Technical Support Document

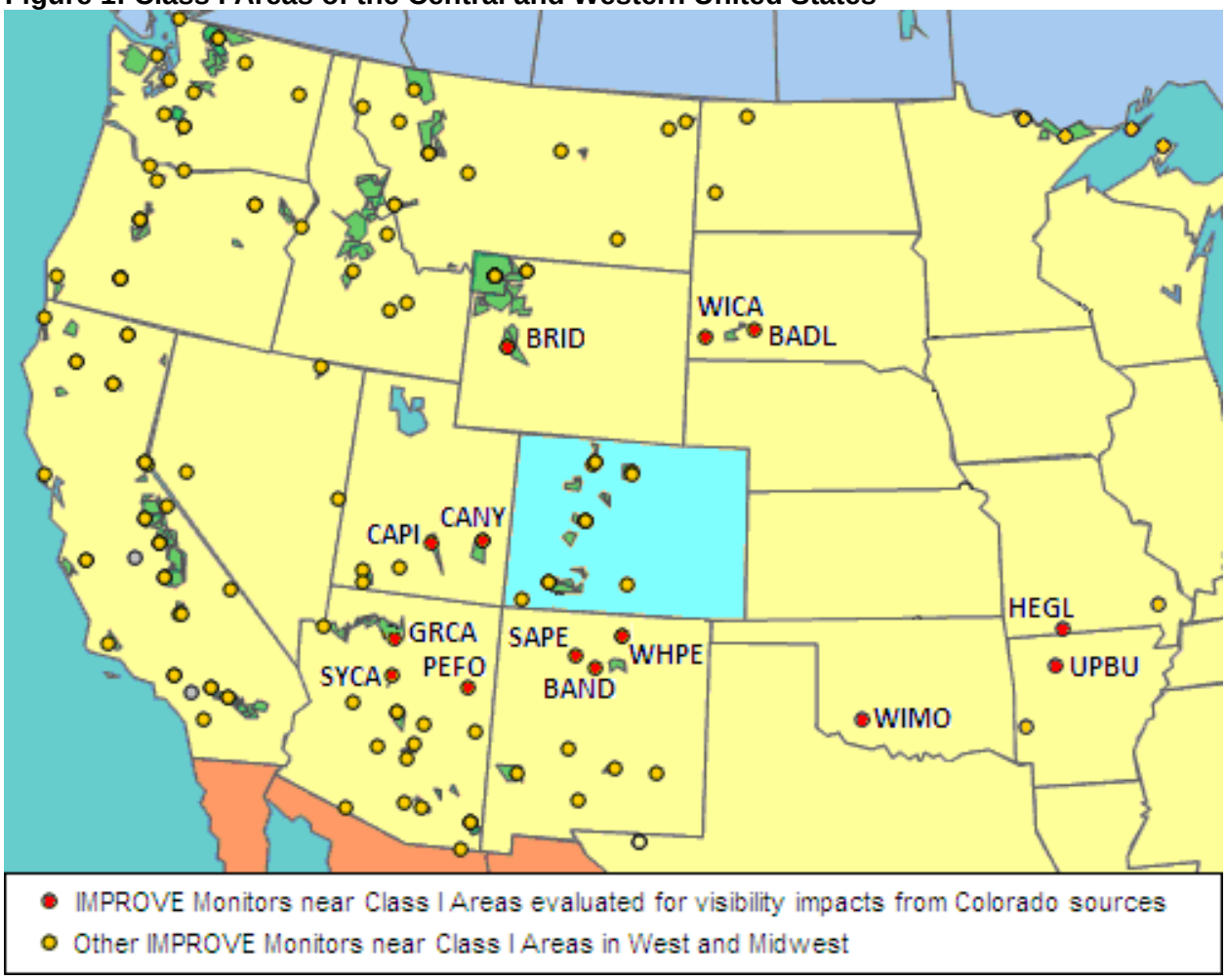
Regional Haze State Implementation Plan

Analysis of Colorado visibility impacts on nearby Class I Areas

October 2008 Revision

The below map (Figure 1), depicts the western and midwestern IMPROVE monitor locations that are identified by small circles. Each IMPROVE monitor is typically sited near a Class I Area (CIA) that may represent one or more nearby CIAs. The IMPROVE monitor locations denoted with a red dot and four letter abbreviations were evaluated for Colorado impacts since they are the closest areas surrounding Colorado. An informal review of PSAT data for more distance IMPROVE monitors (identified by gold circles) indicated minimal or non-existent Colorado impacts.

Figure 1: Class I Areas of the Central and Western United States



The below listed PSAT modeling summary tables for sulfate (Table 1) and nitrate (Table 2) indicate the Colorado visibility impacts in percent and the relative rank. For purposes of identifying Colorado visibility impacts that may be of concern to surrounding States, the Division proposes a threshold criterion to include ≥ 5.0% or a ranking in the top 5 among source regions. In the below tables, all Colorado visibility impacts satisfying these criterion are shaded in purple. Any future (2018) visibility impact from Colorado that is over 10% is indentified in orange and is considered as significant.

Table 1: PM Source Apportionment Technology (PSAT) Modeling Results for Sulfate

PM Source Apportionment Technology (PSAT) Modeling Results for Sulfate			Colorado Visibility Impact on Nearby Class I Areas							
			Sulfate							
			Best Days				Worst Days			
			2002		2018		2002		2018	
Nearby Class I Area (CIA)	CIA Code	State	Impact	Rank	Impact	Rank	Impact	Rank	Impact	Rank
Upper Buffalo Wilderness	UPBU1	AR	0.7%	8	0.6%	9	0.1%	9	0.1%	10
Petrified Forest National Park	PEFO1	AZ	0.4%	16	0.2%	16	1.3%	11	1.0%	12
Grand Canyon National Park	GRCA2	AZ	0.5%	16	0.3%	17	0.9%	15	0.7%	15
Sycamore Canyon Wilderness	SYCA1	AZ	0.3%	16	0.0%	16	0.8%	11	0.5%	12
Hercules-Glade Wilderness	HEGL1	MO	0.8%	8	0.6%	9	0.2%	8	0.3%	8
San Pedro Parks Wilderness	SAPE1	NM	4.3%	5	3.4%	6	1.4%	12	1.2%	13
Bandelier National Monument	BAND1	NM	3.3%	8	2.6%	8	1.4%	11	1.2%	11
Wheeler Peak & Pecos Wilderness	WHPE1	NM	11.0%	2	8.8%	2	3.2%	8	2.5%	9
Wichita Mountains National Wildlife Refuge	WIMO1	OK	2.3%	5	2.0%	12	0.3%	9	0.3%	11
Wind Cave National Park	WICA1	SD	1.9%	11	1.1%	12	3.3%	7	3.1%	7
Badlands National Park	BADL1	SD	0.8%	12	0.4%	14	2.1%	10	2.2%	10
Canyonlands National Park	CANY1	UT	2.0%	10	1.2%	12	3.4%	9	2.3%	10
Capital Reef National Park	CAPI1	UT	0.3%	15	0.3%	15	1.0%	15	0.6%	15
Bridger Wilderness	BRID1	WY	0.0%	17	0.0%	17	0.7%	18	0.5%	18

Note: Colorado Impacts to nearby Class I Areas that exceed 5.0% or are in the top 5 ranking are deemed of possible concern and are shaded in purple

Nearby Class I Areas with Colorado visibility impacts that exceed 10% (for 2018) trigger further consultation with the affected state and are shaded in orange**

****Based on informal agreement among the WRAP IWG members, visibility impacts over 10% are considered to trigger further interstate consultation with the affected State**

Table 2: PM Source Apportionment Technology (PSAT) Modeling Results for Nitrate

PM Source Apportionment Technology (PSAT) Modeling Results for Nitrate			Colorado Visibility Impact on Nearby Class I Areas							
			Nitrate							
			Best Days				Worst Days			
			2002		2018		2002		2018	
Nearby Class I Area (CIA)	CIA Code	State	Impact	Rank	Impact	Rank	Impact	Rank	Impact	Rank
Upper Buffalo Wilderness	UPBU1	AR	2.1%	6	2.2%	7	1.1%	9	1.2%	9
Petrified Forest National Park	PEFO1	AZ	1.3%	10	1.5%	10	0.0%	11	0.9%	9
Grand Canyon National Park	GRCA2	AZ	1.1%	13	1.2%	11	0.0%	13	0.0%	10
Sycamore Canyon Wilderness	SYCA1	AZ	0.5%	10	0.6%	10	1.3%	11	1.6%	9
Hercules-Glade Wilderness	HEGL1	MO	1.6%	7	1.7%	7	1.3%	6	1.6%	6
San Pedro Parks Wilderness	SAPE1	NM	7.7%	4	7.5%	4	2.7%	8	2.4%	7
Bandelier National Monument	BAND1	NM	6.4%	5	6.3%	5	4.8%	7	5.1%	5
Wheeler Peak & Pecos Wilderness	WHPE1	NM	15.3%	3	12.9%	3	4.5%	5	3.8%	7
Wichita Mountains National Wildlife Refuge	WIMO1	OK	5.7%	4	5.4%	5	0.9%	7	0.9%	7
Wind Cave National Park	WICA1	SD	2.8%	10	2.5%	9	5.0%	8	4.1%	8
Badlands National Park	BADL1	SD	2.8%	10	2.6%	8	3.0%	8	2.6%	8
Canyonlands National Park	CANY1	UT	4.6%	4	4.1%	5	6.9%	5	6.9%	6
Capital Reef National Park	CAPI1	UT	1.4%	11	1.3%	11	0.0%	15	0.0%	15
Bridger Wilderness	BRID1	WY	0.3%	13	0.2%	14	0.6%	16	0.0%	16

Note: Colorado Impacts to nearby Class I Areas that exceed 5.0% or are in the top 5 ranking are deemed of possible concern and are shaded in purple

Nearby Class I Areas with Colorado visibility impacts that exceed 10% (for 2018) trigger further consultation with the affected state and are shaded in orange**

****Based on informal agreement among the WRAP IWG members, visibility impacts over 10% are considered to trigger further interstate consultation with the affected State**

For Arkansas, the Colorado visibility impacts were evaluated for the closest CIA – Upper Buffalo Wilderness (UPBU). The single largest Colorado visibility impact identified is 1.2% for nitrate on the worst days in 2018. This level of impact is not considered to a significant contributor to visibility degradation thus the Division has determined that no further evaluation of the remaining Arkansas Class I areas is necessary considering the relative distance from Colorado.

For Arizona, the Colorado visibility impacts were evaluated on the three nearest Class I areas including Petrified Forest National Park (PEFO), Sycamore Canyon Wilderness Area (SYCA) and Grand Canyon National Park (GRCA). The single largest Colorado visibility impact identified (1.6% nitrate) occurs at SYCA in 2018. This level of impact is not considered a significant contributor to visibility degradation thus the Division has determined that no further evaluation of the remaining Arizona Class I areas is necessary considering the relative distance from Colorado.

For Missouri, the Colorado visibility impacts were evaluated for the closest CIA – Hercules-Glade Wilderness (HEGL). The single largest Colorado visibility impact identified is 1.7% for nitrate on the best days in 2018. This level of impact is not considered to a significant contributor to visibility degradation thus the Division has determined that no further evaluation of the remaining Missouri Class I areas is necessary considering the relative distance from Colorado.

For New Mexico, the Colorado visibility impacts were evaluated for the four nearest Class I areas with PSAT modeling. The single largest Colorado visibility impact identified (12.9% nitrate) occurs at WHPE in 2018. The WHPE site represents both Wheeler Peak & Pecos Wilderness Areas. This level of impact exceeds the informal criteria for triggering further interstate consultation. Consequently, the Division will consult further with New Mexico on Colorado visibility impacts on Wheeler Peak and Pecos Wilderness Areas. All other 2018 Colorado visibility impacts on other two nearby New Mexico Class I Areas are under 7.5% which are deemed to be a concern that will be addressed in the WHPE consultation process with New Mexico.

For Oklahoma, the Colorado visibility impacts were evaluated for the only CIA – Wichita Mountains National Wildlife Refuge Wilderness (WIMO). The largest Colorado visibility impacts identified are 5.7% & 5.4% for nitrate on the best days in 2002 & 2018 respectively. These visibility impacts exceed the “concern” threshold criterion.

For South Dakota, the Colorado visibility impacts were evaluated for both Class I areas – Wind Cave National Park (WICA) and Badlands National Park (BADL). The WICA site experiences a Colorado visibility impact exceeding the threshold criteria for nitrate on the worst days in 2002 but this impact appears to be mitigated based on the PSAT model projections for 2018. Thus the Division has determined that no further technical evaluation of Colorado visibility impacts is necessary.

For Utah, the Colorado visibility impact was evaluated for the nearest Class I areas – Canyonlands National Park (CANY) and Capital Reef National Park (CAPI). Looking at the PSAT analysis for the CANY site, Colorado has visibility impacts exceeding the “concern” threshold criterion for nitrate on the best (4.1% in 2018) and worst days (6.9% in 2018). No visibility impacts of “concern” are identified for the CAPI Class I area.

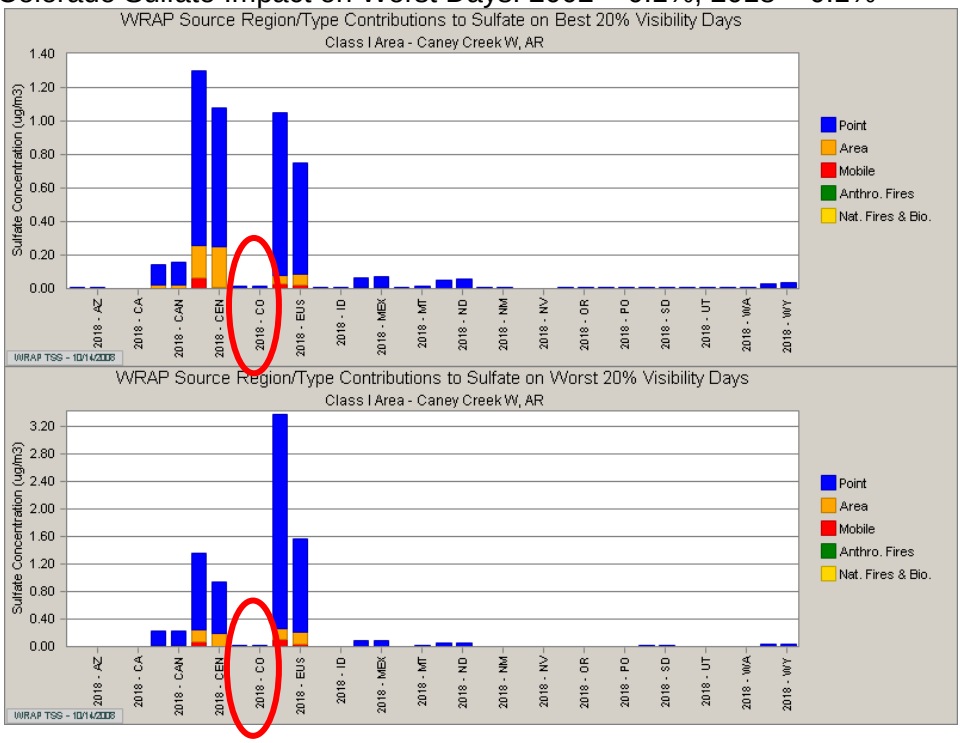
For Wyoming, the Colorado visibility impact was evaluated for the nearest Class I area - Bridger Wilderness (BRID). The single largest Colorado visibility impact identified (0.7% sulfate) occurs on the worst days at BRID in 2002. This level of impact is not considered to a significant contributor to visibility degradation thus the Division has determined that no further evaluation of

the remaining Wyoming Class I areas is necessary considering the relative distance from Colorado.

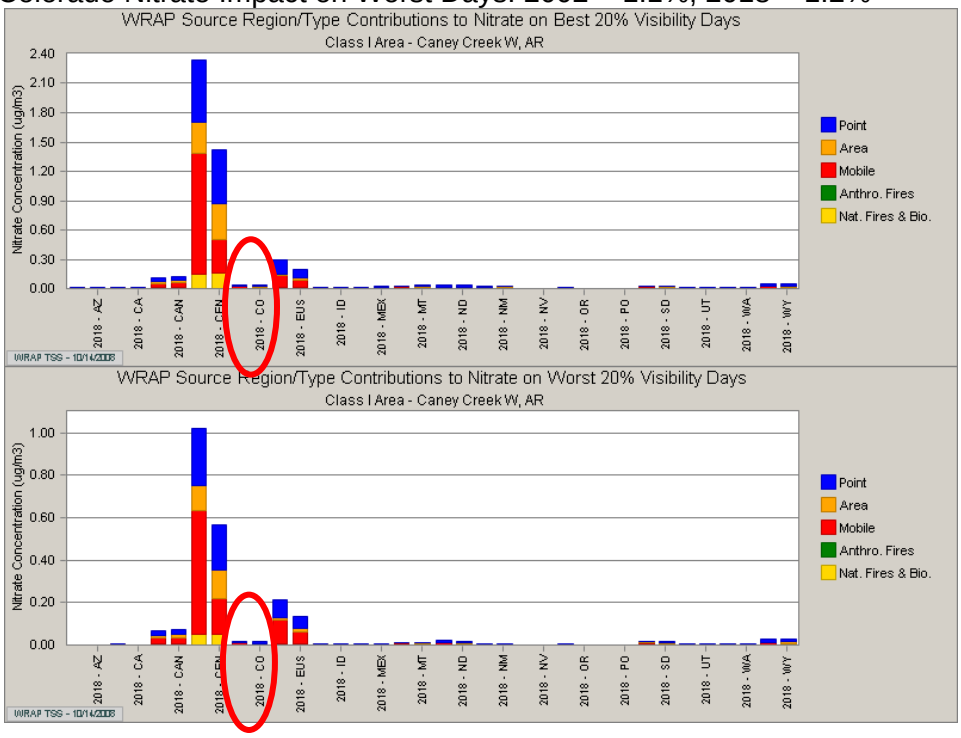
In summary, the Division has identified 2018 nitrate visibility impacts at Wheeler Peak (WHPE) Wilderness Area that trigger interstate consultation with New Mexico. Also, Colorado nitrate impacts are of concern at two other nearby New Mexico Class I areas (BAND & SAPE), Canyonlands National Park (CANY) in Utah, and Wichita Mountains NWR Wilderness in Oklahoma. The “concern” visibility impacts are at or slightly above the arbitrary threshold criteria established by the Division. The Western Regional Air Partnership (WRAP) Implementation Working Group (IWG) has not formally established threshold criteria on interstate Class I area impacts but an informal threshold of 10% has been suggested among member states. If the Division were to utilize the informal threshold criteria of the WRAP IWG, Colorado would have only one 2018 visibility impact on two nearby Class I areas exceeding the 10% threshold.

COLORADO VISIBILITY IMPACTS ON ARKANSAS

Caney Creek Wilderness (CACR) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0.7%; 2018 = 0.6%
Colorado Sulfate Impact on Worst Days: 2002 = 0.1%; 2018 = 0.1%

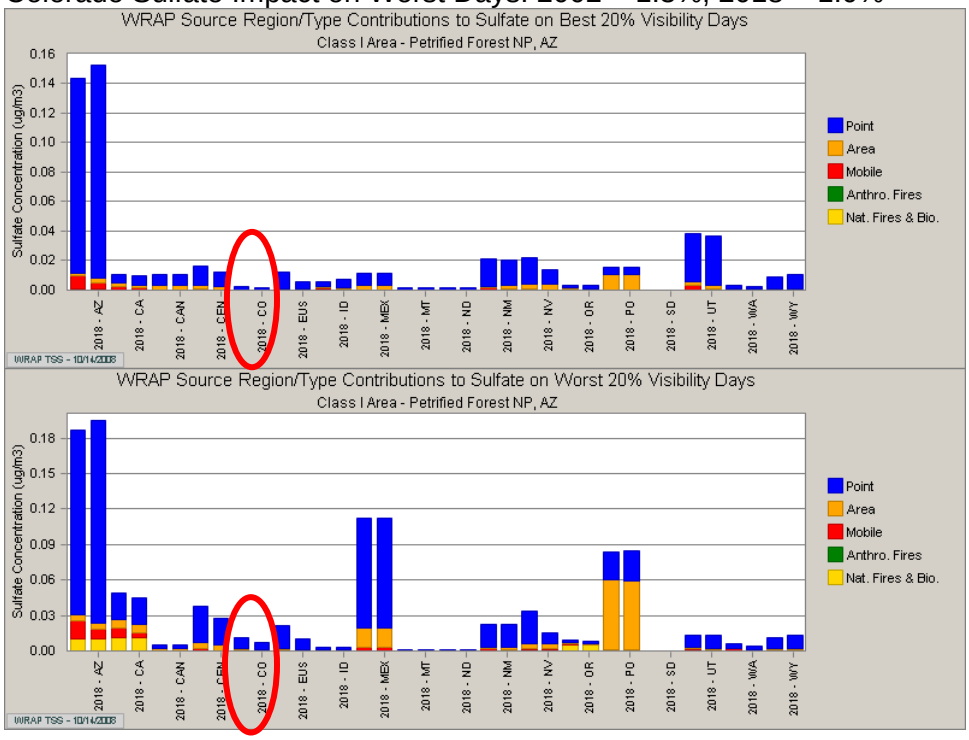


Caney Creek Wilderness (CACR) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 2.1%; 2018 = 2.2%
Colorado Nitrate Impact on Worst Days: 2002 = 1.1%; 2018 = 1.2%

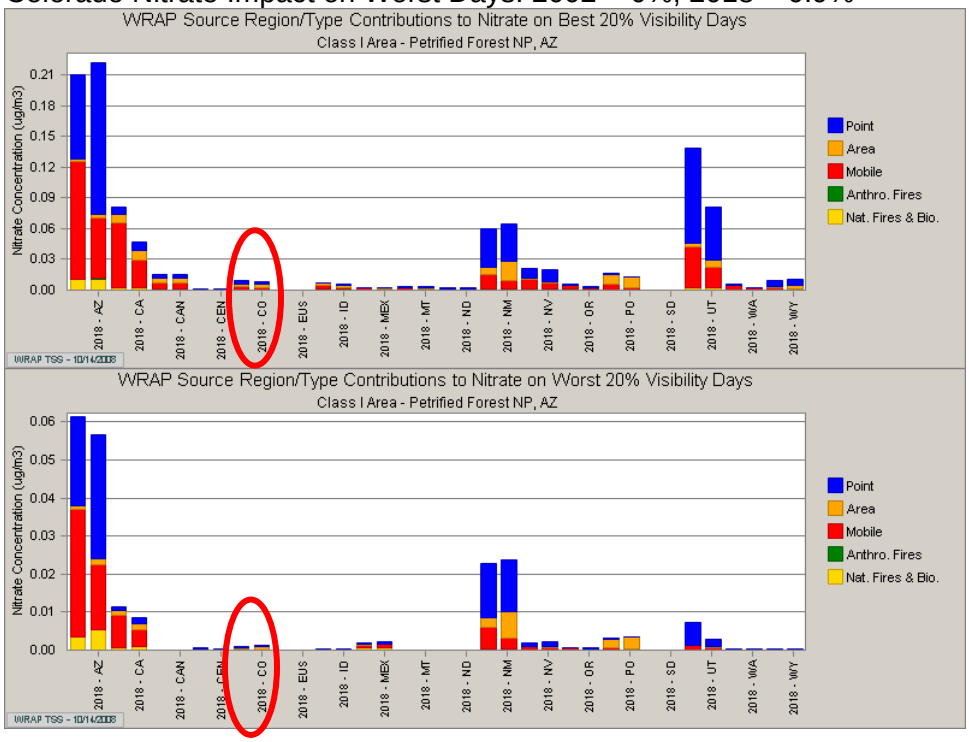


COLORADO VISIBILITY IMPACTS ON ARIZONA

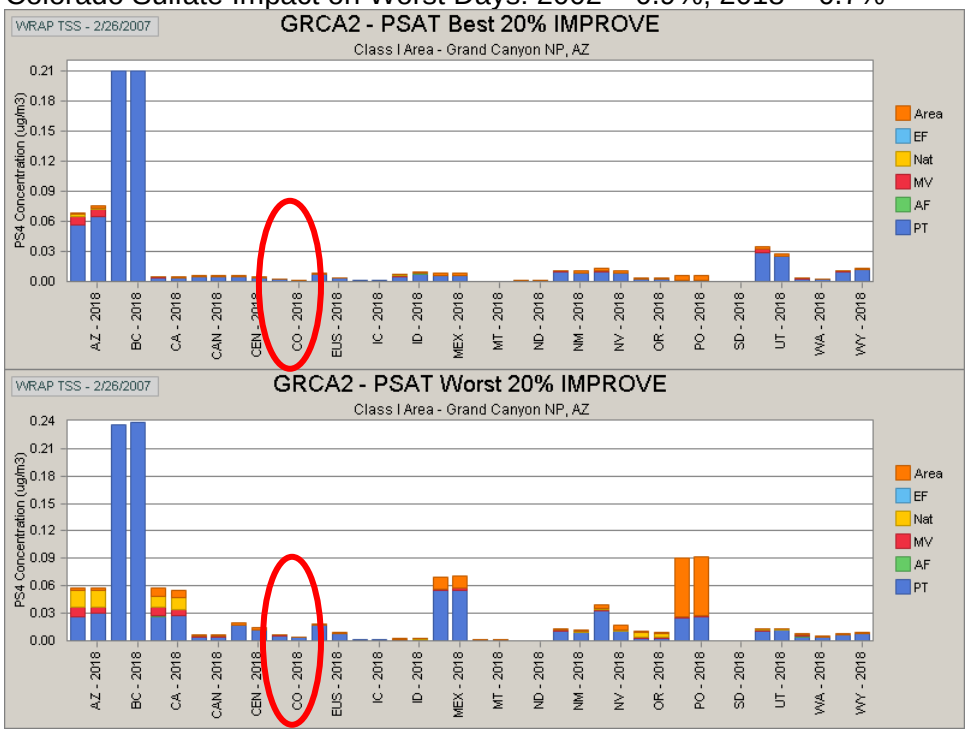
Petrified Forest National Park (PEFO) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0.4%; 2018 = 0.2%
Colorado Sulfate Impact on Worst Days: 2002 = 1.3%; 2018 = 1.0%



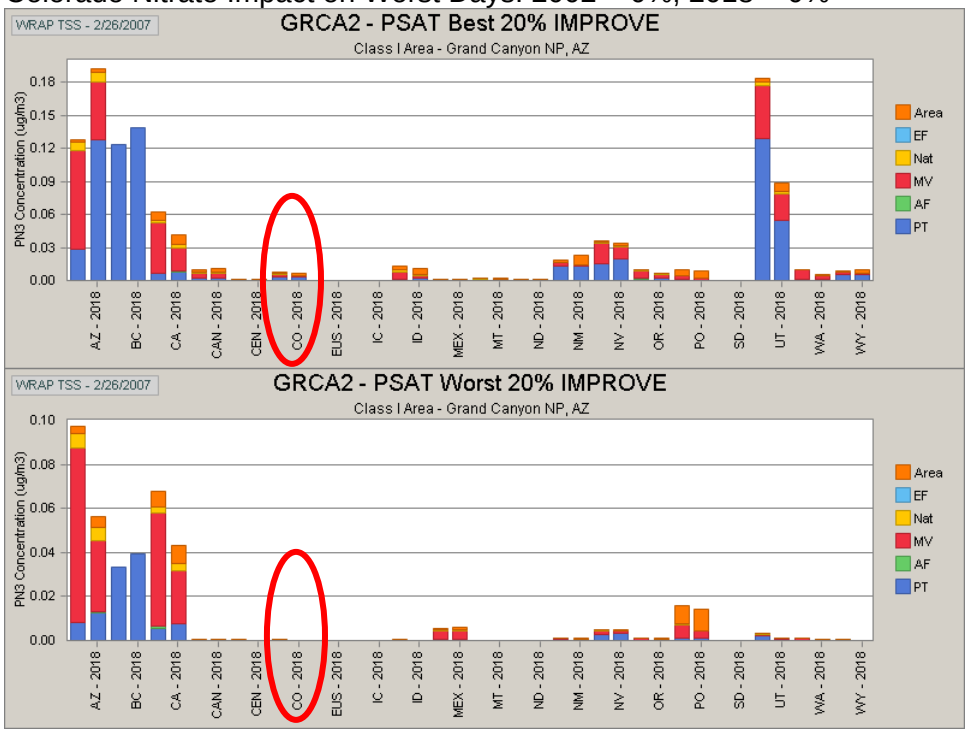
Petrified Forest National Park (PEFO) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 1.3%; 2018 = 1.5%
Colorado Nitrate Impact on Worst Days: 2002 = 0%; 2018 = 0.9%



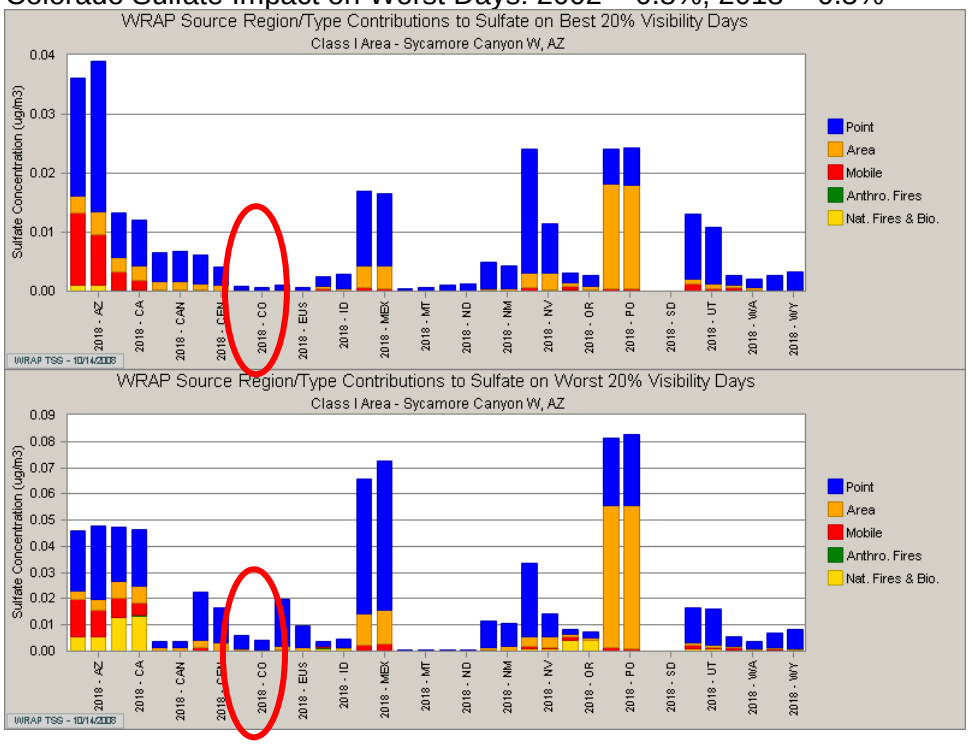
Grand Canyon National Park (GRCA) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0.5%; 2018 = 0.3%
Colorado Sulfate Impact on Worst Days: 2002 = 0.9%; 2018 = 0.7%



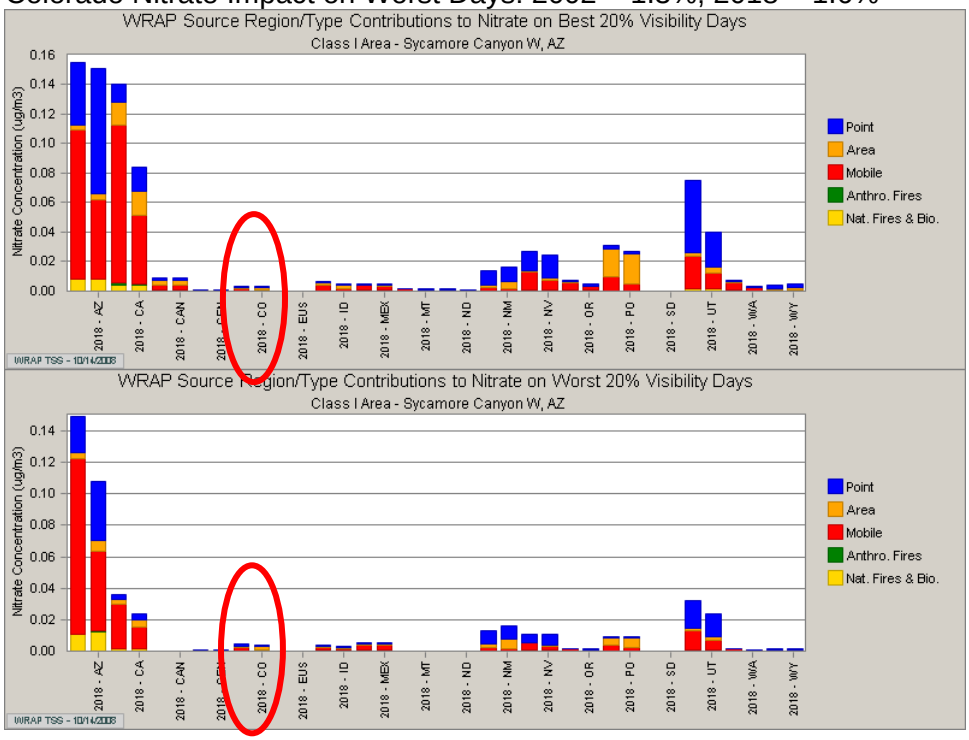
Grand Canyon National Park (GRCA) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 1.1%; 2018 = 1.2%
Colorado Nitrate Impact on Worst Days: 2002 = 0%; 2018 = 0%



Sycamore Canyon Wilderness (SYCA) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0.3%; 2018 = 0%
Colorado Sulfate Impact on Worst Days: 2002 = 0.8%; 2018 = 0.5%

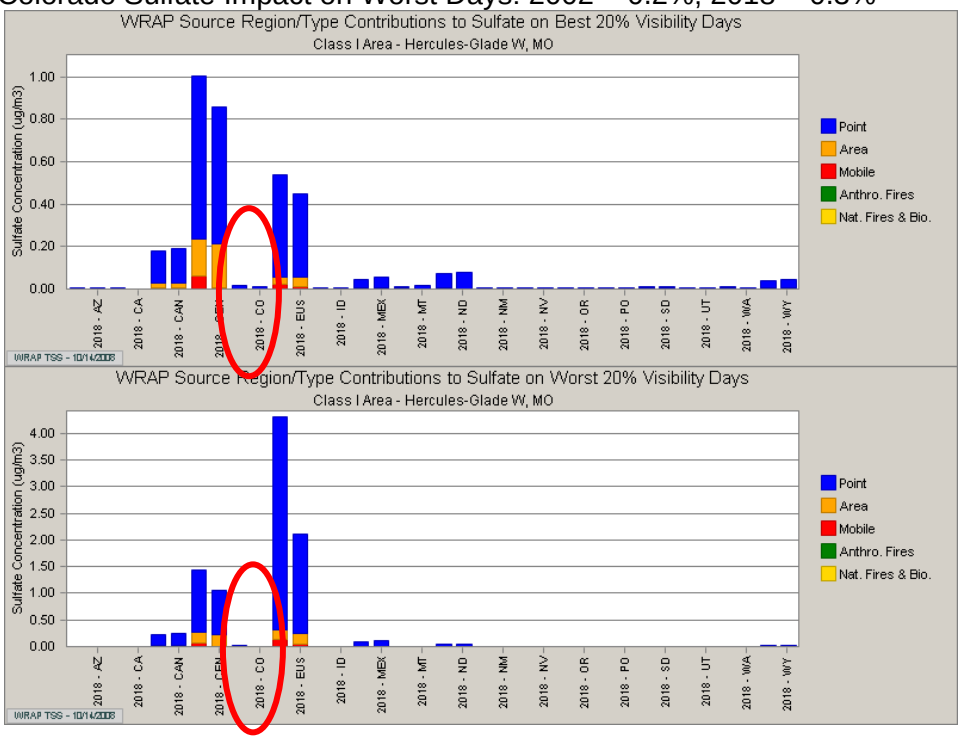


Sycamore Canyon Wilderness (SYCA) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 0.5%; 2018 = 0.6%
Colorado Nitrate Impact on Worst Days: 2002 = 1.3%; 2018 = 1.6%

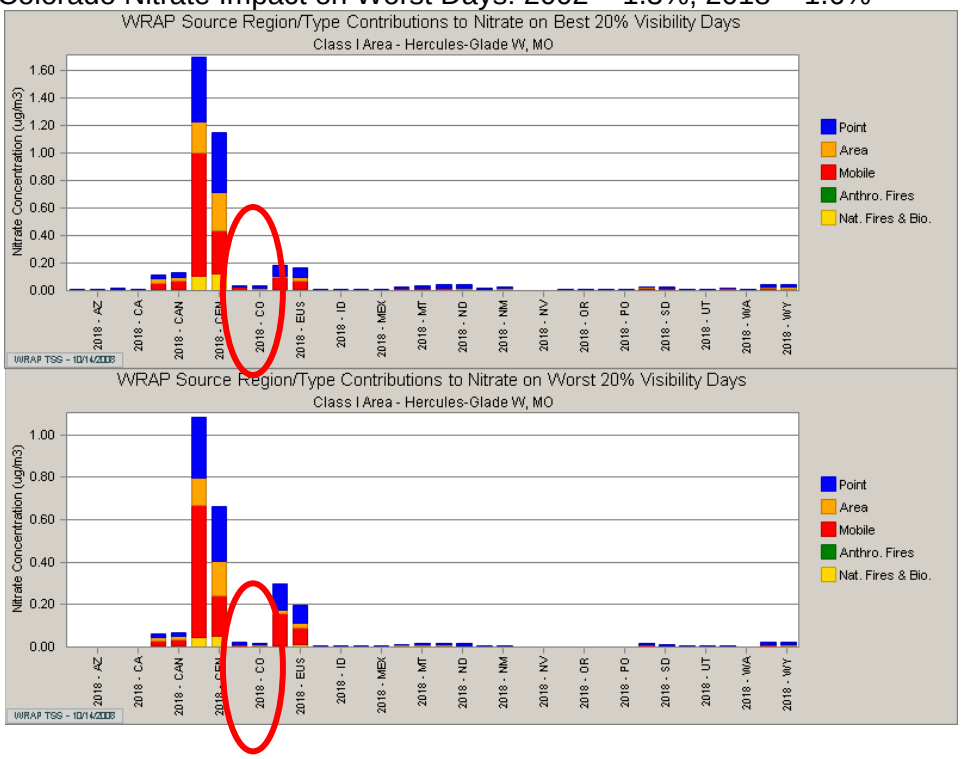


COLORADO VISIBILITY IMPACTS ON MISSOURI

Hercules-Glade Wilderness (HEGL) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0.8%; 2018 = 0.6%
Colorado Sulfate Impact on Worst Days: 2002 = 0.2%; 2018 = 0.3%

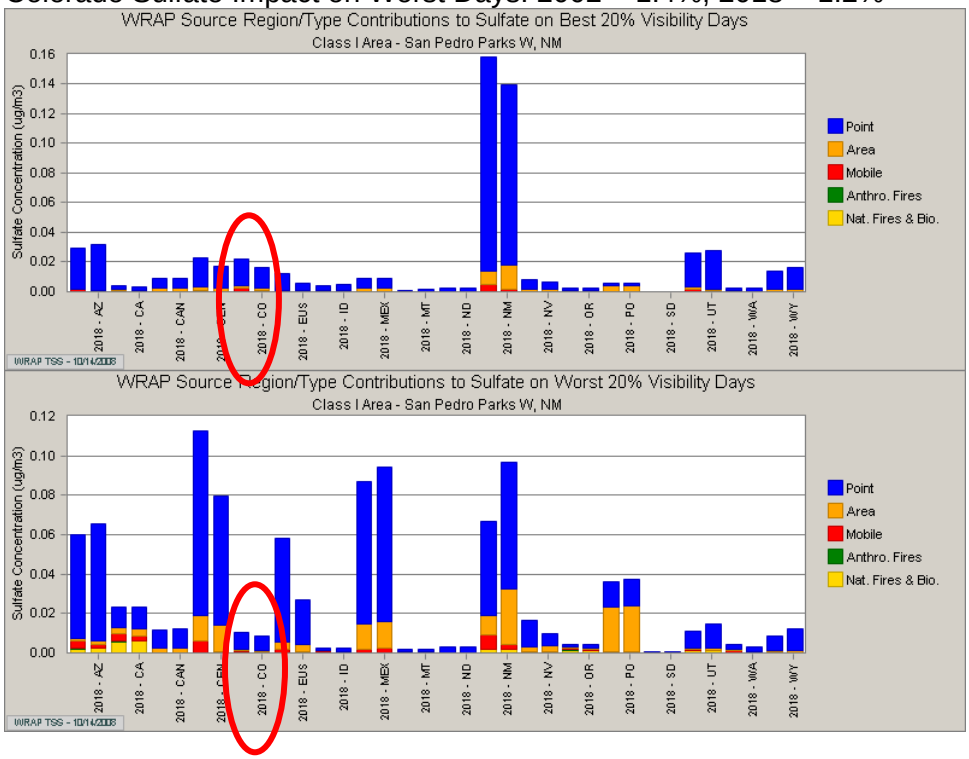


Hercules-Glade Wilderness (HEGL) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 1.6%; 2018 = 1.7%
Colorado Nitrate Impact on Worst Days: 2002 = 1.3%; 2018 = 1.6%

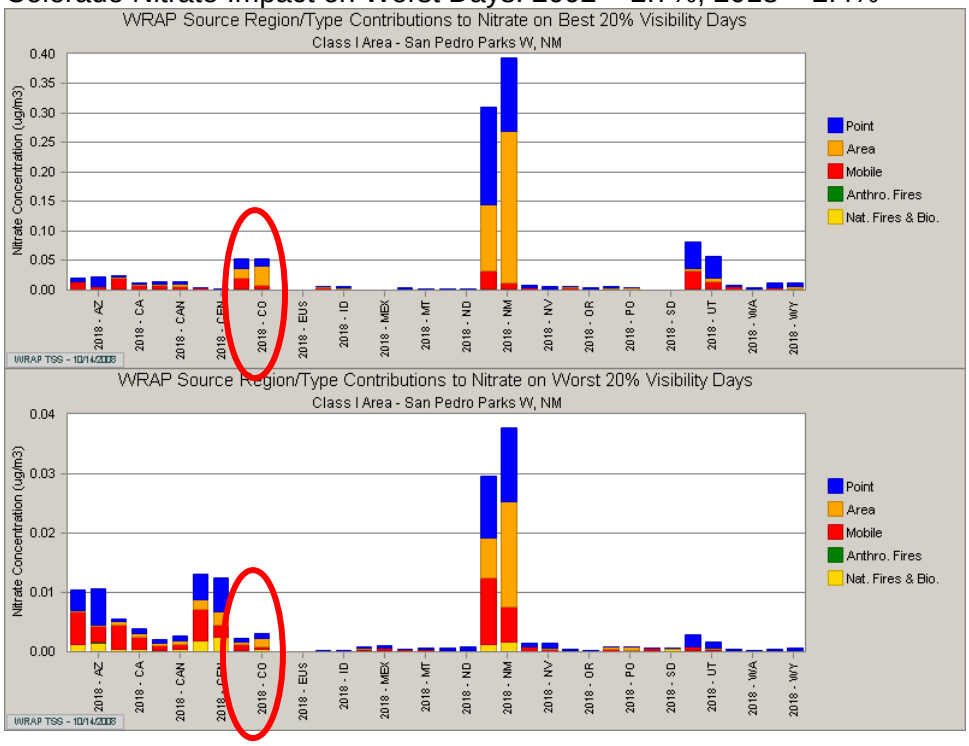


COLORADO VISIBILITY IMPACTS ON NEW MEXICO

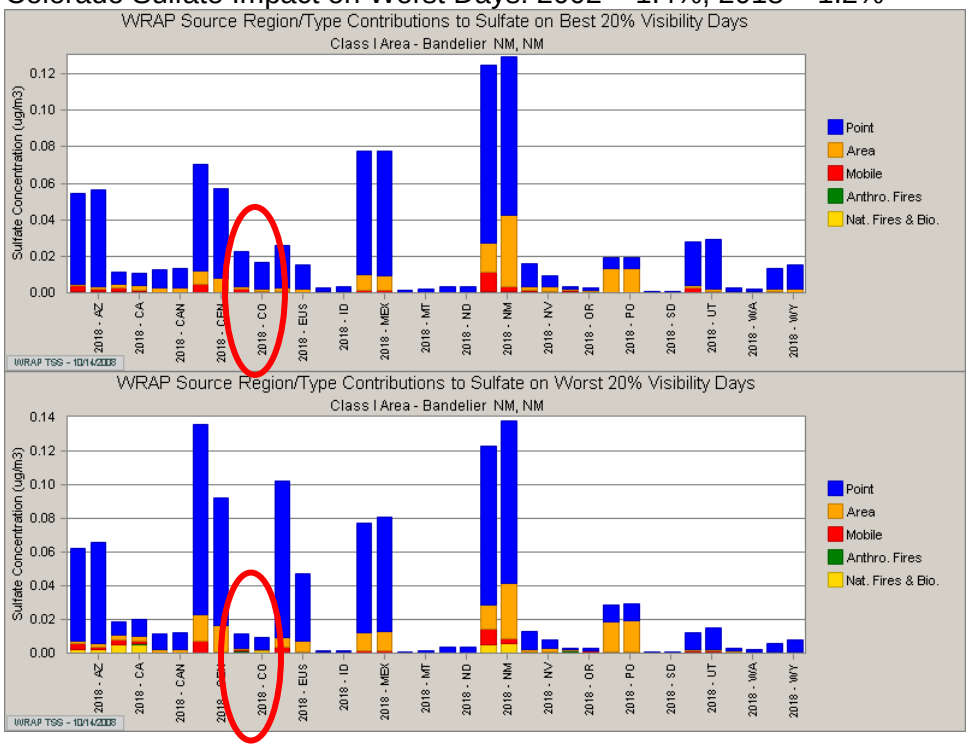
San Pedro Parks Wilderness (SAPE) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 4.3%; 2018 = 3.4%
Colorado Sulfate Impact on Worst Days: 2002 = 1.4%; 2018 = 1.2%



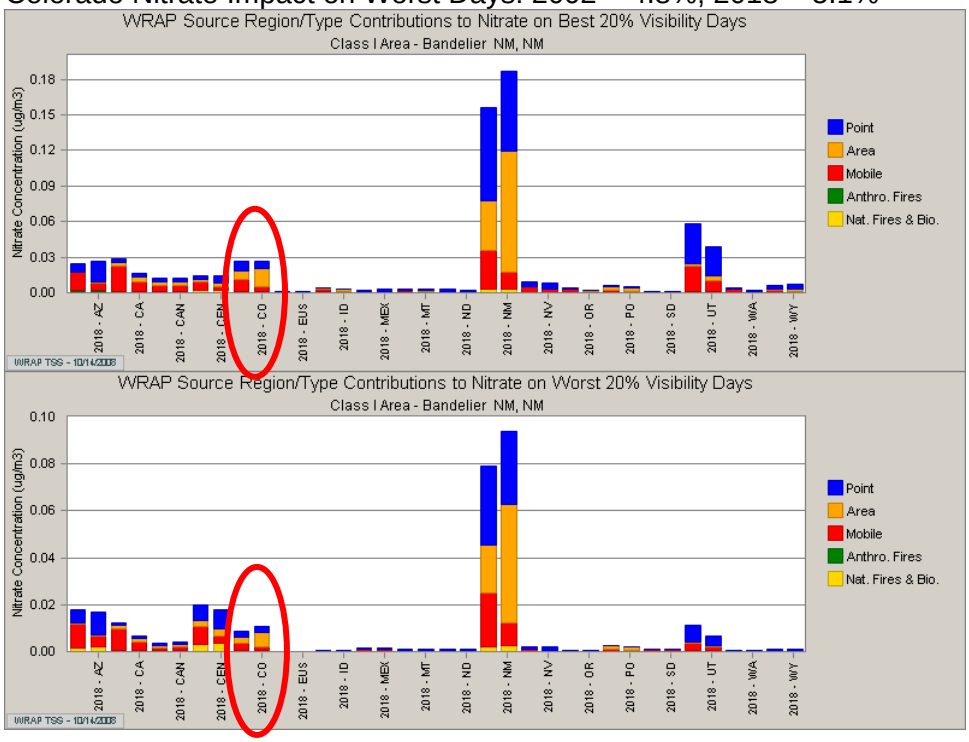
San Pedro Parks Wilderness (SAPE) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 7.7%; 2018 = 7.5%
Colorado Nitrate Impact on Worst Days: 2002 = 2.7%; 2018 = 2.4%



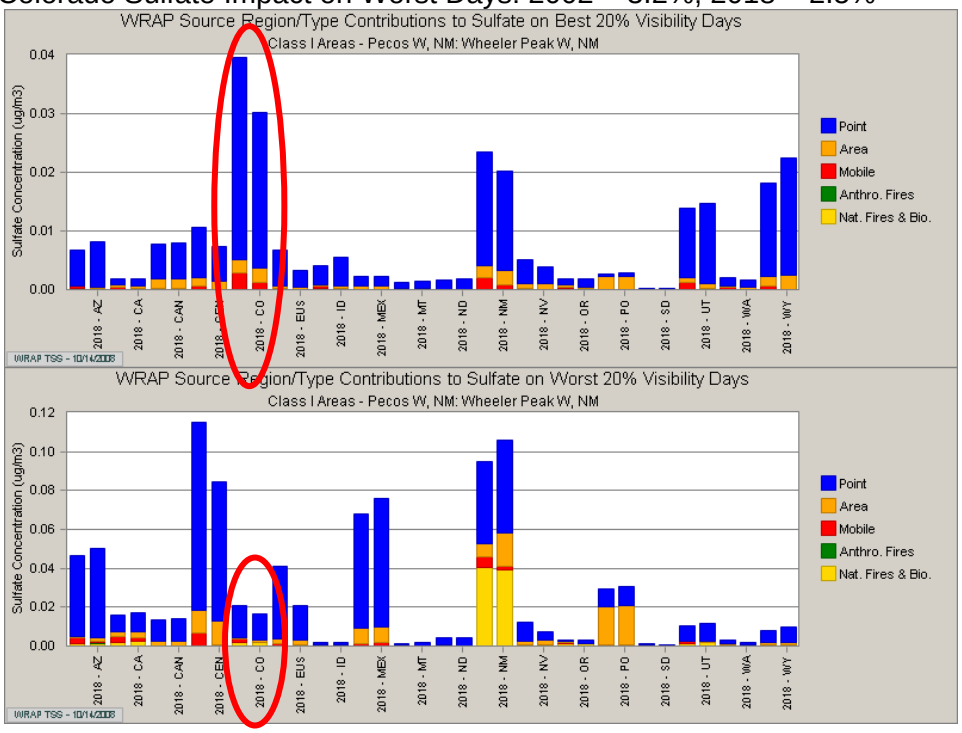
Bandelier National Monument (BAND) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 3.3%; 2018 = 2.6%
Colorado Sulfate Impact on Worst Days: 2002 = 1.4%; 2018 = 1.2%



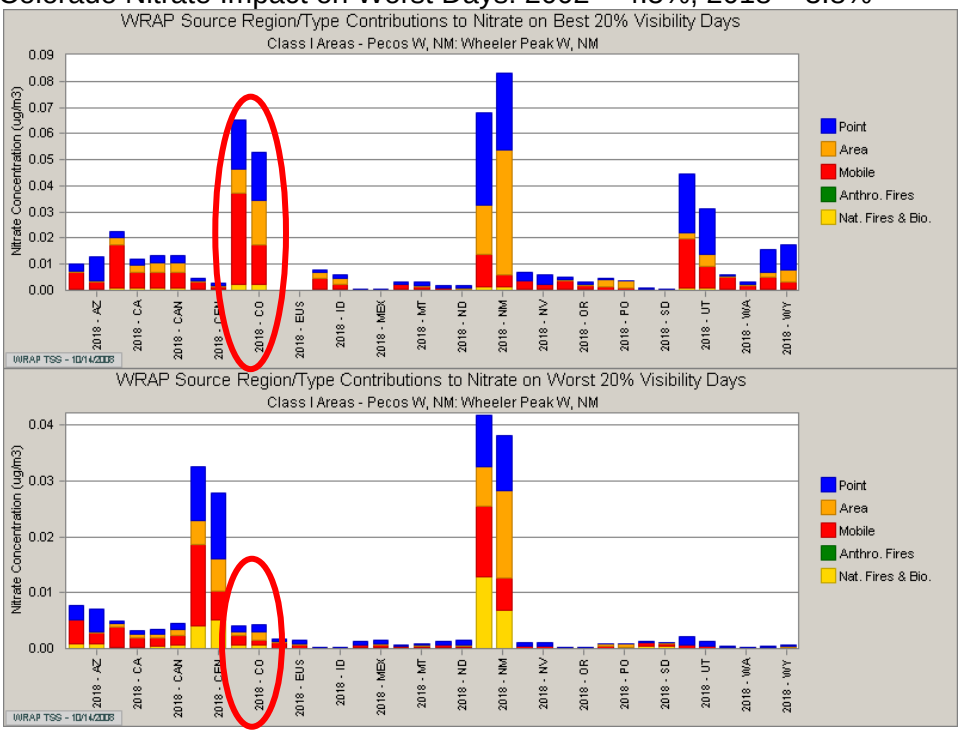
Bandelier National Monument (BAND) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 6.4%; 2018 = 6.3%
Colorado Nitrate Impact on Worst Days: 2002 = 4.8%; 2018 = 5.1%



Wheeler Peak & Pecos Wilderness Areas (WHPE) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 11.0%; 2018 = 8.8%
Colorado Sulfate Impact on Worst Days: 2002 = 3.2%; 2018 = 2.5%

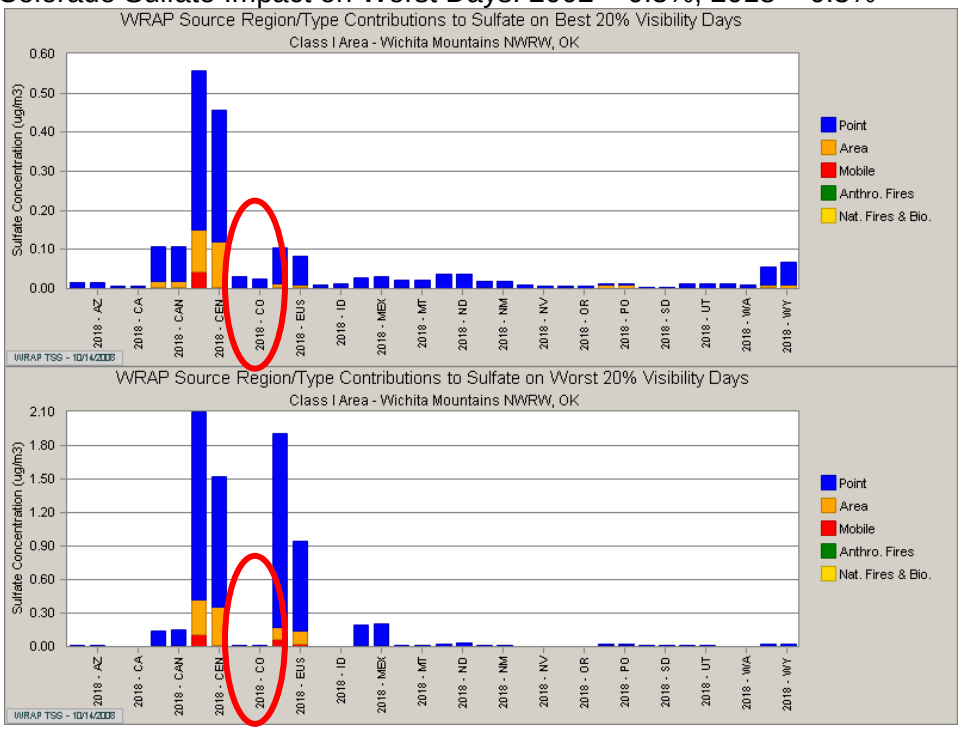


Wheeler Peak & Pecos Wilderness Areas (WHPE) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 15.3%; 2018 = 12.9%
Colorado Nitrate Impact on Worst Days: 2002 = 4.5%; 2018 = 3.8%

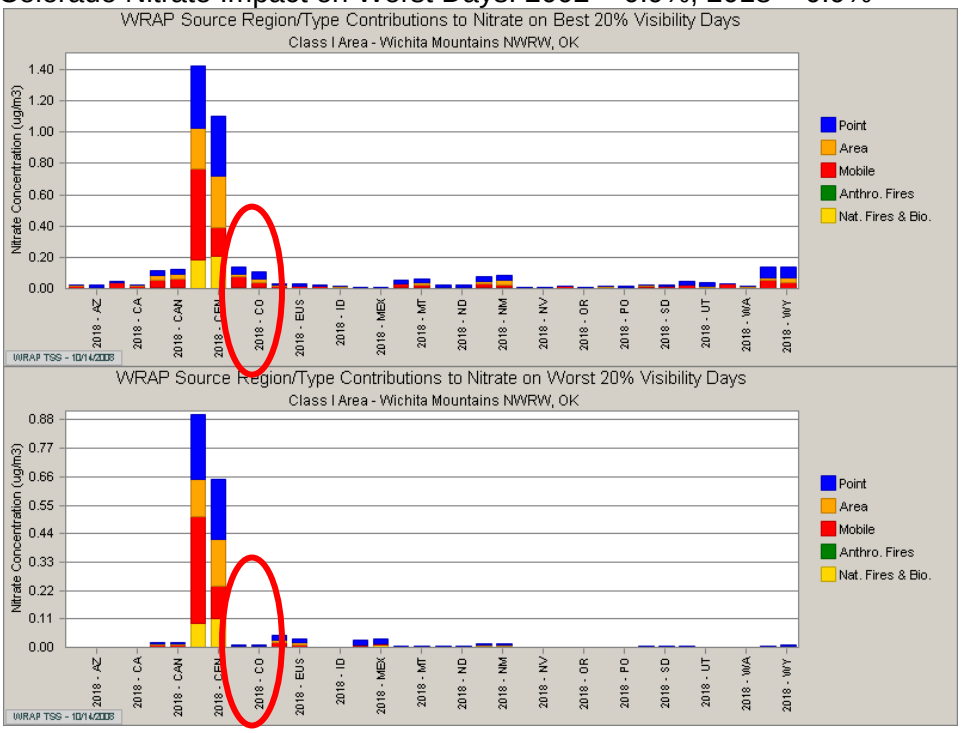


COLORADO VISIBILITY IMPACTS ON OKLAHOMA

Wichita Mountains National Wildlife Refuge (WIMO) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 2.3%; 2018 = 2.0%
Colorado Sulfate Impact on Worst Days: 2002 = 0.3%; 2018 = 0.3%

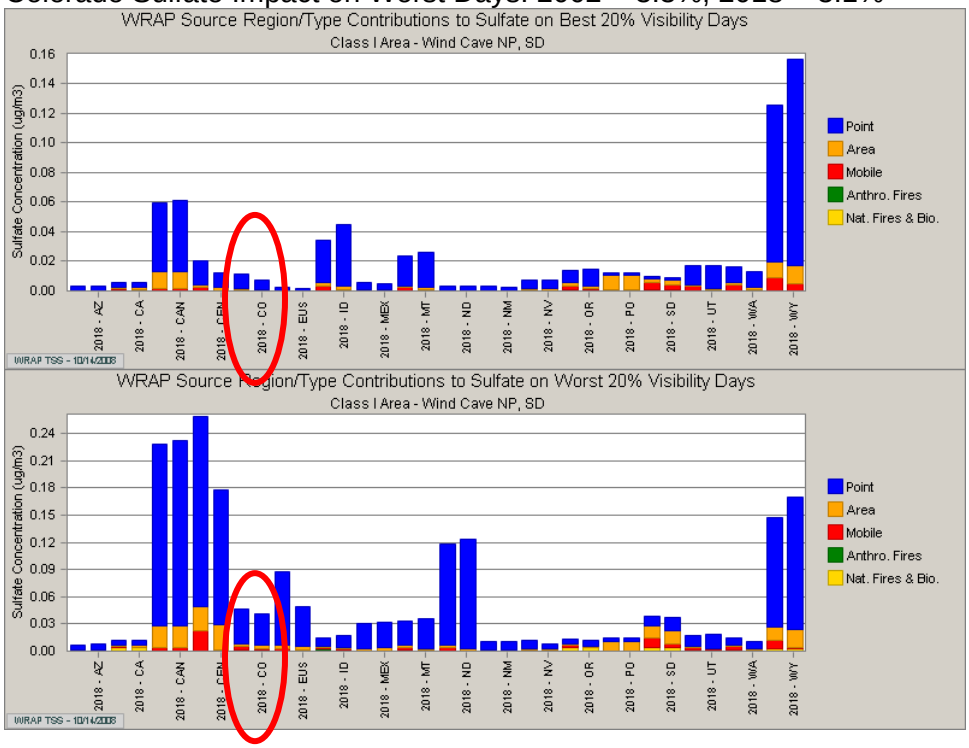


Wichita Mountains National Wildlife Refuge (WIMO) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 5.7%; 2018 = 5.4%
Colorado Nitrate Impact on Worst Days: 2002 = 0.9%; 2018 = 0.9%

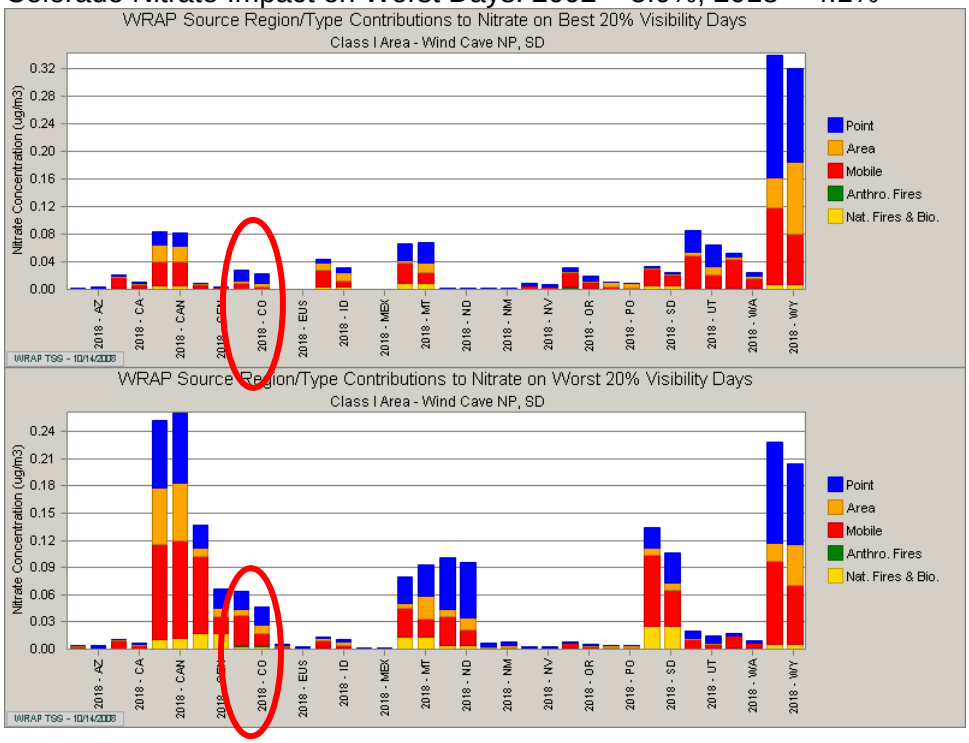


COLORADO VISIBILITY IMPACTS ON SOUTH DAKOTA

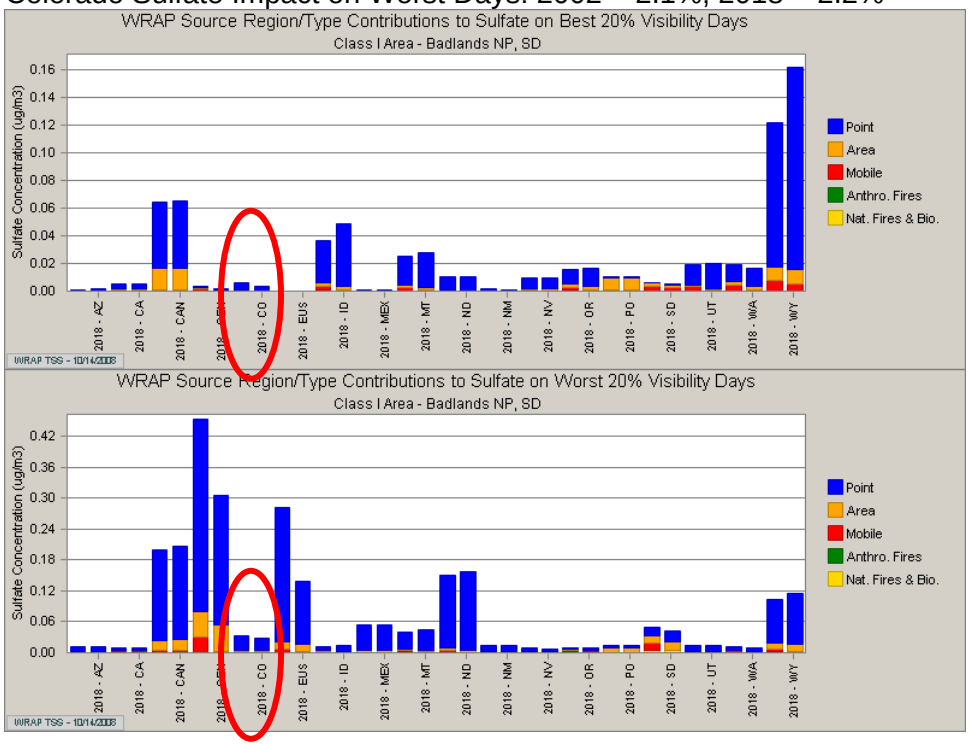
Wind Cave National Park (WICA) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 1.9%; 2018 = 1.1%
Colorado Sulfate Impact on Worst Days: 2002 = 3.3%; 2018 = 3.1%



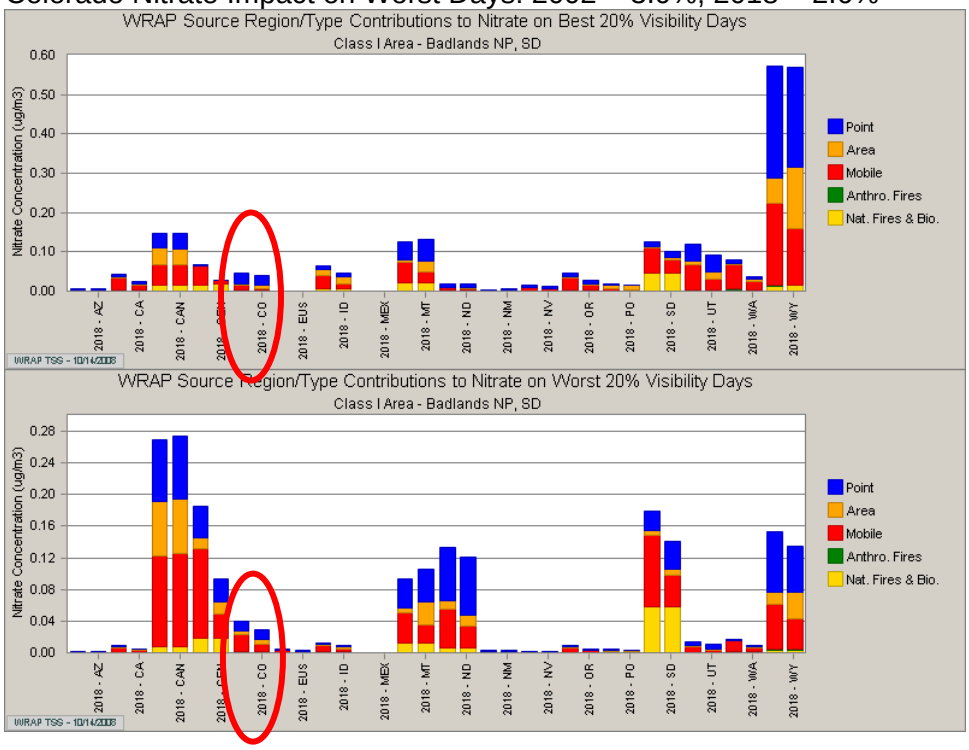
Wind Cave National Park (WICA) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 2.8%; 2018 = 2.5%
Colorado Nitrate Impact on Worst Days: 2002 = 5.0%; 2018 = 4.1%



Badlands National Park (BADL) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0.8%; 2018 = 0.4%
Colorado Sulfate Impact on Worst Days: 2002 = 2.1%; 2018 = 2.2%

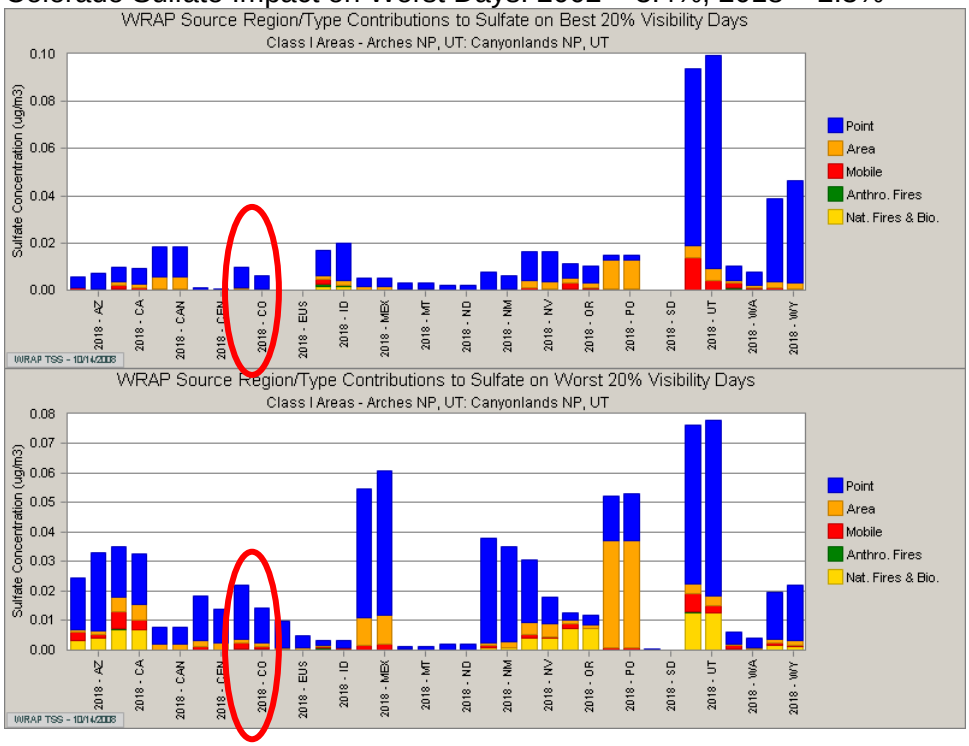


Badlands National Park (BADL) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 2.8%; 2018 = 2.6%
Colorado Nitrate Impact on Worst Days: 2002 = 3.0%; 2018 = 2.6%

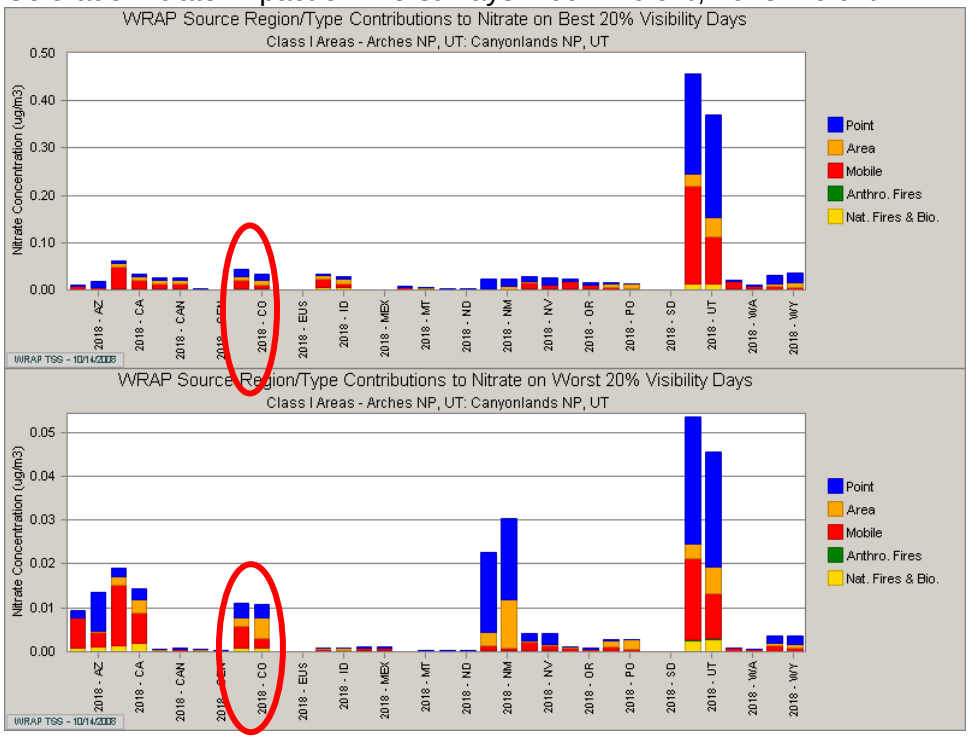


COLORADO VISIBILITY IMPACTS ON UTAH

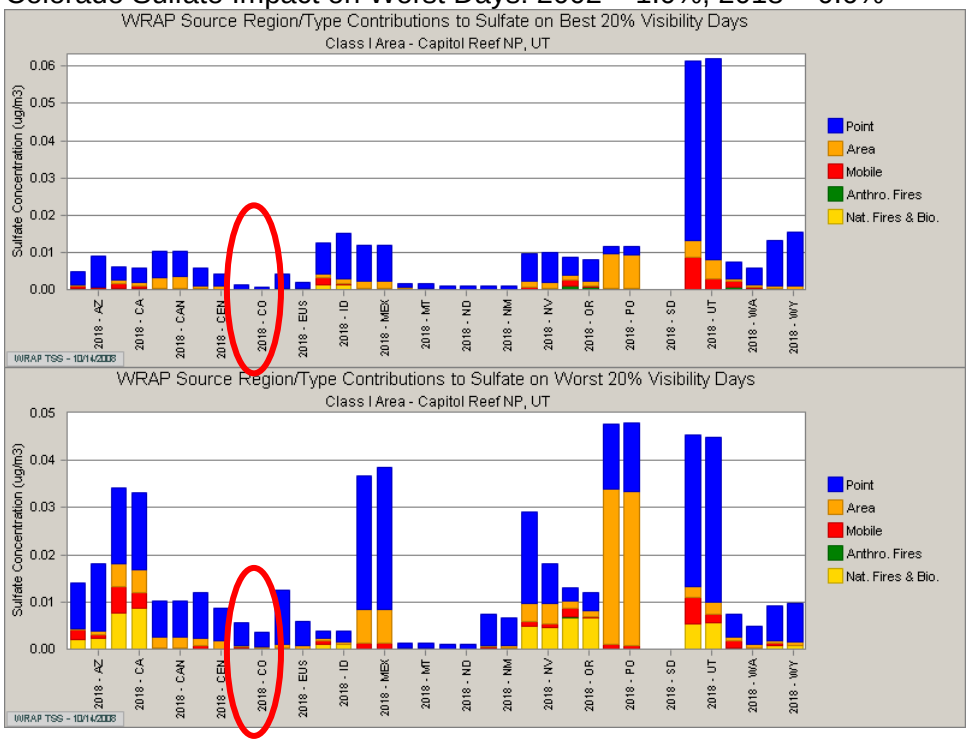
Canyonlands National Park (CANY) - PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 2.0%; 2018 = 1.2%
Colorado Sulfate Impact on Worst Days: 2002 = 3.4%; 2018 = 2.3%



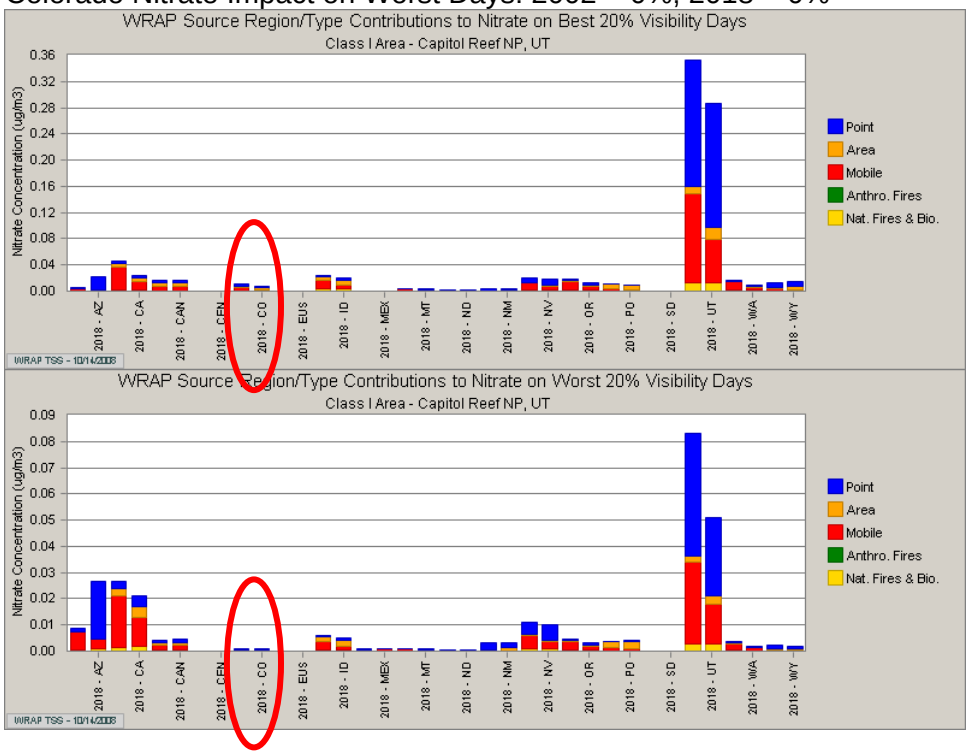
Canyonlands National Park (CANY) - PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 4.6%; 2018 = 4.1%
Colorado Nitrate Impact on Worst Days: 2002 = 6.9%; 2018 = 6.9%



Capital Reef National Park (CAPI)- PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0.3%; 2018 = 0.3%
Colorado Sulfate Impact on Worst Days: 2002 = 1.0%; 2018 = 0.6%

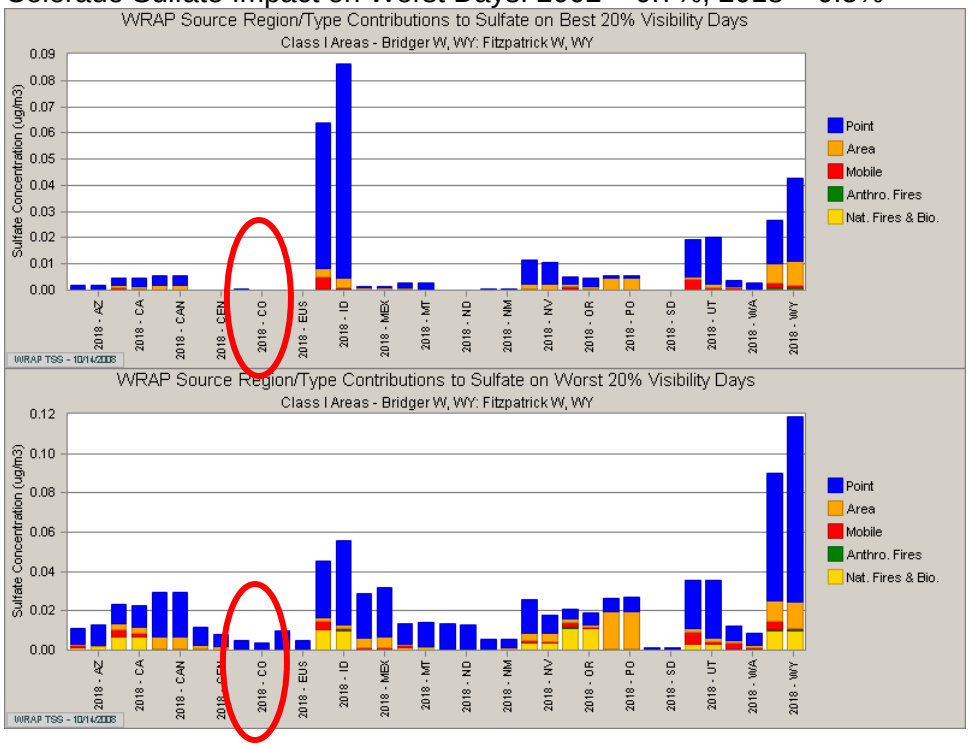


Capital Reef National Park (CAPI)- PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 1.4%; 2018 = 1.3%
Colorado Nitrate Impact on Worst Days: 2002 = 0%; 2018 = 0%



COLORADO VISIBILITY IMPACTS ON WYOMING

Bridger & Fitzpatrick Wilderness Areas (BRID)- PSAT Modeling for PS4 (sulfate)
Colorado Sulfate Impact on Best Days: 2002 = 0%; 2018 = 0%
Colorado Sulfate Impact on Worst Days: 2002 = 0.7%; 2018 = 0.5%



Bridger & Fitzpatrick Wilderness Areas (BRID)- PSAT Modeling for PN3 (nitrate)
Colorado Nitrate Impact on Best Days: 2002 = 0.3%; 2018 = 0.2%
Colorado Nitrate Impact on Worst Days: 2002 = 0.6%; 2018 = 0%