

# *IMPROVE Data and Regional Haze Rule Metrics*

12/3/2024

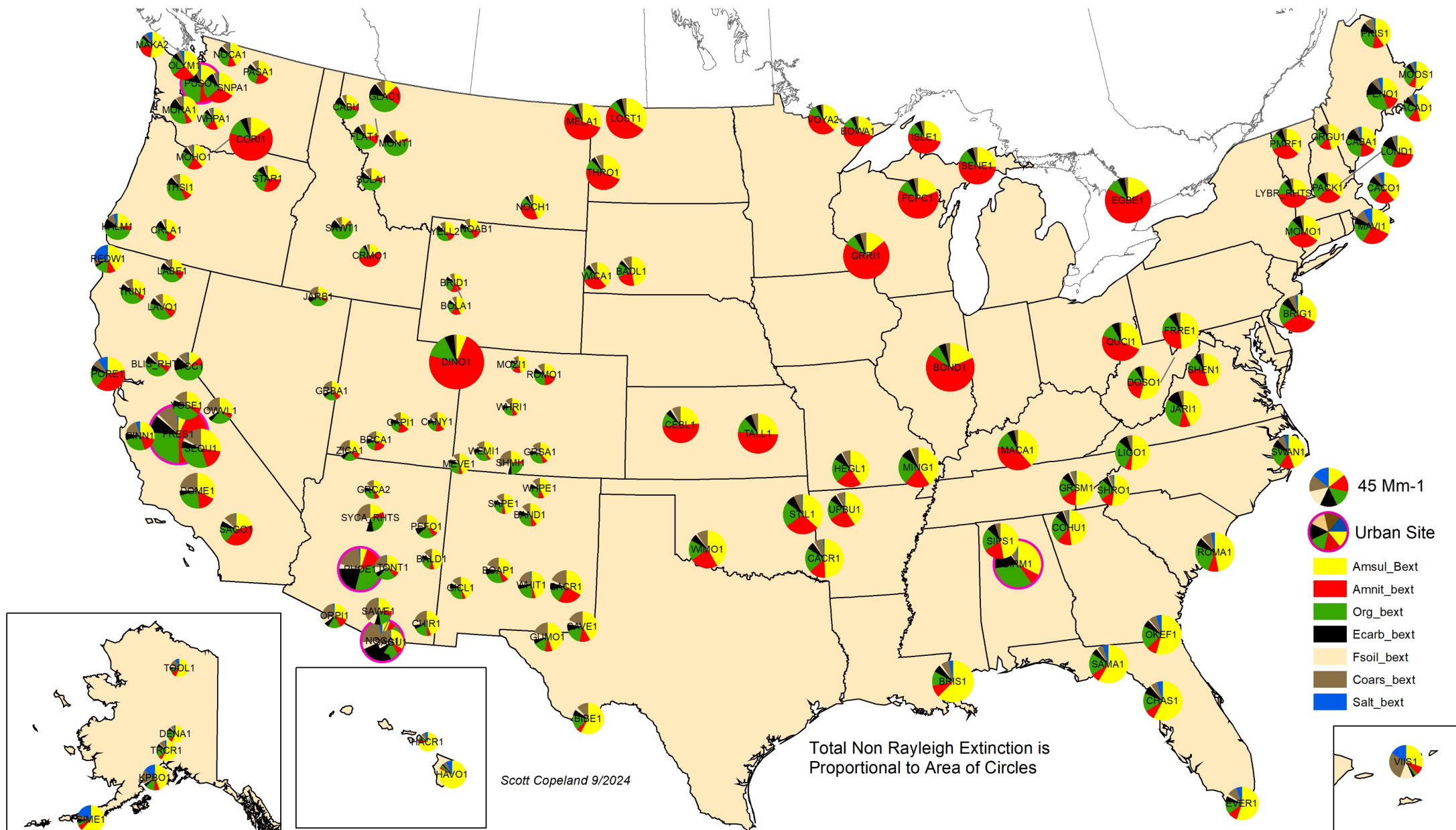
Scott Copeland

Colorado State University/USDA Forest Service



# IMPROVE Data - 2023 Second IMPROVE Algorithm

## Non Rayleigh Mean of 20% Most Impaired



All of the published RHR metrics use the second IMPROVE light extinction algorithm.

$$\begin{aligned} b_{\text{ext}} = & 2.2 \times f_s(\text{RH}) \times [\textit{Small Sulfate}] + \\ & 4.8 \times f_L(\text{RH}) \times [\textit{Large Sulfate}] + \\ & 2.4 \times f_s(\text{RH}) \times [\textit{Small Nitrate}] + \\ & 5.1 \times f_L(\text{RH}) \times [\textit{Large Sulfate}] + \\ & 2.8 \times [\textit{Small Organic Mass}] + \\ & 6.1 \times [\textit{Large Organic Mass}] + \\ & 1 \times [\textit{Fine Soil}] + \\ & 1.7 \times f_{\text{ss}}(\text{RH}) \times [\textit{Sea Salt}] + \\ & 0.6 \times [\textit{Coarse Mass}] + \\ & 10 \times [\textit{Elemental Carbon}] + \\ & \text{Rayleigh Scattering (site specific)} \end{aligned}$$

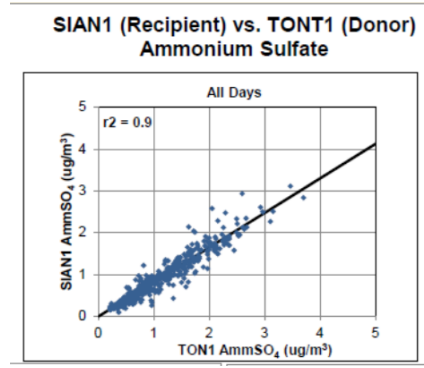
# Validity, Completeness, Patching, Substitution



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- In cases where observations needed to calculate deciview are missing, EPA’s Guidance for Tracking Progress guidance (2003) allows historic medians to be filled in for values which usually contribute little to total haze. (less than 10% difference at least 90% of the time.) This de minimis filling of missing data is called “patching”, though the 2003 guidance regularly calls it “substituted”.
- When data is missing and can’t be “patched” because it is too significant in terms of contribution to haze, FS and RPOs developed another technique which uses surrogate measurements or regressions of species between nearby sites to fill in data gaps. This is referred to as “substituted” data and is regularly included in regional haze metric calculations.
- **Both substituted and patched data are flagged in the datasets.**
- **Patching and Substitution occur before validity and completeness are determined.**
- Every observation has a validity code. All relevant observations for a sample date must have a validity code from the subset of codes that are considered valid to be used to determine completeness or to calculate a deciview value.
- A site-year is considered “complete” with 75% of all observations, 50% of each quarter, and no more than 10 consecutive dates with invalid observations for .



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# Data “Groups”



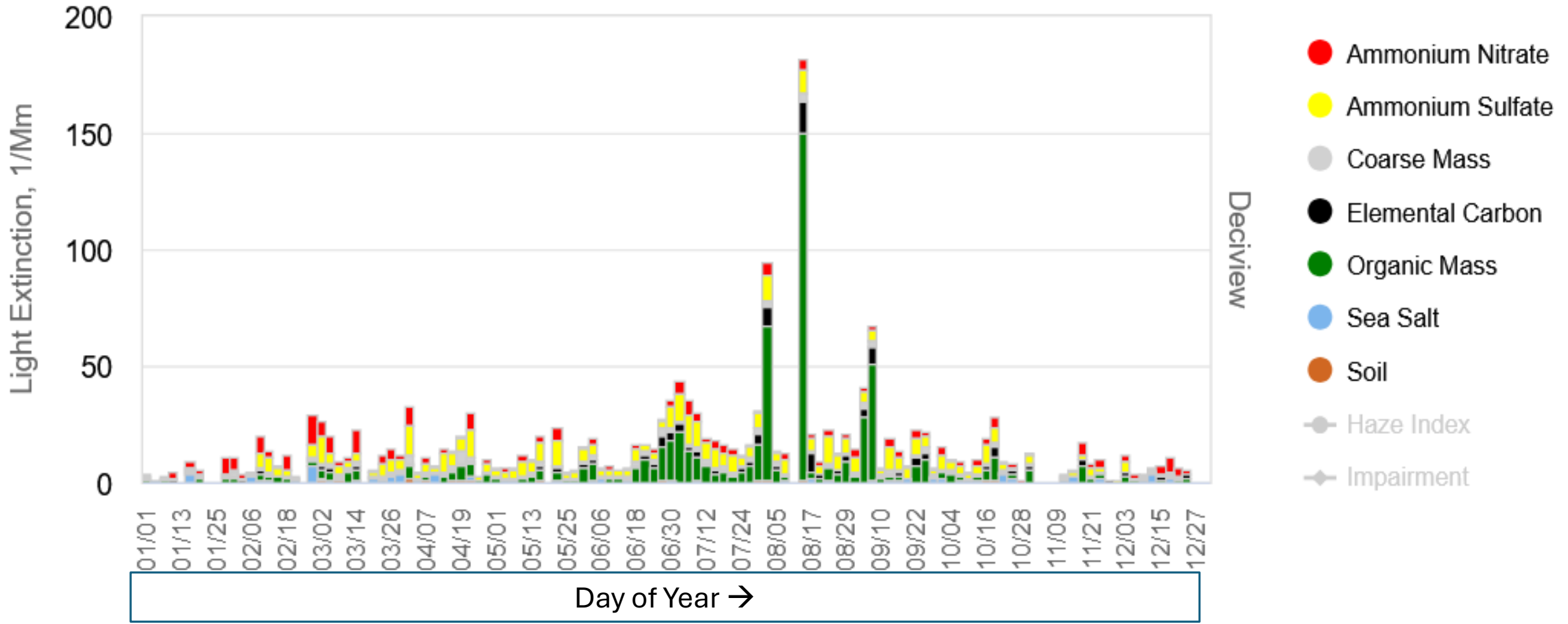
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# Daily Extinction Composition Sorted by Date - All Days (2021)



Snoqualmie Pass (SNPA1)



IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



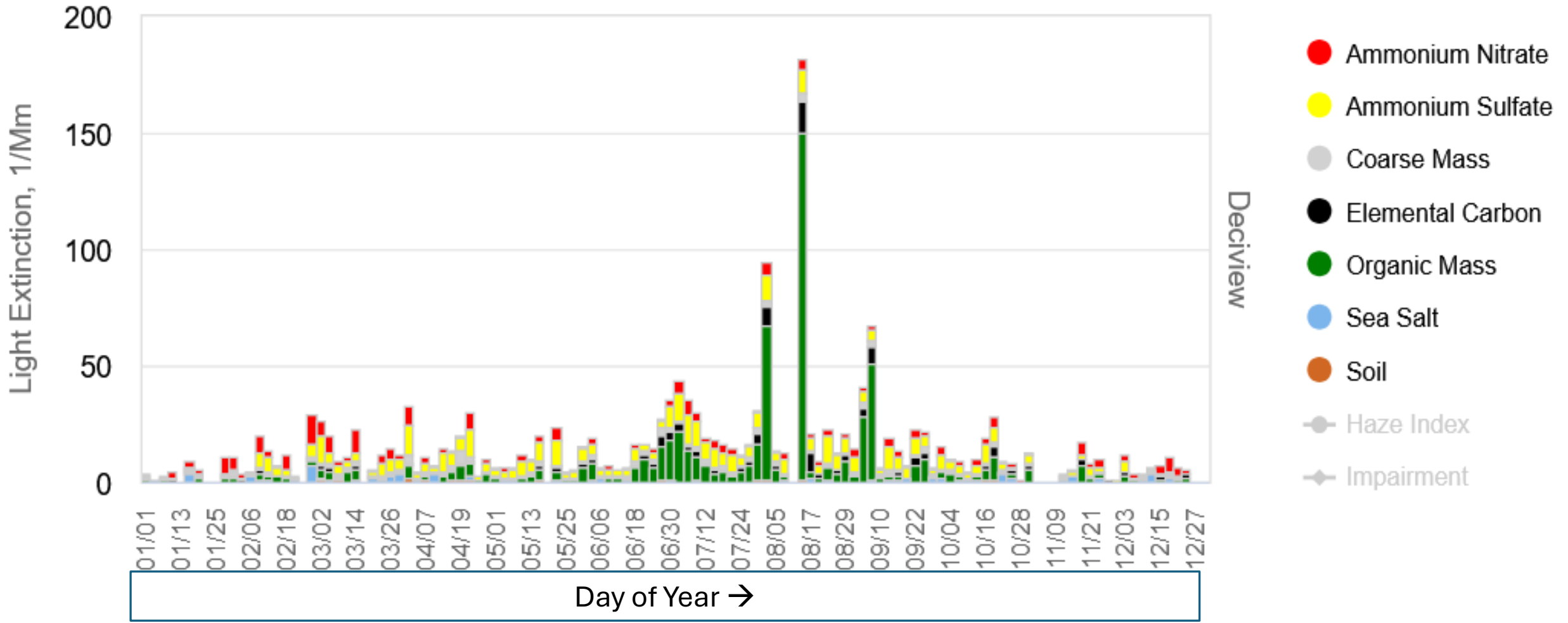
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Snoqualmie Pass (SNPA1)



IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



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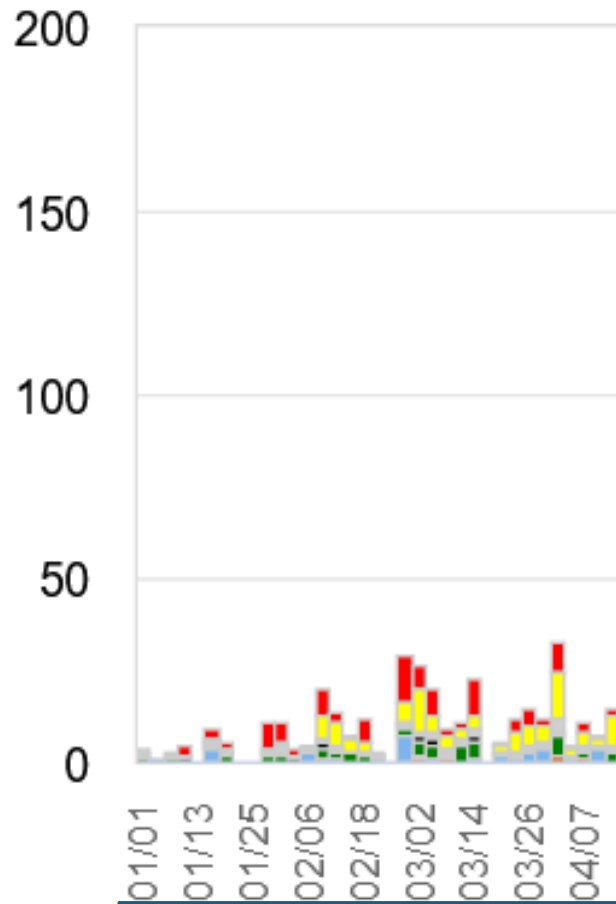




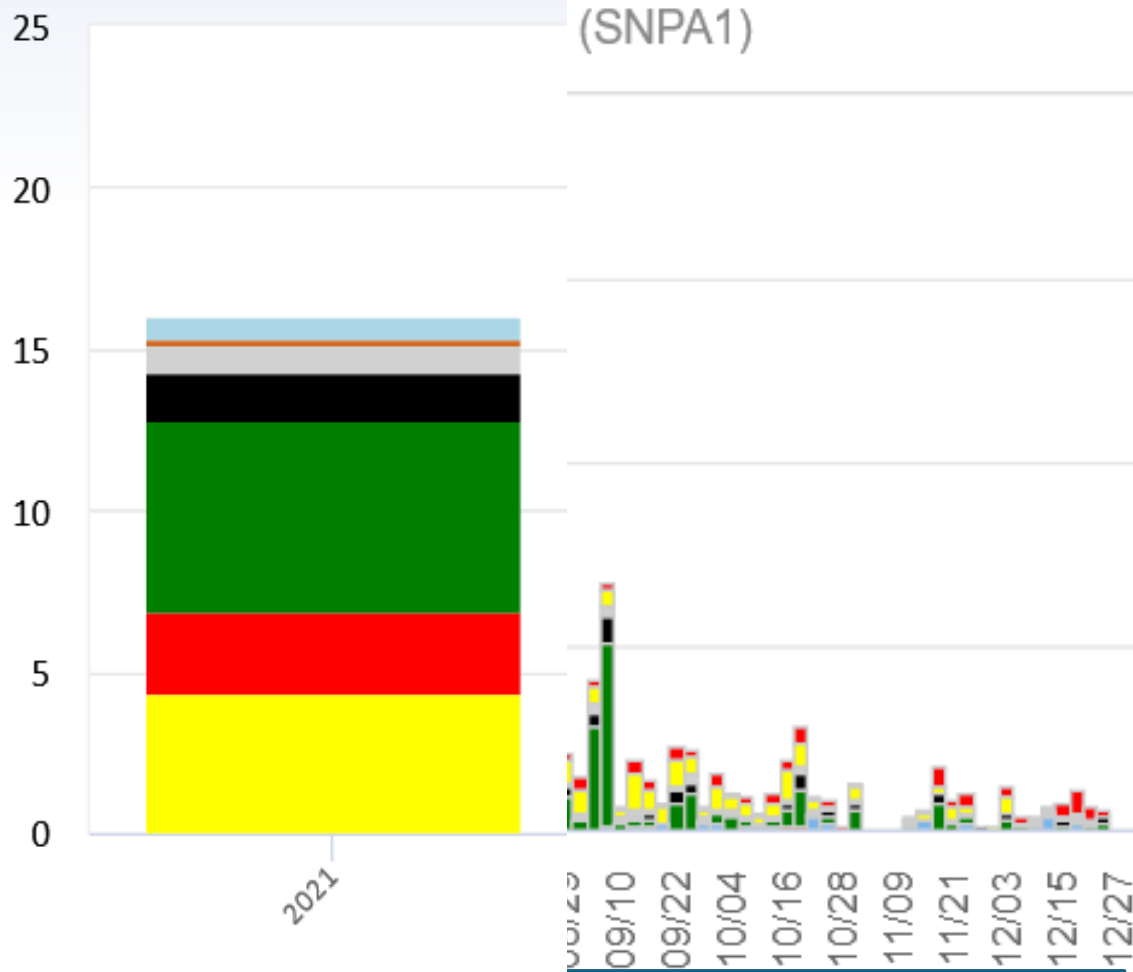
# Daily Extinction Composition Sorted by Date - All Days (2021)



Light Extinction, 1/Mm



Inverse Megameters (1/Mm)



Deciview

- Ammonium Nitrate
- Ammonium Sulfate
- Coarse Mass
- Elemental Carbon
- Organic Mass
- Sea Salt
- Soil
- Haze Index
- Impairment

IMPROVE Monitor: Snoqualmie Pass

IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



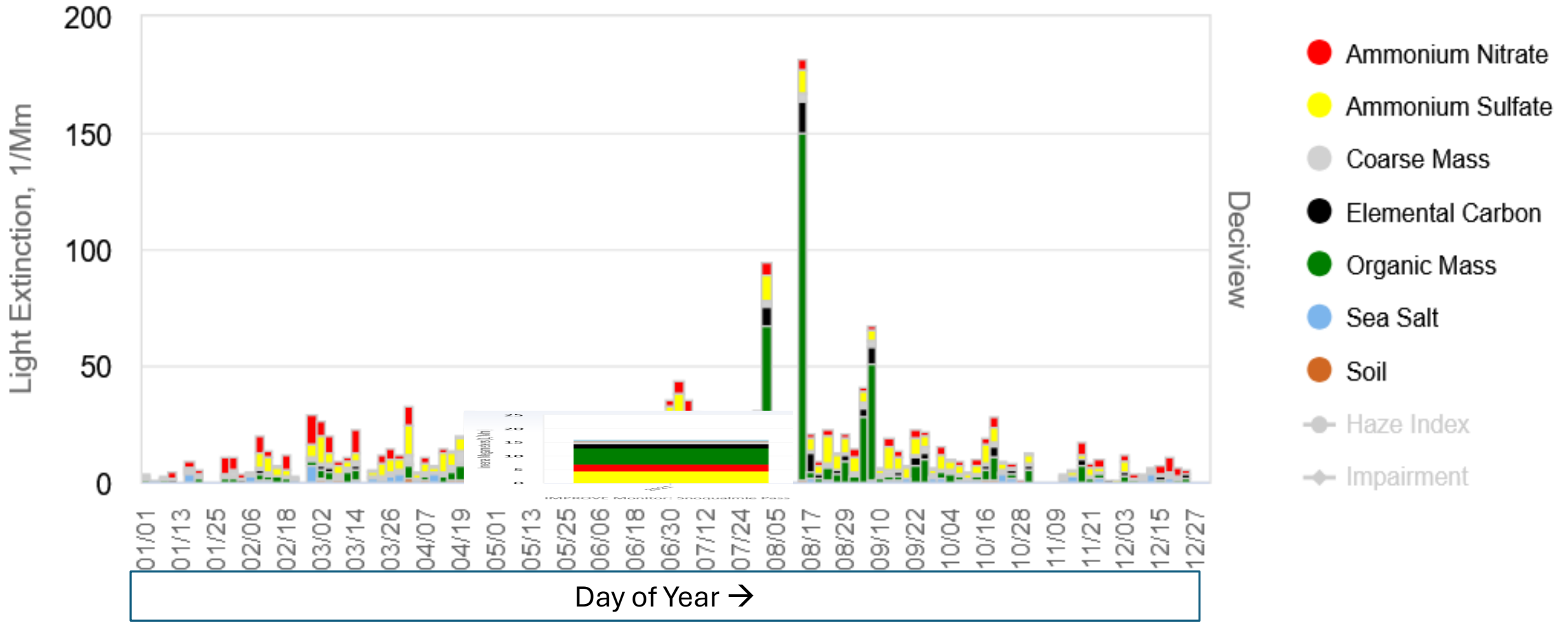
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# Daily Extinction Composition Sorted by Date - All Days (2021)



Snoqualmie Pass (SNPA1)



IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



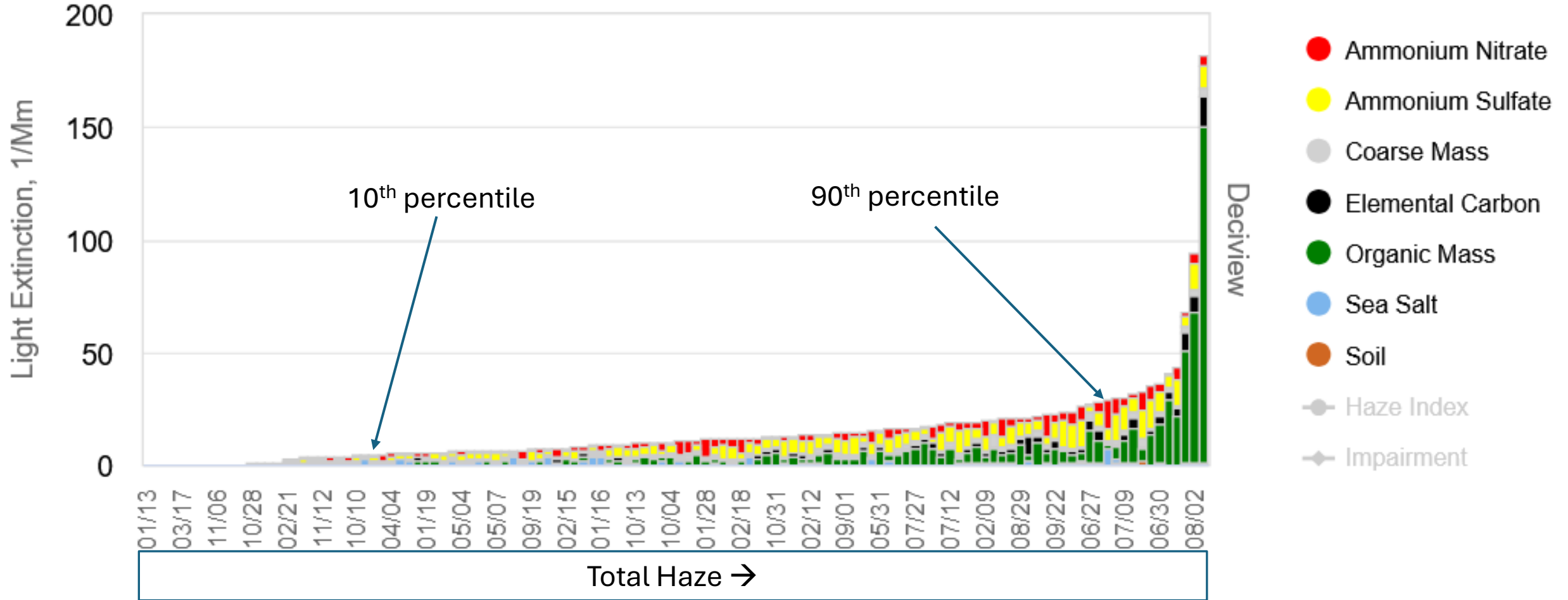
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# Daily Extinction Composition Sorted by Total Haze - All Days (2021)



Snoqualmie Pass (SNPA1)



IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



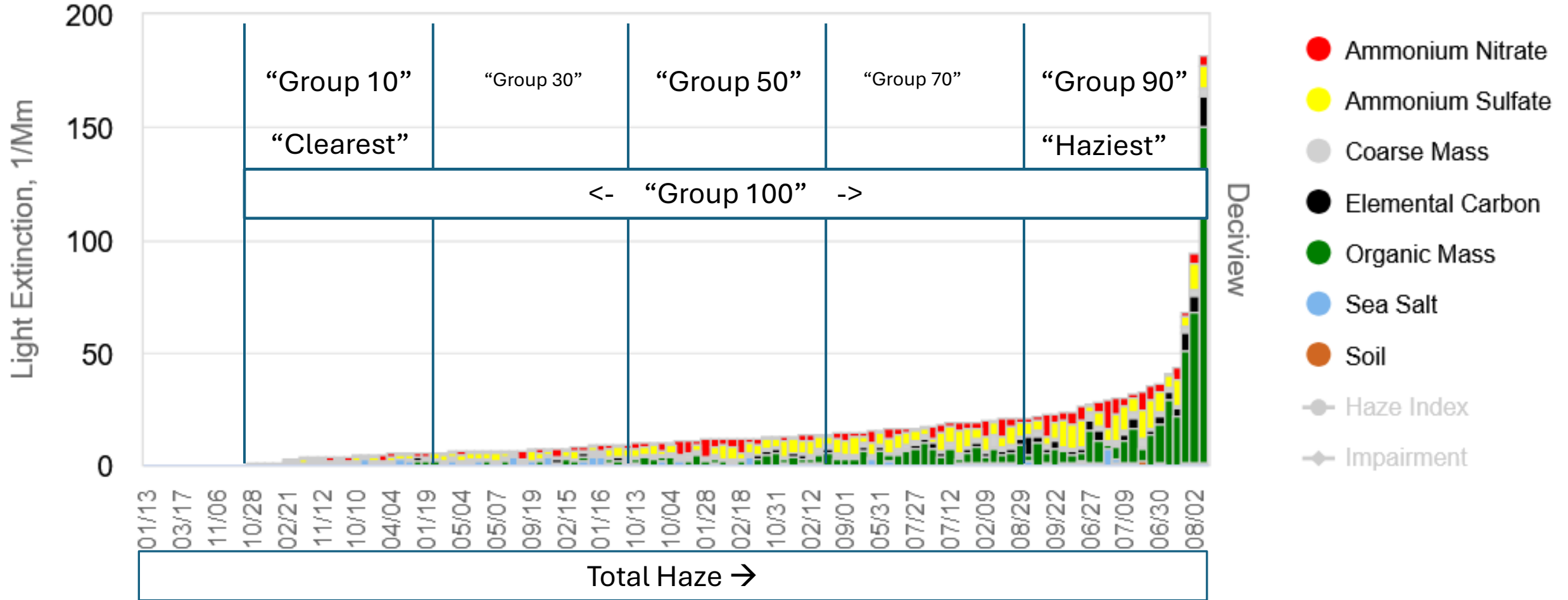
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# Daily Extinction Composition Sorted by Total Haze - All Days (2021)



Snoqualmie Pass (SNPA1)



IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



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# Regional Haze Maps and Metrics

- Impairment metrics here:

<https://drive.google.com/drive/folders/0Bxfj1vyyXeDYWVpfeUo4NEYtTU0?resourcekey=0-d0Bn5HHHEkgbiHZvIQWaLQ&usp=sharing>

- Haziest Day metrics here:

<https://drive.google.com/drive/folders/0Bxfj1vyyXeDYTjNLellwUUx0TTg?resourcekey=0-yt0EY9maDLhRmcE8s5tC6A&usp=sharing>

- History of RHR metric changes since 10/2019.

[https://docs.google.com/presentation/d/16i5fwc6aVAjqNQRAvhd5jllxeiyfCsQQ/edit?usp=drive\\_link&oid=116534812255078445612&rtpof=true&sd=true](https://docs.google.com/presentation/d/16i5fwc6aVAjqNQRAvhd5jllxeiyfCsQQ/edit?usp=drive_link&oid=116534812255078445612&rtpof=true&sd=true)



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SIA\_daily\_budgets\_9\_24.csv

SIA\_complete\_year\_9\_24.csv

SIA\_group\_means\_9\_24.csv

Patched, substituted, completeness flagged

Excel interface showing the View ribbon and a data table. The ribbon includes options for Sheet View, Workbook Views, and Show. The data table has columns for date, site, and various environmental metrics.

	J	K	AK	AO	AP	AQ	AR	AS	AT	AU	AV	AZ	BA	BF
1	date	site	Sea_Salt_subbed	EAmn_SO	EAmn_NC	EOMC	ELAC	ESoil	ECM	ESea_Salt	good_year	n_dv	Group	
302	11/17/1990	ACAD1	0	81.1978	13.50014	20.70055	16.645	0.441766	3.498012	0.01635	###	1	81	90
303	11/21/1990	ACAD1	0	27.03261	0.975266	3.427976	1.988	0.1324	3.269664	0.012828	###	1	81	50
304	11/24/1990	ACAD1	0	29.44279	3.300589	3.248858	2.492	0.044615		0.013394		1	81	
305	11/28/1990	ACAD1	0	83.61305	24.34425	21.23693	12.194	0.357554	1.478448	4.099972	###	1	81	90
306	12/1/1990	ACAD1	0	33.60658	14.12343	6.852617	5.109	0.241367	2.428524	0.013623	###	1	81	70
307	12/5/1990	ACAD1	0	19.12326	1.926404	5.442891	2.5	0.111442	6.870654	0.01041	###	1	81	30
308	12/8/1990	ACAD1	0	55.62583	5.296845	9.724525	4.401	0.164692	5.953848	0.01086	###	1	81	90



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SIA\_daily\_budgets\_9\_24.csv

SIA\_complete\_year\_9\_24.csv

SIA\_group\_means\_9\_24.csv

	A	B	C	D	E	F	G	H	I	J
1	site	year	complete_quarters	total_per_year	complete_days_year	complete_year	max_miss_days	good_year	start_date	end_date
4	ACAD1	1990	4	104	81	1	2	1	3/2/1988	12/29/2023
5	ACAD1	1991	4	104	98	1	2	1	3/2/1988	12/29/2023
6	ACAD1	1992	4	105	102	1	2	1	3/2/1988	12/29/2023
7	ACAD1	1993	4	104	102	1	1	1	3/2/1988	12/29/2023
8	ACAD1	1994	4	105	103	1	1	1	3/2/1988	12/29/2023
		1995	4	104	97	1	4	1	3/2/1988	12/29/2023
		1996	4	104	101	1	3	1	3/2/1988	12/29/2023
		1997	4	105	103	1	2	1	3/2/1988	12/29/2023
		1998	4	104	101	1	2	1	3/2/1988	12/29/2023



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SIA\_daily\_budgets\_9\_24.csv

SIA\_complete\_year\_9\_24.csv

SIA\_group\_means\_9\_24.csv

Only complete years.

The screenshot shows an Excel spreadsheet with the following data:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S
1	site	year	Group	Number_obs	Amm_SO4	Amm_NO3	OMC	LAC	Soil	CM	Sea_Salt	EAmn_SO	EAmn_NC	EOMC	ELAC	ESoil	ECM	ESea_Salt	ss_rayleig
2	ACAD1	1990	10	16	1.082959	0.137683	0.851456	0.160056	0.116002	4.333353	0.075845	9.472403	1.306087	2.523234	1.600563	0.116002	2.600012	0.524941	12
3	ACAD1	1990	30	15	2.135283	0.231976	1.283808	0.22846	0.148083	6.745067	0.172804	19.36192	2.200266	3.926612	2.2846	0.148083	4.04704	1.112759	12
4	ACAD1	1990	50	18	2.777416	0.402745	1.59066	0.318111	0.195569	5.179571	0.155494	25.06164	3.739583	4.914761	3.181111	0.195569	3.107743	0.986283	12
5	ACAD1	1990	70	15	3.959386	0.680552	2.457972	0.534207	0.246838	5.512043	0.281698	37.85728	6.342219	8.059732	5.342067	0.246838	3.307226	1.779247	12
6	ACAD1	1990	90	17	8.059328	1.281949	3.676691	0.763229	0.317073	8.288751	0.220078	87.80531	12.49353	13.02282	7.632294	0.317073	4.973251	1.411339	12
7	ACAD1	1990	100	81	3.651228	0.554733	1.986242	0.403726	0.206053	6.016436	0.179892	36.46477	5.293052	6.543464	4.037259	0.206053	3.609862	1.15463	12
8	ACAD1	1991	10	19	1.096316	0.124465	1.178166	0.150089	0.137587	2.65141	0.076496	9.827444	1.185903	3.568665	1.500895	0.137587	1.590846	0.507285	12
9	ACAD1	1			1.813871	0.245928	1.86174	0.2394	0.226648	5.142277	0.113675	15.87529	2.251445	5.891149	2.394	0.226648	3.085366	0.7351	12
10	ACAD1	1			2.554606	0.331278	1.985606	0.268743	0.202618	5.291497	0.327483	23.7997	3.113563	6.293219	2.687429	0.202618	3.174898	2.257732	12
11	ACAD1	1			4.014732	0.646168	2.49768	0.449942	0.231852	4.897249	0.301875	37.95556	6.223619	8.067261	4.499421	0.231852	2.93835	2.08764	12
12	ACAD1	1			7.518356	0.90093	5.058117	0.61256	0.334284	7.252283	0.258804	82.26767	8.739214	19.19571	6.1256	0.334284	4.35137	1.726777	12
13	ACAD1	1991	100	98	3.42436	0.45194	2.531369	0.345347	0.227207	5.074437	0.218389	34.23117	4.32375	8.664145	3.453469	0.227207	3.044662	1.48182	12



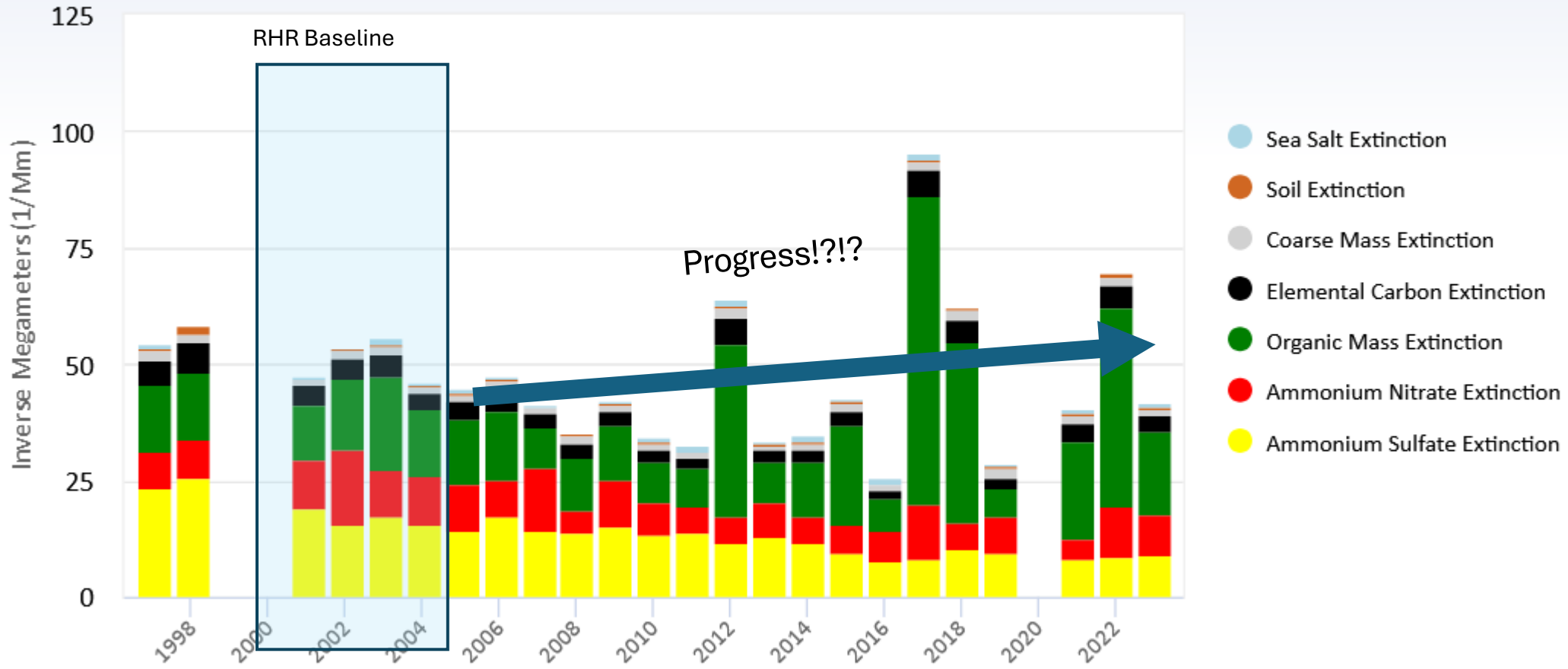
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First, we tried to track haziest days:

### Annual Extinction Composition on the Haziest Days - Snoqualmie Pass 1997 - 2023



# Take a step back...

- *Our Clean Air Act Mandate:*

*“prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Federal Class I areas **which impairment results from manmade air pollution.**”*

- IMPROVE doesn't measure “human caused” air pollution!
- Instead, IMPROVE measures total pollution and we algorithmically infer “human caused”.



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# Impairment Framework




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Impairment Overview - Improve x +  
https://vista.cira.colostate.edu/Improve/impairment/

# IMPROVE

Interagency Monitoring of Protected Visual Environments



Home Overview ▾ Data ▾ RHR ▾ Data Resources ▾ Publications ▾ Meetings ▾ Special Studies

## Impairment Overview

[Introduction to Impairment Overview](#) | [Sort Impairment Framework 2064 Endpoints](#) | [Introduction to Impairment Overview](#)

**Impairment-Based Visibility Metric - Overview** | Scott Copeland

Introduction

Visibility-reducing haze is caused by natural and anthropogenic sources. The Clean Air Act requires that visibility impairment be reduced in certain areas, which include certain National Parks, National Antiquities, and National Monuments. The United States Environmental Protection Agency's (U.S. EPA) original 2003 *Guidance for Assessing Visibility Impairment* is based on the requirement that visibility be maintained on the 20% of days each year with the lowest visibility. In the western United States, many days regularly include large amounts of haze from natural sources. The Clean Air Act goals of removing human-caused haze by focusing on days dominated



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## Most Impaired Day determination has two parts:

1. **Splitting days into estimated anthropogenic and natural parts.**
2. **Sorting days based on “impairment”, defined as fraction of total light extinction that is anthropogenic.**

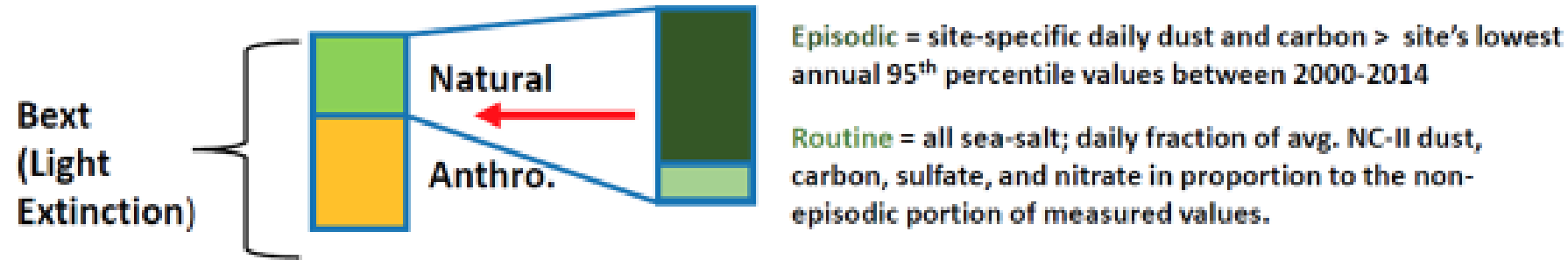


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# Components of an Impairment-based Approach

- 1) Split each day of IMPROVE data into natural and anthropogenic extinction components



- 2) Sort: Several visibility indicators to identify the "worst" days:

1) Current Approach = Total haze    2) Perceptible Anthro. Impairment Approach =  $dv_{Total} - dv_{Nat}$



- 3) Select the 20% most impaired days

From Brett Gantt EPA OAQPS



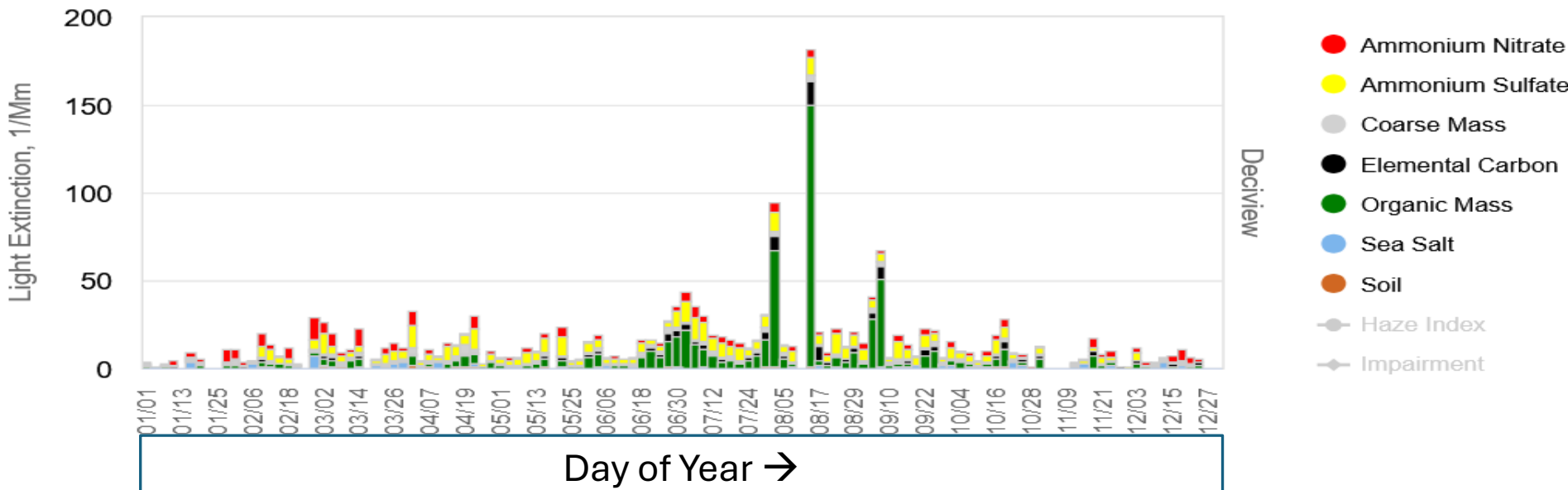
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## Daily Extinction Composition Sorted by Date - All Days (2021)



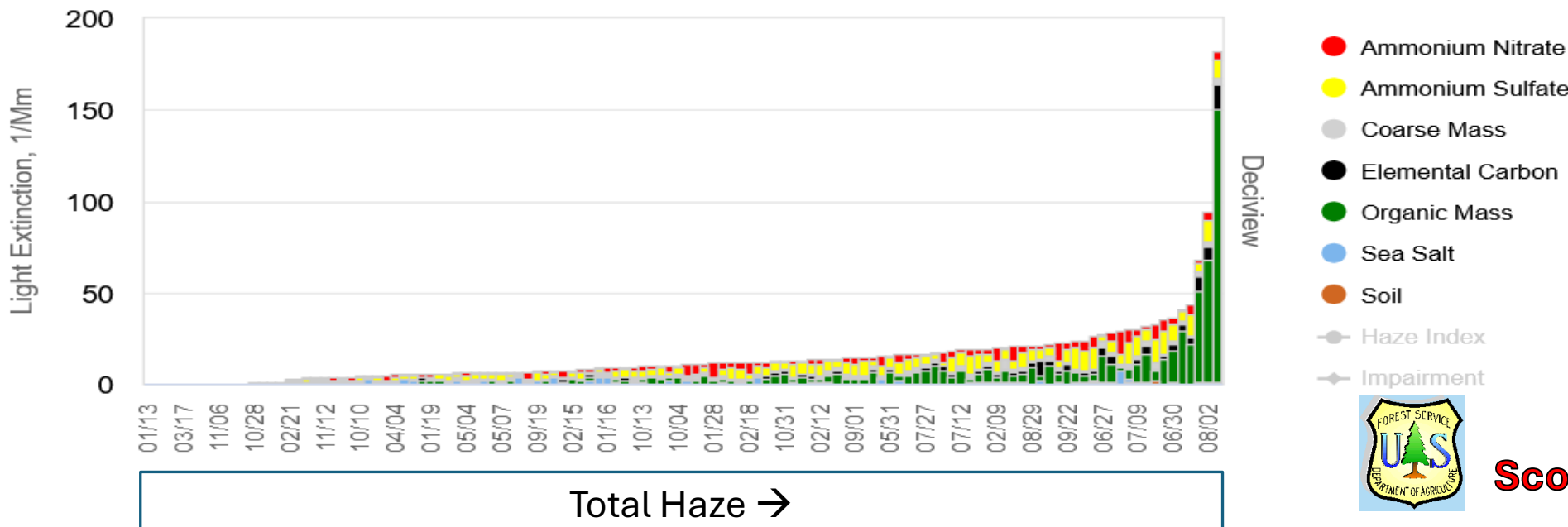
Snoqualmie Pass (SNPA1)



## Daily Extinction Composition Sorted by Total Haze - All Days (2021)



Snoqualmie Pass (SNPA1)



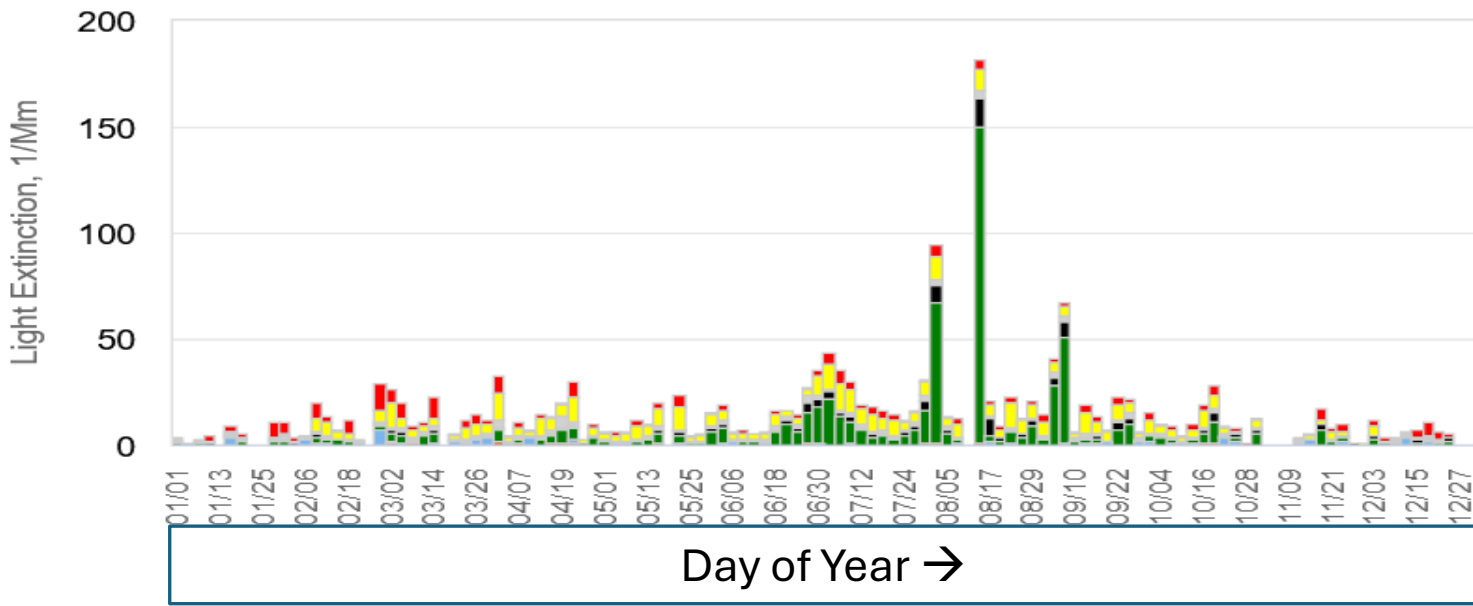
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# Daily Extinction Composition Sorted by Date - All Days (2021)



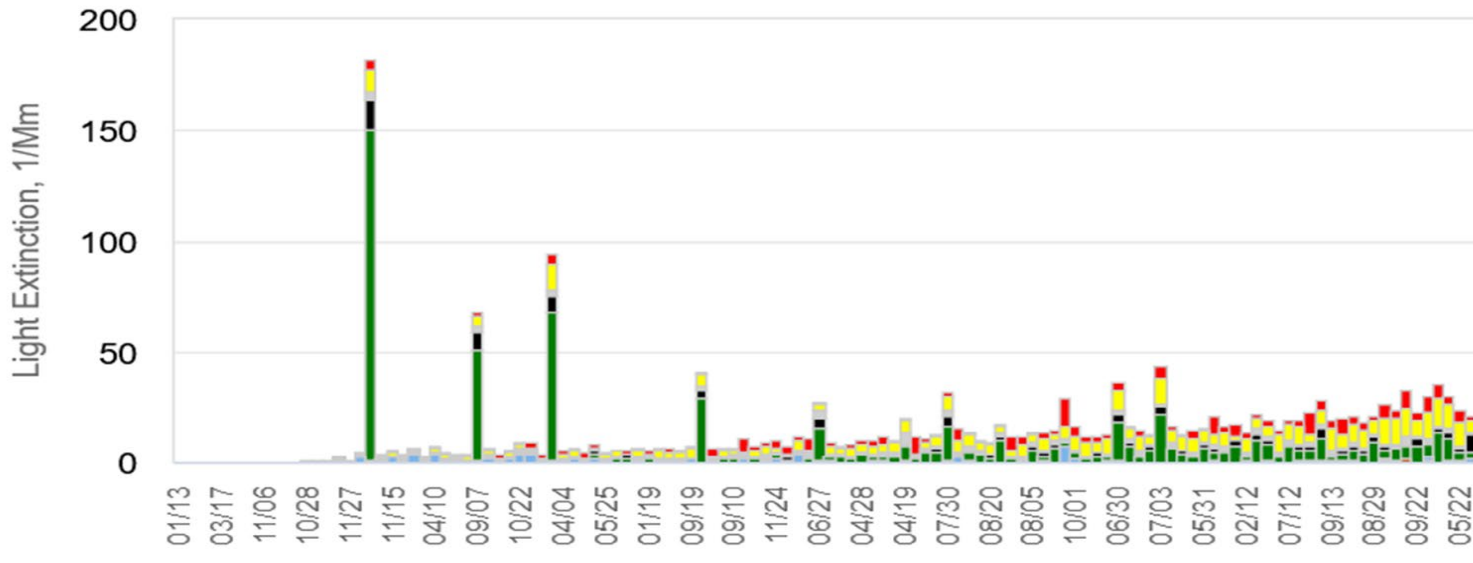
Snoqualmie Pass (SNPA1)



# Daily Extinction Composition Sorted by Impairment - All Days (2021)



Snoqualmie Pass (SNPA1)



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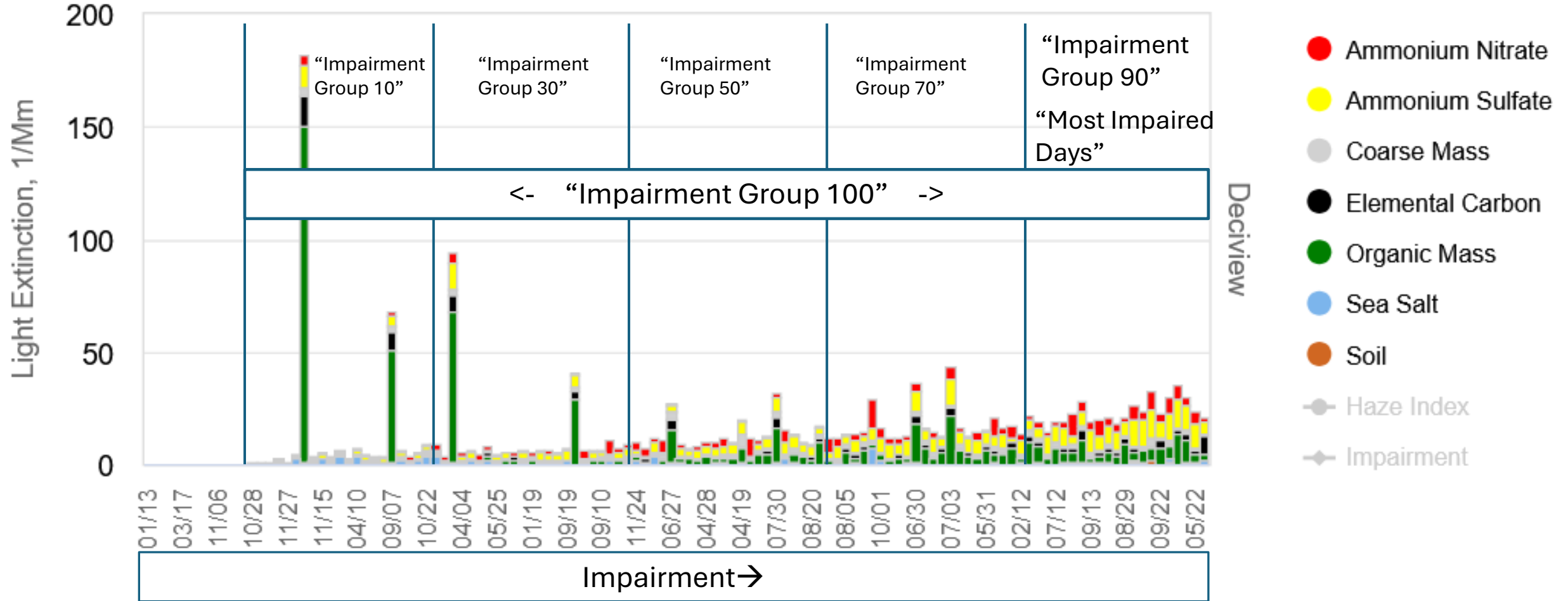




# Daily Extinction Composition Sorted by Impairment - All Days (2021)



Snoqualmie Pass (SNPA1)



IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



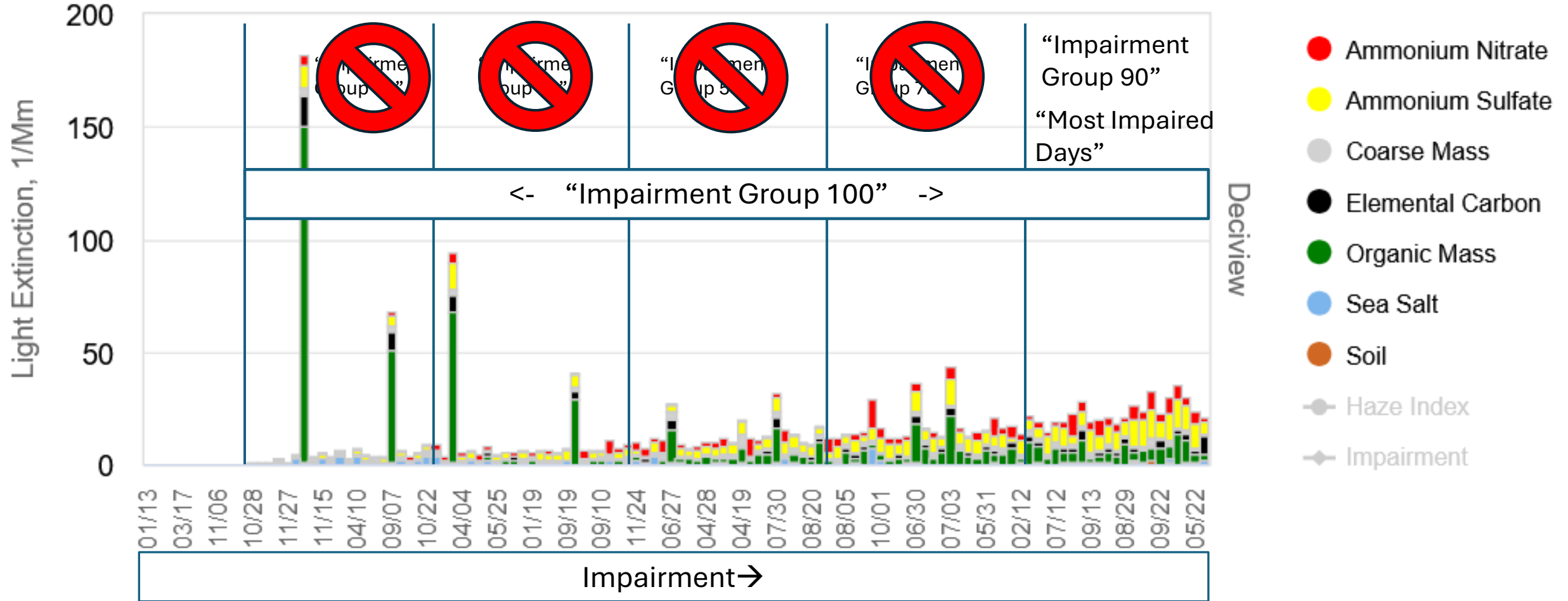
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# Daily Extinction Composition Sorted by Impairment - All Days (2021)



Snoqualmie Pass (SNPA1)



IMPROVE Monitor: SNPA1; Class I Areas: Alpine Lakes Wilderness



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This is so important, that it gets its own slide!

- **The data does not change, we are only looking at a different subset of days.**

... days that should be representative of the highest **impairment**, which **“results from manmade air pollution”**.



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# Start with RHR2 Daily data.

File Explorer showing two CSV files:

- sia\_impairment\_daily\_budgets\_11\_24.csv (528.9 MB)
- sia\_impairment\_group\_means\_11\_24.csv (10 MB)

Microsoft Excel ribbon: File, Home, Insert, Page Layout, Formulas, Data, Review, View, Automate, Help, JMP, Acrobat. The 'View' tab is active, showing options for Sheet View, Workbook Views, and Window.

	J	K	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT	AU	AV	AW	EU	EV
1	date	site	EAmn_SO	EAmn_NC	EOMC	ELAC	ESoil	ECM	ESea_Salt	ABext	TBext	SVR	DV	good_year	Group	impairment_Group	
2	1/3/1990	ACAD1	61.78632	4.454252	9.044839	6.019	0.178747	0.379194	0.011067	81.87342	93.87342	42.55856	22.39362	1	90	90	
3	1/10/1990	ACAD1	38.71687	7.122132	4.328781	4.35	0.095562	1.090362	2.608283	58.31199	70.31199	57.23739	19.50357	1	70	90	
4	1/13/1990	ACAD1	21.56853	2.757141	5.02309	2.663	0.139825	0.911184	0.011785	33.07455	45.07455	90.77286	15.05733	1	30	50	
5	1/17/1990	ACAD1	119.868	49.91588	26.85979	12.987	0.37281	1.473402	2.300793	213.7777	225.7777	17.4727	31.16966	1	90	90	
6	1/20/1990	ACAD1	19.19347	5.890901	6.03394	5.032	0.287255	3.140694	1.463271	41.04153	53.04153	76.60429	16.6849	1	50	30	
7	1/24/1990	ACAD1	42.92785	12.28392	4.859962	5.048	0.111736	0.707178	4.501083	70.43972	82.43972	48.60782	21.09482	1	70	90	
8	1/27/1990	ACAD1	26.78209	2.058118	2.662013	2.43	0.09023	0.768918	2.115341	36.90671	48.90671	83.35694	15.8733	1	50	50	
9	1/31/1990	ACAD1	24.70803	3.12273	4.751251	4.058	0.087855	1.52157	0.010648	38.26008	50.26008	81.01934	16.14626	1	50	50	
10	2/3/1990	ACAD1	18.60653	2.575831	3.816013	2.987	0.314683	2.970192	2.472281	33.74253	45.74253	89.38668	15.20444	1	30	30	
11	2/7/1990	ACAD1	69.12363	16.4332	10.44063	10.448	0.246267	1.481514	1.982097	110.1553	122.1553	32.54121	25.02708	1	90	90	
12	2/10/1990	ACAD1	43.09549	15.81264	6.526213	7.532	0.176527	3.554562	1.718315	78.41575	90.41575	44.22289	22.01833	1	90	90	
13	2/14/1990	ACAD1	40.82174	11.47955	7.227884	4.451	0.329216	2.23995	3.192073	69.74141	81.74141	49.03349	21.00976	1	70	70	
14	2/17/1990	ACAD1	19.14929	2.166438	1.79E-17	0	0.131009	0.833682	0.008917	22.28933	34.28933	121.0926	12.32249	1	10	50	
15	2/21/1990	ACAD1	21.76691	6.160291	5.920859	4.263	0.409469	3.556974	2.490436	44.56794	56.56794	71.65379	17.32857	1	50	30	
16	2/24/1990	ACAD1	13.43452	1.342013	2.602409	2.191	0.144608	0.54411	0.006568	20.26523	32.26523	129.1912	11.71405	1	10	30	
17	2/28/1990	ACAD1	31.85427	4.695689	6.190866	4.251	0.177096	0.855426	0.009558	48.03391	60.03391	67.3744	17.92324	1	50	70	
18	3/3/1990	ACAD1	32.78289	11.56902	9.7422	8.151	0.436647	2.651982	2.459506	67.79324	79.79324	0.76854	0.76854	1	70	70	
19	3/10/1990	ACAD1	39.95528	3.930919	5.365076	3.969	0.25257	1.47303	2.609323	57.5552	69.5552	9.39536	9.39536	1	70	70	
20	3/14/1990	ACAD1	24.25034	4.44695	7.155723	3.24	0.169458	3.766206	4.859708	47.88839	59.88839	7.89888	7.89888	1	50	50	
21	3/17/1990	ACAD1	61.6501	7.16187	2.772072	2.424	0.088412	0.506838	2.594758	77.19805	89.19805	1.88	1.88	1	50	50	
22	3/21/1990	ACAD1	19.41063	0.81709	2.209457	2.393	0.064215	0.188634	0.006607	25.08963	37.08963	13.10752	13.10752	1	30	30	
23	3/24/1990	ACAD1	27.06284	2.178005	3.647882	2.852	0.272227	1.244412	1.048764	29.20722	51.20722	79.45888	16.22205	1	50	70	



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Start with RHR2 Daily data.

File list showing two CSV files:

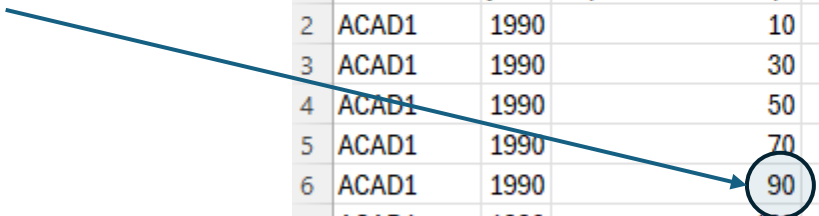
- sia\_impairment\_daily\_budgets\_11\_24.csv (528.9 MB)
- sia\_impairment\_group\_means\_11\_24.csv (10 MB)

The second file is highlighted with a blue box and an arrow pointing to the Excel spreadsheet below.

Excel spreadsheet showing the data from 'sia\_impairment\_group\_means\_11\_24'. The active cell is A1, containing the text 'site'.

	A	B	C	D	E	F	G	H	I	J	K
1	site	year	impairment_Group	Number_obs	EAmn_SO4	EAmn_NO3	EOMC	ELAC	ESoil	ECM	ESea_Salt e
2	ACAD1	1990	10	16	9.597295041	1.671101141	3.587306561	2.8499375	0.135074575	5.337357375	0.884668
3	ACAD1	1990	30	15	20.17645198	2.868534932	6.518861795	3.049133333	0.21091327	4.1209456	0.864524
4	ACAD1	1990	50	18	24.42764584	3.335768151	3.896988763	2.696	0.161202294	2.259215333	1.011468
5	ACAD1	1990	70	15	49.64345388	7.435413554	9.601873469	5.265733333	0.29278464	3.7260044	1.354326
6	ACAD1	1990	90	17	77.24078762	11.02332437	9.450993646	6.362823529	0.239531079	2.860645059	1.640068
7	ACAD1	1990	100	81	36.46476942	5.293051686	6.54346449	4.037259259	0.206053475	3.609861852	1.15463
8	ACAD1	1991	10	19	12.69216604	1.665320245	9.763216653	2.361421053	0.215956558	3.377978263	1.901126
9	ACAD1	1991	30	19	15.80009138	3.100535345	5.827154277	2.516736842	0.183641032	3.502780659	1.550405
10	ACAD1	1991	50	21	24.37354181	3.8288	84922133	2.87	0.257443714		
11	ACAD1	1991	70	19	39.7117212	5.7674	34601302	4.297368421	0.192207468		
12	ACAD1	1991	90	20	77.34673654	7.1594	54642028	5.19175	0.280784908		
13	ACAD1	1991	100	98	34.23117043	4.323749771	8.664145334	3.453469388	0.227207268	3.04466249	1.48182

Most Impaired Days



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Impairment Daily Variable List .XLSX

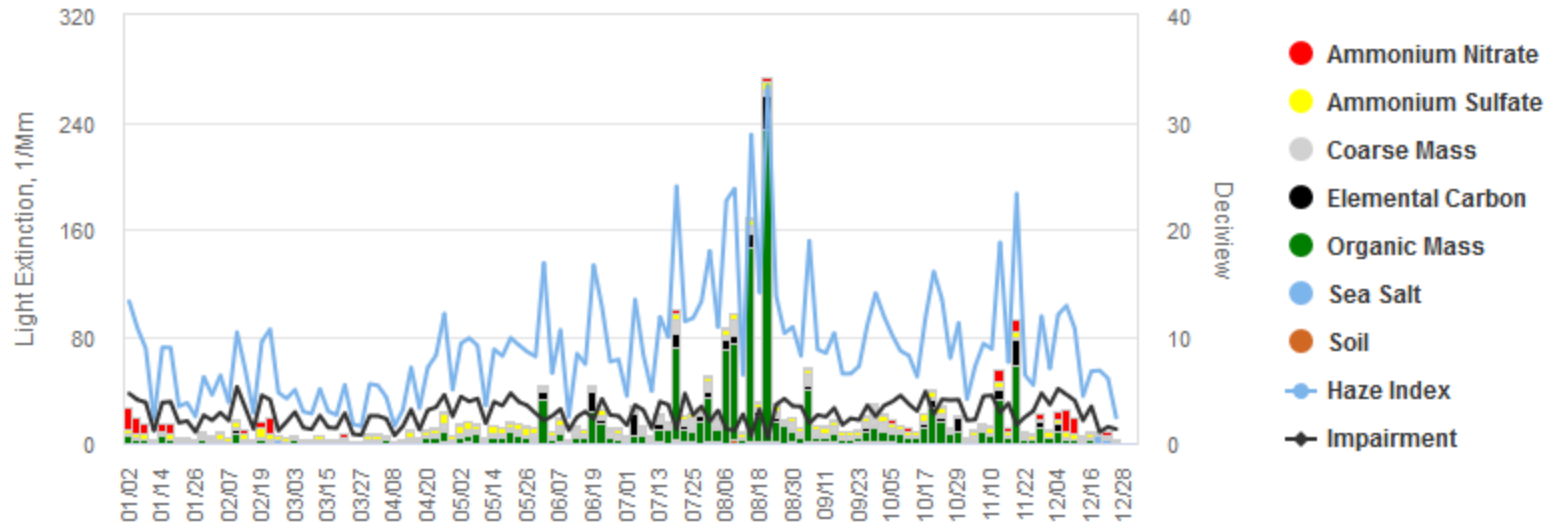
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	A	B	C	D
A1	site	IMPROVE five digit site code	Averaging Period	Units
1	site			
2	month			
3	day			
4	year			
5	fsrh	site/month f(RH) for small mass sulfate and nitrate fraction		
6	flrh	site/month f(RH) for large mass sulfate and nitrate fraction		
7	fssrh	site/month f(RH) for sea salt		
8	frh	site/month f(RH) for first IMPROVE algorithm		
9	ss_rayleigh	site specific Rayleigh scattering		Mm-1
10	CLf_MDL	Chlorine MDL		ug/m3
11	QUARTER	Calendar Quarter (JFM AMJ JAS OND)		
12	date			
13	flag_A_bad	1 if flag_A not in ('NM' 'LF' 'RF' 'AA' 'AP' 'SW' 'SP' 'NR' 'CG' 'TU')		
14	flag_B_bad	1 if flag_B not in ('NM' 'LF' 'RF' 'AA' 'AP' 'SW' 'SP' 'NR' 'CG' 'TU')		
15	flag_C_bad	1 if flag_C not in ('NM' 'LF' 'RF' 'AA' 'AP' 'SW' 'SP' 'NR' 'CG' 'TU')		
16	flag_D_bad	1 if flag_D not in ('NM' 'LF' 'RF' 'AA' 'AP' 'SW' 'SP' 'NR' 'CG' 'TU')		
17	Sea_Salt	Sea salt mass 1.8*Chloride or 1.8*Chlorine if Chloride is missing or <mdl	Daily	ug/m3
18	FMass	Fine mass	Daily	ug/m3
19	Soil	Fine soil mass (2.2*Alf+2.49*Sif+1.63*Caf+2.42*Fef+1.94*Tif)	Daily	ug/m3
20	Amm_NO3	Ammonium nitrate mass =1.39 * NO3f	Daily	ug/m3
21	OMC	Organic mass by carbon = 1.8*(OC1f+OC2f+OC3f+OC4f+OPf)	Daily	ug/m3
22	LAC	Light absorbing carbon = EC1f+EC2f+EC3f-Opf	Daily	ug/m3
23	TMass	Gravimetric mass from D module	Daily	ug/m3
24	CM	Coarse mass = TMass-FMass	Daily	ug/m3
25	Amm_SO4	Inferred Ammonium sulfate mass = 4.125*Sf or 1.375*SO4f if Sf is missing	Daily	ug/m3
26	Large_OMC	"Large" portion of OMC	Daily	ug/m3
27	Small_OMC	"Small" portion of OMC	Daily	ug/m3
28	Large_Amm_SO4	"Large_Amm" portion of SO4	Daily	ug/m3

### Daily Extinction Composition Sorted by Date - All Days (2018)

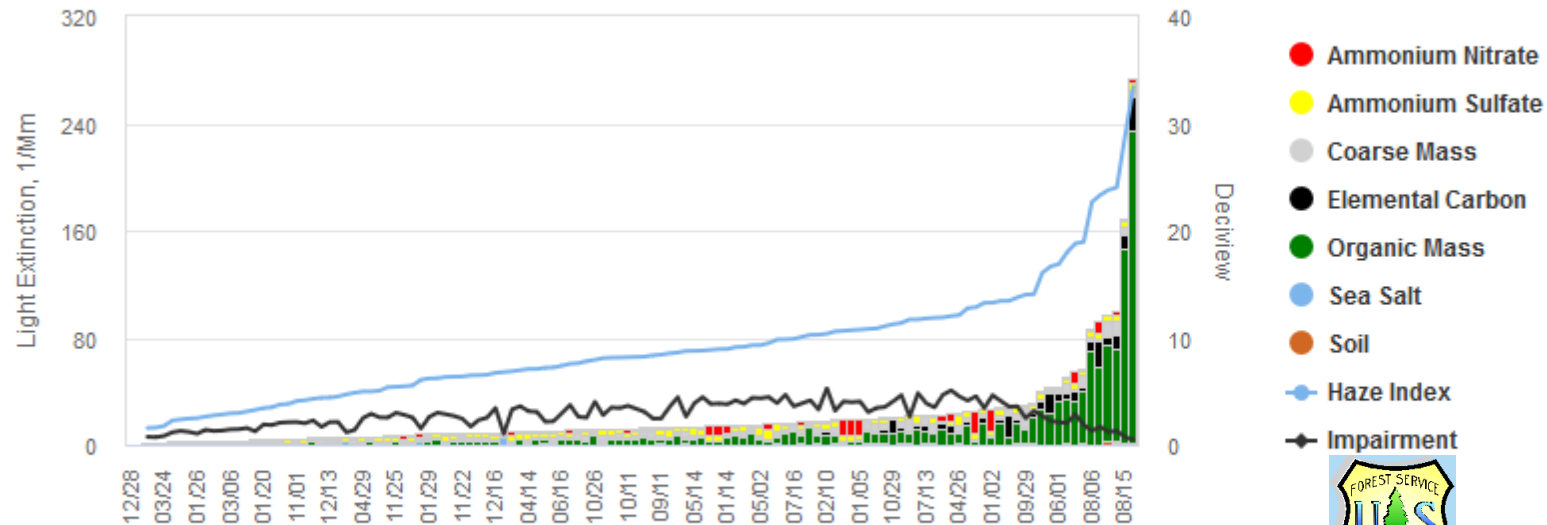
Starkey (STAR1)



IMPROVE Monitor: STAR1; Class I Areas: Eagle Cap Wilderness, Strawberry Mountain

### Daily Extinction Composition Sorted by Total Haze - All Days (2018)

Starkey (STAR1)



IMPROVE Monitor: STAR1; Class I Areas: Eagle Cap Wilderness, Strawberry Mountain Wilderness

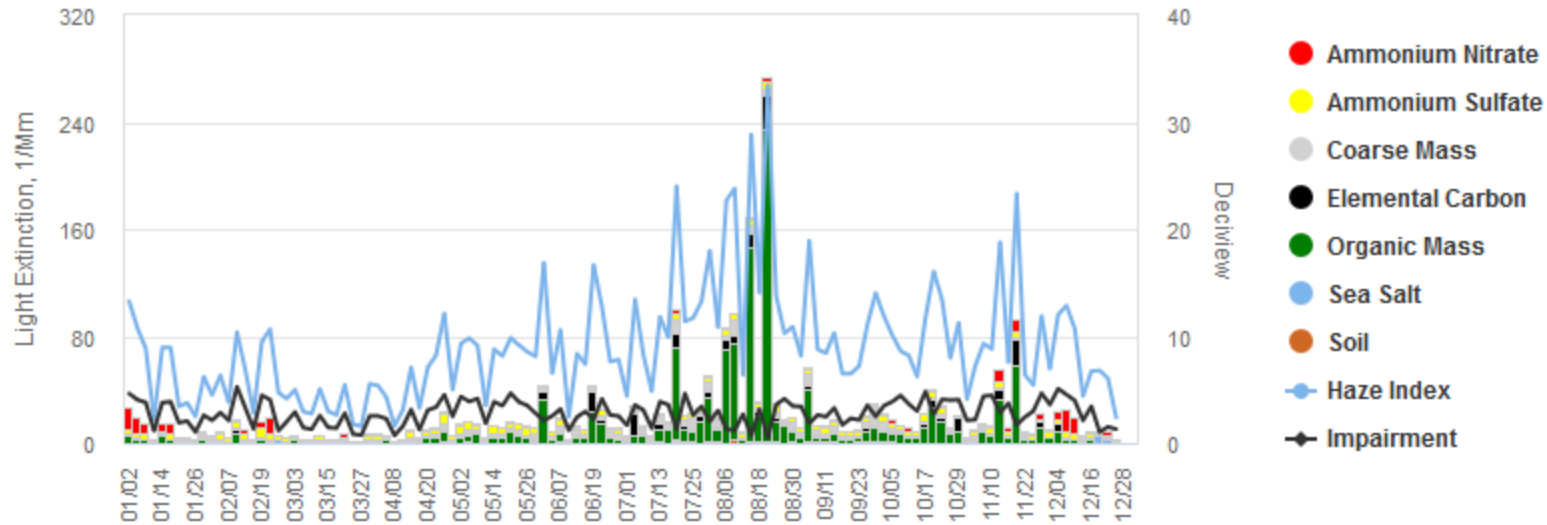


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## Daily Extinction Composition Sorted by Date - All Days (2018)

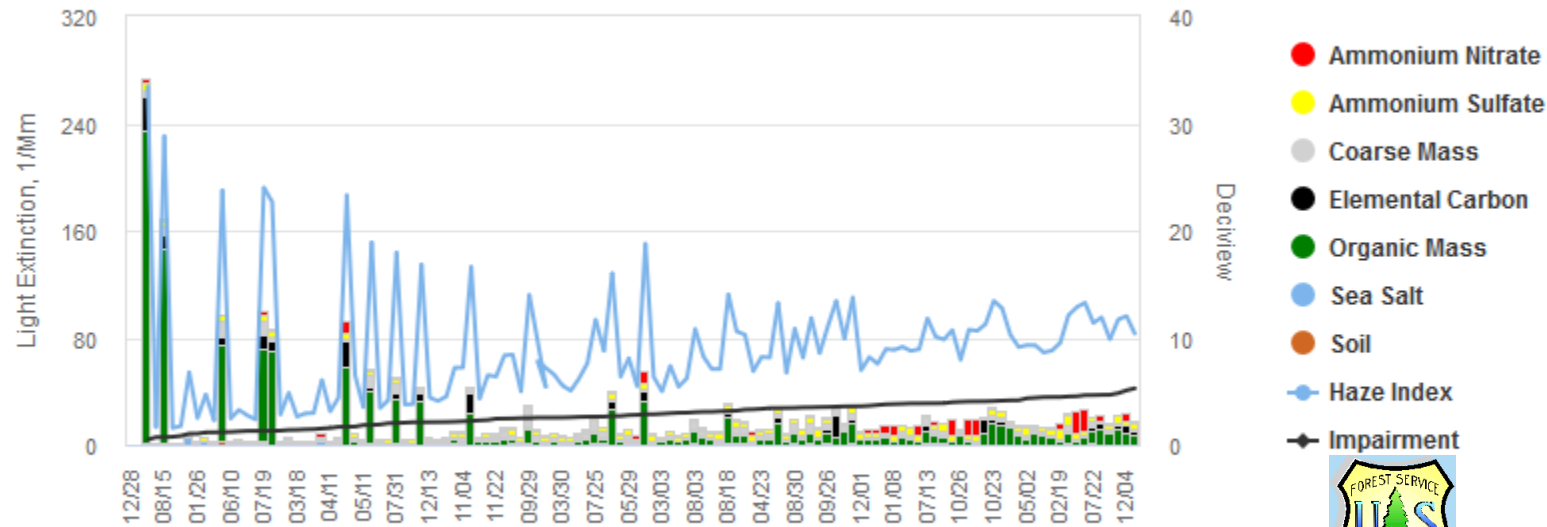
Starkey (STAR1)



IMPROVE Monitor: STAR1; Class I Areas: Eagle Cap Wilderness, Strawberry Mountain

## Daily Extinction Composition Sorted by Impairment - All Days (2018)

Starkey (STAR1)



IMPROVE Monitor: STAR1; Class I Areas: Eagle Cap Wilderness, Strawberry Mountain Wilderness



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# Uniform Rate of Progress



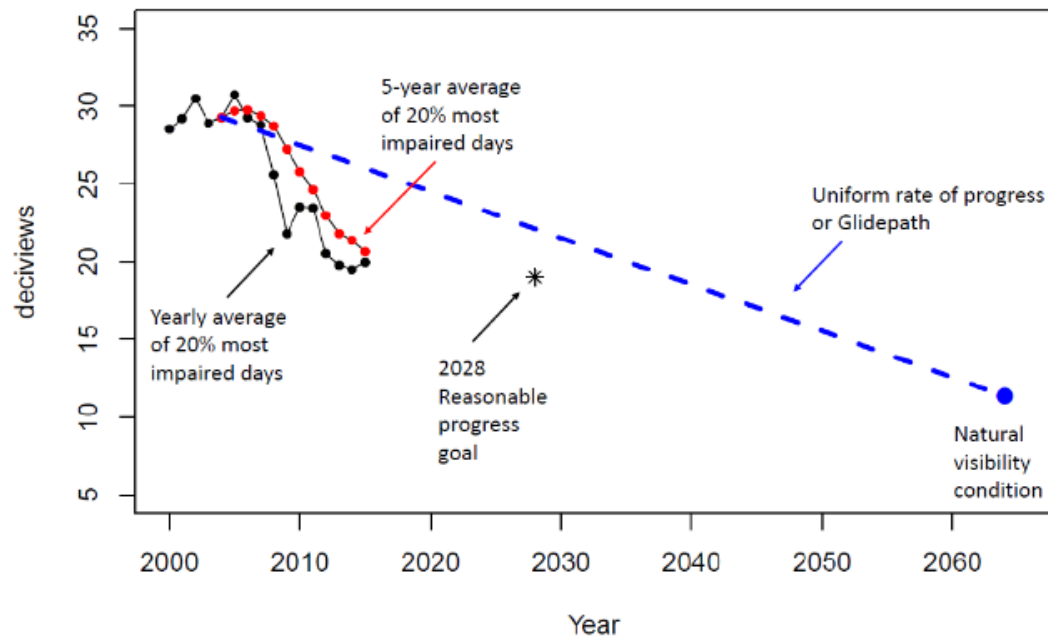
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The 2017 Regional Haze Rule **requires states to determine the baseline (2000-2004) visibility condition for the 20 percent most impaired days and requires that the long-term strategy and RPG must provide for improvement in visibility for the most impaired days, relative to the baseline period.**

Specifically, states must determine the rate of improvement in visibility that would need to be maintained during each implementation period in order to reach natural conditions by 2064 for the 20 percent most impaired days, given the starting point of the 2000-2004 baseline visibility condition. The “glidepath,” or URP, is the amount of visibility improvement that would be needed to stay on a linear path from the baseline period to natural conditions.

[https://www.epa.gov/sites/production/files/2018-12/documents/technical\\_guidance\\_tracking\\_visibility\\_progress.pdf](https://www.epa.gov/sites/production/files/2018-12/documents/technical_guidance_tracking_visibility_progress.pdf)

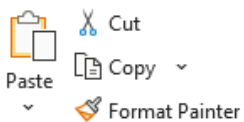


**Figure 3-1** Example Glidepath Plot.

[https://www.epa.gov/sites/production/files/2019-10/documents/updated\\_2028\\_regional\\_haze\\_modeling-tsd-2019\\_0.pdf](https://www.epa.gov/sites/production/files/2019-10/documents/updated_2028_regional_haze_modeling-tsd-2019_0.pdf)

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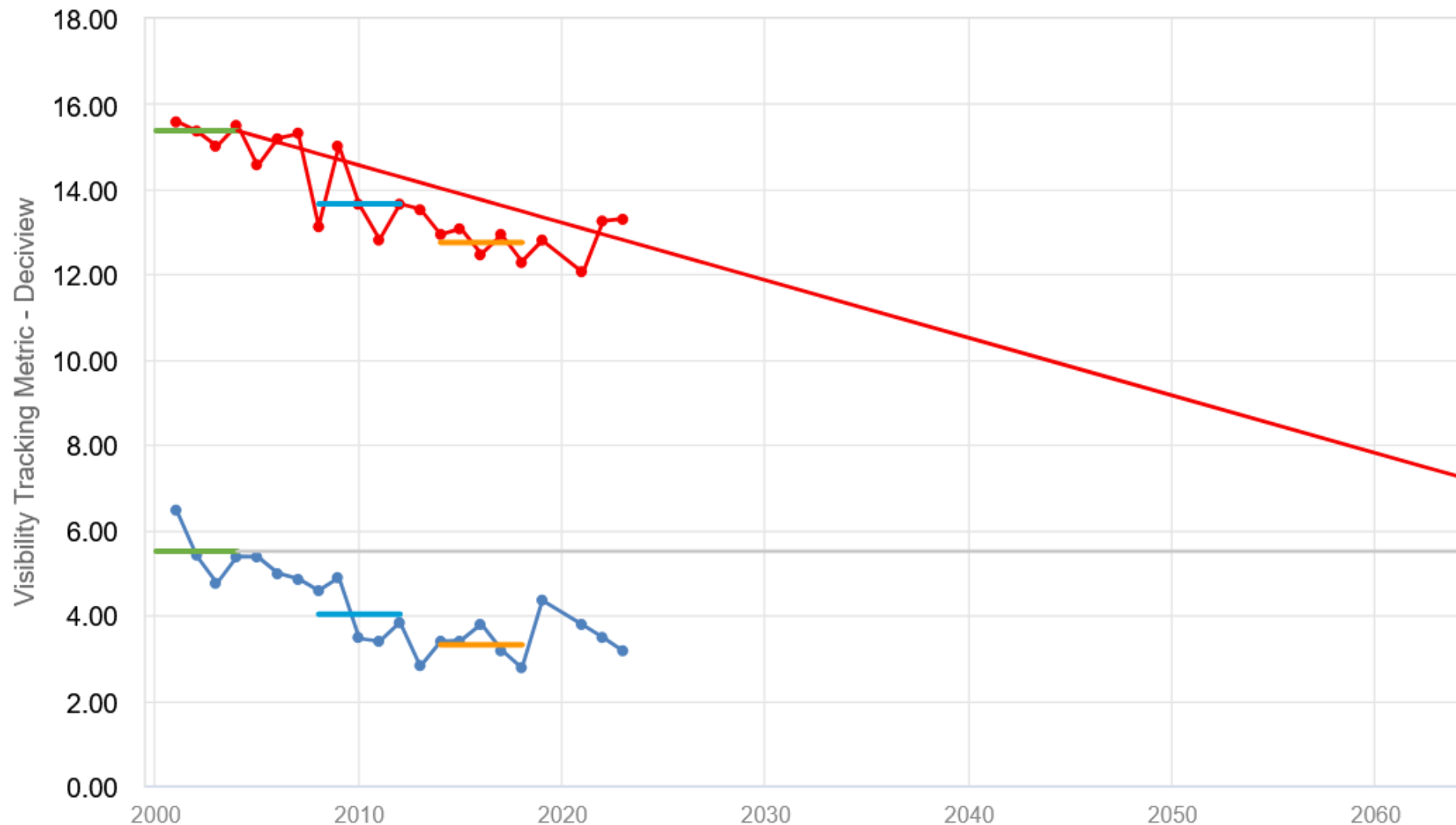
A1 : site

	A	B	C	D	E	F	G	H	I	J	K	
1	site	impairment_Group	fye93_n_years	fye93_sia_Ammonium_Sulfate_Ext	fye93_sia_Ammonium_Nitrate_Ext	fye93_sia_Organic_ext	fye93_sia_Elemental_Carbon_Ext	fye93_sia_Fine_Soil_Ext	fye93_sia_Sea_Salt_Ext	fye93_sia_Coarse_Ext	fye93_sia_Total_Ext	ray
2	ACAD1	10	4	10.30855094	1.624327946	5.205445498	2.260702138	0.150493431	1.229989074	3.273216307	36.05272534	
3	ACAD1	50	4	23.68924935	3.262059386	5.803777302	3.00151087	0.189230586	0.890170657	2.399210652	51.2352088	
4	ACAD1	90	4	92.72696482	7.326943066	10.59776349	5.211655287	0.313777633	0.922880624	2.563305623	131.6632905	
5	ACAD1	100	4	37.47518107	4.172774691	7.189511583	3.537954221	0.213179098	0.991266373	2.841996866	68.4218639	
6	ADPI1	10										
7	ADPI1	50										
8	ADPI1	90										
9	ADPI1	100										
10	AGT11	10										
11	AGT11	50										
12	AGT11	90										
13	AGT11	100										
14	AREN1	10										
15	AREN1	50										
16	AREN1	90										
17	AREN1	100										
18	BADL1	10	5	3.897338348	0.781014911	3.774727639	1.028546765	0.651238743	0.068707938	3.41737125	24.61894559	
19	BADL1	50	5	9.366655783	1.707650845	5.360536016	1.520871692	0.737831117	0.070147521	3.736618386	33.50031136	
20	BADL1	90	5	25.26096092	9.381391372	5.131493683	1.834171541	0.535535698	0.044165601	2.839293322	56.02701213	
21	BADL1	100	5	11.777273	3.3213984	4.689950697	1.434117724	0.669081923	0.071144429	3.420220497	36.38318667	

# Uniform Rate of Progress Glidepath and IMPROVE 2000-2018 for DV



Average Most Impaired and Clearest Days - Snoqualmie Pass (SNPA1)



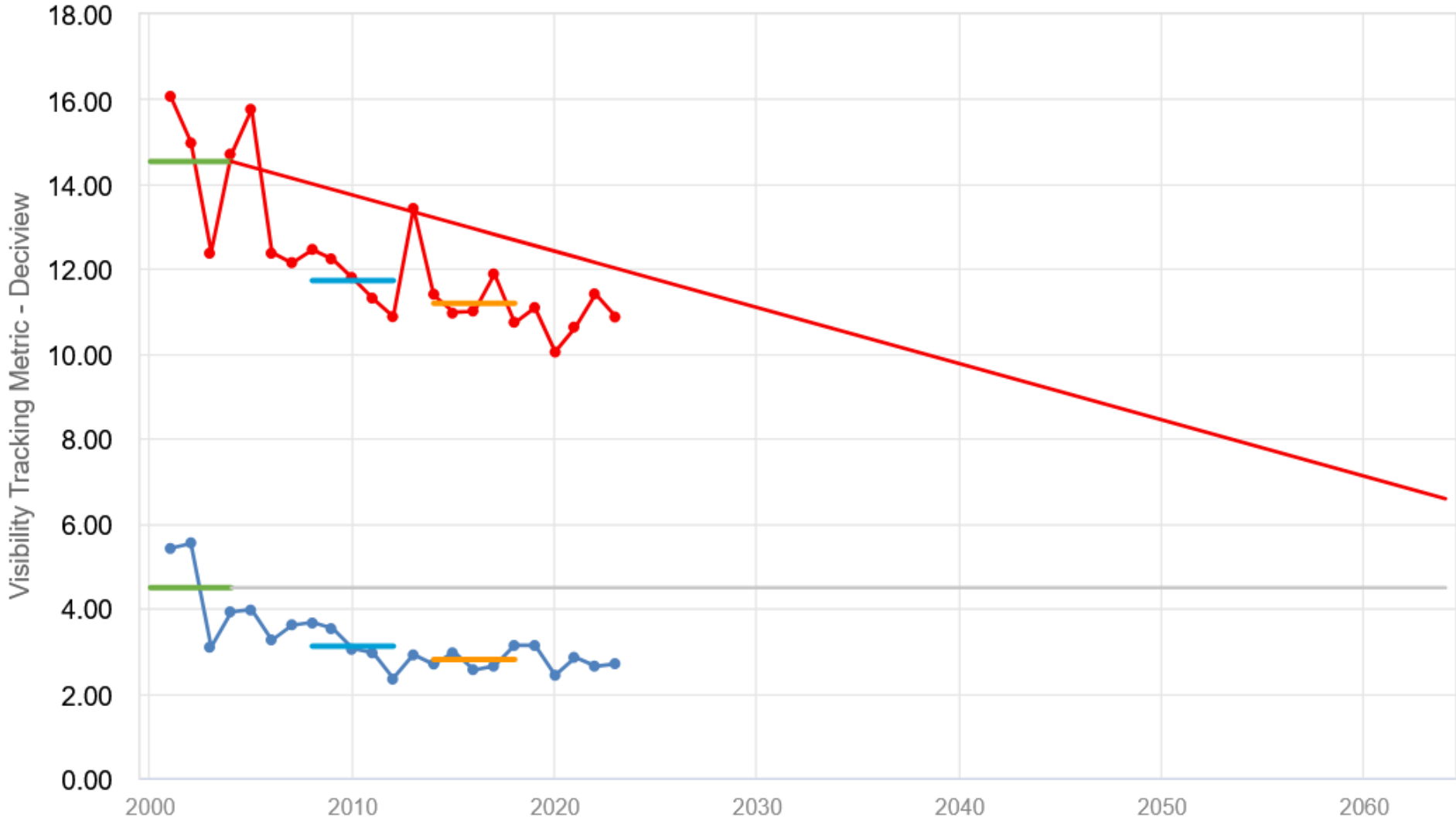
- MID - Observations
- MID - 2000-2004 Obs 5yr-Avg
- MID - 2008-2012 Obs 5yr-Avg
- MID - 2014-2018 Obs 5yr-Avg
- MID - Glidepath
- Clearest - Observations
- Clearest - 2000-2004 Obs 5yr-Avg
- Clearest - 2008-2012 Obs 5yr-Avg
- Clearest - 2014-2018 Obs 5yr-Avg

Clearest Days (2000-2004)

# Uniform Rate of Progress Glidepath and IMPROVE 2000-2018 for DV



Average Most Impaired and Clearest Days - Starkey (STAR1)

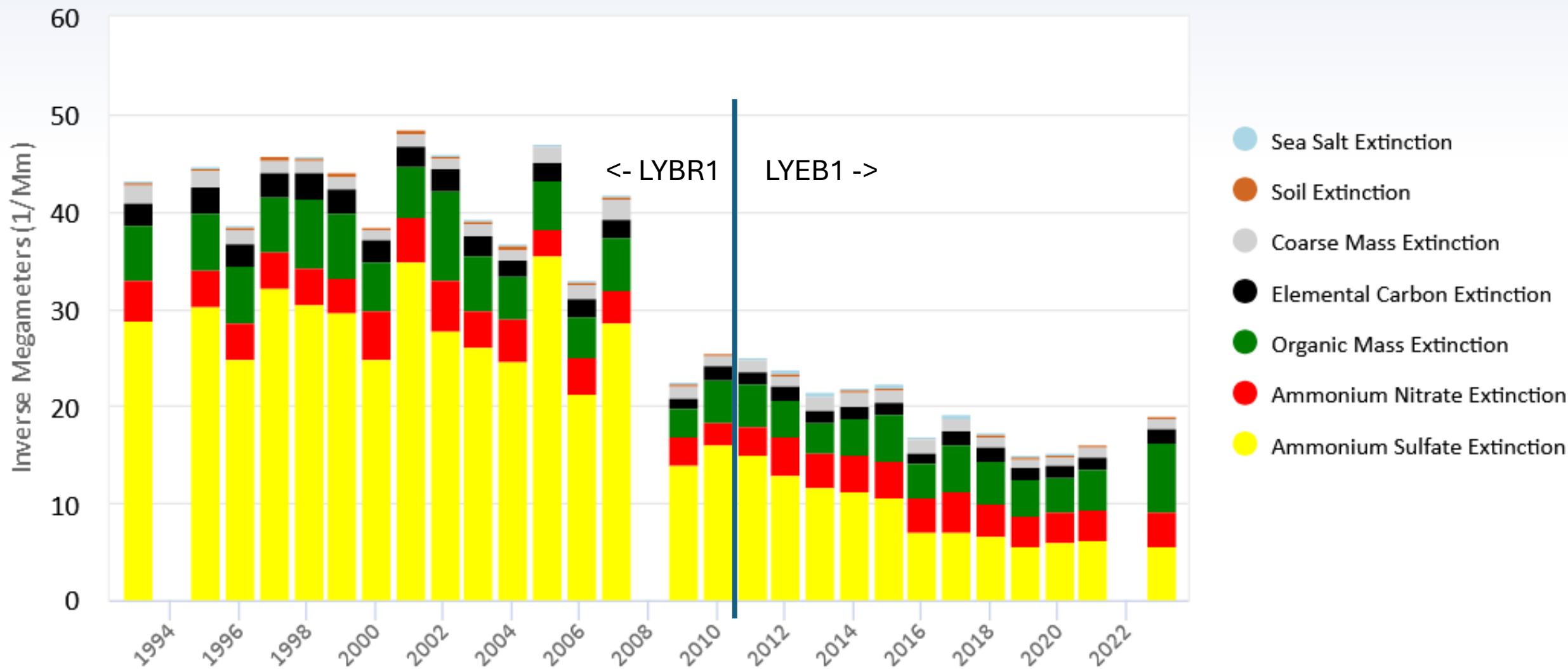


- MID - Observations
- MID - 2000-2004 Obs 5yr-Avg
- MID - 2008-2012 Obs 5yr-Avg
- MID - 2014-2018 Obs 5yr-Avg
- MID - Glidepath
- Clearest - Observations
- Clearest - 2000-2004 Obs 5yr-Avg
- Clearest - 2008-2012 Obs 5yr-Avg
- Clearest - 2014-2018 Obs 5yr-Avg

# Annual Extinction Composition for All Days - Lye Brook Wilderness - RHTS



1993 - 2023



Questions?





# Changes since 2000-2004 RHR Baseline

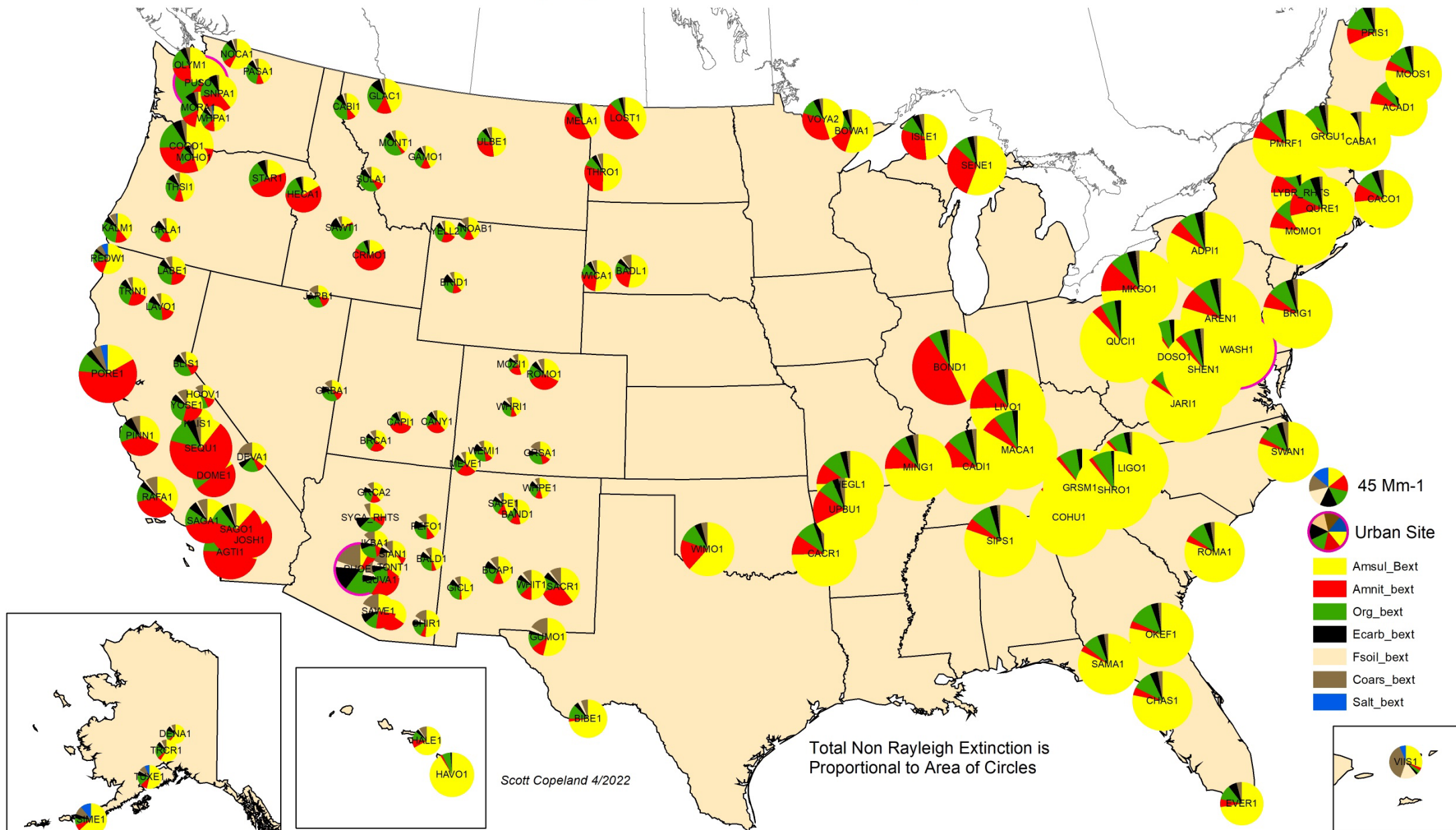


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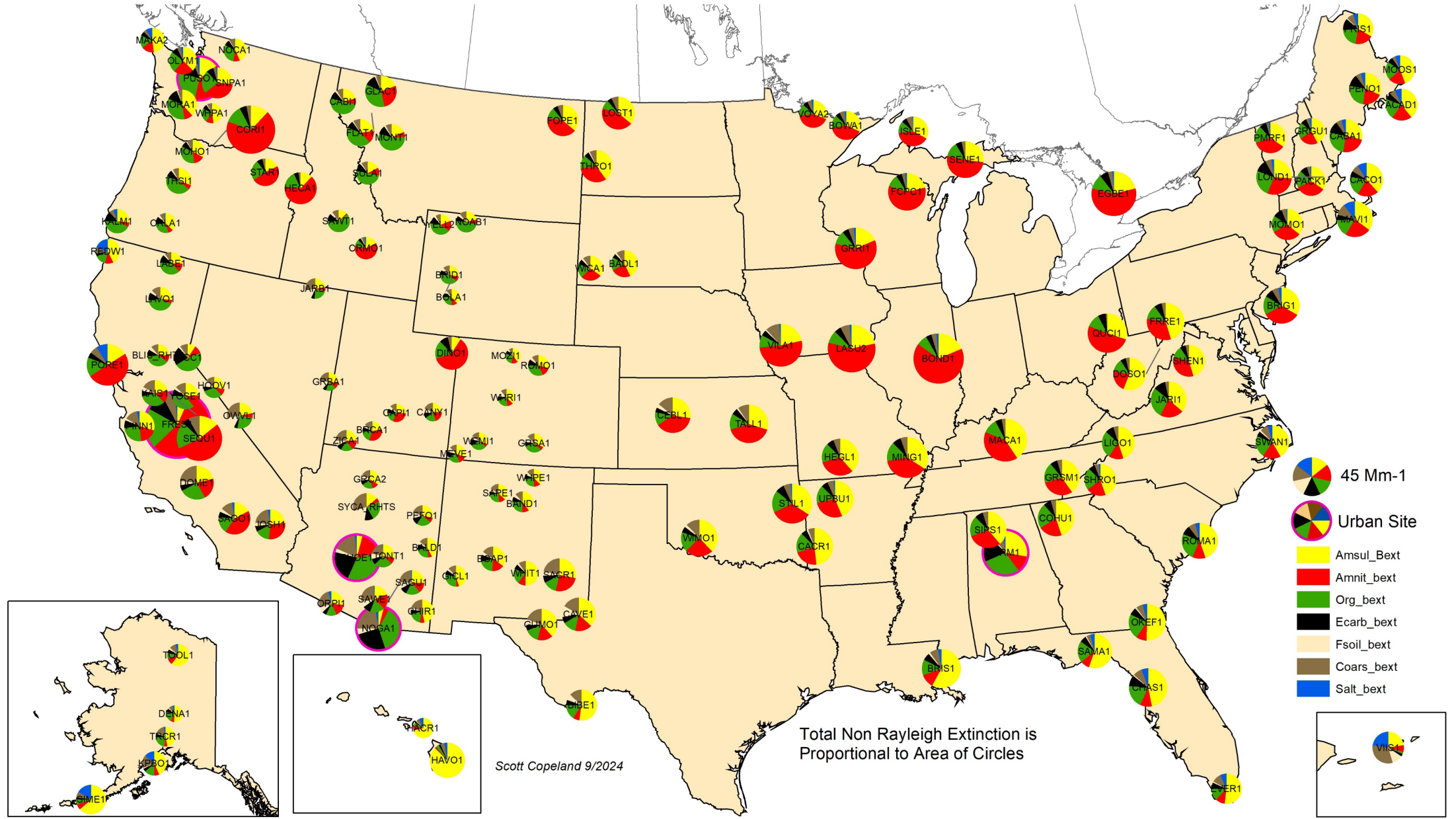
# IMPROVE Data - 2002 Second IMPROVE Algorithm

Non Rayleigh Mean of 20% Most Impaired



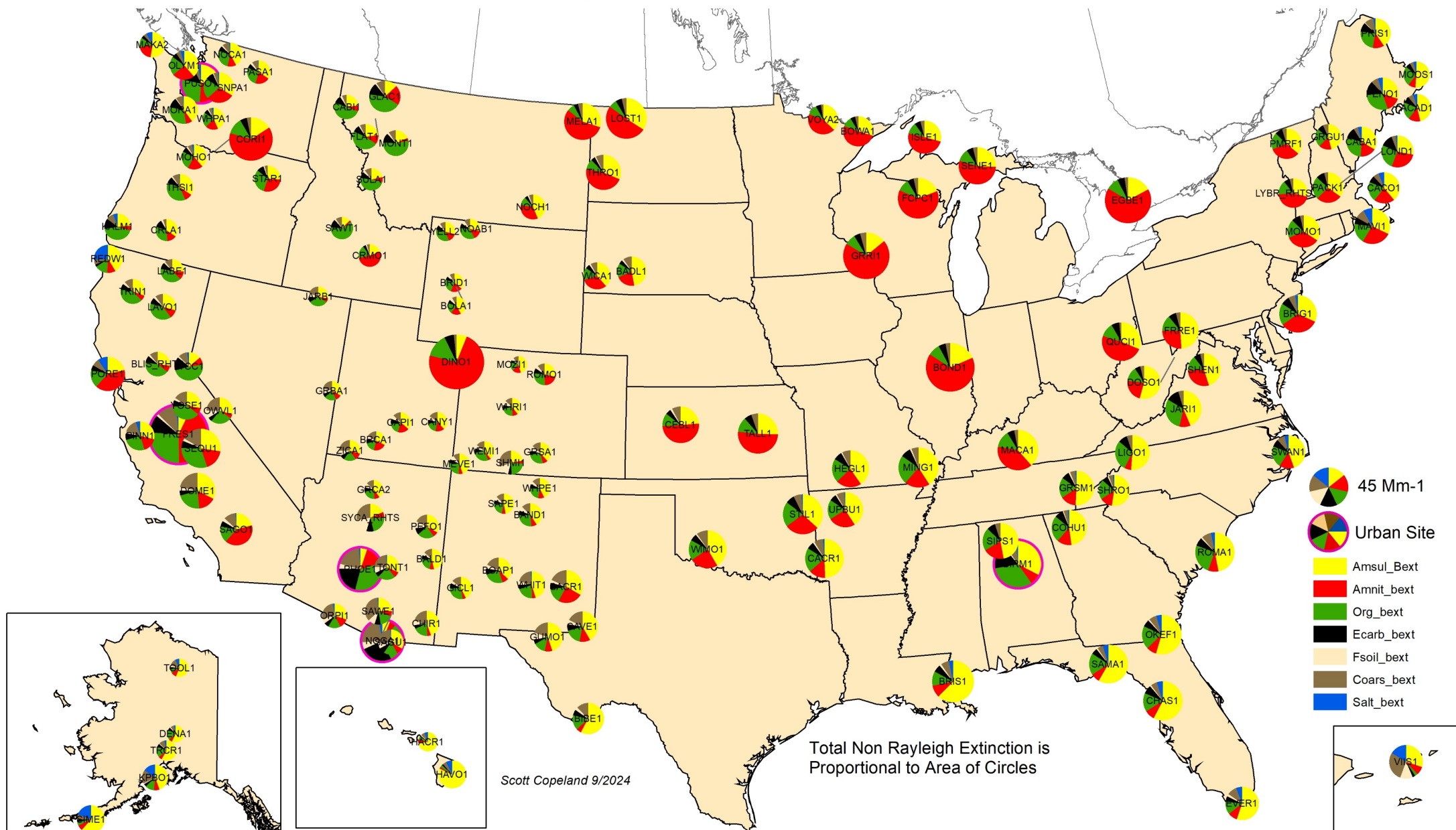
# IMPROVE Data - 2022 Second IMPROVE Algorithm

Non Rayleigh Mean of 20% Most Impaired



# IMPROVE Data - 2023 Second IMPROVE Algorithm

## Non Rayleigh Mean of 20% Most Impaired



# Default 2064 Endpoints (Based on 2000-2015) IMP Sites

## Non Rayleigh Mean of Routine+Episodic on 20% Most Impaired

