brigantine Wilderness Class I Area, extinction due to nitrate remains considerably higher than the natural baseline. At most Class I areas, levels of extinction due to carbonaceous species and coarse mass appear to be near or slightly above natural range levels. Prior peaks in carbonaceous matter extinction at most sites were driven by OCM levels. Carbonaceous matter at the Brigantine Wilderness Class I Area has started to decrease more into the natural range during 2016 and 2017, but coarse mass light extinction levels remain above natural levels at that site.

The fourth set of analysis plots in Figure 3-26 for New England Class I areas and Figure 3-27 for other Class I areas show the mix of 20 percent most impaired days by season. Results clearly show that summer days no longer dominate the mix at all Class I areas. For many of the Class I areas there are now more winter days in the mix than in any other season. That trend is more evident at New Jersey, Virginia and West Virginia Class I areas. This helps to explain why nitrate extinction percent contributions are increasing and is consistent with the seasonality of nitrogen oxides (NO_x) emissions as shown in the Figure 3-28 monitoring data trends plot for sites located in or close to large cities (Boston, Philadelphia and Baltimore) in the region.

BASELINE AND CURRENT VISIBILITY SPECIES TRENDS PLOTS

Figure 3-1. Acadia National Park Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

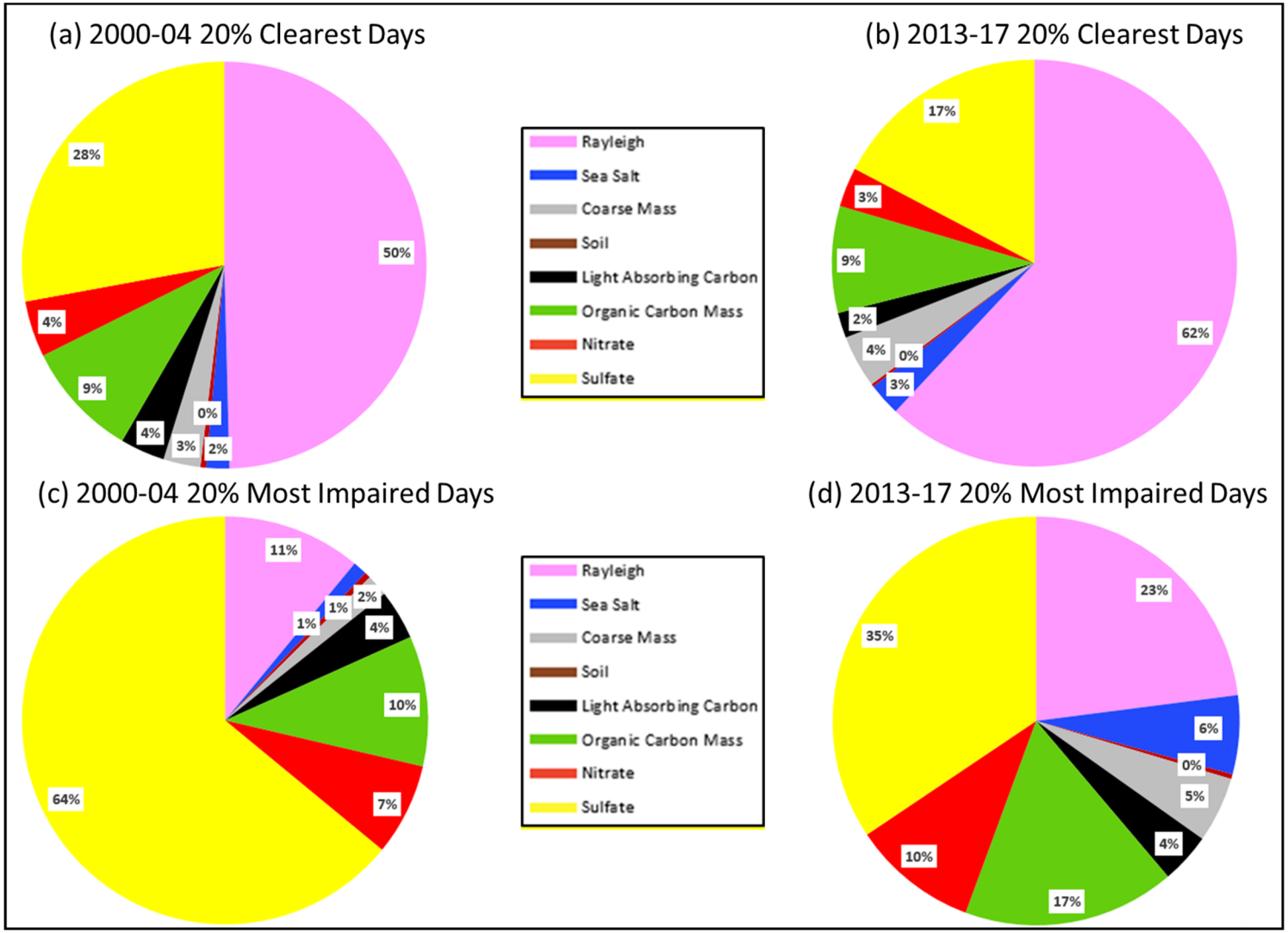


Figure 3-2. Moosehorn Wilderness Area Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

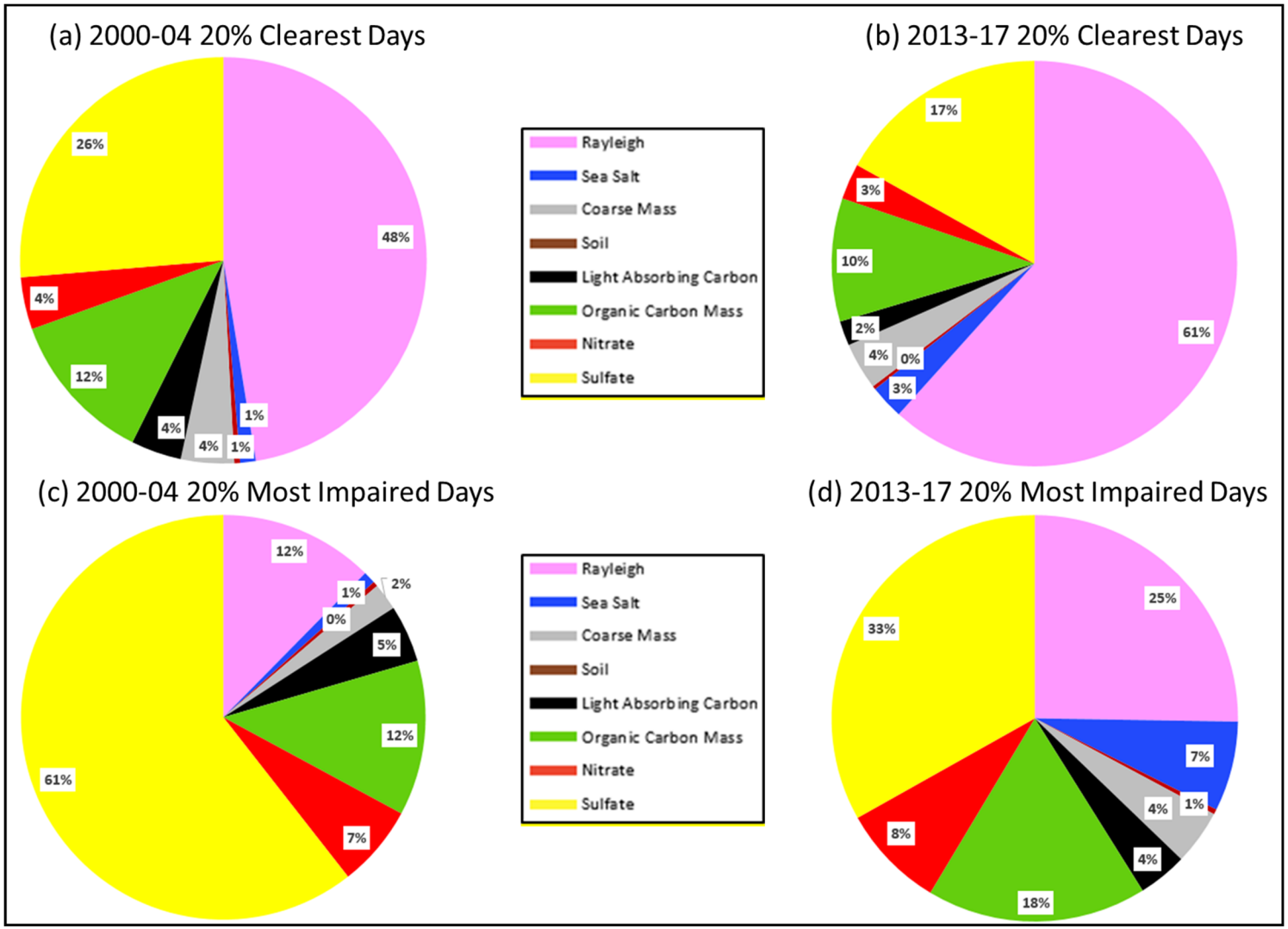


Figure 3-3. Great Gulf Wilderness Area Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

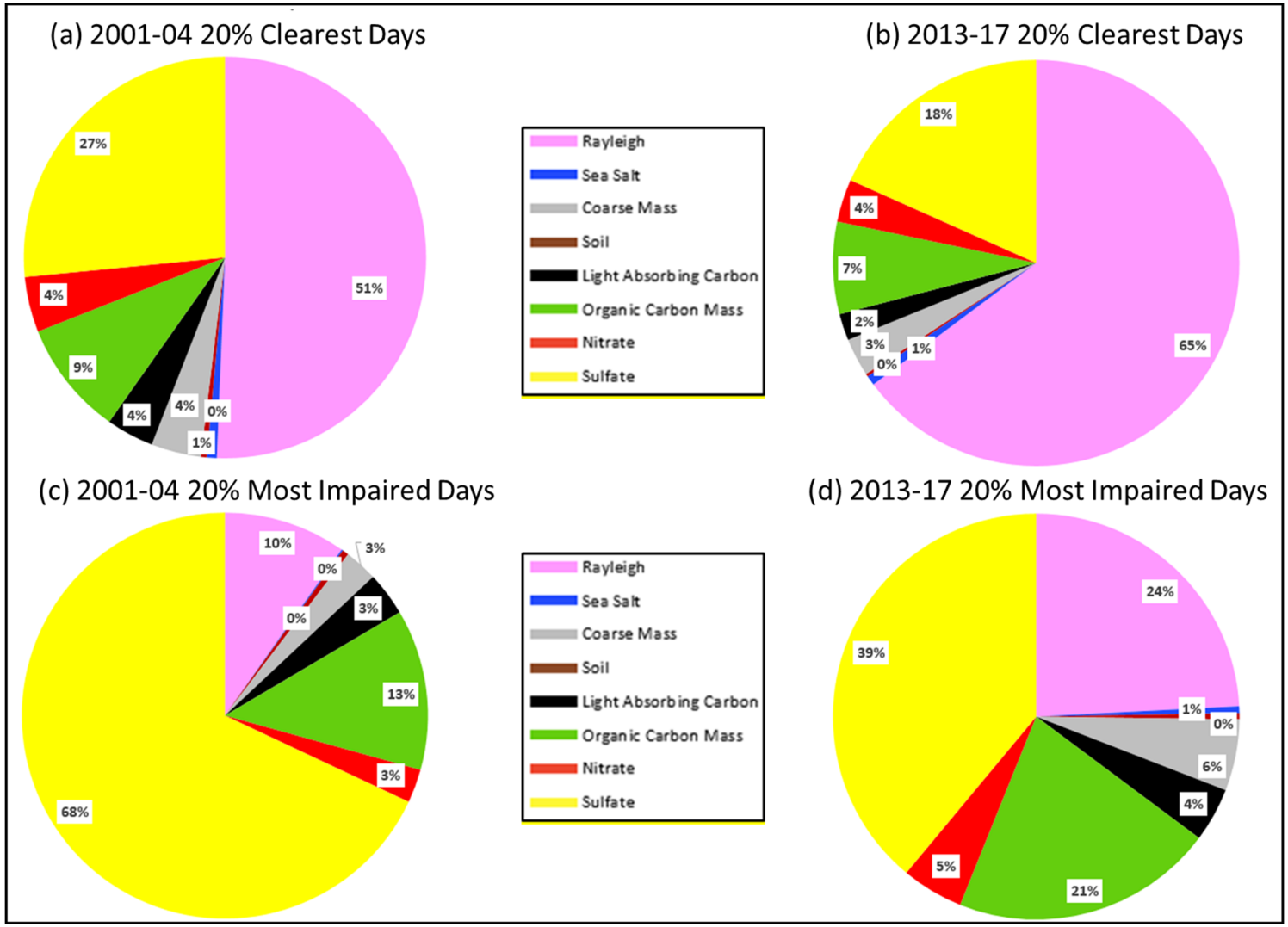


Figure 3-4. Lye Brook Wilderness Area Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

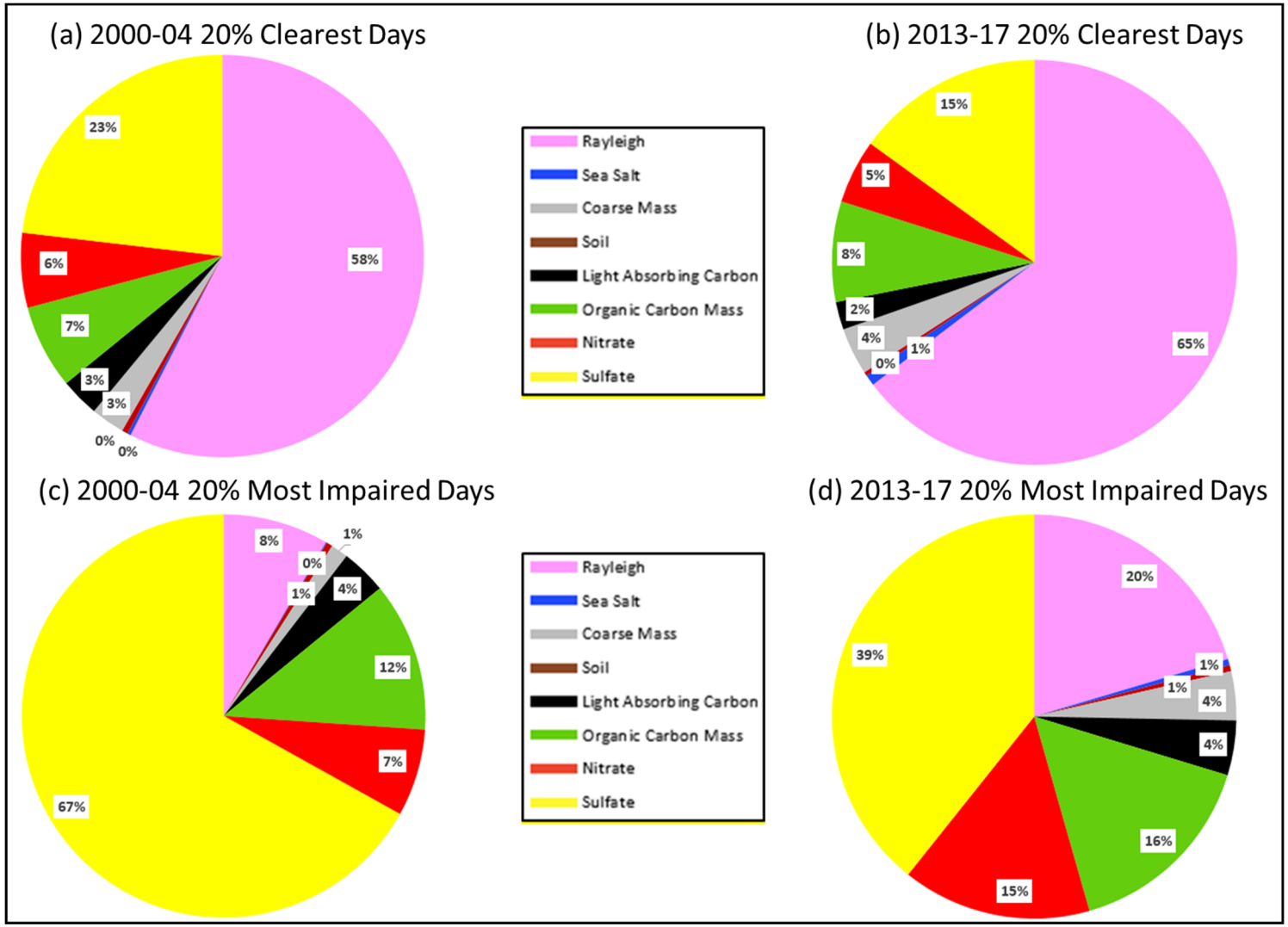


Figure 3-5. Brigantine Wilderness Area Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

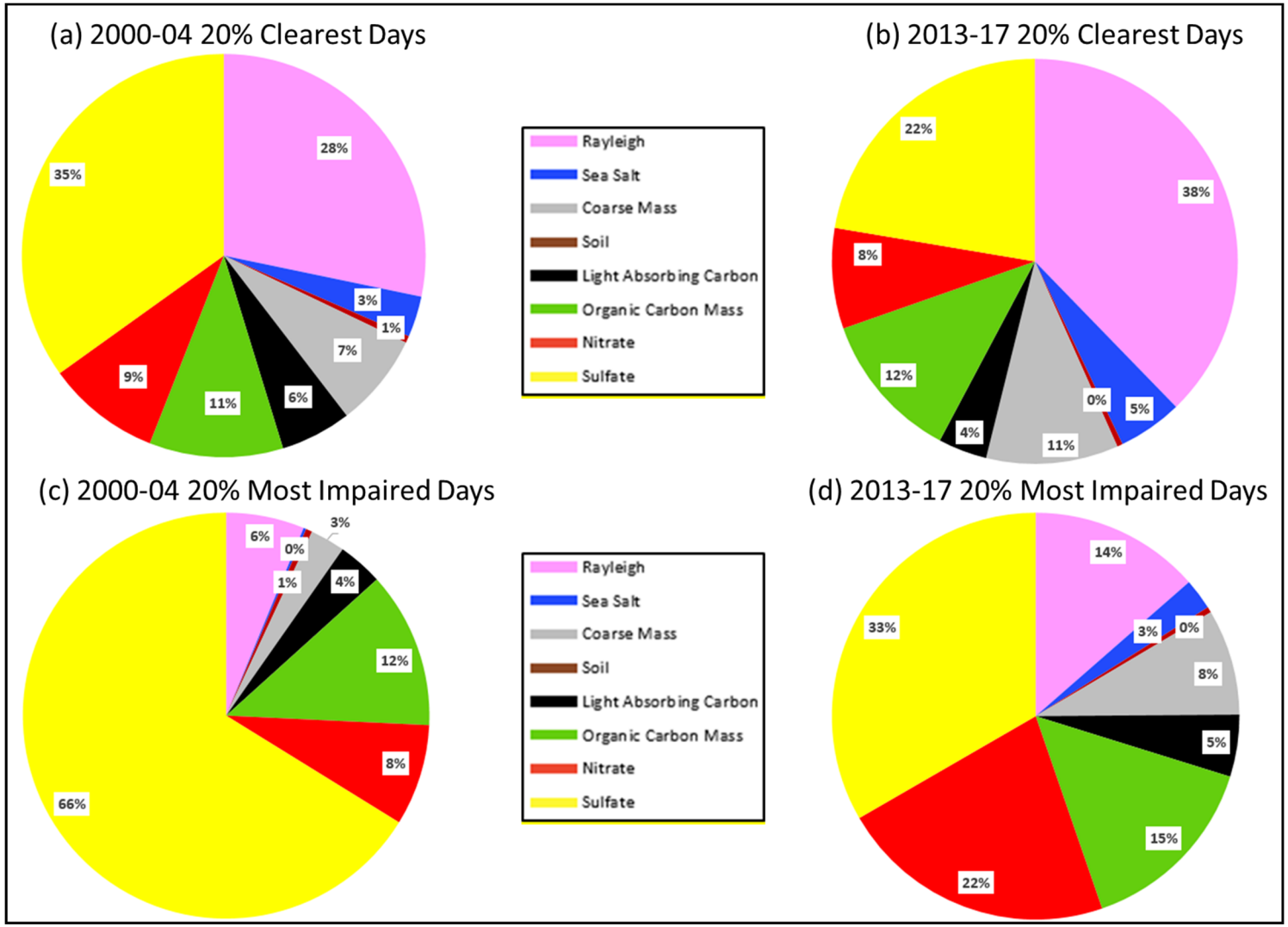


Figure 3-6. Dolly Sods Wilderness Area Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

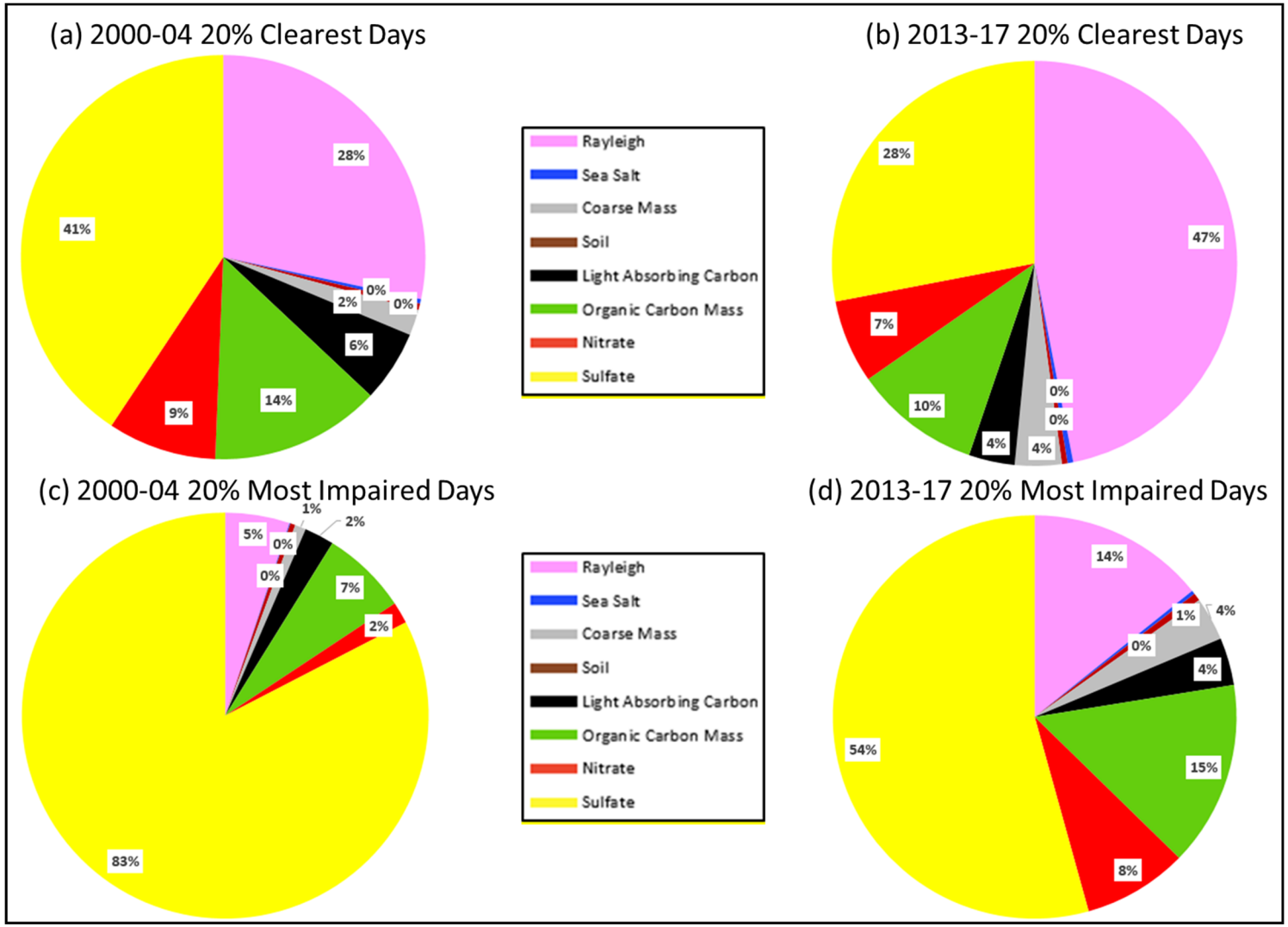


Figure 3-7. Shenandoah National Park Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

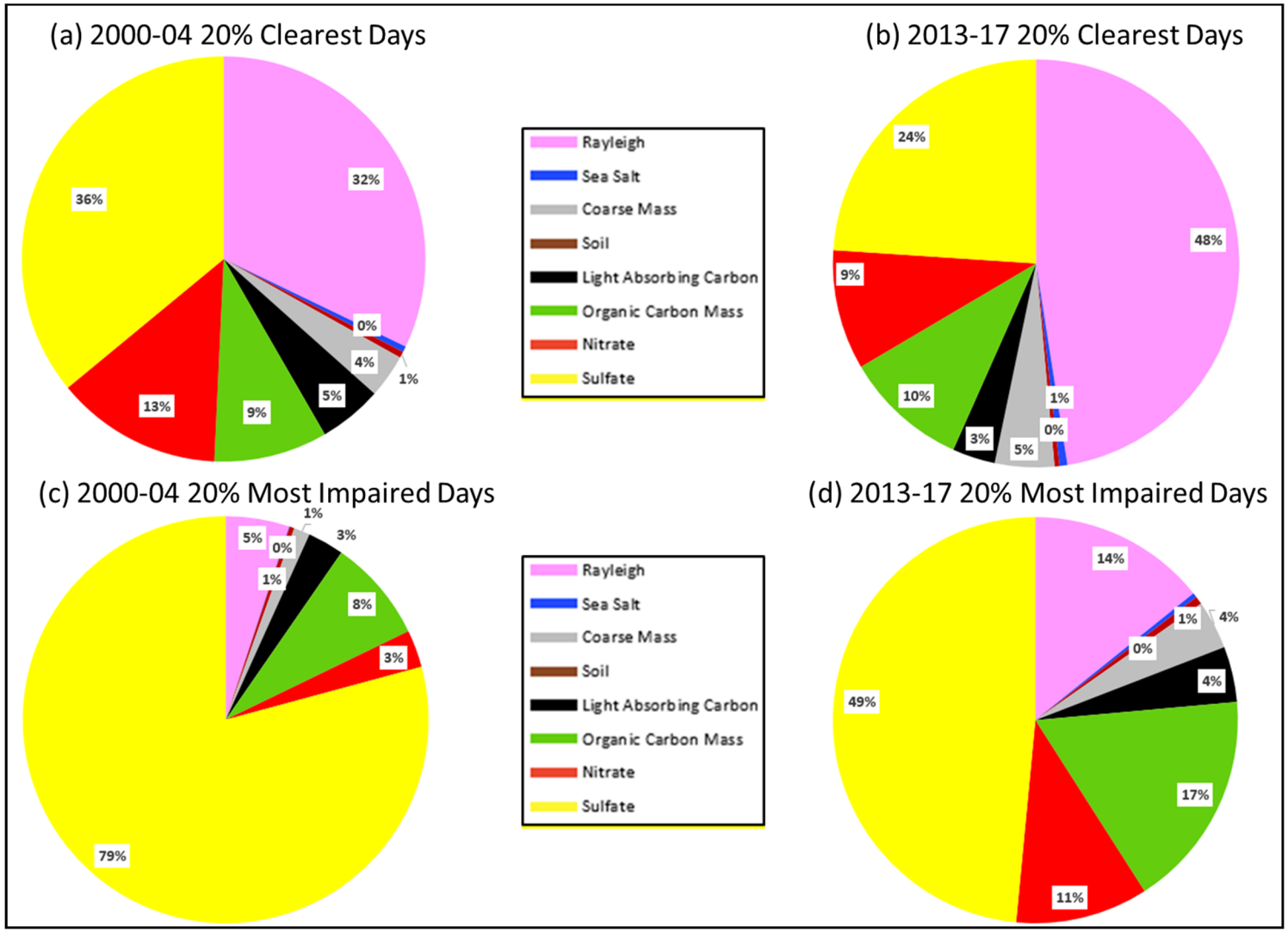


Figure 3-8. James River Face Wilderness Area Species Percent Contribution to Baseline (2000-04) and Current (2013-17) Haze Index Levels

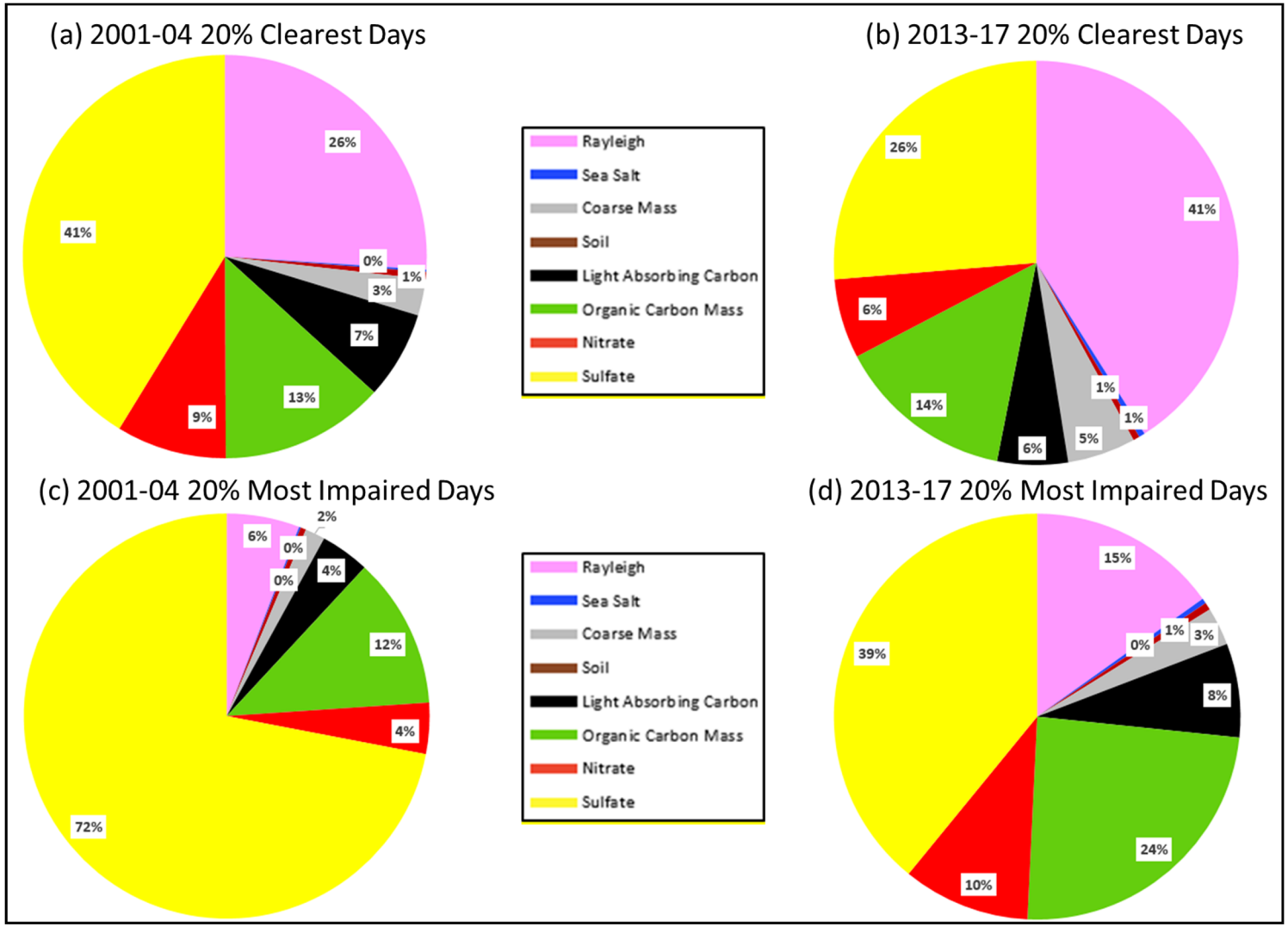
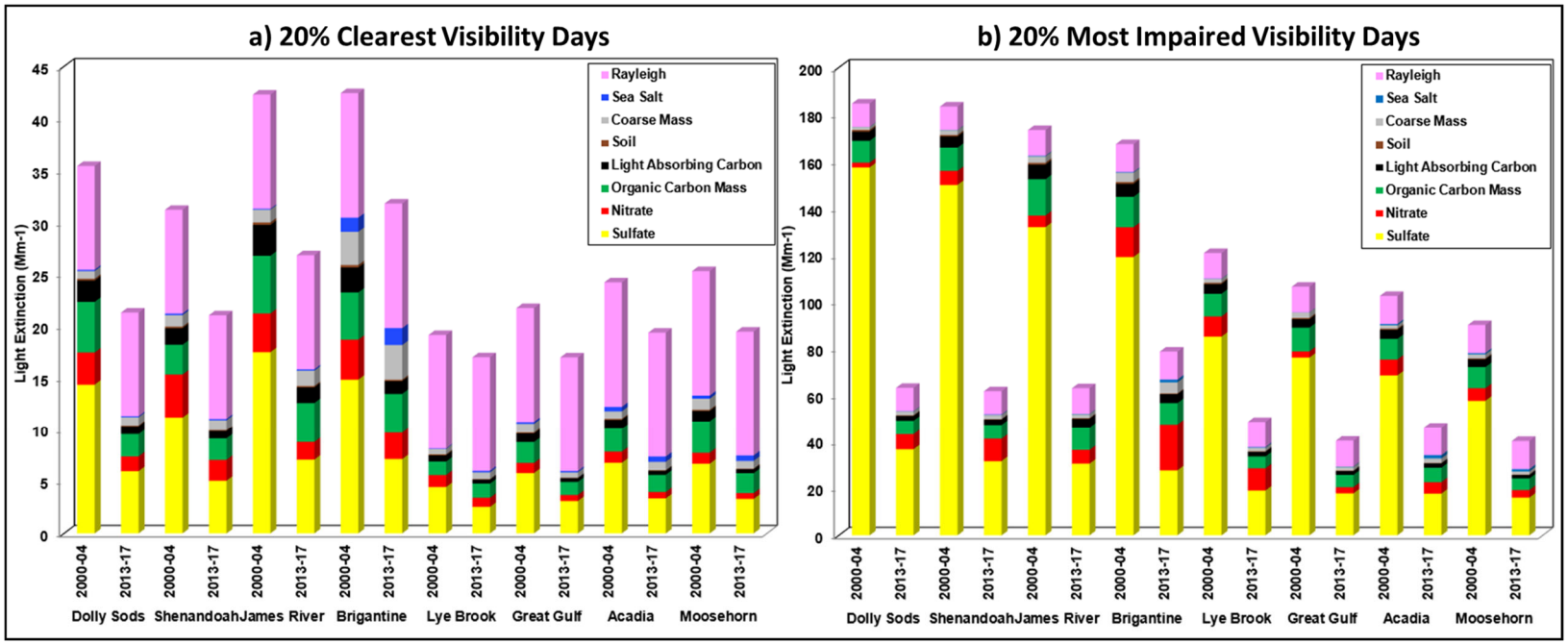


Figure 3-9. Current and Baseline 5-Year Average Light Extinction at Class I Sites on 20 Percent Clearest and 20 Percent Most Impaired Visibility Days



ANNUAL VISIBILITY SPECIES TRENDS PLOTS

Figure 3-10. Individual Species Contribution to Annual Haze Index Levels at Acadia National Park on 20 Percent Clearest and Most Impaired Visibility Days

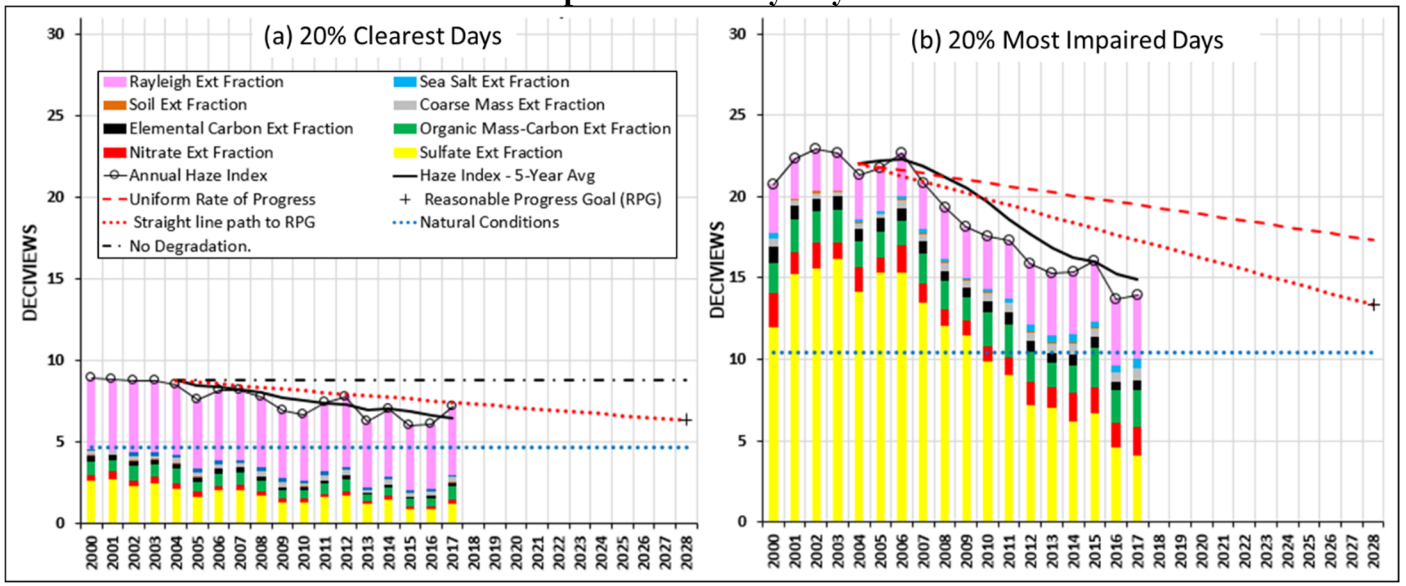


Figure 3-11. Individual Species Contribution to Annual Haze Index Levels at Moosehorn Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days

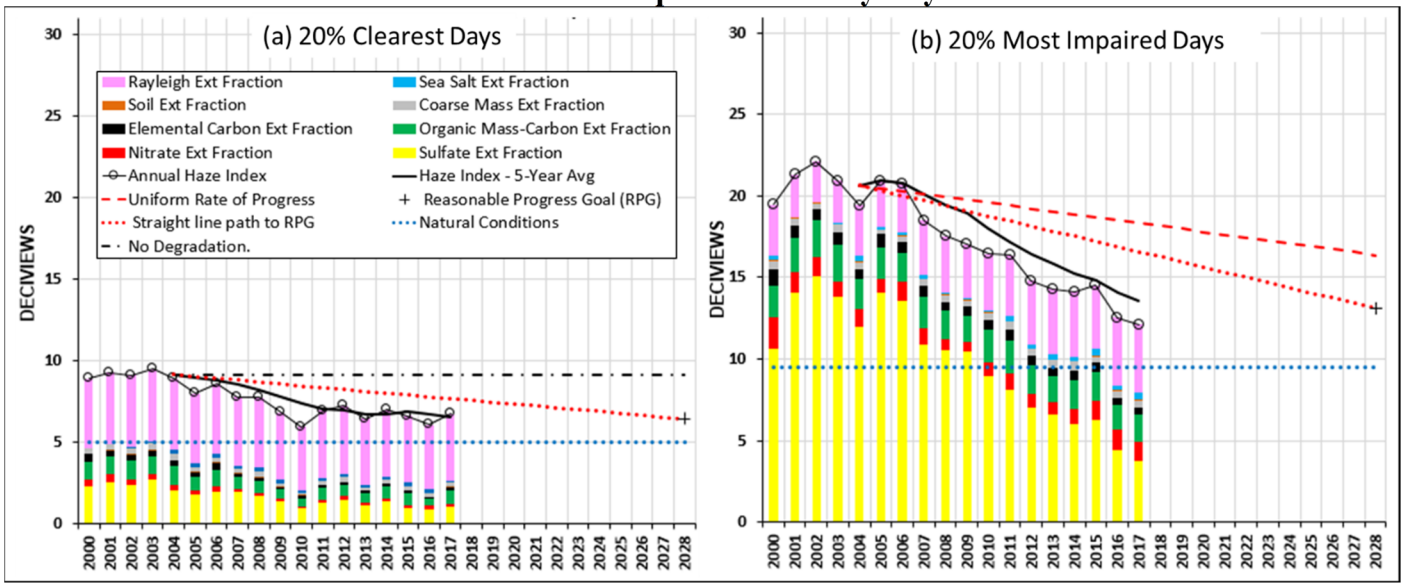


Figure 3-12. Individual Species Contribution to Annual Haze Index Levels at Great Gulf Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days

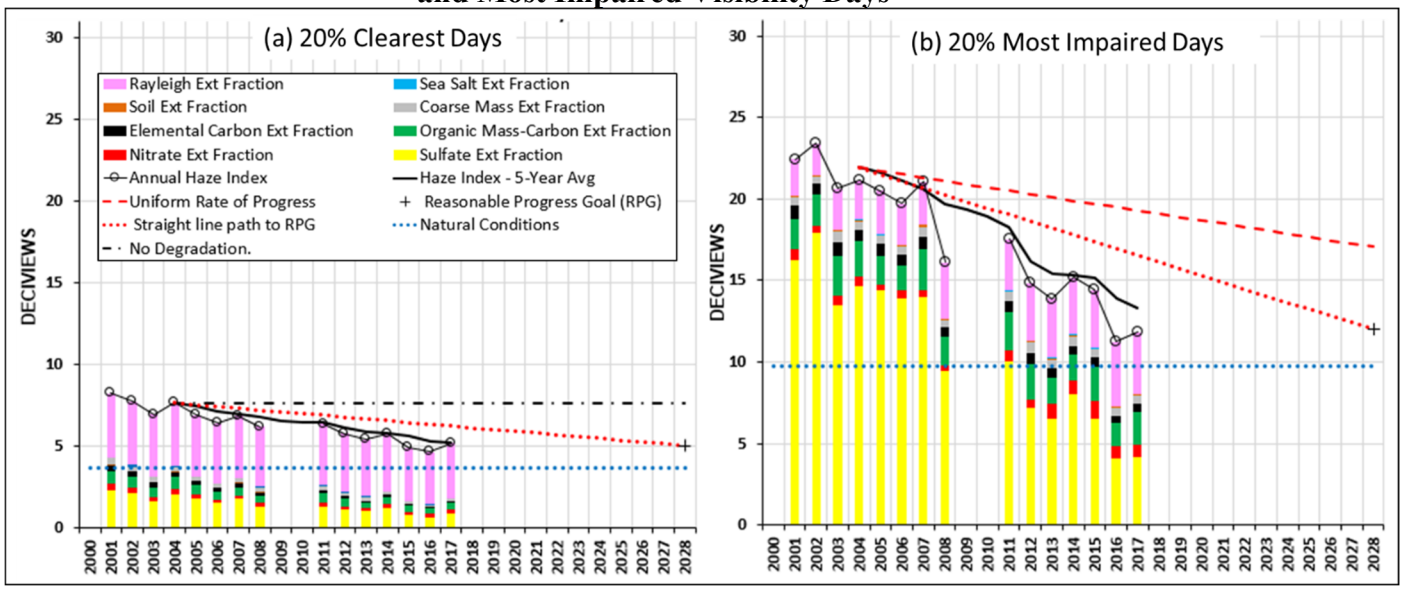


Figure 3-13. Individual Species Contribution to Annual Haze Index Levels at Lye Brook Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days

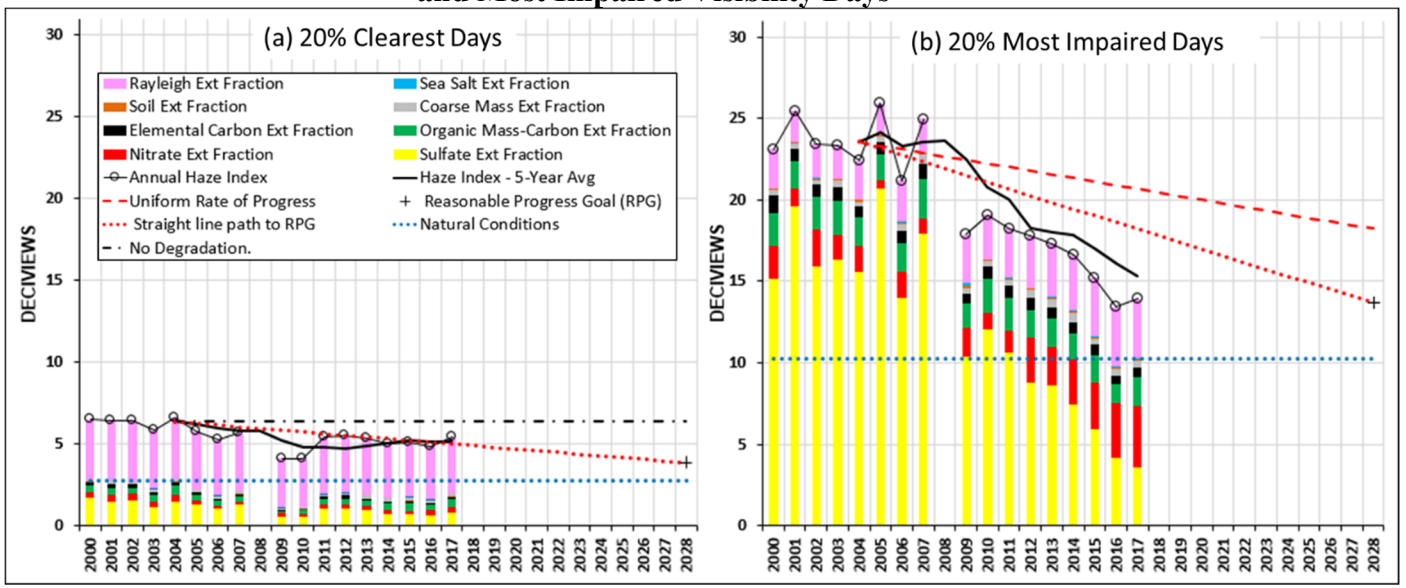


Figure 3-14. Individual Species Contribution to Annual Haze Index Levels at Brigantine Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days

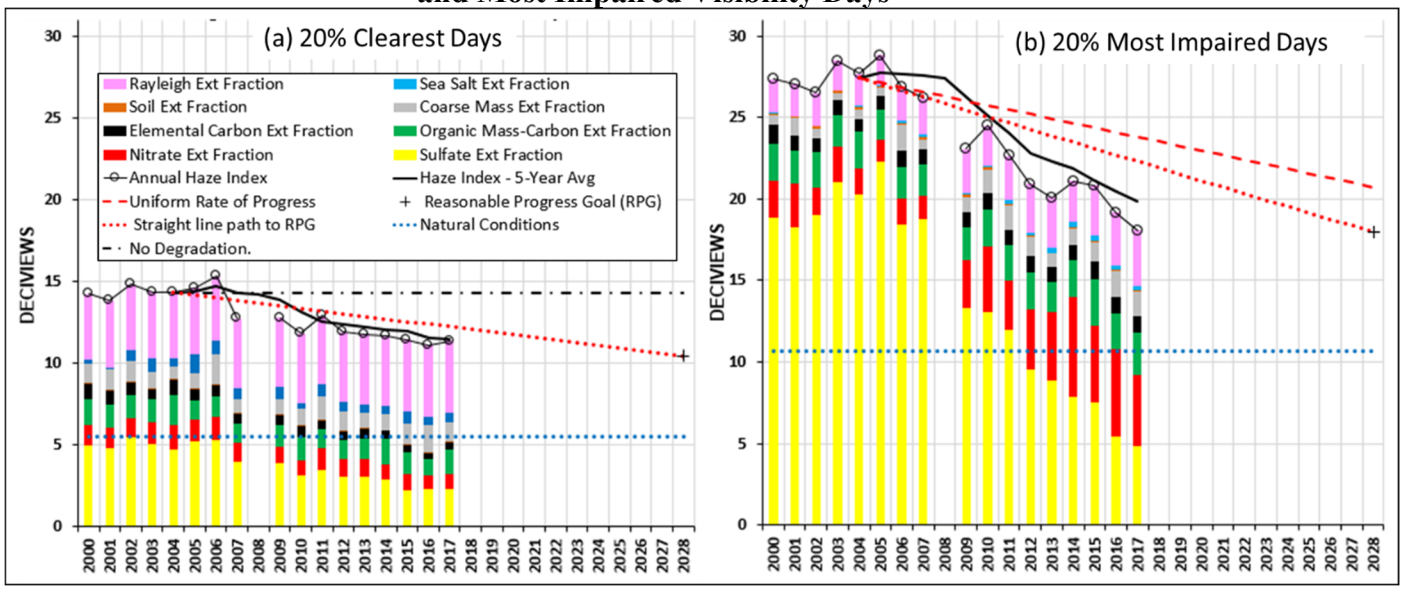


Figure 3-15. Individual Species Contribution to Annual Haze Index Levels at Dolly Sods Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days

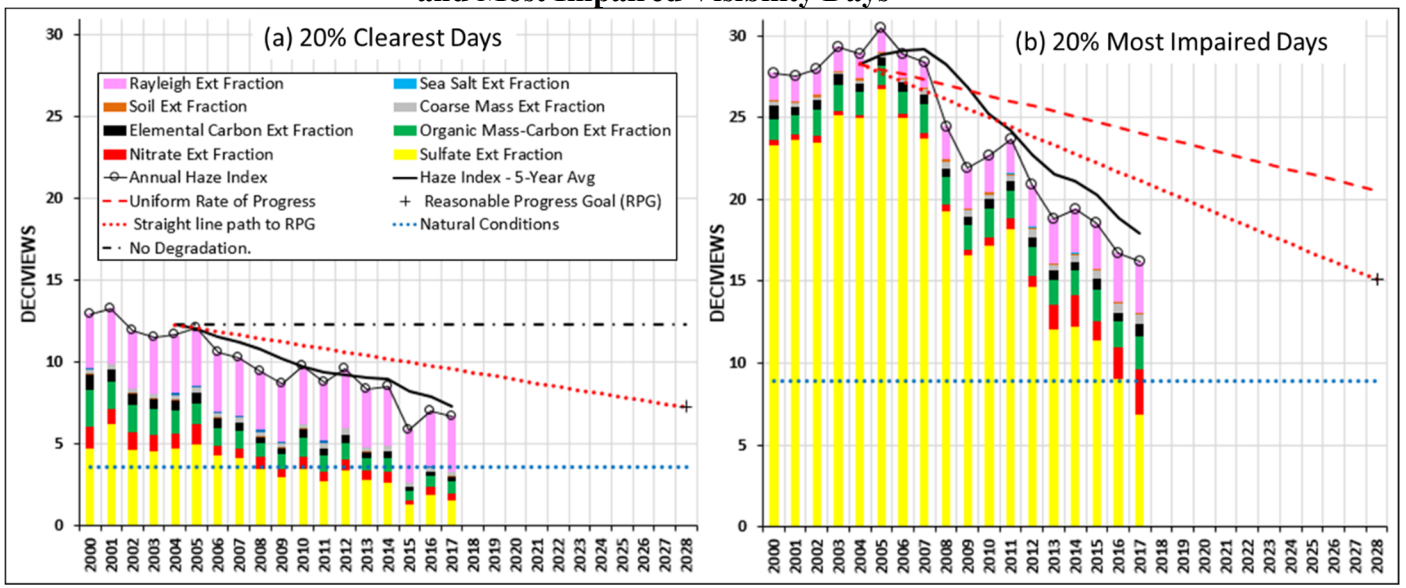


Figure 3-16. Individual Species Contribution to Annual Haze Index Levels at Shenandoah National Park on 20 Percent Clearest and Most Impaired Visibility Days

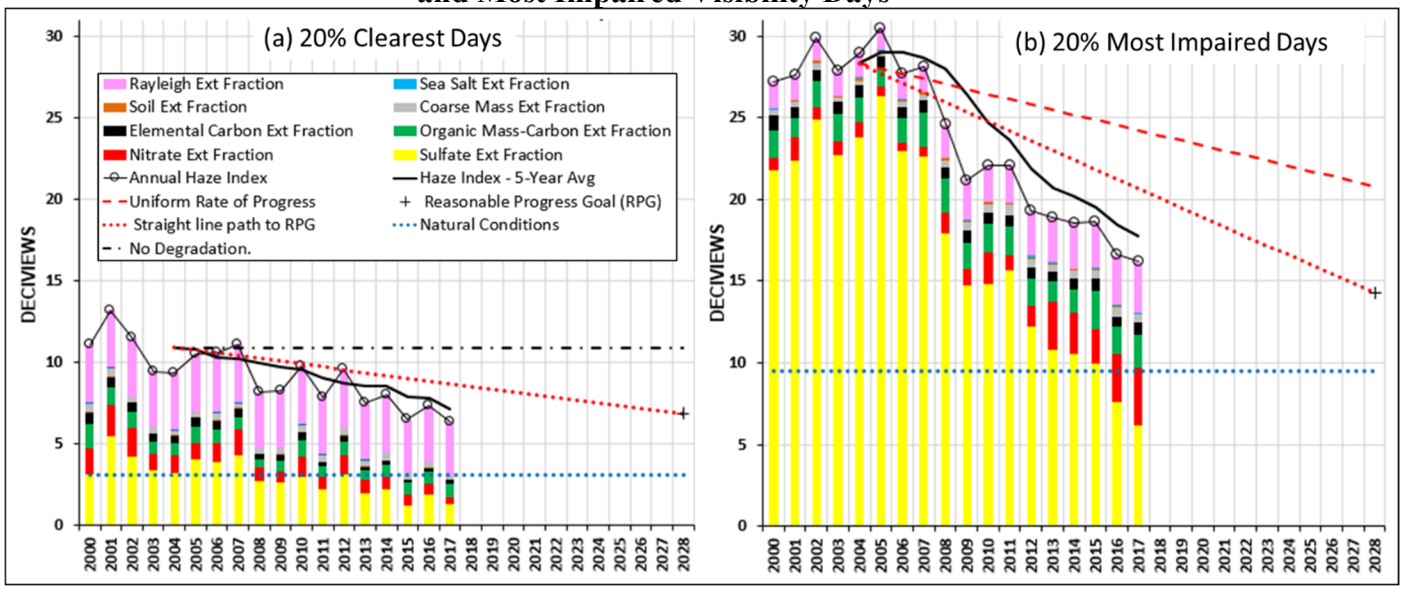
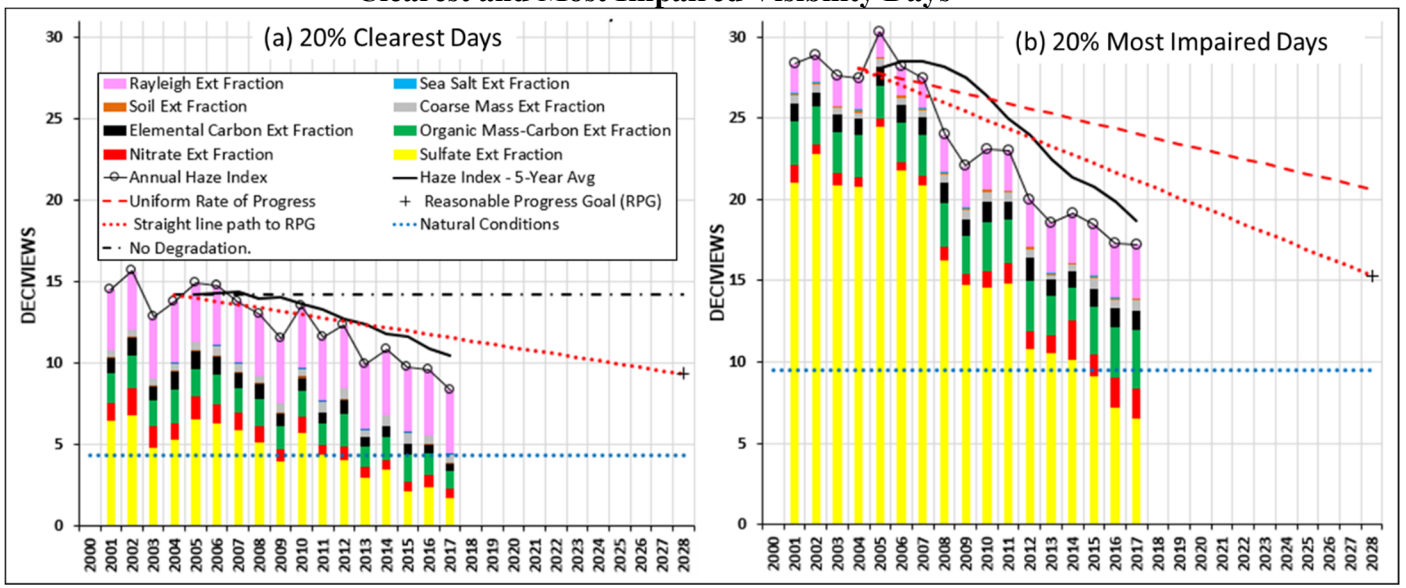
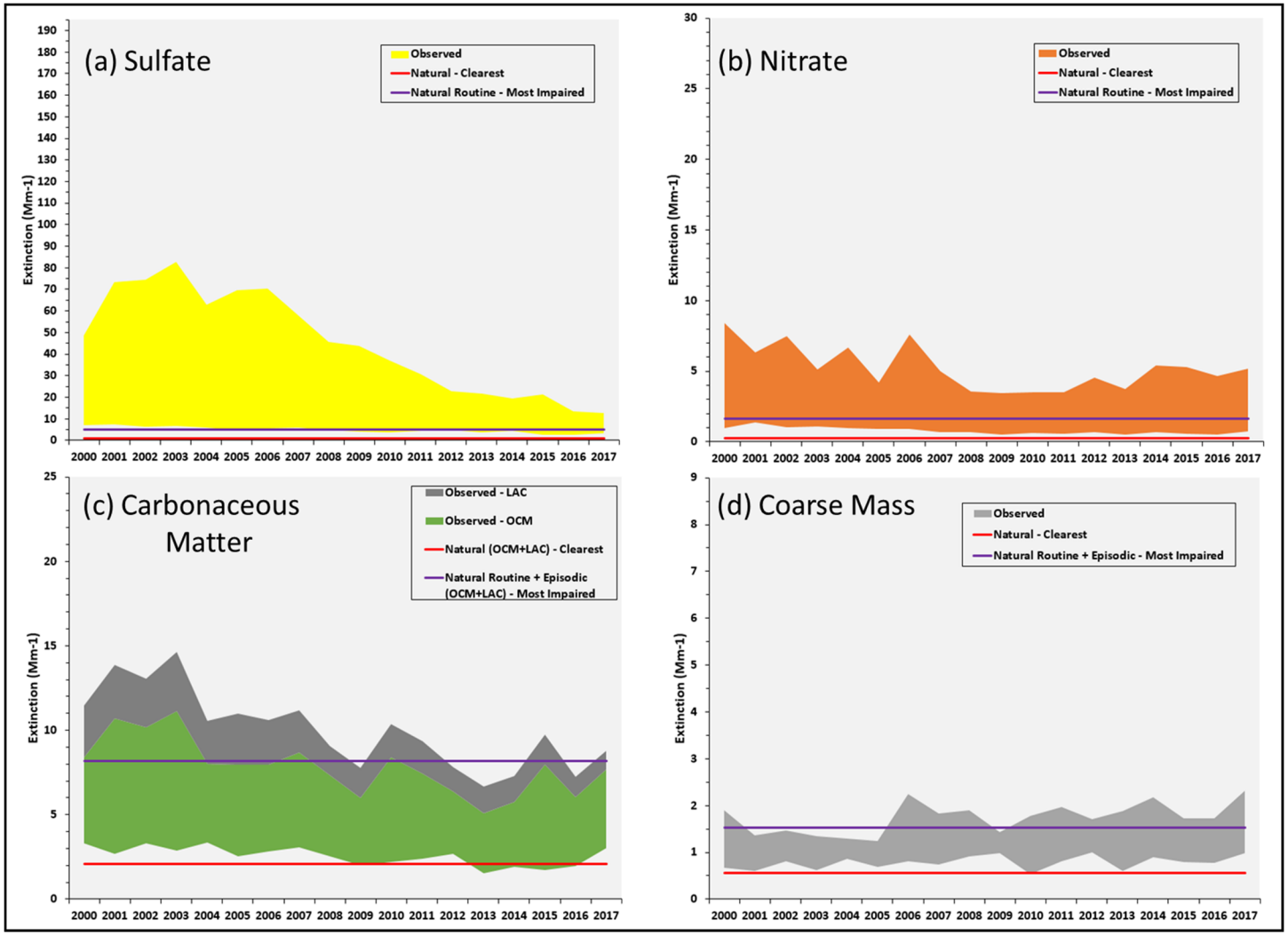


Figure 3-17. Individual Species Contribution to Annual Haze Index Levels at James River Face Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days



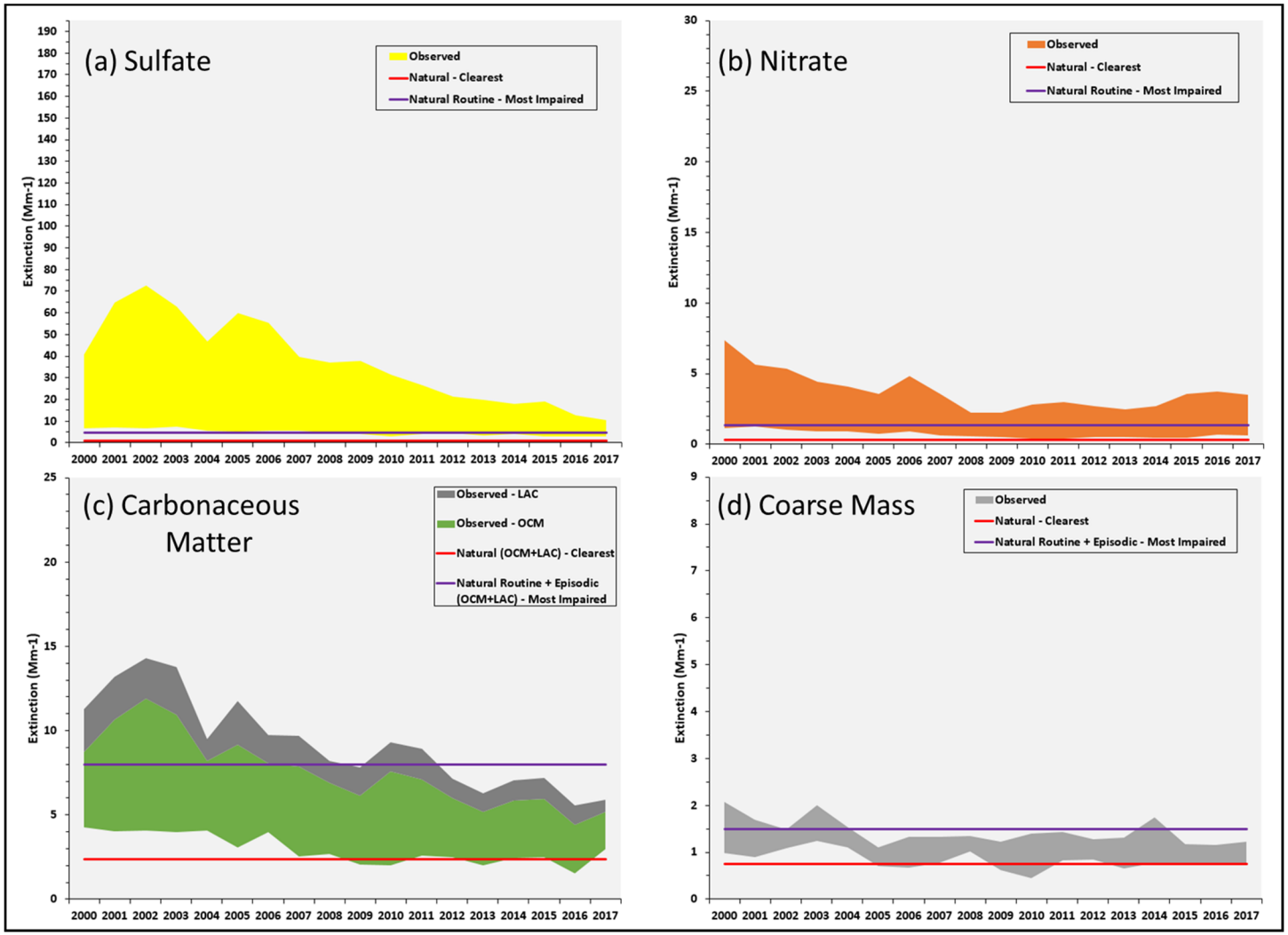
RANGE OF OBSERVED VISIBILITY SPECIES TRENDS PLOTS

Figure 3-18. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at Acadia National Park on 20 Percent Clearest and Most Impaired Visibility Days



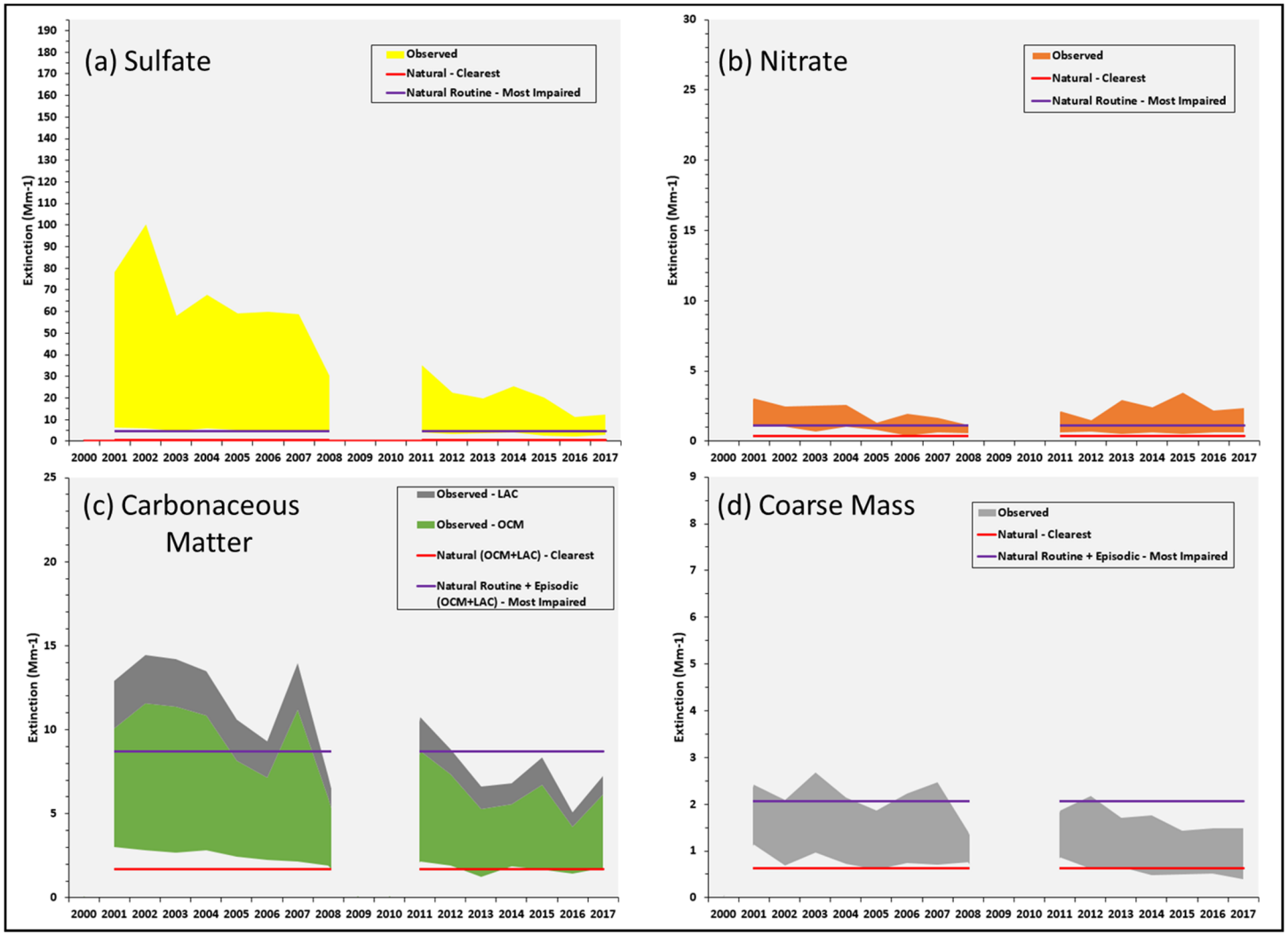
Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

Figure 3-19. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at Moosehorn Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days



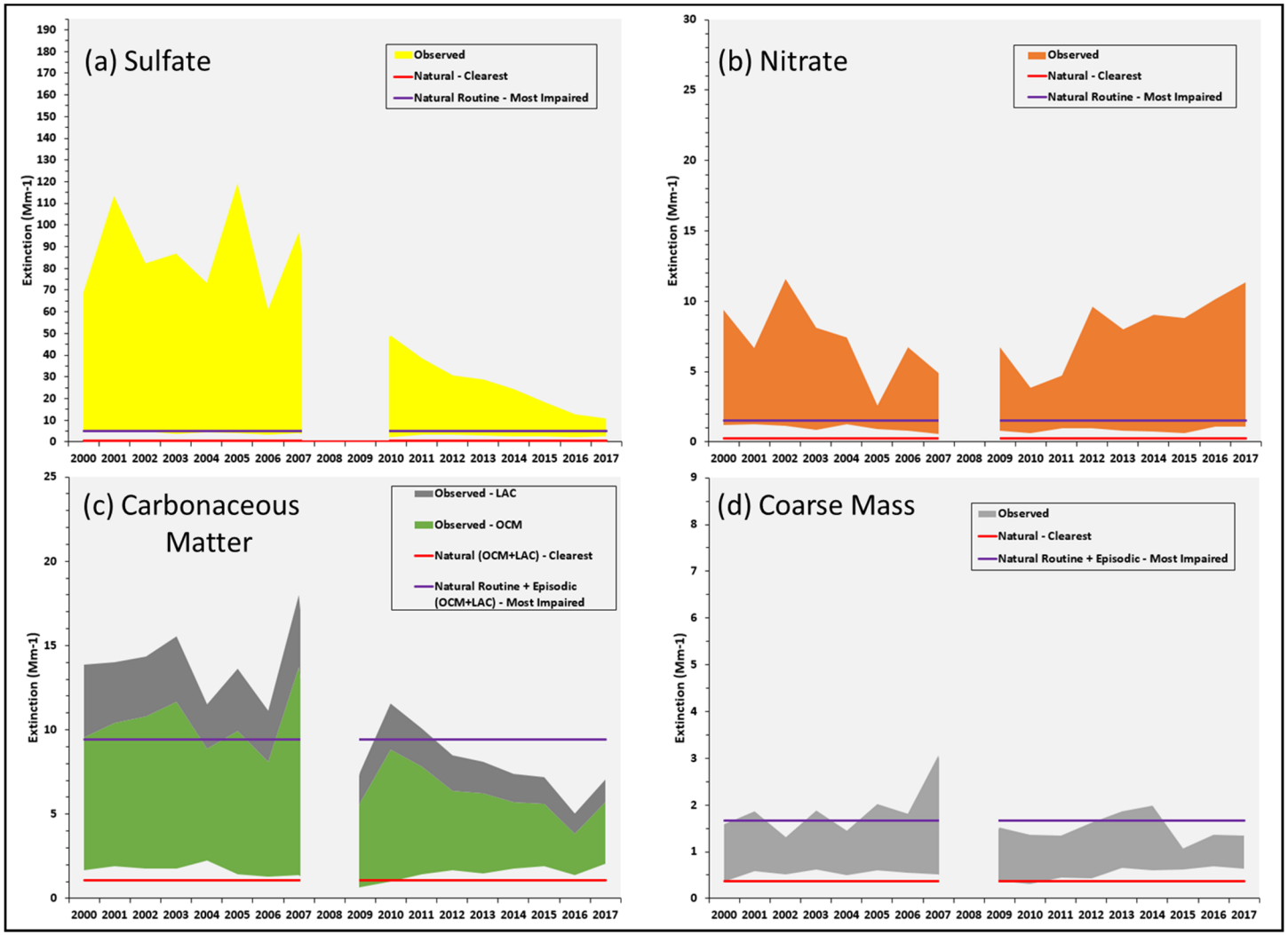
Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

Figure 3-20. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at Great Gulf Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days



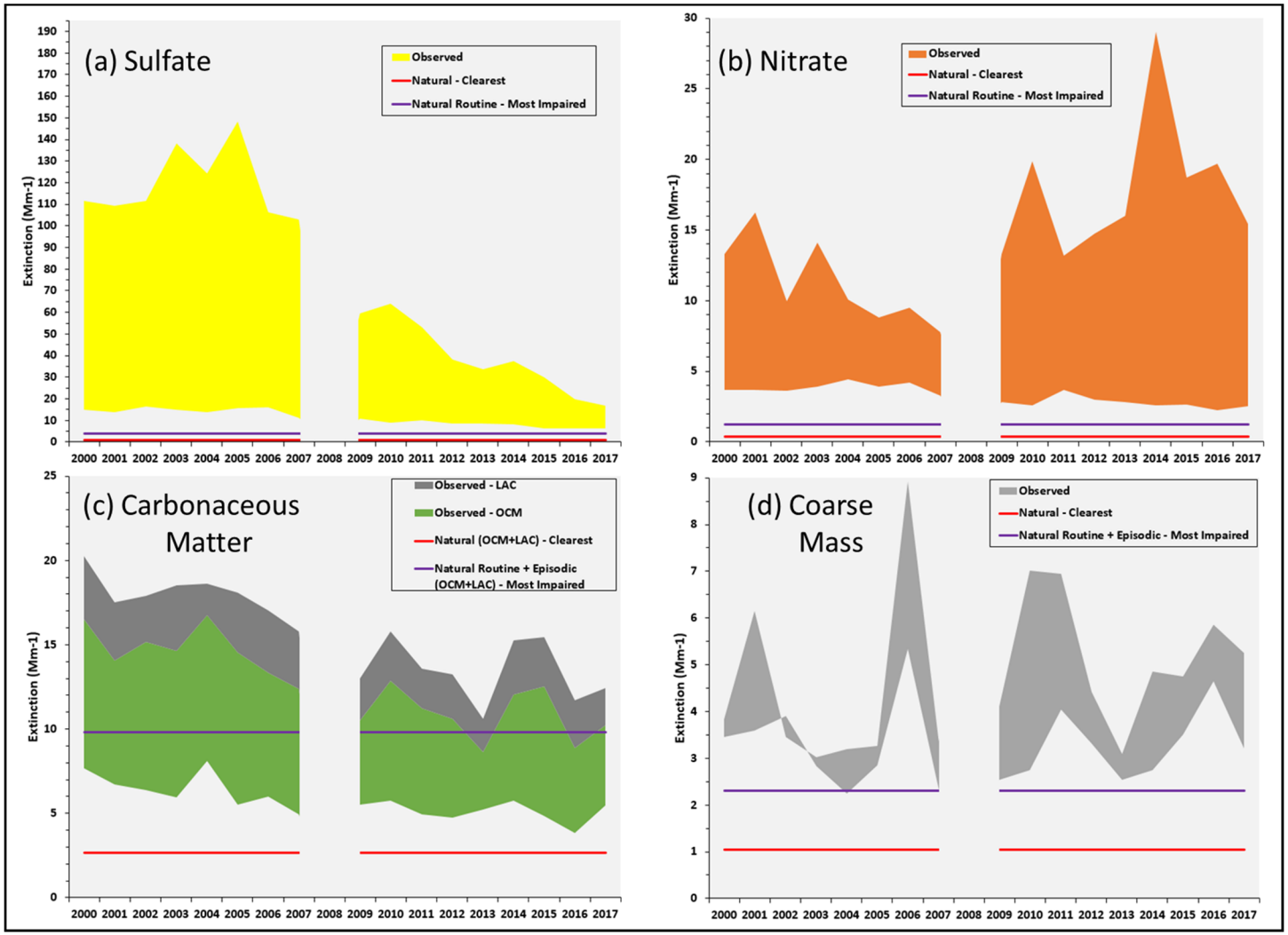
Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

Figure 3-21. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at Lye Brook Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days



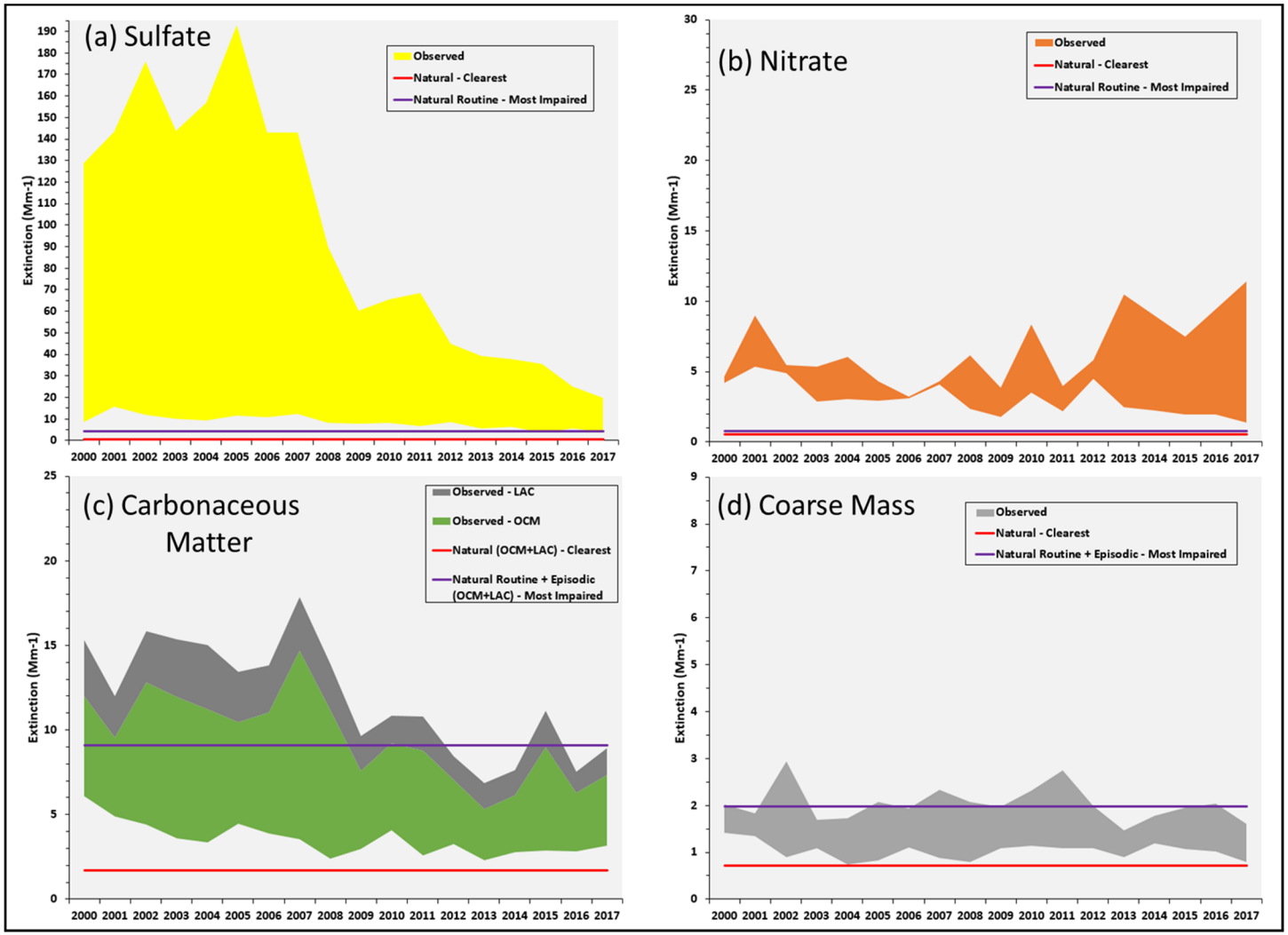
Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

Figure 3-22. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at Brigantine Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days



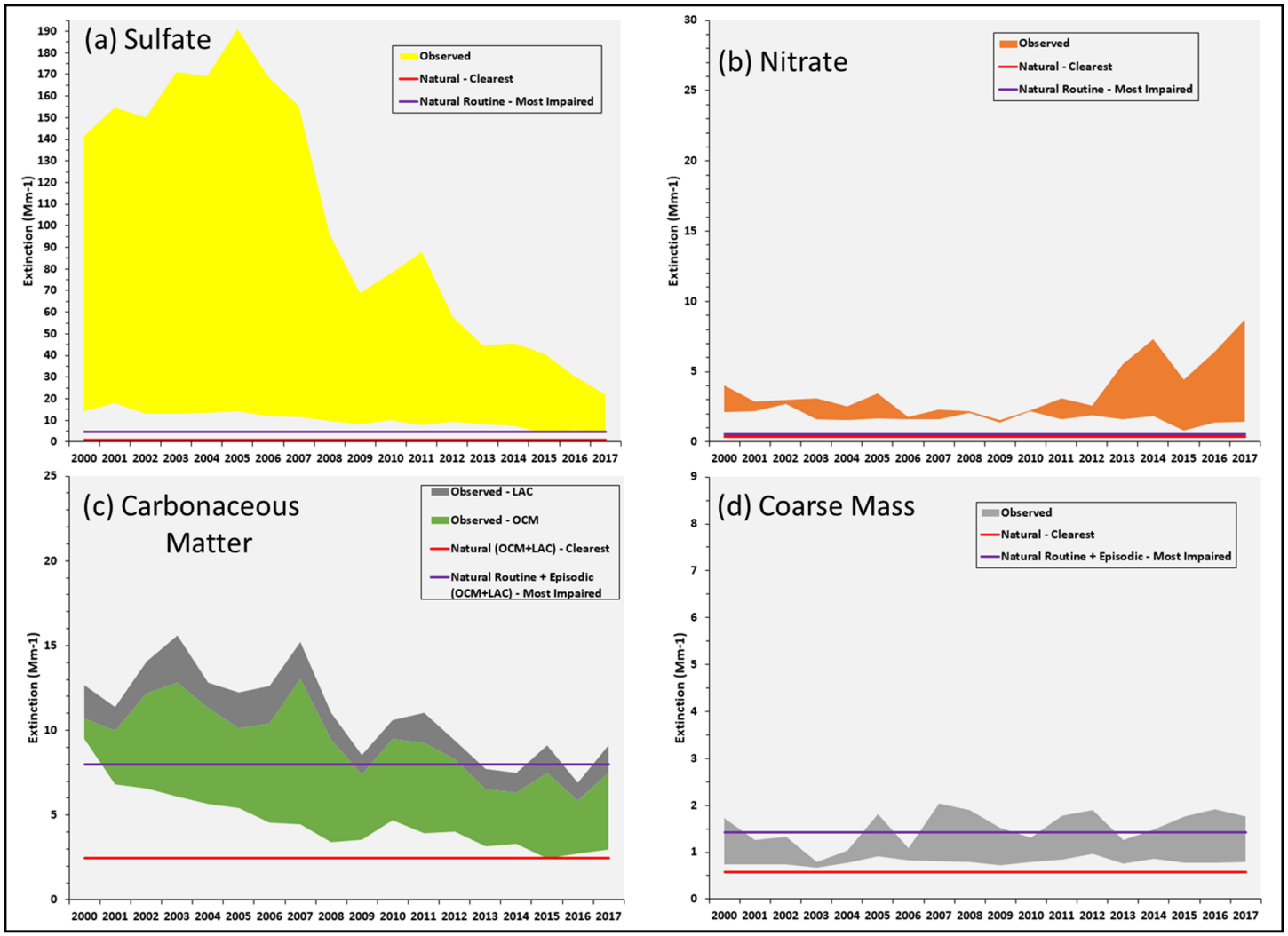
Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

Figure 3-23. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at Dolly Sods Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days



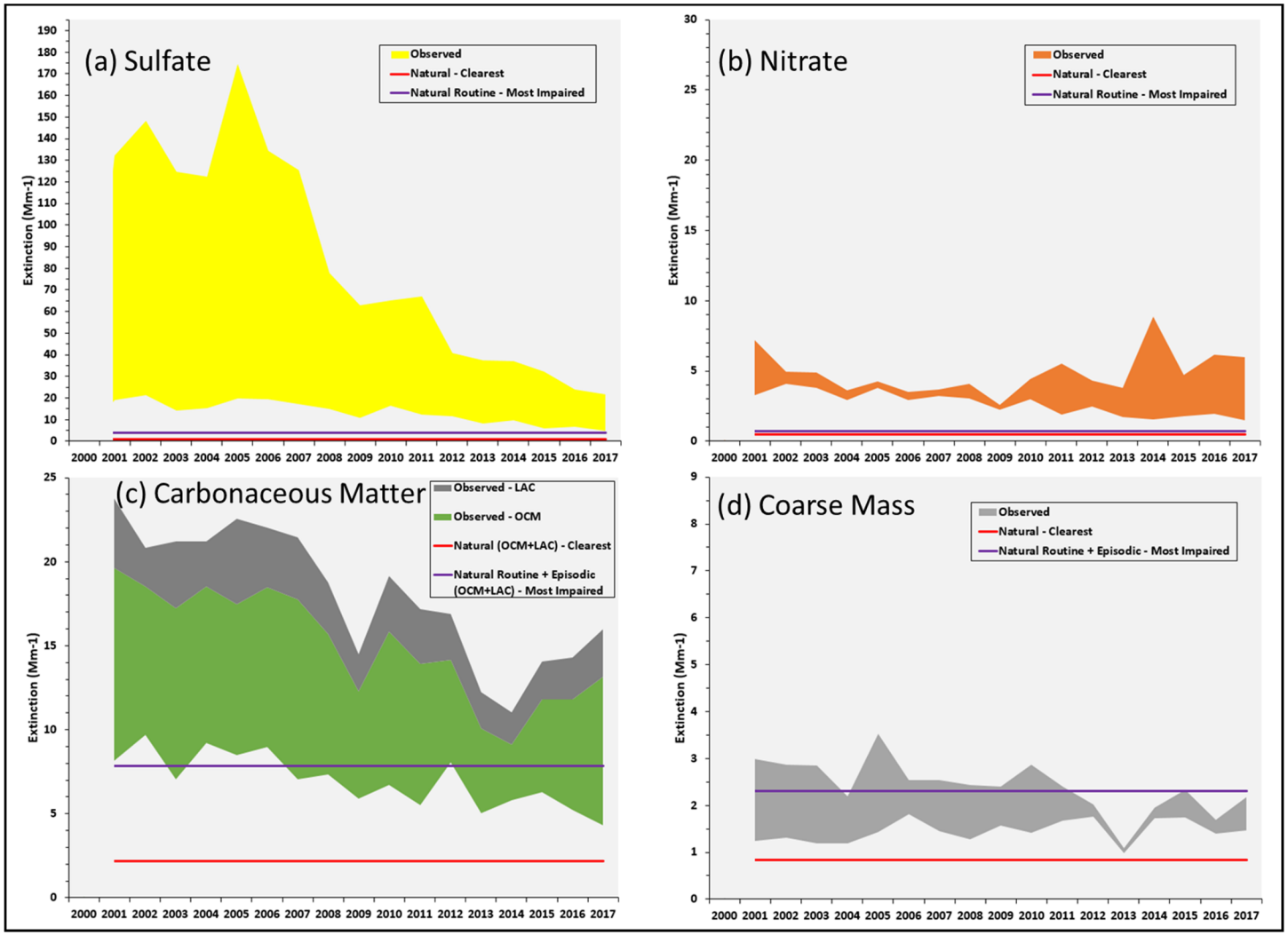
Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

Figure 3-24. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at Shenandoah National Park on 20 Percent Clearest and Most Impaired Visibility Days



Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

Figure 3-25. Range of Observed and Estimated Natural Light Extinction for Select Individual Species at James River Face Wilderness Area on 20 Percent Clearest and Most Impaired Visibility Days



Notes: Light extinction from (a) sulfate, (b) nitrate, (c) carbonaceous matter (i.e., organic carbon mass or OCM and light absorbing carbon or LAC), and (d) coarse mass, alongside estimated natural light extinction from those species.

SEASONAL TRENDS OF 20 PERCENT MOST IMPAIRED DAYS

Figure 3-26. Seasonal Breakdown of 20 Percent Most Impaired Visibility Days for New England Class I Areas

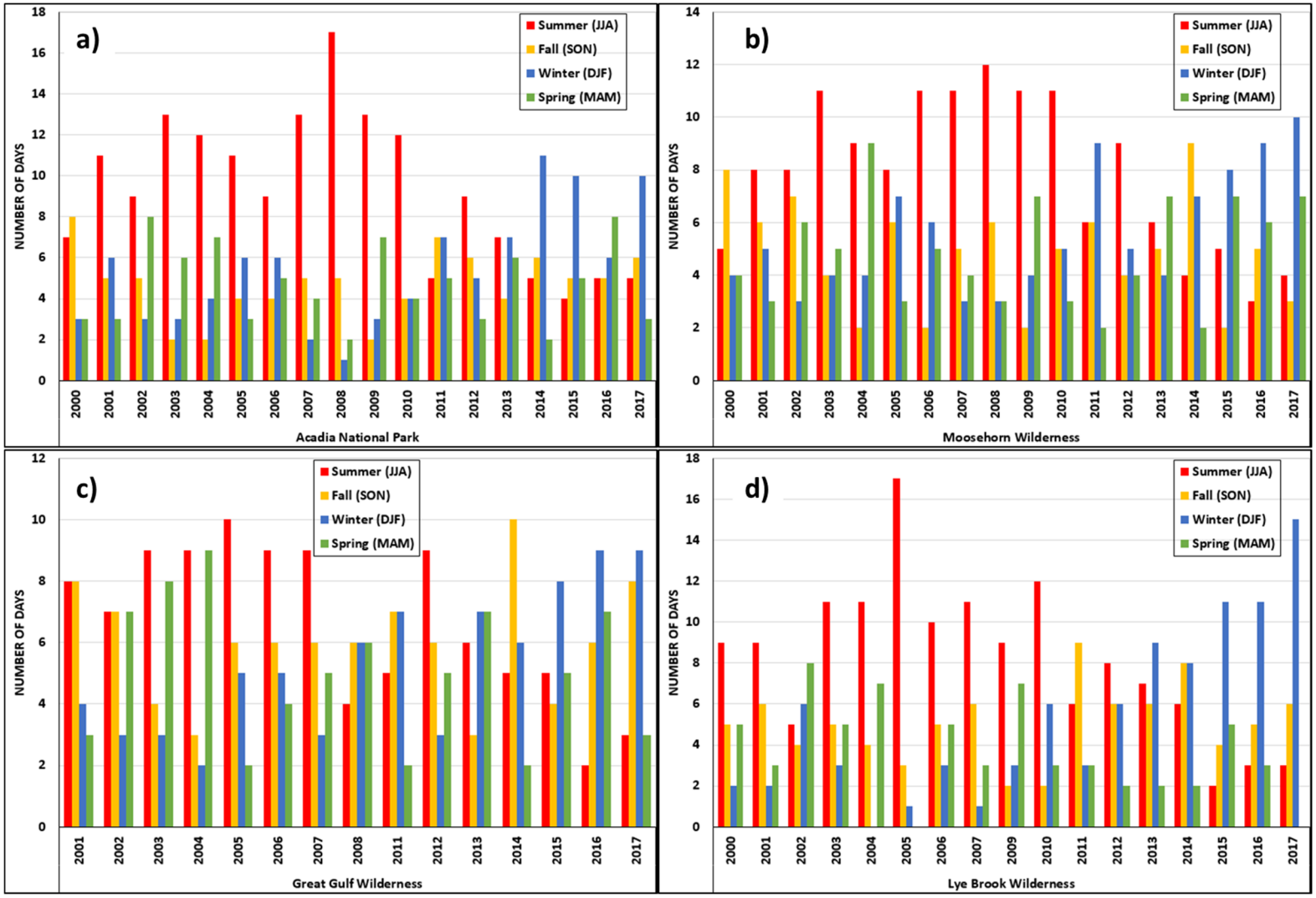


Figure 3-27. Seasonal Breakdown of 20 Percent Most Impaired Visibility Days for New Jersey, West Virginia and Virginia Class I Areas

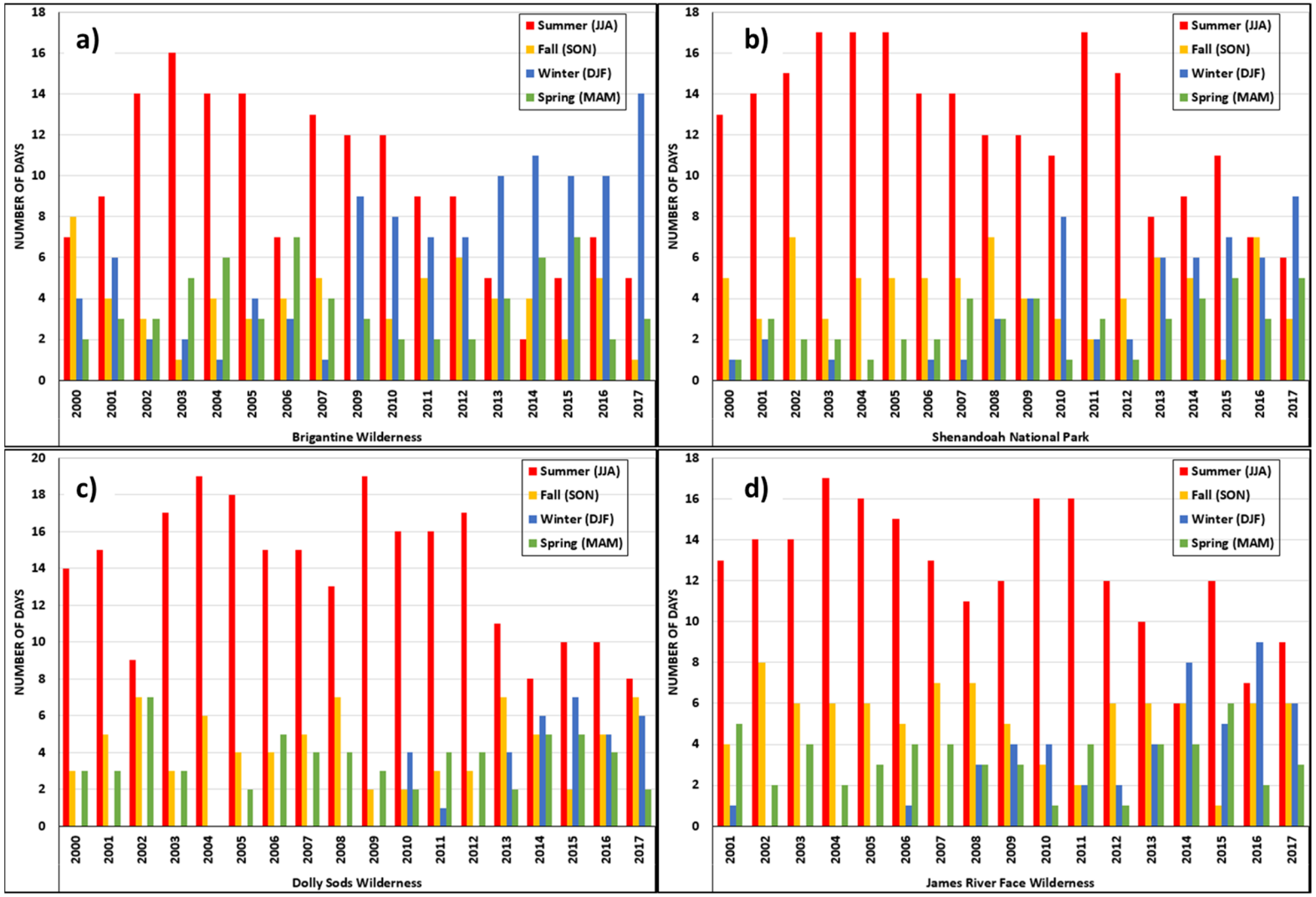
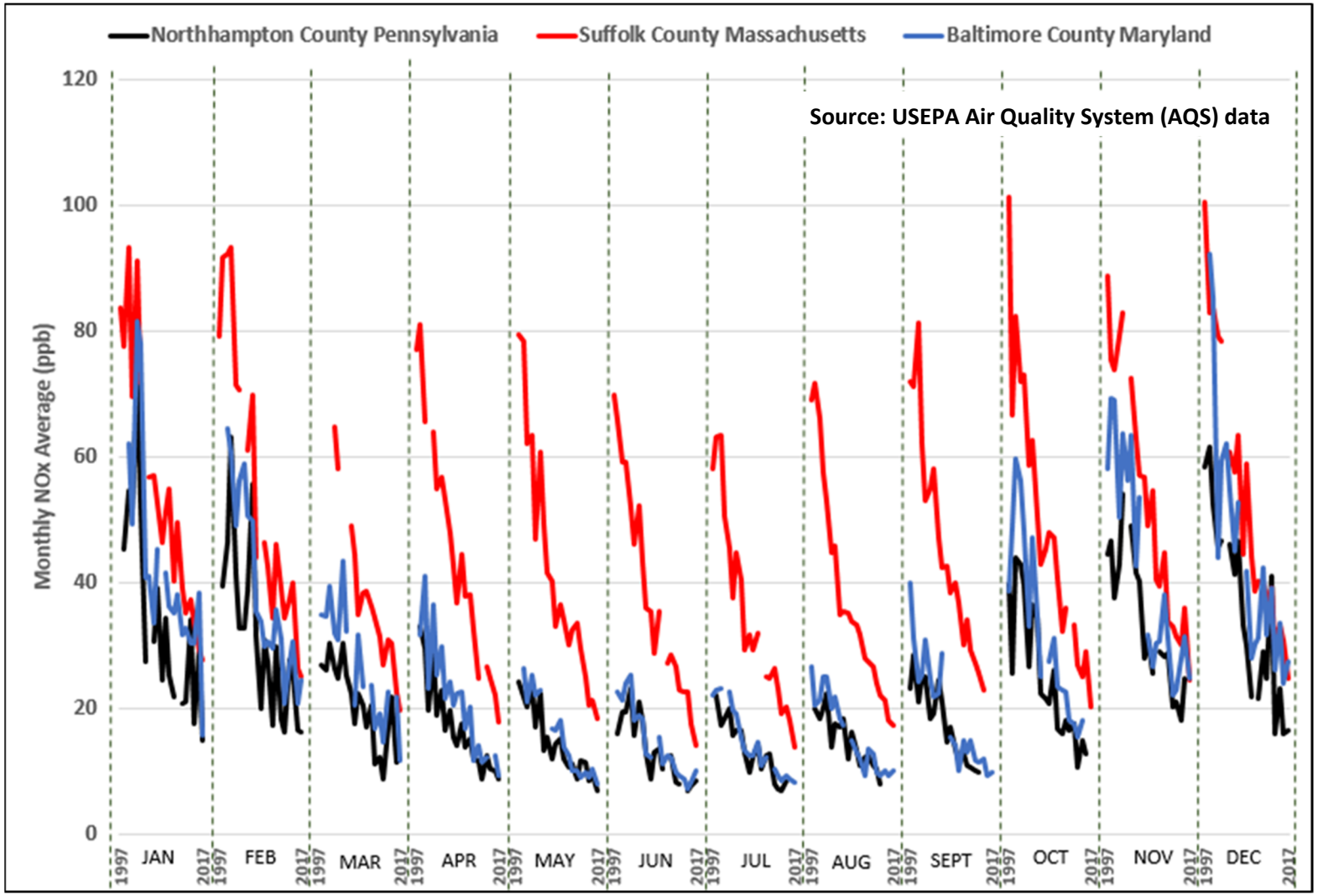


Figure 3-28. 1997-2017 NO_x Trends by Month



4. Summary

There are definite downward trends in overall haze levels at Class I areas in and adjacent to the MANE-VU region. Based on rolling five-year averages demonstrating progress since the 2000-2004 baseline period, Class I areas are currently below 2018 URP and baseline period levels for the 20 percent most impaired visibility days. The trends are mainly driven by large reductions in sulfate light extinction. Levels of nitrate extinction are approaching natural conditions for the 20 percent clearest days, however, percent contribution levels are increasing for the 20 percent most impaired days in recent years as more winter days are in the 20 percent most impaired days mix, especially for southern Class I areas. Levels of carbonaceous matter (OCM and LAC) appear to be approaching natural levels at most of the Class I areas. Though states are on track to be below 2028 URPs, current (2013-17) visibility levels are greater than modeled 2028 RPGs and the 2028 RPG is the metric states need to achieve for the second planning period. Continued sulfate and nitrate reductions are primary drivers in continuing to improve visibility.

Reductions in air pollution continue to bring down levels of fine particulate matter in the eastern United States, which in turn are leading to improved visibility at federally protected Class I areas in and adjacent to the MANE-VU region. Significant improvements in visibility at the MANE-VU Class I sites have been observed, and these changes have been largely driven by reductions in sulfate levels.

Large emission reductions of NO_x and sulfur dioxide (SO_2) across the region in response to regional emission reduction requirements for power plants (i.e., NO_x SIP Call, NO_x Reasonably Available Control Technology (RACT), Cross State Air Pollution Rule (CSAPR), 2010 SO_2 National Ambient Air Quality Standard (NAAQS), etc.) is likely a principal driver for these visibility improvements. Reductions have occurred recently as the power sector continued to control or phase out coal plants across the eastern United States in response to competitive pressures from natural gas generation, overall reduced electricity demand, and more stringent requirements to reduce emissions of air toxics (i.e., 2011 Mercury and Air Toxics (MATS) rule).

In addition to addressing emissions from power plants, states across the Northeast have enacted or are in process of enacting low sulfur content requirements for fuel oils, which cover home heating oil (distillate) and residual oils (#4 and #6). At the federal level, USEPA finalized the Tier 3 motor vehicle program in 2014 that includes lowering sulfur content in gasoline. While gasoline combustion is a minor source of SO_2 emissions, the Tier 3 fuel requirements will significantly reduce NO_x emissions from the existing fleet of on-road gasoline vehicles by reducing sulfur poisoning of the catalyst in catalytic converters, thus improving control technology performance. This would lead to lower nitrate levels, most notably during colder weather months when nitrates are more thermally stable. In warmer weather months, NO_x promotes ground-level ozone formation, which in turn can enhance formation of visibility-limiting secondary organic aerosols (Carleton *et al.* 2010). Therefore, lower levels of NO_x because of Tier 3 can also improve visibility by reducing ozone formation that leads to carbonaceous PM.

In summary, the visibility data examined using the 20 percent most impaired and 20 percent clearest days metrics in this report demonstrate that broad, regional efforts to reduce emissions of visibility-impairing pollutants have had a beneficial effect at the region's Class I areas. IMPROVE data trends indicate that states continue to be on track keeping visibility levels significantly below the uniform rate of progress levels. However, further progress is needed to achieve 2028 reasonable progress goals that have been established for the second regional haze implementation planning period.

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Appendix A: Tracking Progress Data for Current Active IMPROVE Monitoring Sites In and Adjacent to the MANE-VU Region

Table A-1. Tracking Progress Data for Acadia National Park (ME) and Brigantine Wilderness (NJ) Class I Areas in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Acadia National Park (ACAD)	2000	8.90	-	20.75	-
	2001	8.87	-	22.37	-
	2002	8.77	-	22.91	-
	2003	8.77	-	22.70	-
	2004	8.56	8.78	21.34	22.01
	2005	7.58	8.51	21.72	22.21
	2006	8.17	8.37	22.69	22.27
	2007	8.21	8.26	20.84	21.86
	2008	7.76	8.06	19.35	21.19
	2009	6.92	7.73	18.17	20.55
	2010	6.71	7.55	17.52	19.71
	2011	7.45	7.41	17.31	18.64
	2012	7.77	7.32	15.92	17.65
	2013	6.25	7.02	15.31	16.84
	2014	7.03	7.04	15.36	16.28
	2015	6.05	6.91	16.07	15.99
	2016	6.08	6.64	13.72	15.28
	2017	7.18	6.52	13.97	14.89
	2018				
	2028 RPG		**6.33 RPG**		**13.35 RPG**
	2064 NAT		**4.66 NAT**		**10.39 NAT**
Brigantine Wilderness (BRIG)	2000	14.26	-	27.37	-
	2001	13.83	-	27.07	-
	2002	14.83	-	26.53	-
	2003	14.39	-	28.49	-
	2004	14.36	14.33	27.69	27.43
	2005	14.61	14.40	28.81	27.72
	2006	15.35	14.71	26.88	27.68
	2007	12.74	14.29	26.17	27.61
	2008	*	14.26	*	27.39
	2009	12.78	13.87	23.06	26.23
	2010	11.82	13.17	24.51	25.15
	2011	12.92	12.56	22.66	24.10
	2012	11.93	12.36	20.95	22.80
	2013	11.80	12.25	20.12	22.26
	2014	11.66	12.03	21.09	21.87
	2015	11.44	11.95	20.84	21.13
	2016	11.12	11.59	19.18	20.44
	2017	11.36	11.48	18.09	19.86
	2018				
	2028 RPG		**10.47 RPG**		**17.97 RPG**
	2064 NAT		**5.52 NAT**		**10.69 NAT**

"-" = not applicable; "*" = no data available; "RPG" = Reasonable Progress Goal; "NAT" = Natural Conditions

Table A-2. Tracking Progress Data for Great Gulf Wilderness (NH) and Lye Brook Wilderness (VT) Class I Areas in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Great Gulf Wilderness Area (GRGU)	2000	*	-	*	-
	2001	8.26	-	22.47	-
	2002	7.77	-	23.43	-
	2003	6.94	-	20.65	-
	2004	7.68	7.66	21.16	21.93
	2005	6.90	7.51	20.51	21.64
	2006	6.43	7.14	19.74	21.10
	2007	6.86	6.96	21.06	20.62
	2008	6.20	6.81	16.10	19.71
	2009	*	6.60	*	19.35
	2010	*	6.50	*	18.96
	2011	6.37	6.48	17.55	18.24
	2012	5.81	6.13	14.86	16.17
	2013	5.41	5.87	13.87	15.43
	2014	5.75	5.84	15.19	15.37
	2015	4.92	5.65	14.44	15.18
	2016	4.69	5.32	11.23	13.92
	2017	5.22	5.20	11.81	13.31
	2018				
	2028 RPG		**5.06 RPG**		**12.00 RPG**
	2064 NAT		**3.73 NAT**		**9.78 NAT**
Lye Brook Wilderness Area (LYBR 2000-2011) (LYEB 2012-current)	2000	6.49	-	23.10	-
	2001	6.47	-	25.48	-
	2002	6.43	-	23.46	-
	2003	5.83	-	23.37	-
	2004	6.61	6.37	22.41	23.57
	2005	5.74	6.22	25.92	24.13
	2006	5.24	5.97	21.19	23.27
	2007	5.68	5.82	24.96	23.57
	2008	*	5.82	*	23.62
	2009	4.11	5.19	17.85	22.48
	2010	4.08	4.78	19.09	20.77
	2011	5.40	4.82	18.27	20.04
	2012	5.49	4.77	17.78	18.25
	2013	5.35	4.89	17.32	18.06
	2014	5.00	5.07	16.61	17.81
	2015	5.10	5.27	15.22	17.04
	2016	4.88	5.17	13.42	16.07
	2017	5.43	5.15	13.95	15.30
	2018				
	2028 RPG		**3.86 RPG**		**13.68 RPG**
	2064 NAT		**2.79 NAT**		**10.23 NAT**

"-" = not applicable; "*" = no data available; "RPG" = Reasonable Progress Goal; "NAT" = Natural Conditions

Table A-3. Tracking Progress Data for the Moosehorn Wilderness (ME) Class I Area in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Moosehorn Wilderness Area (MOOS)	2000	8.94	-	19.48	-
	2001	9.31	-	21.30	-
	2002	9.12	-	22.12	-
	2003	9.48	-	20.96	-
	2004	8.93	9.16	19.44	20.66
	2005	7.99	8.97	20.92	20.95
	2006	8.60	8.82	20.72	20.83
	2007	7.79	8.56	18.50	20.11
	2008	7.75	8.21	17.52	19.42
	2009	6.83	7.79	17.05	18.94
	2010	5.98	7.39	16.45	18.05
	2011	6.97	7.07	16.38	17.18
	2012	7.27	6.96	14.80	16.44
	2013	6.47	6.71	14.31	15.80
	2014	7.00	6.74	14.15	15.22
	2015	6.64	6.87	14.53	14.83
	2016	6.09	6.69	12.56	14.07
	2017	6.77	6.59	12.13	13.54
	2018				
	2028 RPG		**6.45 RPG**		**13.12 RPG**
	2064 NAT		**5.02 NAT**		**9.97 NAT**

"-" = not applicable; "*" = no data available; "RPG" = Reasonable Progress Goal; "NAT" = Natural Conditions

Table A-4. Tracking Progress Data for the Dolly Sods Wilderness (WV) Class I Area Adjacent to the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Dolly Sods Wilderness (DOSO)	2000	12.96	-	27.72	-
	2001	13.30	-	27.53	-
	2002	11.91	-	27.96	-
	2003	11.54	-	29.33	-
	2004	11.67	12.28	28.91	28.29
	2005	12.09	12.10	30.45	28.84
	2006	10.57	11.56	28.91	29.11
	2007	10.27	11.23	28.39	29.20
	2008	9.44	10.81	24.47	28.23
	2009	8.70	10.21	21.89	26.82
	2010	9.74	9.74	22.68	25.27
	2011	8.75	9.38	23.66	24.22
	2012	9.59	9.25	20.88	22.72
	2013	8.34	9.03	18.83	21.59
	2014	8.52	8.99	19.41	21.09
	2015	5.88	8.22	18.55	20.26
	2016	7.00	7.87	16.76	18.88
	2017	6.71	7.29	16.19	17.95
	2018				
	2028 RPG		**7.27 RPG**		**15.09 RPG**
	2064 NAT		**3.64 NAT**		**8.92 NAT**

"-" = not applicable; "*" = no data available; "RPG" = Reasonable Progress Goal; "NAT" = Natural Conditions

Table A-5. Tracking Progress Data for James River Face Wilderness and Shenandoah National Park (VA) Class I Areas Adjacent to the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
James River Face (JARI)	2000	*	-	*	-
	2001	14.54	-	28.36	-
	2002	15.65	-	28.91	-
	2003	12.85	-	27.61	-
	2004	13.80	14.21	27.45	28.08
	2005	14.92	14.35	30.32	28.53
	2006	14.75	14.39	28.21	28.50
	2007	13.78	14.02	27.49	28.22
	2008	13.03	14.06	24.01	27.50
	2009	11.55	13.61	22.07	26.42
	2010	13.51	13.33	23.12	24.98
	2011	11.57	12.69	23.02	23.95
	2012	12.35	12.40	20.03	22.45
	2013	9.94	11.79	18.59	21.37
	2014	10.81	11.64	19.14	20.78
	2015	9.76	10.89	18.45	19.85
	2016	9.57	10.49	17.28	18.70
	2017	8.38	9.69	17.26	18.15
	2018				
	2028 RPG		**9.36 RPG**		**15.31 RPG**
	2064 NAT		**4.39 NAT**		**9.48 NAT**
Shenandoah National Park (SHEN)	2000	11.08	-	27.23	-
	2001	13.21	-	27.62	-
	2002	11.49	-	29.89	-
	2003	9.48	-	27.87	-
	2004	9.37	10.93	29.00	28.32
	2005	10.48	10.81	30.51	28.98
	2006	10.59	10.28	27.75	29.01
	2007	11.13	10.21	28.17	28.66
	2008	8.16	9.95	24.59	28.00
	2009	8.23	9.72	21.20	26.44
	2010	9.79	9.58	22.12	24.77
	2011	7.87	9.04	22.10	23.64
	2012	9.63	8.73	19.30	21.86
	2013	7.50	8.60	18.88	20.72
	2014	8.02	8.56	18.58	20.20
	2015	6.50	7.90	18.65	19.50
	2016	7.32	7.79	16.59	18.40
	2017	6.39	7.14	16.18	17.78
	2018				
	2028 RPG		**6.83 RPG**		**14.25 RPG**
	2064 NAT		**3.15 NAT**		**9.52 NAT**

"-" = not applicable; "*" = no data available; "RPG" = Reasonable Progress Goal; "NAT" = Natural Conditions

Table A-6. Tracking Progress Data for Addison Pinnacle (NY) and Arendtsville (PA) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Addison Pinnacle (ADPI)	2000	*	-	*	-
	2001	*	-	*	-
	2002	12.38	-	28.45	-
	2003	11.79	-	27.37	-
	2004	11.18	11.78	26.54	27.45
	2005	11.63	11.75	29.08	27.86
	2006	10.22	11.44	25.78	27.44
	2007	10.65	11.09	26.79	27.11
	2008	10.99	10.93	24.45	26.53
	2009	9.57	10.61	21.94	25.61
	2010	*	*	*	*
	2011	*	*	*	*
	2012	*	*	*	*
	2013	*	*	*	*
	2014	*	*	*	*
	2015	*	*	*	*
	2016	*	*	*	*
	2017				
	2018				
	2064 NAT		**4.12 NAT**		**10.42 NAT**
Arendtsville (AREN)	2000	*	-	*	-
	2001	*	-	*	-
	2002	15.49	-	29.19	-
	2003	14.32	-	28.68	-
	2004	12.87	14.23	29.44	29.10
	2005	14.41	14.27	30.99	29.58
	2006	13.29	14.08	28.87	29.44
	2007	13.22	13.62	27.51	29.10
	2008	13.59	13.48	26.28	28.62
	2009	11.70	13.24	24.97	27.73
	2010	11.74	12.71	24.25	26.38
	2011	*	*	*	*
	2012	*	*	*	*
	2013	*	*	*	*
	2014	*	*	*	*
	2015	*	*	*	*
	2016	*	*	*	*
	2017				
	2018				
	2064 NAT		**4.24 NAT**		**10.21 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-7. Tracking Progress Data for Bridgton (ME) and Casco Bay (ME) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Bridgton (BRMA)	2000	*	-	*	-
	2001	*	-	*	-
	2002	9.34	-	22.10	-
	2003	8.92	-	21.92	-
	2004	9.19	9.15	22.31	22.11
	2005	7.77	8.81	20.79	21.78
	2006	8.15	8.67	22.21	21.87
	2007	7.76	8.36	20.58	21.56
	2008	7.88	8.15	18.17	20.81
	2009	6.64	7.64	17.78	19.91
	2010	6.30	7.34	17.12	19.17
	2011	7.33	7.18	17.72	18.27
	2012	7.44	7.12	16.08	17.37
	2013	6.71	6.89	15.60	16.86
	2014	6.93	6.94	15.60	16.42
	2015	6.22	6.93	15.50	16.10
	2016	*	*	*	*
	2017				
	2018				
	2064 NAT		**4.65 NAT**		**10.48 NAT**
Casco Bay (CACO)	2000	*	-	*	-
	2001	*	-	*	-
	2002	9.84	-	23.58	-
	2003	9.52	-	22.24	-
	2004	10.12	9.82	21.96	22.59
	2005	8.88	9.59	22.15	22.48
	2006	8.98	9.47	22.36	22.46
	2007	8.77	9.25	21.15	21.97
	2008	9.65	9.28	20.02	21.53
	2009	7.75	8.80	19.23	20.98
	2010	7.64	8.56	18.08	20.17
	2011	8.84	8.53	18.19	19.34
	2012	9.17	8.61	17.23	18.55
	2013	7.68	8.22	16.86	17.92
	2014	7.81	8.23	16.65	17.40
	2015	7.67	8.23	17.18	17.22
	2016	7.35	7.94	14.22	16.43
	2017	8.01	7.70	14.81	15.94
	2018				
	2064 NAT		**4.83 NAT**		**10.92 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-8. Tracking Progress Data for Cape Cod (MA) and Frostburg Reservoir (MD) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Cape Cod (CACO)	2000	*	-	*	-
	2001	*	-	*	-
	2002	11.18	-	23.59	-
	2003	11.00	-	25.59	-
	2004	11.97	11.38	23.74	24.31
	2005	12.12	11.57	24.78	24.43
	2006	10.96	11.45	22.93	24.13
	2007	10.02	11.21	24.71	24.35
	2008	10.82	11.18	20.91	23.42
	2009	9.89	10.76	21.06	22.88
	2010	9.81	10.30	19.41	21.81
	2011	10.35	10.18	19.22	21.06
	2012	9.74	10.12	18.48	19.82
	2013	9.43	9.84	17.00	19.03
	2014	9.12	9.69	16.79	18.18
	2015	8.74	9.48	17.04	17.70
	2016	8.33	9.07	15.09	16.88
	2017	9.61	9.05	15.39	16.26
	2018				
	2064 NAT		**5.95 NAT**		**10.99 NAT**
Frostburg Reservoir (FRRE)	2000	*	-	*	-
	2001	*	-	*	-
	2002	*	-	*	-
	2003	*	-	*	-
	2004	*	*	*	*
	2005	14.49	*	31.80	*
	2006	13.69	*	29.72	*
	2007	12.82	13.67	27.90	29.81
	2008	12.74	13.44	24.91	28.58
	2009	10.85	12.92	23.68	27.60
	2010	11.81	12.38	24.14	26.07
	2011	11.11	11.87	23.86	24.90
	2012	11.76	11.66	21.04	23.53
	2013	10.57	11.22	21.04	22.75
	2014	10.94	11.24	21.22	22.26
	2015	9.44	10.77	19.84	21.40
	2016	9.37	10.42	17.85	20.20
	2017	9.53	9.97	18.21	19.63
	2018				
	2064 NAT		*		**9.61 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-9. Tracking Progress Data for Londonderry (NH) and Martha's Vineyard (MA) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Londonderry (LOND)	2000	*	-	*	-
	2001	*	-	*	-
	2002	*	-	*	-
	2003	*	-	*	-
	2004	*	*	*	*
	2005	*	*	*	*
	2006	*	*	*	*
	2007	*	*	*	*
	2008	*	*	*	*
	2009	*	*	*	*
	2010	*	*	*	*
	2011	9.84	*	19.89	*
	2012	9.34	*	18.39	*
	2013	8.17	9.12	18.28	18.85
	2014	8.33	8.92	17.82	18.59
	2015	7.98	8.73	17.99	18.47
	2016	7.79	8.32	16.02	17.70
	2017	8.72	8.20	16.88	17.40
	2018				
	2064 NAT		*		**10.42 NAT**
Martha's Vineyard (MAVI)	2000	*	-	*	-
	2001	*	-	*	-
	2002	*	-	*	-
	2003	11.83	-	26.56	-
	2004	12.25	*	24.14	*
	2005	12.31	12.13	25.85	25.51
	2006	11.17	11.89	24.90	25.36
	2007	10.50	11.61	23.74	25.04
	2008	10.77	11.40	22.55	24.23
	2009	9.94	10.94	22.00	23.81
	2010	9.98	10.47	21.05	22.85
	2011	11.24	10.49	20.86	22.04
	2012	9.93	10.37	18.71	21.03
	2013	8.92	10.00	19.41	20.41
	2014	10.23	10.06	17.74	19.55
	2015	10.14	10.09	19.06	19.16
	2016	9.42	9.73	16.45	18.27
	2017	10.03	9.75	16.74	17.88
	2018				
	2064 NAT		*		**11.11 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-10. Tracking Progress Data for M.K. Goddard (PA) and Mohawk Mt. (CT) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
M.K. Goddard. (MKGO)	2000	*	-	*	-
	2001	*	-	*	-
	2002	14.75	-	28.74	-
	2003	13.76	-	27.76	-
	2004	13.76	14.09	27.85	28.11
	2005	14.78	14.26	31.11	28.86
	2006	13.07	14.02	27.44	28.58
	2007	12.91	13.66	28.07	28.44
	2008	13.30	13.56	25.70	28.03
	2009	11.81	13.17	25.37	27.54
	2010	11.54	12.53	25.74	26.46
	2011	*	*	*	*
	2012	*	*	*	*
	2013	*	*	*	*
	2014	*	*	*	*
	2015	*	*	*	*
	2016	*	*	*	*
	2017				
	2018				
	2064 NAT		**4.52 NAT**		**10.14 NAT**
Mohawk Mt. (MOMO)	2000	*	-	*	-
	2001	*	-	*	-
	2002	10.34	-	25.59	-
	2003	9.31	-	25.53	-
	2004	9.85	9.83	25.96	25.69
	2005	8.87	9.59	27.24	26.08
	2006	8.39	9.35	24.93	25.85
	2007	7.88	8.86	26.69	26.07
	2008	*	8.75	*	26.21
	2009	6.97	8.03	20.56	24.86
	2010	6.71	7.49	20.64	23.20
	2011	8.06	7.40	20.37	22.06
	2012	7.68	7.36	19.08	20.16
	2013	6.70	7.22	18.01	19.73
	2014	7.35	7.30	16.55	18.93
	2015	6.08	7.17	17.45	18.29
	2016	6.30	6.82	14.75	17.17
	2017	6.19	6.53	15.06	16.36
	2018				
	2064 NAT		**3.67 NAT**		**10.89 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-11. Tracking Progress Data for Pack Monadnock Summit (NH) and Penobscot Nation (ME) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Pack Monadnock Summit (PACK)	2000	*	-	*	-
	2001	*	-	*	-
	2002	*	-	*	-
	2003	*	-	*	-
	2004	*	*	*	*
	2005	*	*	*	*
	2006	*	*	*	*
	2007	*	*	*	*
	2008	6.56	*	18.81	*
	2009	4.89	*	18.20	*
	2010	5.14	5.53	18.79	18.60
	2011	5.63	5.56	17.87	18.42
	2012	5.55	5.55	17.24	18.18
	2013	5.12	5.27	15.95	17.61
	2014	4.75	5.24	16.25	17.22
	2015	4.57	5.12	15.66	16.60
	2016	4.57	4.91	12.87	15.60
	2017	5.27	4.85	12.71	14.69
	2018				
	2064 NAT		*		**9.54**
Penobscot Nation (PENO)	2000	*	-	*	-
	2001	*	-	*	-
	2002	*	-	*	-
	2003	*	-	*	-
	2004	*	*	*	*
	2005	*	*	*	*
	2006	9.10	*	21.88	*
	2007	8.37	*	20.41	*
	2008	8.52	9.45	19.23	20.51
	2009	7.55	8.75	19.25	20.19
	2010	7.24	8.16	17.76	19.70
	2011	8.38	8.01	18.18	18.97
	2012	8.50	8.04	16.35	18.15
	2013	8.19	7.97	16.20	17.55
	2014	7.77	8.02	15.97	16.89
	2015	6.96	7.96	17.73	16.89
	2016	6.74	7.63	15.22	16.29
	2017	8.11	7.55	14.55	15.93
	2018				
	2064 NAT		*		**10.39 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-12. Tracking Progress Data for Proctor Maple R. F. (VT) and Presque Isle (ME) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Proctor Maple R. F. (PMRF)	2000	*	-	*	-
	2001	*	-	*	-
	2002	8.67	-	25.34	-
	2003	7.82	-	23.25	-
	2004	8.26	8.25	24.13	24.24
	2005	7.94	8.17	25.36	24.52
	2006	7.97	8.13	21.36	23.89
	2007	7.71	7.94	23.56	23.53
	2008	7.58	7.89	19.63	22.81
	2009	6.27	7.49	18.61	21.70
	2010	6.77	7.26	18.90	20.41
	2011	7.82	7.23	19.57	20.06
	2012	6.40	6.97	17.14	18.77
	2013	6.48	6.75	16.16	18.08
	2014	6.54	6.80	16.78	17.71
	2015	5.70	6.59	16.80	17.29
	2016	5.65	6.15	13.18	16.01
	2017	6.07	6.09	13.10	15.20
	2018				
	2064 NAT		**3.86 NAT**		**10.29 NAT**
Presque Isle (PRIS)	2000	*	-	*	-
	2001	*	-	*	-
	2002	9.39	-	21.95	-
	2003	9.53	-	19.49	-
	2004	9.52	9.48	20.04	20.49
	2005	8.80	9.31	19.33	20.20
	2006	9.45	9.34	20.47	20.26
	2007	8.24	9.11	17.53	19.37
	2008	8.21	8.85	17.75	19.03
	2009	8.40	8.62	17.58	18.53
	2010	6.81	8.23	16.16	17.90
	2011	8.25	7.99	16.65	17.14
	2012	7.85	7.91	15.00	16.63
	2013	7.20	7.70	15.02	16.08
	2014	8.39	7.70	15.28	15.62
	2015	6.66	7.67	15.34	15.46
	2016	7.26	7.47	14.23	14.97
	2017	7.68	7.44	13.44	14.66
	2018				
	2064 NAT		**4.91 NAT**		**10.24 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-13. Tracking Progress Data for Quabbin Summit (MA) and Washington (DC) IMPROVE Protocol Sites in the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Quabbin Summit (QURE)	2000	*	-	*	-
	2001	*	-	*	-
	2002	9.83	-	24.91	-
	2003	9.43	-	24.70	-
	2004	10.06	9.77	24.51	24.71
	2005	9.11	9.61	26.40	25.13
	2006	8.50	9.39	24.71	25.05
	2007	8.32	9.08	25.06	25.08
	2008	*	9.00	*	25.17
	2009	7.46	8.35	20.44	24.15
	2010	6.82	7.77	20.82	22.76
	2011	7.74	7.58	19.51	21.46
	2012	7.45	7.37	18.74	19.88
	2013	6.33	7.16	17.75	19.45
	2014	6.64	7.00	16.81	18.73
	2015	6.41	6.91	17.87	18.13
	2016	*	*	*	*
	2017				
	2018				
	2064 NAT		**3.92 NAT**		**10.82 NAT**
Washington D.C. (WASH)	2000	17.83	-	27.48	-
	2001	17.10	-	28.36	-
	2002	17.92	-	28.87	-
	2003	16.79	-	28.27	-
	2004	16.29	17.19	28.71	28.34
	2005	17.71	17.16	31.19	29.08
	2006	17.19	17.18	27.69	28.95
	2007	16.80	16.95	27.99	28.77
	2008	16.30	16.86	26.86	28.49
	2009	15.01	16.60	24.17	27.58
	2010	*	16.32	*	26.68
	2011	14.17	15.57	22.86	25.47
	2012	13.16	14.66	21.49	23.84
	2013	*	14.11	*	22.84
	2014	12.69	13.34	22.54	22.30
	2015	*	*	*	*
	2016	*	*	*	*
	2017				
	2018				
	2064 NAT		**5.52 NAT**		**9.85 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Table A-14. Tracking Progress Data for the Quaker City (OH) IMPROVE Protocol Site Adjacent to the MANE-VU Region (dv)

		20 Percent Clearest Days		20 Percent Most Impaired Days	
Class I Area	Year	Haze Index, Annual	Haze Index, 5-Year Rolling	Haze Index, Annual	Haze Index, Year Rolling
Quaker City (QUCI)	2000	*	-	*	-
	2001	*	-	*	-
	2002	15.59	-	29.77	-
	2003	15.30	-	29.55	-
	2004	14.79	15.23	30.12	29.81
	2005	16.09	15.44	31.60	30.26
	2006	14.65	15.28	28.86	29.98
	2007	14.89	15.14	29.47	29.92
	2008	14.04	14.89	25.81	29.17
	2009	13.02	14.54	24.79	28.11
	2010	*	14.15	*	27.23
	2011	12.80	13.69	25.11	26.30
	2012	12.14	13.00	22.22	24.48
	2013	12.12	12.52	22.66	23.69
	2014	12.47	12.38	23.11	23.28
	2015	11.53	12.21	22.13	23.05
	2016	10.49	11.75	19.98	22.02
	2017	10.17	11.36	19.52	21.48
	2018				
	2064 NAT		**4.96 NAT**		**9.78 NAT**

"-" = not applicable; "*" = no data available; "NAT" = Natural Conditions

Appendix B: Species Light Extinction Data for Current Active IMPROVE Monitoring Sites In and Adjacent to the MANE-VU Region

Table B-1. Observed Light Extinction Conditions for the Acadia National Park (ME) MANE-VU Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	7.2439	0.9890	2.2073	1.0977	0.6710	0.2676	0.0982	12.5746
2001	7.5656	1.3663	1.8168	0.8588	0.6108	0.1218	0.1346	12.4748
2002	6.2921	1.0140	2.4590	0.8563	0.8157	0.6305	0.0969	12.1646
2003	6.8416	1.0701	2.0937	0.7825	0.6141	0.6702	0.1005	12.1727
2004	5.8580	0.9467	2.6046	0.7523	0.8663	0.5067	0.1235	11.6581
2005	4.7059	0.9316	1.7707	0.7716	0.6932	0.7887	0.0681	9.7297
2006	5.7226	0.8888	1.9404	0.8722	0.8172	0.6234	0.0764	10.9409
2007	5.8610	0.7017	2.3054	0.7483	0.7392	0.3777	0.0995	10.8328
2008	4.9094	0.6604	1.9764	0.5716	0.9105	0.8242	0.0898	9.9423
2009	3.9262	0.5181	1.5387	0.4616	0.9874	0.5966	0.0904	8.1191
2010	3.8472	0.6466	1.6922	0.5004	0.5350	0.4318	0.0746	7.7278
2011	4.6339	0.5538	1.8537	0.5208	0.8091	0.7817	0.0453	9.1983
2012	4.9331	0.6886	2.0719	0.6228	0.9935	0.5476	0.0904	9.9478
2013	3.5974	0.5339	1.2331	0.3073	0.5955	0.5328	0.0421	6.8422
2014	4.3119	0.6779	1.5715	0.3670	0.8943	0.5999	0.0466	8.4690
2015	2.6593	0.5998	1.4613	0.2484	0.8013	0.6041	0.0331	6.4073
2016	2.7208	0.5094	1.5919	0.3522	0.7841	0.4607	0.0391	6.4582
2017	3.5016	0.7208	2.3469	0.6753	0.9776	0.3367	0.0581	8.6169
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	48.4979	8.4336	7.2967	4.1520	1.9028	1.2459	0.2887	71.8176
2001	73.2714	6.3115	9.8357	4.0405	1.3606	0.0236	0.5719	95.4153
2002	74.4633	7.4757	9.3296	3.7231	1.4681	0.3109	0.7489	97.5196
2003	82.8832	5.1382	10.3711	4.2866	1.3472	0.0646	0.4282	104.5190
2004	62.9697	6.6607	7.2555	3.2798	1.2953	1.0110	0.3848	82.8569
2005	69.5882	4.2073	7.2078	3.7605	1.2359	0.4234	0.2211	86.6443
2006	70.2979	7.5744	7.0839	3.5330	2.2396	1.0120	0.3092	92.0501
2007	57.9373	5.0296	7.9271	3.2620	1.8317	1.1123	0.3166	77.4166
2008	45.5628	3.5388	6.7849	2.2689	1.9068	0.5328	0.3039	60.8989
2009	43.8824	3.4504	5.5392	2.2404	1.4246	0.4638	0.3398	57.3407
2010	37.0754	3.5319	7.8980	2.4852	1.7852	0.4855	0.3996	53.6609
2011	30.6761	3.5265	6.8990	2.4389	1.9639	0.8779	0.1433	46.5257
2012	22.7935	4.5419	5.7796	2.0322	1.7074	1.3146	0.2155	38.3847
2013	21.8019	3.7479	4.7924	1.9000	1.8805	1.1469	0.1791	35.4487
2014	19.3692	5.4096	5.3878	1.8853	2.1834	1.5683	0.1777	35.9814
2015	21.4853	5.2711	7.6988	2.0343	1.7263	1.2249	0.2076	39.6482
2016	13.3955	4.6563	5.7005	1.5548	1.7320	1.1553	0.1437	28.3381
2017	12.6150	5.1885	7.0210	1.7494	2.3115	1.7149	0.1777	30.7780
2018								

"@" = does not include Rayleigh (12 Mm^{-1})

Table B-2. Observed Light Extinction Conditions for the Brigantine Wilderness Area (NJ) MANE-VU Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	14.8238	3.6542	4.6951	2.9656	3.4484	0.7103	0.2252	30.5226
2001	13.9839	3.6573	4.3049	2.3899	3.5978	0.2006	0.2412	28.3755
2002	16.3451	3.6267	4.3113	2.0506	3.9049	2.0065	0.2334	32.4786
2003	15.1058	3.9268	4.0418	1.9022	2.8311	2.6278	0.1906	30.6260
2004	13.8696	4.4112	5.3658	2.7658	2.2370	1.2595	0.2807	30.1895
2005	15.7543	3.9352	3.3387	2.1872	2.8512	3.4870	0.1678	31.7215
2006	16.1510	4.1794	3.9553	2.0306	5.3474	2.6397	0.2519	34.5552
2007	11.2823	3.2614	3.2743	1.6435	2.3860	1.9732	0.2112	24.0319
2008	*	*	*	*	*	*	*	*
2009	10.9321	2.8349	3.8262	1.6765	2.5362	2.0940	0.2574	24.1573
2010	8.8392	2.6038	3.8829	1.8747	2.7450	0.9082	0.2386	21.0923
2011	9.9082	3.6809	3.3135	1.6273	4.0391	1.9930	0.1506	24.7126
2012	8.4524	2.9757	3.3331	1.3942	3.3176	1.5212	0.1470	21.1413
2013	8.5972	2.8276	3.6730	1.5700	2.5344	1.4887	0.1325	20.8234
2014	8.0833	2.5614	4.5244	1.2381	2.7491	1.3747	0.1385	20.6695
2015	6.2453	2.6372	3.6758	1.1527	3.5153	2.1706	0.1648	19.5617
2016	6.3094	2.2466	2.9277	0.8905	4.6521	1.4024	0.1265	18.5552
2017	6.3476	2.5019	4.1128	1.3472	3.2181	1.7228	0.1425	19.3928
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	111.7086	13.2827	13.5226	6.7326	3.8412	0.3462	0.5193	149.9532
2001	109.3284	16.2179	11.6909	5.8471	6.1491	0.0272	0.6750	149.9355
2002	111.5146	9.9718	13.1074	4.7817	3.4526	0.0049	0.9796	143.8127
2003	138.1686	14.1055	12.7253	5.8170	3.0298	0.1735	0.6977	174.7173
2004	124.4343	10.0838	13.9639	4.6505	3.1954	0.7008	1.0301	158.0589
2005	148.1647	8.8207	12.3468	5.7592	3.2587	0.4506	0.6081	179.4088
2006	106.3302	9.4834	11.3070	5.7187	8.9091	0.9038	0.6277	143.2799
2007	102.9678	7.7454	10.7177	5.0605	3.4406	0.9971	0.6460	131.5751
2008	*	*	*	*	*	*	*	*
2009	59.6198	13.2996	8.8431	4.1603	4.1142	0.4522	0.6819	91.1711
2010	64.1135	19.8793	10.9749	4.8308	7.0200	0.6283	0.7222	108.1690
2011	53.1299	13.2064	9.6229	3.9417	6.9547	1.1175	0.2801	88.2533
2012	38.0020	14.7369	9.2022	4.0501	4.4206	0.8079	0.3397	71.5594
2013	33.8086	16.0339	7.0515	3.5416	3.0877	1.0351	0.2369	64.7952
2014	37.5657	29.0515	10.8042	4.4723	4.8486	1.4178	0.2801	88.4403
2015	29.7893	18.7241	11.3917	4.0414	4.7592	1.4490	0.3801	70.5349
2016	19.9051	19.7135	7.9937	3.7230	5.8627	0.8746	0.3208	58.3934
2017	16.7380	15.4306	8.8659	3.5555	5.2505	0.9267	0.1911	50.9582
2018								

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-3. Observed Light Extinction Conditions for the Great Gulf Wilderness Area (NH) MANE-VU Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	6.4643	1.1261	2.1295	0.8689	1.1306	0.0493	0.1617	11.9304
2002	5.9630	1.0314	2.0081	0.8356	0.6854	0.3935	0.0607	10.9777
2003	4.8105	0.6938	1.8576	0.8166	0.9618	0.0462	0.0691	9.2556
2004	5.8601	1.0328	2.0283	0.8013	0.7181	0.2029	0.1182	10.7616
2005	5.2539	0.7792	1.6723	0.7775	0.5980	0.1316	0.0554	9.2679
2006	4.7361	0.4188	1.5973	0.6683	0.7403	0.0730	0.0818	8.3155
2007	5.2079	0.6450	1.4722	0.6859	0.7000	0.1614	0.0980	8.9704
2008	4.0328	0.5706	1.4574	0.4780	0.7648	0.2821	0.0806	7.6662
2009	*	*	*	*	*	*	*	*
2010	*	*	*	*	*	*	*	*
2011	4.0137	0.6572	1.6326	0.5217	0.8591	0.2971	0.0426	8.0239
2012	3.5133	0.6748	1.4012	0.4949	0.6135	0.1974	0.0656	6.9606
2013	3.5433	0.5099	0.9524	0.3053	0.6614	0.3016	0.0431	6.3168
2014	3.9499	0.6105	1.3963	0.4815	0.4897	0.0938	0.0459	7.0676
2015	2.6693	0.5148	1.4270	0.2617	0.5017	0.0420	0.0264	5.4429
2016	2.3030	0.6382	1.1407	0.2984	0.5188	0.1261	0.0327	5.0579
2017	3.0619	0.6171	1.3255	0.4418	0.4000	0.1018	0.0386	5.9866
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	78.2944	3.0570	9.1867	3.7371	2.4170	0.0227	0.4523	97.1673
2002	100.1793	2.4723	10.7277	3.7306	2.0905	0.0711	0.6003	119.8719
2003	58.1345	2.5496	10.5478	3.6373	2.6763	0.0035	0.3945	77.9433
2004	67.5660	2.6112	10.0684	3.4280	2.1347	0.2243	0.5342	86.5667
2005	59.0981	1.3483	7.3579	3.2399	1.8591	0.1350	0.2231	73.2613
2006	60.0020	1.9604	6.4616	2.8349	2.2355	0.0866	0.3374	73.9183
2007	58.9391	1.6376	10.5126	3.4490	2.4657	0.1926	0.4336	77.6301
2008	30.2044	1.1744	5.4478	1.8138	1.4153	0.0276	0.2960	40.3795
2009	*	*	*	*	*	*	*	*
2010	*	*	*	*	*	*	*	*
2011	35.3014	2.1504	8.2137	2.5134	1.8660	0.2382	0.1642	50.4472
2012	22.5650	1.5174	6.8358	1.9920	2.1838	0.1123	0.2317	35.4380
2013	19.8868	2.9073	4.9679	1.6316	1.7137	0.1683	0.2204	31.4960
2014	25.3918	2.4169	5.0876	1.7147	1.7690	0.2179	0.1899	36.7877
2015	20.1602	3.4500	6.4735	1.8760	1.4266	0.2133	0.1866	33.7861
2016	11.3886	2.1854	3.9049	1.1997	1.4883	0.1432	0.1630	20.4730
2017	12.1416	2.3728	5.7004	1.5520	1.4882	0.1781	0.1454	23.5784
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-4. Observed Light Extinction Conditions for the Lye Brook Wilderness Area^ (VT) MANE-VU Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	5.0730	1.2224	1.1102	0.5864	0.3690	0.0141	0.0787	8.4537
2001	4.3964	1.2348	1.2440	0.6783	0.5800	0.0107	0.1613	8.3056
2002	4.6585	1.1722	1.2096	0.5562	0.5116	0.0731	0.0579	8.2390
2003	3.6867	0.8746	1.1944	0.5886	0.6148	0.0541	0.0549	7.0682
2004	4.3933	1.2637	1.6766	0.5782	0.4973	0.1027	0.1148	8.6265
2005	4.0182	0.9138	0.9613	0.4954	0.6019	0.0403	0.0468	7.0776
2006	3.3859	0.7785	0.8306	0.4587	0.5574	0.0733	0.0629	6.1473
2007	4.0784	0.5532	0.9245	0.4713	0.5213	0.1313	0.0737	6.7536
2008	*	*	*	*	*	*	*	*
2009	2.2098	0.7777	0.3783	0.2772	0.3799	0.1260	0.0578	4.2067
2010	2.1616	0.6283	0.7178	0.2853	0.3021	0.0485	0.0643	4.2080
2011	3.3050	0.9908	1.0028	0.4270	0.4547	0.1268	0.0433	6.3502
2012	3.2847	0.9485	1.1227	0.5641	0.4243	0.0964	0.0511	6.4919
2013	3.0485	0.7958	1.1521	0.3481	0.6484	0.2108	0.0478	6.2515
2014	2.5889	0.7431	1.3781	0.3925	0.6074	0.1360	0.0369	5.8830
2015	2.4516	0.6370	1.5611	0.3714	0.6150	0.2240	0.0574	5.9174
2016	2.1129	1.0996	1.0990	0.3044	0.6968	0.0952	0.0437	5.4515
2017	2.5184	1.0784	1.6167	0.4661	0.6342	0.0818	0.0805	6.4761
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	68.7784	9.3691	8.9556	4.8968	1.5933	0.0209	0.3470	93.9611
2001	113.5720	6.6982	9.7213	4.3009	1.8725	0.0291	0.6378	136.8317
2002	82.3920	11.5951	10.2339	4.0980	1.3150	0.0442	0.6132	110.2914
2003	86.8995	8.1352	11.0648	4.4938	1.8842	0.1923	0.4617	113.1314
2004	73.3012	7.4419	8.2774	3.2225	1.4424	0.1721	0.6564	94.5139
2005	119.1209	2.5625	9.4428	4.1880	2.0173	0.2031	0.3828	137.9173
2006	61.1557	6.7590	7.6585	3.4686	1.8053	0.1588	0.3959	81.4018
2007	96.5843	4.8669	13.2639	4.7265	3.0551	0.1382	0.6634	123.2983
2008	*	*	*	*	*	*	*	*
2009	38.3424	6.7383	5.4013	2.0802	1.5245	0.5294	0.4336	55.0498
2010	48.9262	3.8690	8.5482	3.0050	1.3671	0.0675	0.4620	66.2449
2011	38.4088	4.6949	7.4059	2.6808	1.3462	0.1505	0.2222	54.9093
2012	30.5210	9.6101	5.7988	2.6883	1.6259	0.2118	0.2668	50.7226
2013	28.9599	7.9744	5.8887	2.2408	1.8681	0.2242	0.2551	47.4111
2014	24.2942	9.0156	5.3153	2.0819	1.9914	0.2328	0.2585	43.1897
2015	18.4813	8.8210	5.2320	1.9877	1.0638	0.3890	0.1895	36.1644
2016	12.5572	10.1097	3.5438	1.5143	1.3625	0.2643	0.1812	29.5329
2017	10.8510	11.3285	5.2294	1.8197	1.3505	0.2528	0.1361	30.9680
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1});
"^" = merged LYBR (2000-2011) and LYEB (2012-current) data

Table B-5. Observed Light Extinction Conditions for the Moosehorn Wilderness Area (ME) MANE-VU Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	6.6094	1.1516	3.0241	1.2397	0.9853	0.0436	0.0933	13.1471
2001	7.0210	1.2883	3.0124	1.0359	0.9001	0.1404	0.1360	13.5341
2002	6.5543	1.0383	3.0820	1.0036	1.0919	0.2597	0.1245	13.1543
2003	7.3850	0.9131	3.0920	0.9067	1.2369	0.3470	0.1041	13.9848
2004	5.7625	0.9065	3.1237	0.9300	1.1010	0.7105	0.1144	12.6485
2005	5.1411	0.7229	2.2331	0.8519	0.7050	0.8046	0.0784	10.5369
2006	5.4998	0.9418	2.8619	1.1318	0.6747	0.7096	0.1060	11.9256
2007	5.5015	0.6425	1.9018	0.6390	0.7789	0.3474	0.1051	9.9162
2008	4.8291	0.5542	2.0217	0.6440	1.0175	0.7004	0.1278	9.8947
2009	4.0301	0.5086	1.6421	0.4299	0.6257	0.6457	0.0794	7.9616
2010	2.9271	0.4116	1.5581	0.4693	0.4481	0.4170	0.0802	6.3114
2011	3.9249	0.3987	2.0636	0.5066	0.8260	0.4426	0.0325	8.1948
2012	4.3322	0.5173	1.9993	0.5145	0.8500	0.5350	0.0878	8.8361
2013	3.5033	0.5274	1.6247	0.3689	0.6483	0.5338	0.0413	7.2476
2014	4.1757	0.4658	2.0379	0.4181	0.7746	0.3532	0.0625	8.2878
2015	2.9793	0.4800	2.1457	0.3508	0.7836	0.7284	0.0397	7.5075
2016	2.8048	0.6860	1.3279	0.2047	0.7386	0.6593	0.0433	6.4646
2017	3.0473	0.6140	2.4057	0.5582	0.7249	0.3768	0.0754	7.8024
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	40.6148	7.3681	7.5082	3.7488	2.0787	1.0254	0.2444	62.5885
2001	64.7383	5.6566	9.6352	3.5389	1.6920	0.0234	0.4239	85.7083
2002	72.6980	5.3515	10.8759	3.4497	1.4912	0.0695	0.4568	94.3925
2003	62.8914	4.4503	10.0547	3.7341	2.0093	0.1218	0.2876	83.5492
2004	46.8080	4.1015	7.2903	2.2014	1.5327	1.4089	0.3851	63.7280
2005	60.0160	3.5937	8.3036	3.4497	1.1093	0.6235	0.2168	77.3125
2006	55.3450	4.8091	6.9353	2.7994	1.3327	0.8269	0.2530	72.3014
2007	39.4883	3.5534	7.2203	2.4658	1.3275	0.8751	0.2594	55.1897
2008	37.0484	2.2499	6.2838	1.9134	1.3542	0.4444	0.2619	49.5561
2009	37.7180	2.2324	5.7319	2.0849	1.2247	0.2125	0.3662	49.5706
2010	31.2618	2.8187	7.1016	2.2234	1.3960	0.2501	0.3697	45.4213
2011	26.4268	3.0111	6.5973	2.3142	1.4287	1.1761	0.1463	41.1004
2012	21.4805	2.7008	5.4908	1.6560	1.2853	0.7056	0.1964	33.5154
2013	19.8242	2.4443	4.7963	1.4853	1.3077	1.0228	0.1777	31.0583
2014	18.0345	2.7000	5.4235	1.6450	1.7365	0.7363	0.1536	30.4295
2015	19.0876	3.5576	5.5928	1.6121	1.1762	1.1180	0.2080	32.3524
2016	12.7132	3.7279	4.2231	1.3392	1.1608	0.8114	0.1402	24.1160
2017	10.5651	3.5222	4.6255	1.2530	1.2337	1.1486	0.1325	22.4806
2018								

"@" = does not include Rayleigh (12 Mm^{-1})

Table B-6. Observed Light Extinction Conditions for the Dolly Sods Wilderness Area (WV) Nearby Adjacent Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	14.1466	4.0176	6.5973	2.8846	0.7419	0.1281	0.2106	28.7267
2001	17.9991	2.8831	4.6931	2.1210	0.7378	0.0141	0.1950	28.6431
2002	13.1993	2.9989	4.6255	1.9693	0.7351	0.0028	0.1443	23.6752
2003	12.9810	3.0857	4.4461	1.6669	0.6758	0.0656	0.1626	23.0838
2004	13.4115	2.5299	4.0154	1.6233	0.7774	0.4166	0.1786	22.9527
2005	14.1525	3.4712	3.5653	1.8713	0.9139	0.1391	0.1609	24.2743
2006	12.0237	1.6111	2.9423	1.5956	0.8240	0.1772	0.1714	19.3452
2007	11.5849	1.6258	3.0507	1.4260	0.8161	0.2150	0.1849	18.9034
2008	9.7196	2.0432	2.3644	1.0493	0.7962	0.3067	0.1588	16.4381
2009	8.3081	1.5507	2.4941	1.0434	0.7285	0.1285	0.2595	14.5128
2010	10.0016	2.1692	3.4043	1.3171	0.7944	0.0642	0.2051	17.9559
2011	7.7774	1.5901	2.8769	1.0764	0.8510	0.3453	0.1047	14.6219
2012	9.3727	1.9137	2.7927	1.2251	0.9676	0.0776	0.1834	16.5328
2013	8.0718	1.5874	2.2204	0.9367	0.7561	0.0835	0.0959	13.7516
2014	7.4931	1.8611	2.3603	0.9700	0.8653	0.1416	0.1192	13.8107
2015	4.1304	0.8187	1.8949	0.5658	0.7754	0.1075	0.0884	8.3811
2016	5.5703	1.3965	2.0647	0.6652	0.7795	0.0845	0.0947	10.6555
2017	4.5396	1.4293	2.2045	0.7778	0.8010	0.0681	0.0712	9.8915
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	141.5192	2.1099	7.8060	4.8605	1.7264	0.0271	0.4600	158.5091
2001	154.5992	2.1851	7.8786	3.5032	1.2588	0.0284	0.7117	170.1650
2002	150.0593	2.6829	10.2265	3.8450	1.3325	0.0055	0.7638	168.9155
2003	171.0568	1.6116	11.1697	4.4499	0.7911	0.0045	0.5357	189.6192
2004	169.3490	1.5754	9.7011	3.1170	1.0405	0.2883	1.0374	186.1087
2005	190.9884	1.6732	8.2384	3.9760	1.8064	0.1128	0.5083	207.3035
2006	168.7131	1.7941	8.8231	3.7962	1.0891	0.1492	0.6420	185.0067
2007	155.1983	2.3273	11.6254	3.5723	2.0360	0.0630	0.8377	175.6599
2008	96.3276	2.1748	8.3898	2.6344	1.9012	0.0859	0.7568	112.2706
2009	68.9218	1.3986	6.3392	2.2077	1.5237	0.0071	0.6529	81.0510
2010	77.8422	2.2409	8.1699	2.4250	1.3044	0.0094	0.7305	92.7223
2011	88.1058	3.1288	8.2012	2.8346	1.7730	0.2635	0.3597	104.6666
2012	57.9241	2.5758	7.0945	2.3103	1.9001	0.2145	0.4910	72.5102
2013	44.6409	5.5172	5.6007	2.1222	1.2681	0.1556	0.2406	59.5453
2014	45.4693	7.2939	5.3741	2.1244	1.4915	0.1668	0.2355	62.1554
2015	40.6151	4.4176	6.9028	2.2084	1.7542	0.1015	0.3080	56.3077
2016	30.1309	6.3747	5.2023	1.7298	1.9187	0.1482	0.2416	45.7463
2017	22.0949	8.7003	6.6903	2.4259	1.7656	0.0530	0.2130	41.9429
2018								

"@" = does not include Rayleigh (10 Mm^{-1})

Table B-7. Observed Light Extinction Conditions for the Shenandoah National Park (VA) Nearby Adjacent Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	8.7478	4.6604	4.0378	2.0622	1.4201	0.0906	0.1602	21.1790
2001	15.7978	5.3540	3.1117	1.7873	1.3521	0.2586	0.2044	27.8660
2002	11.9042	4.8729	2.7816	1.6172	0.9004	0.0029	0.1368	22.2160
2003	10.0164	2.9020	2.2700	1.3118	1.0800	0.1302	0.1665	17.8768
2004	9.3532	3.0335	2.1409	1.2039	0.7366	0.2529	0.1188	16.8397
2005	11.5988	2.9367	2.7523	1.6925	0.8282	0.1313	0.1311	20.0708
2006	10.8099	3.2486	2.3501	1.5255	1.1004	0.2713	0.2052	19.5111
2007	12.1544	4.3317	2.1840	1.3783	0.8723	0.1863	0.1395	21.2465
2008	8.0929	2.3305	1.5283	0.8868	0.7935	0.1485	0.1268	13.9073
2009	7.7142	1.7652	1.9921	0.9887	1.0924	0.0972	0.1407	13.7905
2010	8.3517	3.4914	2.7915	1.2714	1.1434	0.0751	0.1637	17.2882
2011	6.5673	2.1707	1.7210	0.8535	1.0937	0.2929	0.0727	12.7718
2012	8.6585	3.1769	2.2517	1.0074	1.0954	0.1083	0.1496	16.4479
2013	5.6372	2.4554	1.6530	0.6622	0.8900	0.2996	0.1150	11.7124
2014	6.2681	2.2664	1.9677	0.8285	1.1921	0.1635	0.1031	12.7893
2015	3.8239	1.9364	2.2123	0.6580	1.0629	0.0848	0.0534	9.8318
2016	5.5528	1.9586	2.1164	0.6997	1.0231	0.0488	0.0932	11.4926
2017	3.9204	1.3711	2.4161	0.7356	0.7898	0.0524	0.0545	9.3399
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	128.8990	4.1850	9.9459	5.3869	2.0290	0.0284	0.3600	150.8343
2001	143.4537	9.0001	7.7466	4.2740	1.8318	0.0304	0.4454	166.7820
2002	176.1417	5.4536	11.2035	4.6183	2.9405	0.0055	1.1210	201.4840
2003	143.9188	5.3701	10.6380	4.7023	1.6874	0.0043	0.4480	166.7688
2004	156.8712	6.0322	10.0209	4.9937	1.7256	0.3596	0.9235	180.9266
2005	192.8233	4.3379	8.7925	4.6373	2.0647	0.3389	0.5038	213.4984
2006	143.1303	3.0866	9.5239	4.3166	1.9407	0.3166	0.6003	162.9150
2007	143.0214	4.0684	13.2888	4.5619	2.3397	0.2650	0.7244	168.2697
2008	89.6640	6.1538	10.3181	3.6208	2.0745	0.2069	0.7028	112.7409
2009	60.3784	3.8315	6.5886	3.0711	1.9642	0.2288	0.5177	76.5802
2010	65.4576	8.3506	7.9447	2.9117	2.3196	0.0023	0.5464	87.5328
2011	68.3673	3.9443	7.9373	2.8746	2.7379	0.2975	0.3384	86.4972
2012	45.0159	4.5070	6.0342	2.4316	1.9784	0.4315	0.4152	60.8138
2013	39.4577	10.4940	4.6677	2.1982	1.4645	0.2447	0.1881	58.7150
2014	37.7059	8.9706	5.2984	2.3515	1.7870	0.2155	0.2264	56.5552
2015	35.3857	7.4756	8.3309	2.7946	1.9578	0.1964	0.2586	56.3996
2016	25.1219	9.4588	5.5815	1.9341	2.0337	0.1534	0.1871	44.4705
2017	19.9101	11.4253	6.6022	2.3073	1.6005	0.2105	0.1835	42.2394
2018								

"@" = does not include Rayleigh (10 Mm^{-1})

Table B-8. Observed Light Extinction Conditions for the James River Face Wilderness Area (VA) Nearby Adjacent Class I Area

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	19.1849	3.2609	5.3709	2.8101	1.2455	0.0531	0.2245	32.1499
2002	21.1568	4.9388	6.2412	3.4439	1.3101	0.0039	0.2379	37.3326
2003	14.0850	3.8128	4.5797	2.4597	1.1918	0.0287	0.2739	26.4316
2004	15.4764	2.9258	6.0497	3.1613	1.1898	0.2229	0.2445	29.2706
2005	19.9807	4.2811	5.2626	3.2265	1.4257	0.1126	0.2319	34.5212
2006	19.2788	3.4986	5.5706	3.4102	1.8087	0.1551	0.2657	33.9877
2007	17.3316	3.2157	4.3385	2.7048	1.4582	0.2023	0.2249	29.4760
2008	14.9188	3.0528	4.6712	2.6783	1.2790	0.1013	0.2087	26.9101
2009	10.9888	2.2523	3.8284	2.0831	1.5694	0.1648	0.2033	21.0900
2010	16.4704	3.0192	4.5629	2.1453	1.4140	0.0464	0.3205	27.9787
2011	12.3627	1.8692	3.7655	1.7429	1.6762	0.2397	0.1593	21.8155
2012	11.5967	2.4637	5.6302	2.4316	1.7589	0.1271	0.2318	24.2399
2013	8.2139	1.7395	3.5919	1.4437	0.9826	0.2296	0.1687	16.3699
2014	9.6828	1.5492	4.0243	1.7648	1.7273	0.1115	0.1411	19.0011
2015	5.8387	1.7649	4.5823	1.7035	1.7368	0.1577	0.1371	15.9209
2016	6.6056	1.9722	3.8130	1.4122	1.3947	0.0954	0.1169	15.4099
2017	4.9494	1.4940	3.0558	1.2448	1.4754	0.0561	0.1301	12.4057
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	132.2904	7.2127	16.8323	6.9203	2.9931	0.5025	0.7988	167.5500
2002	148.0798	4.0817	15.0645	5.7830	2.8611	0.1352	1.0157	177.0209
2003	124.7295	4.8802	14.7736	6.4411	2.8455	0.0041	0.4914	154.1654
2004	122.2393	3.6224	15.3622	5.8388	2.1932	0.3523	0.9054	150.5136
2005	174.5107	3.7972	14.2471	8.2945	3.5191	0.1969	0.4817	205.0473
2006	134.4870	2.9221	15.0747	6.9537	2.5464	0.2995	0.6027	162.8861
2007	125.5670	3.6713	15.0670	6.3978	2.5319	0.2789	0.7232	154.2371
2008	77.6731	4.1059	13.0174	5.7342	2.4304	0.2376	0.6638	103.8623
2009	63.0029	2.5947	10.2159	4.2880	2.3932	0.1162	0.5421	83.1530
2010	65.0319	4.4435	13.7092	5.4270	2.8733	0.0144	0.7022	92.2015
2011	66.9082	5.5241	12.1515	5.0145	2.3976	0.3096	0.3431	92.6485
2012	40.6596	4.3408	11.7355	5.1452	2.0124	0.1735	0.4783	64.5453
2013	37.5307	3.8115	8.6118	3.6434	0.8789	0.1950	0.2939	54.9652
2014	36.9775	8.8556	7.3489	3.6913	1.4973	0.1731	0.1957	58.7394
2015	32.0451	4.6975	10.0984	3.9861	2.3362	0.1440	0.2627	53.5699
2016	24.0117	6.1615	10.3791	3.9140	1.6937	0.1437	0.2418	46.5456
2017	21.5483	5.9999	11.8928	4.0705	2.1686	0.0999	0.2612	46.0413
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-9. Observed Light Extinction Conditions for the Addison Pinnacle (NY) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	14.3098	3.2439	3.2420	1.6765	1.1586	0.0475	0.1581	23.8365
2003	12.0673	3.5573	3.5365	1.6258	0.8857	0.1424	0.1445	21.9594
2004	10.3916	3.0171	3.3263	1.6408	0.9852	0.4677	0.1308	19.9594
2005	12.9827	3.2517	2.6764	1.8089	0.9346	0.1856	0.1189	21.9587
2006	9.2887	1.7348	2.9776	1.4604	1.2672	0.2287	0.2046	17.1621
2007	9.6633	2.5217	2.9100	1.4816	1.2204	0.1937	0.1669	18.1576
2008	10.1652	2.6421	3.5225	1.5237	1.2474	0.1716	0.2107	19.4831
2009	8.8203	1.4799	2.3712	1.0268	1.2121	0.1999	0.1353	15.2455
2010	*	*	*	*	*	*	*	*
2011	*	*	*	*	*	*	*	*
2012	*	*	*	*	*	*	*	*
2013	*	*	*	*	*	*	*	*
2014	*	*	*	*	*	*	*	*
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	147.2118	10.2574	12.4725	5.7629	2.1695	0.0054	0.8373	178.7168
2003	131.6619	8.4282	11.4617	5.0231	1.9470	0.0545	0.5337	159.1101
2004	123.2724	4.7459	8.8514	4.6669	1.6855	0.2534	0.6340	144.1095
2005	160.9014	9.6897	8.9090	4.9204	1.8335	0.3185	0.4726	187.0453
2006	108.8439	5.5277	8.7107	4.5502	2.1023	0.1947	0.5210	130.4504
2007	120.4900	6.4069	11.7953	5.5383	2.9194	0.1520	0.7114	148.0134
2008	84.3684	9.1221	9.2028	4.4413	2.0756	0.1375	0.5934	109.9411
2009	61.6627	10.7476	6.4110	3.2622	1.8475	0.1468	0.5140	84.5919
2010	*	*	*	*	*	*	*	*
2011	*	*	*	*	*	*	*	*
2012	*	*	*	*	*	*	*	*
2013	*	*	*	*	*	*	*	*
2014	*	*	*	*	*	*	*	*
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-10. Observed Light Extinction Conditions for the Arendtsville (PA) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	22.0022	6.4678	4.5852	2.4352	1.3356	0.0395	0.2230	37.0884
2003	16.1986	6.2926	4.8707	2.3333	1.5366	0.0830	0.2085	31.5232
2004	12.0715	5.0880	4.4856	2.1399	1.4076	0.4677	0.1880	25.8484
2005	17.9307	6.9589	3.6971	2.7031	1.5183	0.5123	0.1592	33.4796
2006	15.0883	3.6052	3.6534	2.2960	2.0266	0.3328	0.3637	27.3660
2007	14.0387	4.4303	3.8319	2.2713	2.0327	0.4273	0.1952	27.2274
2008	15.7186	4.8699	4.0369	1.9598	1.4737	0.4338	0.2840	28.7767
2009	11.9705	2.5735	3.4752	1.5925	1.4796	0.3480	0.2354	21.6748
2010	11.1675	3.0761	3.5510	1.6060	1.8222	0.1833	0.2213	21.6273
2011	*	*	*	*	*	*	*	*
2012	*	*	*	*	*	*	*	*
2013	*	*	*	*	*	*	*	*
2014	*	*	*	*	*	*	*	*
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	153.4380	15.3681	15.1674	5.7473	2.8931	0.3890	1.2543	194.2572
2003	126.3764	29.2450	12.3877	6.1613	2.7975	0.6718	0.5454	178.1851
2004	139.8009	25.8959	13.7780	6.2432	2.8723	1.0920	0.7680	190.4503
2005	167.7738	27.4705	11.2578	6.5765	3.4616	0.9172	0.6263	218.0837
2006	129.7382	22.1610	14.0652	6.8423	2.7192	0.9502	0.5505	177.0266
2007	114.5123	16.4667	12.6944	5.9311	3.2036	0.5699	0.5886	153.9665
2008	84.7384	28.7637	10.3864	5.5553	2.8005	0.9508	0.6416	133.8366
2009	68.0285	30.3833	8.8085	4.8030	2.1924	0.6942	0.5800	115.4898
2010	64.7452	23.1160	10.7114	4.5343	3.2007	0.3598	0.6412	107.3086
2011	*	*	*	*	*	*	*	*
2012	*	*	*	*	*	*	*	*
2013	*	*	*	*	*	*	*	*
2014	*	*	*	*	*	*	*	*
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-11. Observed Light Extinction Conditions for the Bridgton (ME) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	6.5068	1.1147	3.3996	1.3354	0.9291	0.2309	0.0941	13.6107
2003	6.4513	0.9757	2.5871	1.0466	0.8844	0.5976	0.1004	12.6430
2004	6.4566	1.3435	2.9691	1.1354	0.7100	0.4664	0.1437	13.2247
2005	5.3204	0.8802	1.9260	0.9305	0.6332	0.2303	0.0673	9.9879
2006	5.9962	0.7028	2.0918	0.8815	0.8410	0.2012	0.1347	10.8493
2007	5.4504	0.6410	1.8614	0.7950	0.7357	0.2481	0.1088	9.8405
2008	4.8453	0.7733	2.3597	0.8825	0.8528	0.2418	0.1466	10.1022
2009	3.3433	0.5732	1.9008	0.7066	0.7854	0.1462	0.0558	7.5112
2010	3.2480	0.4166	1.8345	0.6461	0.5718	0.0909	0.0893	6.8972
2011	4.2680	0.4760	2.4528	0.7117	0.7644	0.1871	0.0491	8.9091
2012	4.4539	0.6537	2.2453	0.7930	0.8536	0.1320	0.0927	9.2241
2013	3.8550	0.5873	1.7434	0.5043	0.6199	0.3390	0.0412	7.6900
2014	4.1292	0.4561	2.3145	0.5896	0.6553	0.0670	0.0715	8.2832
2015	3.0030	0.4985	1.9250	0.4655	0.7191	0.0961	0.0490	6.7562
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	75.9993	4.6227	10.3022	4.2093	1.2230	0.0045	0.5019	96.8629
2003	66.1309	6.3634	12.9541	5.2657	1.7869	0.0033	0.3822	92.8865
2004	75.5098	5.3729	9.7986	3.7952	1.4997	0.4360	0.6473	97.0594
2005	54.1735	3.7681	9.1455	4.3707	1.3107	0.2918	0.2675	73.3277
2006	67.8324	4.6819	11.2145	5.6335	1.5411	0.2219	0.3744	91.4997
2007	49.9504	4.4478	9.9760	4.0050	2.3760	0.3213	0.3692	71.4458
2008	37.4506	2.2429	7.3768	3.1380	1.6719	0.1206	0.4236	52.4244
2009	37.8962	3.3005	6.9534	3.1104	1.4412	0.1219	0.4170	53.2407
2010	33.4854	1.6679	8.5539	2.8307	1.5203	0.0512	0.4596	48.5690
2011	32.0726	2.8399	8.5669	2.9070	1.5154	0.2808	0.1833	48.3659
2012	22.5613	2.8876	8.2610	3.1499	1.5317	0.3435	0.2514	38.9864
2013	21.4136	5.5048	7.0842	2.7930	0.7902	0.5277	0.2440	38.3575
2014	21.8151	4.3202	6.6720	2.7339	0.9275	0.3897	0.1780	37.0364
2015	19.0368	5.3387	8.1311	2.4677	1.6595	0.3786	0.2215	37.2339
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-12. Observed Light Extinction Conditions for the Casco Bay (ME) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	6.9717	1.3286	3.3737	1.4910	1.1093	0.4593	0.2577	14.9912
2003	7.0204	1.0527	3.0516	1.3818	1.0457	0.4674	0.1226	14.1422
2004	7.2197	1.2592	3.5968	1.4790	1.1877	0.8551	0.1411	15.7387
2005	6.3643	0.9904	2.6444	1.4617	0.7411	0.4118	0.1010	12.7146
2006	5.9500	0.9737	2.7449	1.4267	1.1580	0.4858	0.1161	12.8552
2007	6.0368	0.8225	2.6782	1.1812	0.9444	0.4763	0.0981	12.2376
2008	6.6669	1.2631	3.1171	1.2708	1.1315	0.9036	0.1327	14.4858
2009	3.7985	0.8163	2.6830	1.0390	0.9768	0.4165	0.0829	9.8129
2010	4.0077	0.4863	2.6941	0.9420	0.9060	0.4040	0.1037	9.5439
2011	5.6707	0.7078	2.8931	1.2188	1.2024	0.4985	0.0699	12.2612
2012	5.4883	0.9129	3.3724	1.3128	1.5722	0.4018	0.1052	13.1656
2013	4.1198	0.8417	2.4618	0.8302	0.9247	0.4673	0.0450	9.6906
2014	4.6067	0.6526	2.6086	0.7785	1.0936	0.3798	0.0845	10.2041
2015	3.6036	0.6904	2.6868	0.8427	1.2129	0.5999	0.0736	9.7100
2016	3.3965	0.7968	2.3699	0.7629	1.0312	0.5289	0.0506	8.9366
2017	4.0325	0.9554	2.7486	0.9078	1.0970	0.6043	0.0944	10.4400
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	69.2842	8.8081	15.9070	6.2515	2.6307	0.8533	0.7234	104.4582
2003	63.8771	6.6185	13.8836	6.1549	2.3605	0.3447	0.4605	93.6999
2004	55.8988	10.6492	10.6811	5.1528	2.2638	1.3565	0.6218	86.6239
2005	58.8241	8.0369	8.9060	5.5807	1.4236	1.5530	0.2471	84.5714
2006	66.1071	6.0088	9.2793	5.2034	2.0210	0.8612	0.3601	89.8410
2007	50.8797	7.0599	11.0686	4.9112	2.2263	1.3366	0.3433	77.8256
2008	45.0073	3.8482	9.2318	4.2275	2.0675	0.6131	0.3326	65.3280
2009	42.3892	4.2860	8.4970	3.8310	1.6904	0.9254	0.4635	62.0826
2010	34.9994	3.4687	9.9669	4.3200	2.3786	0.4085	0.5171	56.0592
2011	28.7485	3.7704	10.6488	4.2323	2.8348	0.8661	0.1521	51.2529
2012	20.2141	7.1320	9.6302	3.9995	2.7225	1.5139	0.1934	45.4056
2013	21.5208	6.8882	9.4878	4.0167	1.4140	1.2256	0.1893	44.7422
2014	18.3033	7.0615	9.1231	3.9035	2.2854	1.2878	0.1762	42.1407
2015	19.6606	7.1699	11.3830	4.1927	1.9681	0.9411	0.2514	45.5668
2016	11.0766	6.1420	7.7270	3.1415	1.9646	1.0097	0.1588	31.2200
2017	11.3610	6.2870	9.0874	3.2891	1.7264	1.5419	0.1776	33.4704
2018								

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-13. Observed Light Extinction Conditions for the Cape Cod (MA) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	8.7183	2.1123	2.7332	1.0693	2.1392	1.7875	0.1288	18.6888
2003	8.0773	2.0469	2.6667	0.9823	2.4270	1.9618	0.1005	18.2624
2004	9.3367	2.1563	3.1652	1.1716	2.2252	3.0661	0.1319	21.2530
2005	9.0531	2.0156	3.0087	1.1159	2.6698	3.8321	0.1087	21.8038
2006	8.3215	1.5172	2.5552	0.8530	1.9050	2.7402	0.1215	18.0137
2007	6.4979	1.5679	2.3042	0.6978	1.6533	2.5264	0.0759	15.3235
2008	7.3679	1.8205	3.1270	0.9675	2.1612	2.0988	0.1357	17.6786
2009	6.3511	1.5907	2.0891	0.6154	1.4596	2.9063	0.0988	15.1110
2010	5.2003	1.2133	2.5608	0.7940	2.0873	2.8893	0.1028	14.8477
2011	6.5535	1.4917	2.5496	0.8673	1.9673	2.7183	0.1103	16.2580
2012	5.5078	1.5293	2.7486	0.7840	1.8231	2.1637	0.0718	14.6283
2013	4.7140	1.3181	2.4550	0.7923	2.0687	2.4438	0.0888	13.8806
2014	4.7730	1.1507	2.3014	0.5282	1.9366	2.2738	0.0768	13.0405
2015	4.2916	1.1158	2.2686	0.4204	1.9361	2.0517	0.0575	12.1417
2016	3.6306	1.2773	1.6470	0.4767	1.6836	2.3156	0.0596	11.0903
2017	4.4379	1.8601	2.6997	0.7354	2.1515	2.2944	0.0728	14.2518
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	73.2399	10.0071	9.5210	3.7644	3.2254	0.4950	0.5689	100.8217
2003	108.1193	5.9113	13.5769	4.8970	3.5191	0.9021	0.6221	137.5478
2004	81.3048	4.9970	9.6704	3.7600	3.3094	0.9293	0.7269	104.6977
2005	102.4779	4.9417	9.3678	4.3730	2.5936	1.0497	0.4102	125.2139
2006	67.9692	6.9172	10.3374	4.4235	2.5520	1.5102	0.4551	94.1647
2007	90.6716	6.7007	9.5946	4.2273	2.6075	0.7524	0.5214	115.0756
2008	50.7998	6.0937	7.7092	2.5787	2.6986	1.7387	0.4788	72.0976
2009	54.6003	6.1389	6.8661	3.0727	1.9646	1.2261	0.5746	74.4434
2010	40.2509	6.8138	8.7154	2.8100	3.2303	1.5791	0.5286	63.9281
2011	35.2372	5.4837	9.4345	3.2965	2.8684	1.7919	0.2128	58.3250
2012	30.8188	7.0575	8.5350	3.1935	2.3216	1.2936	0.2866	53.5067
2013	24.6006	5.7284	6.5260	2.2329	2.7725	2.0213	0.3522	44.2339
2014	20.6290	8.0132	6.1066	2.4060	3.4617	2.1057	0.2038	42.9261
2015	22.5081	7.7088	7.1359	2.2879	2.6067	1.7823	0.4237	44.4534
2016	15.5484	5.8914	6.5655	2.0725	3.2928	1.8171	0.2110	35.3986
2017	15.6885	5.3626	7.4624	2.1782	3.1612	2.0008	0.1757	36.0293
2018								

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-14. Observed Light Extinction Conditions for the Frostburg Reservoir (MD) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	19.5307	4.6939	3.8228	2.7718	1.4485	0.1692	0.2050	32.6420
2006	16.6169	3.4710	3.8400	2.5899	1.7274	0.1224	0.3124	28.6799
2007	15.7978	2.4874	3.3963	2.2525	1.5201	0.1794	0.2561	25.8895
2008	15.2038	3.3614	3.4822	1.9813	1.4243	0.0867	0.2515	25.7913
2009	12.4382	1.8374	2.1476	1.3663	1.0161	0.0913	0.1622	19.0590
2010	13.3502	2.7730	3.0765	1.7378	1.5518	0.1217	0.2502	22.8612
2011	11.5495	2.4756	2.9537	1.4885	1.1988	0.3958	0.1254	20.1872
2012	11.2503	2.9650	3.4149	1.8485	2.1214	0.1353	0.2560	21.9914
2013	9.8060	2.4969	2.3486	1.1689	1.9725	0.2133	0.1410	18.1471
2014	10.0682	2.6941	2.9209	1.4022	1.9191	0.2274	0.1654	19.3973
2015	7.3375	2.3083	3.1229	1.4135	1.0481	0.0730	0.1190	15.4223
2016	6.7722	2.2396	3.0257	1.2230	1.5861	0.1175	0.1266	15.0907
2017	7.2708	2.3975	2.9038	1.1779	1.2158	0.0879	0.0997	15.1535
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	218.6769	2.2453	9.4548	4.9361	2.0187	0.0245	0.6899	238.0461
2006	172.8702	2.4451	10.3833	4.4489	2.2564	0.0502	0.7350	193.1891
2007	143.4868	2.7350	10.8874	4.4373	2.5379	0.0835	0.6873	164.8552
2008	93.0224	4.4962	9.0923	3.6639	2.3965	0.0576	0.7588	113.4876
2009	78.9589	7.4247	7.2391	3.4051	1.9697	0.0632	0.5959	99.6566
2010	84.5645	5.3723	9.1193	3.4745	2.1335	0.0113	0.6977	105.3732
2011	88.3061	3.9633	8.9770	3.2757	2.4857	0.1679	0.2922	107.4678
2012	52.0661	6.8132	6.7866	3.3068	2.8818	0.2161	0.4164	72.4870
2013	48.9757	10.4874	6.6976	3.2476	3.0203	0.2165	0.2340	72.8790
2014	46.1406	16.3683	5.3425	3.3970	2.4002	0.1714	0.2649	74.0850
2015	41.5633	7.9025	7.9334	3.3281	2.1576	0.1647	0.2880	63.3374
2016	29.7627	9.4846	5.5844	2.4090	2.1158	0.1613	0.2057	49.7236
2017	26.0703	13.8708	7.4232	3.2851	2.1588	0.1754	0.2177	53.2013
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-15. Observed Light Extinction Conditions for the Londonderry (NH) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	*	*	*	*	*	*	*	*
2006	*	*	*	*	*	*	*	*
2007	*	*	*	*	*	*	*	*
2008	*	*	*	*	*	*	*	*
2009	*	*	*	*	*	*	*	*
2010	*	*	*	*	*	*	*	*
2011	6.2645	1.1709	4.0150	1.7625	1.2097	0.3493	0.1037	14.8757
2012	5.4793	1.2984	3.5015	1.4822	1.4031	0.3723	0.1040	13.6407
2013	4.3779	0.9793	2.6627	1.0693	1.0926	0.5664	0.0834	10.8316
2014	4.6697	0.8976	3.2118	1.1417	1.2596	0.3351	0.1018	11.6173
2015	4.1106	0.8347	2.8049	0.9961	1.1157	0.3105	0.1129	10.2853
2016	3.6141	0.9369	2.5247	0.9780	1.4608	0.3658	0.0859	9.9662
2017	4.0964	1.4122	3.3031	1.2478	1.4828	0.3975	0.0903	12.0300
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	*	*	*	*	*	*	*	*
2006	*	*	*	*	*	*	*	*
2007	*	*	*	*	*	*	*	*
2008	*	*	*	*	*	*	*	*
2009	*	*	*	*	*	*	*	*
2010	*	*	*	*	*	*	*	*
2011	37.1126	4.4598	13.9113	4.4975	2.2160	0.4737	0.2557	62.9266
2012	26.4690	6.7072	11.3191	4.4694	2.2691	0.6138	0.3828	52.2306
2013	26.6229	8.7824	9.9717	4.1445	1.9351	0.5319	0.2373	52.2258
2014	21.8842	10.0899	9.4488	4.5110	2.0099	0.5356	0.2746	48.7539
2015	21.4511	11.1478	10.5983	4.2550	2.1171	0.5301	0.3321	50.4316
2016	13.4719	8.5233	10.4587	4.4889	1.8319	0.6106	0.2105	39.5959
2017	12.7247	10.4952	11.8638	4.7629	2.3379	0.9828	0.1981	43.3653
2018								

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-16. Observed Light Extinction Conditions for the Martha's Vineyard (MA) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	10.8222	2.0740	3.7599	1.2498	1.9621	1.1291	0.1424	21.1395
2004	9.3018	2.4877	3.4634	1.4371	2.3856	2.9856	0.1487	22.2098
2005	10.8933	2.3023	2.3525	1.2992	2.0316	3.5102	0.1185	22.5076
2006	8.6764	1.7992	2.6706	1.2176	1.9884	2.2495	0.1228	18.7245
2007	7.1104	1.8843	2.1647	0.8424	2.2370	2.2968	0.1081	16.6437
2008	8.0043	1.9408	2.3850	0.9749	2.0102	2.1225	0.1534	17.5911
2009	6.3300	1.4967	2.1481	0.8140	2.0975	2.1173	0.1216	15.1251
2010	5.4134	1.3882	2.6449	0.8812	2.1720	2.6969	0.1266	15.3232
2011	6.9767	1.8929	3.0550	0.8395	2.8383	3.2830	0.1136	18.9993
2012	5.7813	1.5651	2.7404	0.8143	2.2629	1.8954	0.1025	15.1619
2013	4.0052	1.3179	1.9339	0.6963	3.0522	2.0821	0.0828	13.1703
2014	5.6109	1.9058	2.3256	0.7689	2.8817	2.3271	0.1140	15.9340
2015	4.6062	1.2953	2.2204	0.5726	4.5833	2.3162	0.0879	15.6819
2016	4.2220	1.5061	1.8954	0.5895	3.6326	1.8536	0.0767	13.7759
2017	5.0410	1.9351	2.5496	0.7648	2.5959	2.3530	0.0841	15.3236
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	120.2975	7.3178	12.5998	4.7506	1.2200	0.0041	0.4570	146.6469
2004	87.0309	6.6082	8.0904	3.0150	2.7385	1.4863	0.7398	109.7090
2005	112.0928	7.4668	7.1089	4.2904	3.2808	2.0736	0.4548	136.7681
2006	89.9496	8.9973	9.6157	3.3616	3.6038	3.9033	0.5283	119.9595
2007	77.3993	7.2726	7.0549	3.4650	3.7560	1.4042	0.4887	100.8406
2008	60.4868	7.7358	10.0101	3.1372	3.3516	2.0663	0.5264	87.3141
2009	57.4253	8.6667	7.8092	3.1878	3.0916	2.3927	0.6340	83.2074
2010	45.8534	10.8577	9.3774	3.3440	3.6400	2.1978	0.6899	75.9602
2011	50.1773	7.4570	10.9220	2.9341	4.3905	3.1288	0.2688	79.2784
2012	30.5686	8.9615	7.2111	2.5827	3.8551	2.1589	0.3141	55.6520
2013	30.7035	10.4202	7.6676	2.8394	4.9670	2.8485	0.3710	59.8172
2014	21.4909	9.5212	5.7282	2.1990	6.7941	2.8552	0.2383	48.8269
2015	27.9163	11.3054	8.7854	2.4459	5.1995	2.4494	0.2853	58.3871
2016	15.2560	8.2512	6.2948	1.9496	6.9511	3.5886	0.2223	42.5137
2017	16.4017	8.0259	7.5927	2.0761	5.7839	3.8699	0.1996	43.9499
2018								

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-17. Observed Light Extinction Conditions for the M.K. Goddard (PA) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	17.7122	6.0997	5.2179	2.7078	1.2241	0.0033	0.1928	33.1580
2003	13.3865	6.1889	5.4603	2.6730	1.3967	0.2096	0.2142	29.5292
2004	14.3822	5.4775	5.1188	2.5964	1.1767	0.4740	0.1987	29.4243
2005	18.4982	5.3294	5.2542	2.9640	1.7132	0.3384	0.1862	34.2836
2006	13.4433	3.9845	4.1680	2.7179	1.5477	0.4714	0.2543	26.5870
2007	12.3619	4.4558	4.4874	2.6555	1.3001	0.4348	0.1908	25.8862
2008	13.6642	4.5931	5.0039	2.4250	1.1841	0.2529	0.2546	27.3777
2009	11.1118	2.4858	4.3083	2.0400	1.3470	0.2770	0.1891	21.7589
2010	9.4091	2.7387	4.7290	2.4187	1.2865	0.3600	0.2448	21.1867
2011	*	*	*	*	*	*	*	*
2012	*	*	*	*	*	*	*	*
2013	*	*	*	*	*	*	*	*
2014	*	*	*	*	*	*	*	*
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	129.8110	22.3573	13.8993	6.4218	2.9646	0.1019	0.7833	176.3393
2003	114.3294	17.8439	15.1810	7.2518	2.3014	0.2166	0.5042	157.6283
2004	120.9804	12.8055	15.5130	7.5364	2.4426	0.6810	0.8159	160.7748
2005	188.5080	8.6301	14.9874	8.2395	2.9933	0.3292	0.6331	224.3205
2006	118.7798	13.1396	11.1408	6.4711	2.2708	0.4617	0.6280	152.8918
2007	123.1580	13.7453	13.6989	7.6191	2.6344	0.3726	0.8732	162.1015
2008	83.6967	21.0123	12.8935	6.0036	2.1773	0.3635	0.6744	126.8214
2009	76.8780	24.3304	10.8396	5.5025	2.1313	0.3619	0.6236	120.6673
2010	82.9720	18.0328	14.7833	5.5942	1.9687	0.3489	0.6878	124.3878
2011	*	*	*	*	*	*	*	*
2012	*	*	*	*	*	*	*	*
2013	*	*	*	*	*	*	*	*
2014	*	*	*	*	*	*	*	*
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-18. Observed Light Extinction Conditions for the Mohawk Mt. (CT) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	9.3532	2.3162	2.8952	1.4436	1.2737	0.0992	0.1617	17.5429
2003	8.0144	1.5965	2.7895	1.2836	0.7407	0.0873	0.1418	14.6537
2004	8.1904	2.1376	2.9937	1.2570	0.8491	0.4916	0.1467	16.0660
2005	7.5203	1.5636	2.3574	1.2520	0.9531	0.2256	0.1157	13.9876
2006	6.5565	1.3116	2.4017	1.1065	0.9348	0.1889	0.1432	12.6431
2007	6.2404	0.9544	1.9199	0.9959	0.8145	0.2144	0.1082	11.2477
2008	*	*	*	*	*	*	*	*
2009	4.1491	1.0581	1.7300	0.8088	1.1085	0.3136	0.0724	9.2406
2010	3.9627	1.1592	1.8881	0.7093	0.7556	0.1923	0.1383	8.8055
2011	5.5822	1.6276	2.2673	0.9437	0.9948	0.2398	0.0714	11.7268
2012	5.3238	1.6446	2.0054	0.8277	0.7062	0.2604	0.0889	10.8571
2013	4.2424	1.1461	1.7616	0.6410	0.7125	0.2032	0.0626	8.7695
2014	4.6490	1.4651	2.1135	0.7509	1.2191	0.1324	0.0607	10.3906
2015	3.0929	1.0114	1.8668	0.6171	0.7940	0.1185	0.0733	7.5740
2016	3.1386	1.1654	1.9228	0.6367	0.8212	0.1955	0.0683	7.9485
2017	3.2054	1.2010	1.7936	0.6363	0.7471	0.0984	0.0599	7.7416
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	103.2350	10.7503	12.9688	5.3793	1.9452	0.2029	0.6463	135.1277
2003	97.5035	12.8803	13.3995	6.0738	1.9694	1.7684	0.6417	134.2367
2004	113.1590	5.7663	18.7812	4.2017	1.2830	0.1861	0.9481	144.3253
2005	139.6234	5.4332	10.8384	5.6316	1.7436	0.2100	0.4968	163.9770
2006	97.1985	6.7073	13.0157	5.5117	2.0676	0.1991	0.5624	125.2623
2007	119.5890	5.0466	13.8510	5.0686	2.7964	0.1488	0.6771	147.1776
2008	*	*	*	*	*	*	*	*
2009	51.4179	8.6118	8.2499	3.2522	1.5945	0.0924	0.5494	73.7682
2010	48.2256	7.5110	10.5350	4.2409	2.1052	0.1055	0.4898	73.2129
2011	42.4310	9.9903	8.8258	3.8366	2.5608	0.5142	0.2496	68.4083
2012	32.7642	12.1586	7.7623	3.6010	1.7111	0.3630	0.2891	58.6492
2013	29.6422	9.1534	6.8698	3.0807	1.6771	0.3101	0.2035	50.9369
2014	22.3731	10.2318	5.2408	2.5568	1.9040	0.3229	0.2674	42.8968
2015	23.1169	12.4729	7.3603	3.0285	1.6005	0.2052	0.2590	48.0433
2016	14.8916	9.8774	5.8499	2.3449	1.5072	0.2266	0.2266	34.9243
2017	13.0906	10.4739	7.0073	2.5747	1.5889	0.3014	0.1761	35.2129
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-19. Observed Light Extinction Conditions for the Pack Monadnock Summit (NY) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	*	*	*	*	*	*	*	*
2006	*	*	*	*	*	*	*	*
2007	*	*	*	*	*	*	*	*
2008	4.3131	0.8160	1.6656	0.6319	0.8070	0.1731	0.0897	8.4963
2009	2.4704	0.4882	1.3798	0.4875	0.4023	0.1938	0.0590	5.4809
2010	2.7436	0.5448	1.5079	0.4668	0.4713	0.1038	0.0716	5.9098
2011	3.1593	0.4990	1.8138	0.6292	0.6312	0.0588	0.0587	6.8498
2012	3.4098	0.6552	1.2654	0.5682	0.4384	0.1979	0.0604	6.5952
2013	3.0724	0.5540	1.1161	0.4599	0.4193	0.2254	0.0392	5.8863
2014	2.5548	0.5531	1.2615	0.3394	0.3986	0.2928	0.0294	5.4297
2015	2.2442	0.4814	1.3628	0.3782	0.4183	0.0606	0.0335	4.9790
2016	1.8194	0.5932	1.3948	0.4004	0.6169	0.1107	0.0341	4.9693
2017	2.3033	0.8320	1.6444	0.6696	0.4862	0.0822	0.0443	6.0619
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	*	*	*	*	*	*	*	*
2006	*	*	*	*	*	*	*	*
2007	*	*	*	*	*	*	*	*
2008	45.6744	2.2798	7.6391	2.6080	1.9859	0.1071	0.4340	60.7284
2009	41.0632	4.3599	6.8705	2.4180	1.2633	0.0502	0.4680	56.4931
2010	42.6229	2.8880	9.6986	2.7737	1.6214	0.0121	0.4556	60.0723
2011	34.7469	3.7279	7.9896	2.5159	1.8217	0.1841	0.1988	51.1849
2012	28.7522	6.3031	7.3021	2.9854	1.6094	0.1769	0.3262	47.4554
2013	25.0046	5.6610	5.7007	2.0013	1.5955	0.1832	0.2720	40.4182
2014	23.3051	6.7493	6.3602	2.5225	1.3944	0.2197	0.2525	40.8038
2015	20.5674	7.8123	7.2712	2.2022	0.7914	0.2907	0.2180	39.1532
2016	11.4898	6.8528	4.8263	1.7434	1.0864	0.3050	0.1608	26.4645
2017	10.7531	5.8733	5.5644	1.8492	1.4027	0.2246	0.1479	25.8150
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-200. Observed Light Extinction Conditions for the Penobscot Nation (ME) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	*	*	*	*	*	*	*	*
2006	6.3824	0.8709	2.5743	1.3770	1.2729	0.5033	0.1584	13.1390
2007	5.4866	0.6090	2.7115	1.1489	0.7900	0.4125	0.1342	11.2927
2008	5.2648	0.7396	2.6271	1.2742	1.1349	0.5205	0.1387	11.6998
2009	3.8265	0.6526	2.3481	0.9930	1.2474	0.2427	0.1308	9.4410
2010	3.8102	0.4320	2.2784	0.8915	0.9777	0.3284	0.1058	8.8240
2011	5.1089	0.5069	2.7476	1.0301	1.5062	0.3117	0.0849	11.2962
2012	4.6924	0.7005	2.6865	1.0140	1.4501	0.9624	0.1152	11.6211
2013	4.4052	0.7072	2.3957	0.9256	2.0916	0.3450	0.1286	10.9990
2014	4.3162	0.5338	2.6455	0.8321	1.5159	0.1684	0.0628	10.0746
2015	2.8211	0.5757	2.4916	0.6927	1.2763	0.3106	0.0742	8.2422
2016	2.9048	0.6724	1.9979	0.6864	1.0099	0.4040	0.0748	7.7503
2017	3.9128	0.7030	2.9301	0.9145	1.8129	0.2182	0.1365	10.6281
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	*	*	*	*	*	*	*	*
2003	*	*	*	*	*	*	*	*
2004	*	*	*	*	*	*	*	*
2005	*	*	*	*	*	*	*	*
2006	55.3871	6.2032	12.6024	5.3001	2.7185	0.4418	0.3740	83.0270
2007	45.0437	4.7104	11.5241	4.6615	2.0867	0.5693	0.4162	69.0119
2008	41.8376	3.6042	9.1363	3.5124	1.8692	0.4160	0.4026	60.7782
2009	42.9295	2.8994	9.2038	3.8523	2.5998	0.3168	0.4614	62.2631
2010	32.5225	2.6590	9.4404	3.4939	3.1397	0.4622	0.5733	52.2910
2011	28.8310	4.5257	10.6233	3.7743	3.1949	1.0020	0.1982	52.1493
2012	22.2367	4.1332	8.2475	3.3043	2.1857	0.5449	0.2418	40.8941
2013	20.2761	5.0171	8.0937	3.3028	3.3908	0.8357	0.3129	41.2291
2014	18.5569	5.1216	8.8551	3.5798	2.7076	0.7840	0.2139	39.8189
2015	21.0195	6.8324	12.1692	4.5952	3.5474	0.6117	0.3022	49.0776
2016	13.4935	6.0678	9.5284	4.4487	2.6923	0.9024	0.2787	37.4117
2017	11.3638	4.5102	8.8266	3.9176	2.6212	0.7811	0.2438	32.2643
2018								

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-21. Observed Light Extinction Conditions for the Proctor Maple R.F. (VT) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	5.9488	1.4018	3.0953	1.1501	1.1571	0.1783	0.1033	13.0348
2003	5.3978	0.9670	2.7246	1.0366	0.6116	0.2143	0.0839	11.0358
2004	5.6241	1.3382	2.7812	1.0793	0.7034	0.3640	0.1134	12.0037
2005	5.4871	1.2700	2.4577	1.2398	0.8252	0.1872	0.0779	11.5449
2006	5.0904	0.9190	2.7036	1.1789	1.1897	0.2374	0.1095	11.4285
2007	5.1846	1.3521	2.2895	0.9050	0.5334	0.3441	0.1075	10.7161
2008	5.0932	1.0848	2.2435	0.6846	1.0269	0.2432	0.1113	10.4876
2009	3.6918	0.6024	1.9927	0.6681	0.7540	0.1458	0.0734	7.9282
2010	3.9128	0.9372	2.2889	0.7910	0.5350	0.2666	0.1139	8.8452
2011	5.3599	0.8719	2.5922	0.7943	1.0853	0.2028	0.0720	10.9783
2012	3.6687	0.7775	1.8291	0.5613	0.8108	0.3887	0.0748	8.1110
2013	4.0806	0.8304	1.7347	0.6038	0.7588	0.2549	0.0606	8.3238
2014	4.1222	0.7259	1.8746	0.6909	0.7842	0.1444	0.0656	8.4078
2015	3.0361	0.6941	1.9656	0.3961	0.6178	0.0762	0.0416	6.8275
2016	2.6504	0.9036	1.6867	0.4434	0.7424	0.2113	0.0489	6.6867
2017	3.1405	0.9037	2.0984	0.6265	0.6749	0.0460	0.0542	7.5442
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	104.8198	11.5481	11.8546	4.7046	1.8691	0.1002	0.6445	135.5408
2003	78.4745	7.0667	12.4771	4.4437	1.6196	0.0036	0.4369	104.5221
2004	89.4194	10.2047	10.5420	4.2480	1.5028	0.2338	0.6930	116.8438
2005	111.4801	2.5834	10.8225	4.5692	1.4637	0.1580	0.3496	131.4265
2006	60.9977	6.2781	8.1045	3.6542	1.5455	0.2338	0.3676	81.1814
2007	80.1652	6.7358	11.3978	4.4210	0.8979	0.1461	0.5172	104.2810
2008	49.4072	3.5024	7.9083	2.8364	1.6318	0.0417	0.4539	65.7817
2009	42.4721	5.5101	7.1810	2.6571	1.5976	0.1242	0.3963	59.9384
2010	41.4445	4.2640	9.6326	3.1345	0.8242	0.0539	0.4324	59.7860
2011	38.7429	10.8606	10.3541	3.2674	1.6970	0.3583	0.2304	65.5108
2012	28.2410	5.8490	6.7864	2.7267	1.7321	0.1910	0.2374	45.7635
2013	24.6318	6.5487	6.1294	2.1358	1.4845	0.1438	0.1854	41.2594
2014	28.3320	6.5607	6.0054	2.2980	1.6692	0.1854	0.2025	45.2532
2015	24.0040	8.3185	7.6623	2.3984	1.3643	0.4307	0.2106	44.3887
2016	13.7575	5.4084	4.6847	1.8682	1.3822	0.1444	0.1836	27.4291
2017	11.0288	7.2261	5.9499	2.0340	1.3384	0.1673	0.1528	27.8973
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-22. Observed Light Extinction Conditions for the Presque Isle (ME) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	6.0901	0.7359	3.2724	1.4467	1.8093	0.0368	0.3474	13.7386
2003	5.3617	0.6920	3.4593	1.9003	2.1466	0.2825	0.2750	14.1174
2004	5.9751	0.8713	3.0309	1.8203	1.8130	0.4302	0.2017	14.1424
2005	5.5373	0.6303	2.6188	1.6274	1.3859	0.4887	0.1444	12.4329
2006	6.0962	0.6243	3.1503	1.6649	1.9762	0.2590	0.2047	13.9755
2007	5.3524	0.4205	2.2781	1.0287	1.4070	0.3224	0.1541	10.9632
2008	4.8733	0.4654	2.3033	0.9115	1.8232	0.2663	0.1988	10.8420
2009	4.9813	0.8105	2.2257	1.1078	1.5624	0.3810	0.1772	11.2459
2010	3.2246	0.3181	1.9121	0.6511	1.3050	0.3750	0.1558	7.9417
2011	4.9538	0.5305	2.5015	0.8497	1.6678	0.3191	0.1139	10.9362
2012	4.2667	0.5303	2.3279	0.9150	1.5563	0.3455	0.1403	10.0820
2013	3.4235	0.4123	2.0976	0.6348	1.5787	0.4709	0.0874	8.7052
2014	4.7842	0.6336	2.4693	0.9183	1.8361	0.4225	0.1376	11.2014
2015	2.5756	0.4277	2.1263	0.5518	1.5566	0.2870	0.1027	7.6277
2016	2.8498	0.5620	2.3831	0.8328	1.7029	0.3653	0.1041	8.7999
2017	3.0695	0.6813	2.6322	0.9161	1.9994	0.2201	0.2000	9.7186
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	64.0137	8.5786	13.8518	4.7774	2.3260	0.3196	0.6348	94.5019
2003	39.0918	4.0396	12.1778	4.5100	2.8718	0.0536	0.4769	63.2215
2004	49.7447	4.6336	9.6007	4.2843	3.0337	0.3795	0.5872	72.2636
2005	44.7608	4.2051	8.5332	4.2178	2.2284	0.2958	0.3398	64.5810
2006	50.4603	4.8491	10.5366	4.4455	2.6688	0.2545	0.3547	73.5696
2007	28.7081	3.7584	7.7462	3.3510	2.8901	0.4123	0.4485	47.3147
2008	33.6567	3.1295	8.7899	3.6653	2.8253	0.1368	0.4211	52.6246
2009	33.7238	2.8002	7.3336	2.6634	3.4513	0.3525	0.4861	50.8111
2010	25.5356	2.8443	8.4364	2.4975	2.6212	0.3421	0.5356	42.8127
2011	24.0169	3.5503	8.1989	2.9378	2.8120	0.7784	0.2446	42.5389
2012	17.1378	3.2180	6.7956	2.5305	3.4225	0.4228	0.3526	33.8798
2013	17.3155	4.0673	6.8311	2.9541	2.8665	0.4179	0.2929	34.7454
2014	19.4462	3.4689	5.9225	3.0727	2.6671	0.5378	0.2430	35.3581
2015	18.0160	4.1418	6.8330	2.3292	3.6389	0.5180	0.2959	35.7728
2016	12.6632	4.6483	5.8637	2.5892	3.8842	0.6259	0.3514	30.6259
2017	10.2545	3.7968	6.0526	2.8590	3.3117	0.7195	0.3024	27.2965
2018								

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-23. Observed Light Extinction Conditions for the Quabbin Summit (MA) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	8.7360	1.4980	3.1423	1.4287	1.0350	0.0682	0.1367	16.0449
2003	8.1061	1.3763	2.6126	1.3030	0.9913	0.4342	0.1069	14.9303
2004	8.4933	2.0595	3.1251	1.1864	0.8605	0.6640	0.1592	16.5479
2005	8.1678	1.4947	2.5061	1.3084	0.7654	0.3605	0.0996	14.7023
2006	6.8134	0.9413	2.4860	1.1023	1.0471	0.3127	0.1578	12.8606
2007	6.3782	0.8752	2.5085	1.1659	0.8128	0.3377	0.1115	12.1898
2008	*	*	*	*	*	*	*	*
2009	4.4180	1.1751	2.5844	0.9510	0.7106	0.3178	0.0958	10.2527
2010	4.4277	0.8346	2.0701	0.8020	0.5855	0.1490	0.1004	8.9692
2011	4.9204	0.9940	2.6365	0.9750	0.9782	0.2626	0.0770	10.8437
2012	4.9341	1.0878	2.2377	0.8340	0.7773	0.2506	0.0777	10.1993
2013	3.5838	0.8489	1.8138	0.6467	0.6720	0.3885	0.0595	8.0133
2014	3.6155	0.7482	2.6904	0.8088	0.7503	0.1924	0.0674	8.8730
2015	3.2001	0.7587	2.4806	0.6919	0.7758	0.1779	0.0547	8.1397
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*
20 PERCENT MOST IMPAIRED DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	87.5615	13.5877	13.5346	5.8099	2.0144	0.3988	0.6542	123.5613
2003	95.9812	8.6454	14.3193	5.6276	1.8462	0.0036	0.5139	126.9373
2004	99.2982	6.1668	11.7721	4.6397	1.3856	0.3633	0.8338	124.4595
2005	123.9746	5.4925	12.7811	5.5915	1.0014	0.1662	0.5204	149.5277
2006	89.3196	7.1143	14.2509	5.5725	1.9501	0.2324	0.5624	119.0022
2007	96.5809	5.0212	13.0335	5.5507	2.0740	0.1952	0.6265	123.0821
2008	*	*	*	*	*	*	*	*
2009	51.1634	7.4767	9.0318	3.7350	1.3693	0.0305	0.5207	73.3275
2010	51.4030	7.7336	11.9438	4.3581	1.2227	0.0706	0.5861	77.3178
2011	38.3809	5.3707	11.0617	3.8056	1.9313	0.2922	0.2500	61.0924
2012	30.5335	10.1828	9.0695	3.9060	1.8711	0.3922	0.2695	56.2245
2013	26.5061	9.1901	9.1149	3.3680	1.1220	0.3286	0.2333	49.8631
2014	21.9011	9.1925	7.2063	3.2608	1.5754	0.3099	0.2563	43.7023
2015	23.7573	12.4556	9.9636	3.5234	1.6061	0.2683	0.2337	51.8081
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})

Table B-24. Observed Light Extinction Conditions for the Washington (DC) MANE-VU IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	20.2290	8.3613	8.1563	7.8486	2.9868	0.2903	0.4916	48.3639
2001	21.8856	6.4138	6.9678	5.2682	2.5693	0.4244	0.4576	43.9868
2002	24.7875	7.7029	7.3664	5.3982	2.3853	0.4245	0.4397	48.5045
2003	18.7825	8.9710	6.6378	5.2137	2.3440	0.1197	0.4276	42.4963
2004	15.9874	6.9398	6.7776	5.1714	3.2455	0.9924	0.4796	39.5935
2005	21.0992	7.5743	6.4890	7.3366	3.6654	1.0452	0.4160	47.6257
2006	16.5686	6.5176	7.9629	9.0311	3.4080	0.7728	0.5712	44.8322
2007	18.7606	5.7842	6.3020	7.1679	2.9891	0.5558	0.4960	42.0557
2008	16.5293	6.2891	6.4253	6.3233	2.7337	0.8000	0.6174	39.7181
2009	16.1941	3.3231	4.7106	5.8078	2.4292	0.4784	0.4419	33.3851
2010	*	*	*	*	*	*	*	*
2011	11.4729	3.7464	5.5214	5.0912	2.9435	0.7431	0.3690	29.8875
2012	12.0839	2.8738	4.0092	3.2173	2.8258	0.4443	0.3253	25.7796
2013	*	*	*	*	*	*	*	*
2014	9.4982	2.9110	5.4467	3.2020	2.1887	0.5367	0.3278	24.1112
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*
20 PERCENT MOST IMPAIRED DAYS								
2000	101.8412	19.3286	15.1918	10.2366	2.4995	0.3616	0.6862	150.1454
2001	112.1808	22.1919	15.8360	10.8048	2.9061	0.1285	0.6833	164.7314
2002	138.3024	8.0661	19.2023	7.7938	3.5035	0.0094	1.3091	178.1866
2003	122.8629	16.7564	17.2556	8.9322	2.4289	0.0811	0.8751	169.1922
2004	123.2557	20.2104	17.8209	7.8739	3.7668	1.0454	1.2879	175.2609
2005	172.2435	19.8351	14.8549	12.6165	4.2873	0.6540	0.8269	225.3183
2006	112.6566	12.5358	14.2134	12.3617	4.0716	0.8624	0.8636	157.5652
2007	117.0108	12.3225	15.5118	10.9556	3.3505	0.6589	0.9586	160.7687
2008	95.1768	13.1989	14.8612	11.4457	4.2110	0.6096	1.2040	140.7072
2009	65.8230	12.4647	9.8868	9.3945	3.4887	0.6692	0.8189	102.5457
2010	*	*	*	*	*	*	*	*
2011	47.2417	15.5062	12.0078	9.9480	3.4113	0.5644	0.5456	89.2249
2012	33.9678	20.3509	9.0519	8.1215	3.0201	0.8689	0.5126	75.8938
2013	*	*	*	*	*	*	*	*
2014	35.1024	30.6659	9.9955	6.8273	2.8687	1.1537	0.5077	87.1213
2015	*	*	*	*	*	*	*	*
2016	*	*	*	*	*	*	*	*
2017	*	*	*	*	*	*	*	*
2018	*	*	*	*	*	*	*	*

"*" = no data available; "@" = does not include Rayleigh (12 Mm^{-1})

Table B-25. Observed Light Extinction Conditions for the Quaker City (OH) Nearby Adjacent IMPROVE Protocol Site

Year	Sulfate (Mm^{-1})	Nitrate (Mm^{-1}))	Organic Mass Carbon (Mm^{-1})	Light Absorbing Carbon (LAC or EC) (Mm^{-1})	Coarse Mass (Mm^{-1})	Sea Salt (Mm^{-1})	Soil (Mm^{-1})	Total PM@ (Mm^{-1})
20 PERCENT CLEAREST DAYS								
2000	*	*	*	*	*	*	*	*
2001	*	*	*	*	*	*	*	*
2002	20.5021	6.5356	5.1468	2.7708	1.6979	0.1220	0.2376	37.0128
2003	17.6515	7.5608	5.5429	2.8919	2.0305	0.0030	0.2955	35.9762
2004	17.8375	6.6934	4.4398	2.3143	1.7140	0.3865	0.2687	33.6542
2005	23.3790	5.9021	4.4962	3.0408	2.1995	0.2783	0.2602	39.5560
2006	19.1357	4.0837	4.2366	2.7183	2.2009	0.2075	0.2323	32.8151
2007	18.8184	5.4690	4.3600	2.5641	2.0017	0.3315	0.2555	33.8003
2008	17.1187	3.6323	4.3403	2.1668	2.4037	0.1282	0.3142	30.1041
2009	15.3529	2.8048	3.2733	1.7114	2.5106	0.1752	0.2954	26.1237
2010	*	*	*	*	*	*	*	*
2011	12.0258	3.8813	4.1104	2.1617	2.5419	0.5807	0.1825	25.4842
2012	11.8023	2.9627	3.6892	1.8430	2.7258	0.1412	0.2876	23.4517
2013	12.0585	3.0855	3.0215	1.6305	2.7867	0.1984	0.2033	22.9844
2014	12.0703	3.7801	3.3463	1.9473	2.4510	0.1887	0.2086	23.9924
2015	9.4963	2.5841	4.4384	1.9158	2.3409	0.1248	0.2370	21.1371
2016	8.3378	2.5489	3.1611	1.3198	2.4612	0.1001	0.1234	18.0524
2017	7.2834	2.6762	3.3910	1.5753	1.9262	0.0667	0.1337	17.0525
2018								
20 PERCENT MOST IMPAIRED DAYS								
2000								
2001								
2002	174.6730	7.9584	11.2093	5.0152	1.9320	0.0056	0.9305	201.7239
2003	165.8683	6.4209	10.7639	5.9894	1.9306	0.6483	0.5785	192.1999
2004	181.6486	3.1243	12.1142	5.6321	2.6744	0.2931	1.2210	206.7077
2005	209.9119	5.6818	9.0714	6.0485	3.4965	0.1527	0.5462	234.9091
2006	155.3690	3.6090	10.8931	5.4906	3.0936	0.1042	0.6713	179.2308
2007	162.9619	5.0574	10.7505	5.6853	4.1748	0.1070	1.0382	189.7751
2008	100.2149	10.7560	10.1620	4.8675	3.4314	0.1683	0.7921	130.3922
2009	81.7305	15.8324	8.2018	4.5637	2.6836	0.1396	0.6345	113.7861
2010	*	*	*	*	*	*	*	*
2011	90.5283	11.2599	7.7036	3.8591	3.2474	0.2704	0.3223	117.1910
2012	56.1394	11.7765	7.0154	4.0644	3.4367	0.3290	0.4387	83.2001
2013	51.2245	25.6599	6.2777	3.5775	2.6427	0.4484	0.2872	90.1178
2014	46.6566	30.8552	7.0661	4.4335	2.6618	0.4846	0.3386	92.4964
2015	45.9649	20.6321	9.0459	4.6403	3.0543	0.3390	0.3691	84.0457
2016	28.3577	23.5362	6.2186	3.0954	2.6312	0.2541	0.2181	64.3113
2017	26.6334	20.4893	8.0184	4.0430	2.4108	0.1671	0.2628	62.0248
2018								

"*" = no data available; "@" = does not include Rayleigh (11 Mm^{-1})