USFS Air Quality Briefing
PAPA Operators Annual Meeting
August 20, 2013

Terry Svalberg
Air Quality Specialist
R2/R4/Bridger-Teton NF

Air Quality Related Mandates

"Wilderness areas…shall be administered…in such a manner as will **leave them unimpaired** for future use and enjoyment as wilderness…" (Wilderness Act of 1964)

"…**preserve, protect and enhance the air quality** in national parks, national wilderness areas, national monuments, national seashores…" (Clean Air Act as amended in 1977)

"…National Forest wilderness resources shall be managed to promote, perpetuate and, where necessary, restore the wilderness character of the land…" (FS Regs Implementing the Wilderness Act, 1997)

"In cases of doubt the land manager should err on the side of protecting the air quality-related values for future generations." (Senate Report No. 95-127, 95th Congress, 1977)

Under the Clean Air Act, Federal Land Managers are given the "affirmative responsibility" to protect Class I Areas, but no authority to do so.

Why are high elevation areas in GYA at risk?

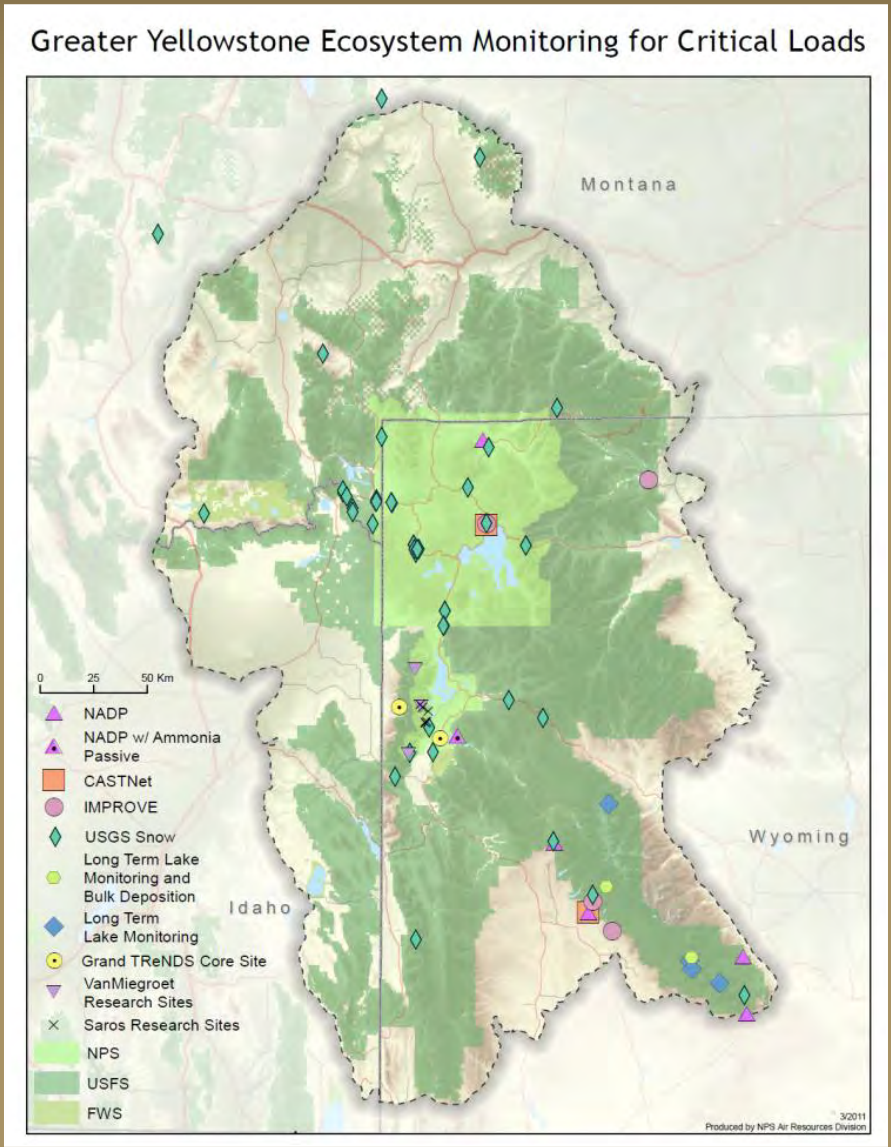
- Shallow soils
- Granitic bedrock
- Scant vegetation
- Higher precipitation/deposition
- Very good visibility

USFS Monitoring

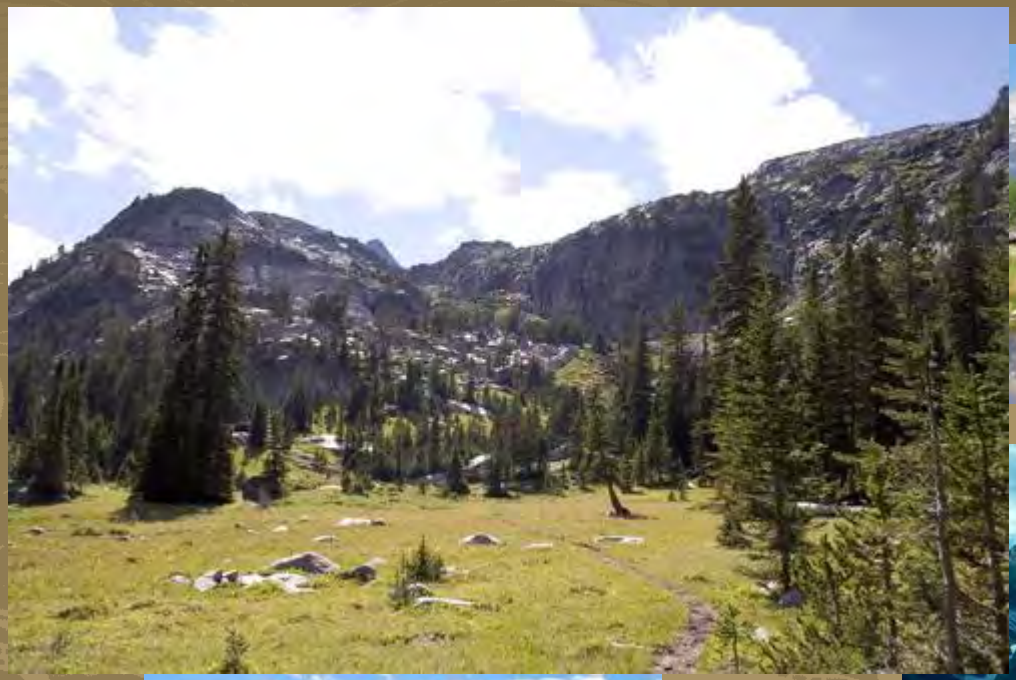
- **Deposition**
  - NADP (4 monitors)
  - Bulk Deposition (2 Monitors)
- **Lake Chemistry**
  - Inlet
  - Outlet
  - Hypolimnion
  - Epilimnion
  - Macroinvertebrates
- **Visibility**
  - Aerosol (2)
  - Transmissometer
  - Camera

Methods for Estimating Deposition

- Deposition Monitoring
  - NADP
  - CASTNet
  - Passive Ammonia
  - Bulk sampling
    - Snow surveys (USGS)
    - Containers (USFS)
    - Ion exchange resins
- Deposition Models
  - Using PRISM (a precipitation model)
  - CMAQ emission-based model

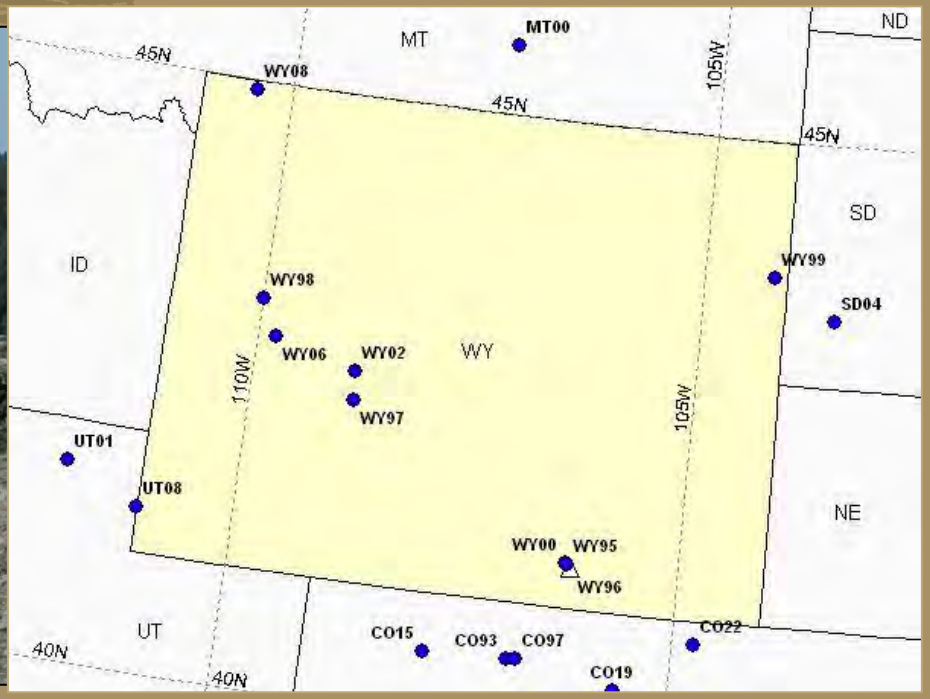


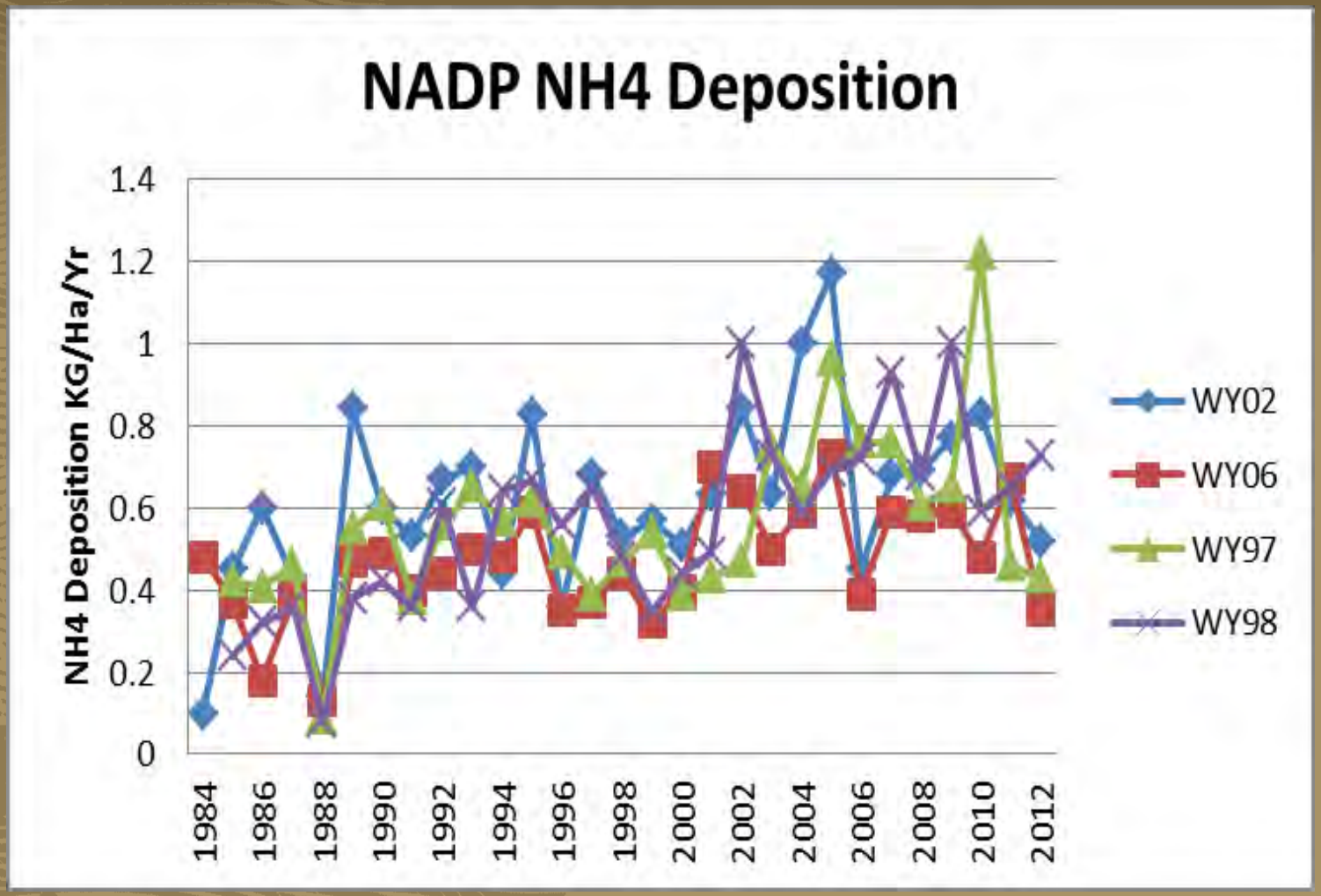
Data Overview

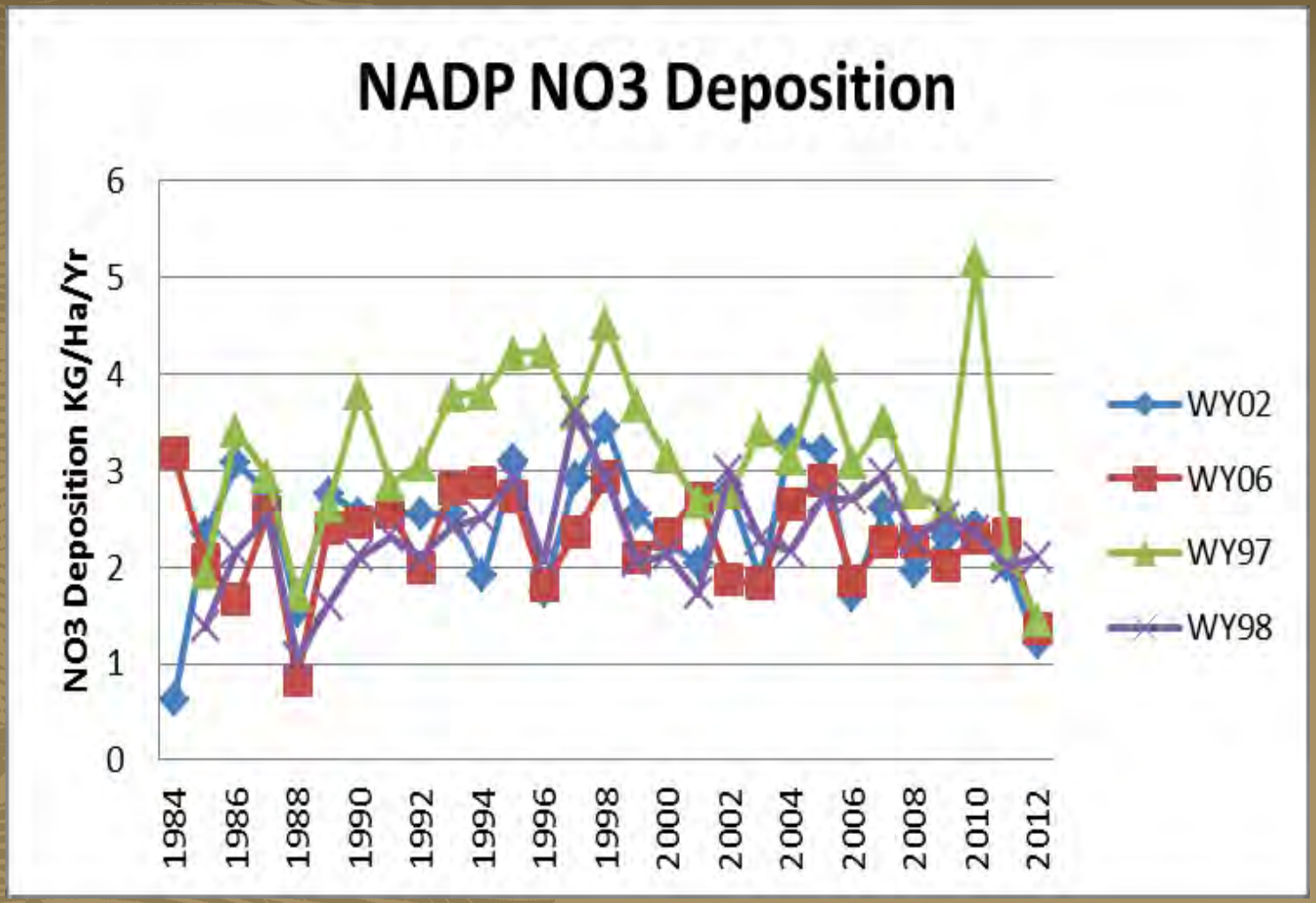


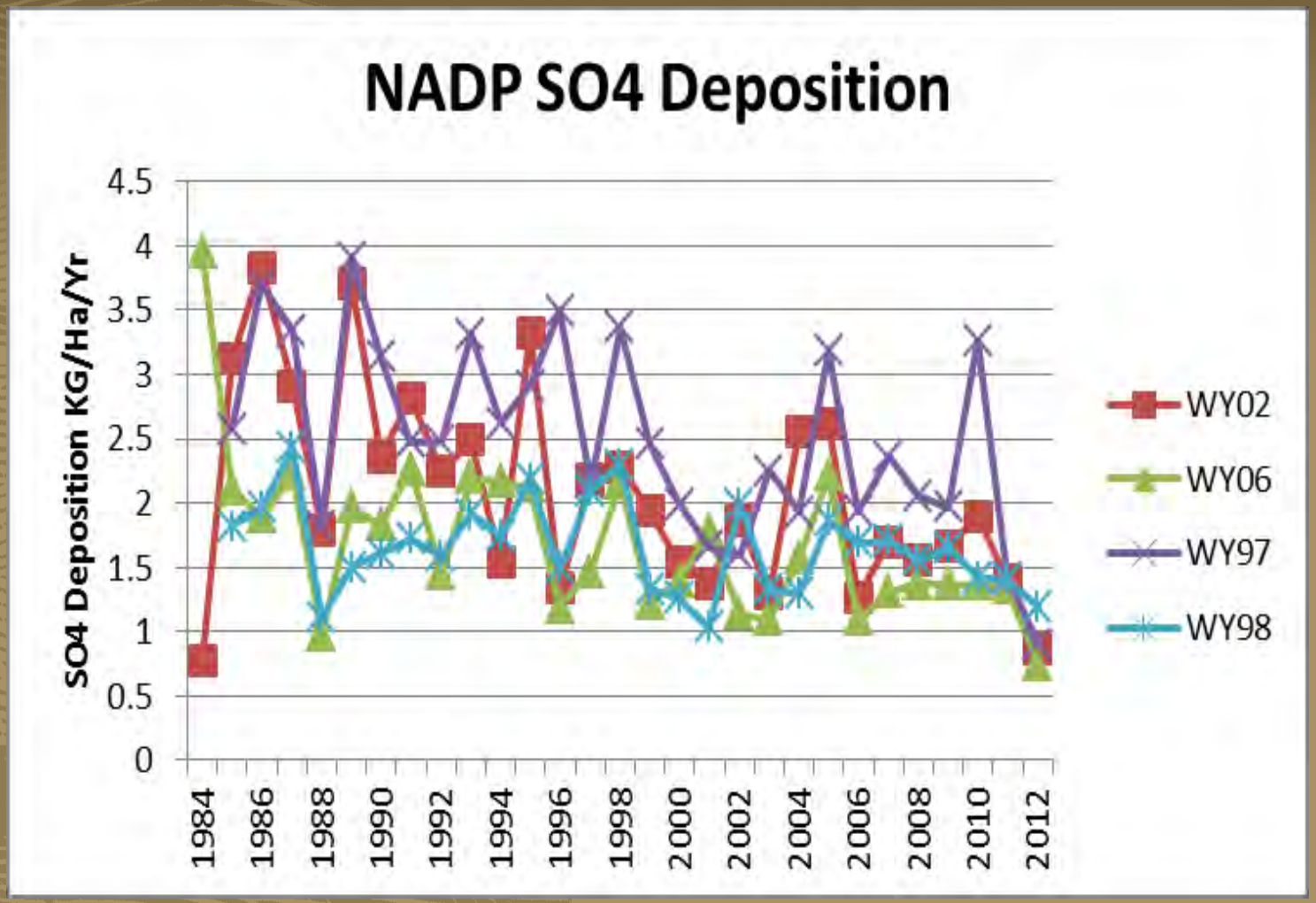
NADP Annual Trends (1986-2010)

Variable	Yellowstone (NPS)	Gypsum Creek (BTNF)	Murphy Ridge (BLM)	Pinedale (BLM/BTNF)	Sinks Canyon (BLM)	South Pass (BTNF/SNF)
NH4	↑	↑	↑	↑	↑	↑
NO3	–	–	–	–	–	↑
SO4	↓	↓	↓	↓	↓	↓




NADP NH4 Deposition
NH4 Deposition KG/Ha/Yr
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
WY02
WY06
WY97
WY98


NADP NO3 Deposition
NO3 Deposition KG/Ha/Yr
0
1
2
3
4
5
6
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
WY02
WY06
WY97
WY98


NADP SO4 Deposition
SO4 Deposition KG/Ha/Yr
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1984
1986
1988
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
2010
2012
WY02
WY06
WY97
WY98

Annual Bulk Deposition Trends at Hobbs and Black Joe Collectors (1984-2010)

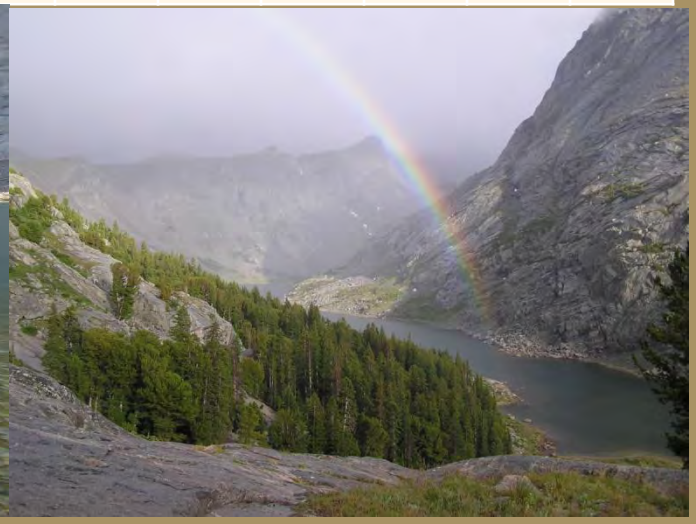
Variable kg/ha	Hobbs (BTNF)	Black Joe (BTNF)
NH_4^+	*** ↑	** ↑
NO_3^-	*** ↑	* ↑
Total N	*** ↑	** ↑
SO_4^{2-}	---	---
Precipitation	** ↑	---

* = p<0.1, **= p<0.05, ***= p<0.01, **** = p<0.001

Significant Trends for Long-Term Lakes (1984-2010)

	Black Joe (BTNF)			Hobbs (BTNF)			Deep (BTNF)			Ross (SNF)			Lower Saddlebag (SNF)		
	Inlet	Outlet	Hypo	Inlet	Outlet	Hypo	Inlet	Outlet	Hypo	Inlet	Outlet	Hypo	Inlet	Outlet	Hypo
ANC	–	–	–	–	↓	–	–	–	–	↓	↓	↓	↓	–	–
NH4	–	↑	↑	↑	↑	↑	–	–	↑	ND	ND	ND	ND	ND	ND
NO3	↑	–	–	–	–	↓	–	–	↑	↑	–	–	↑	–	↑
SO4	↑	–	–	–	–	–	–	–	–	–	↓	↓	–	–	–

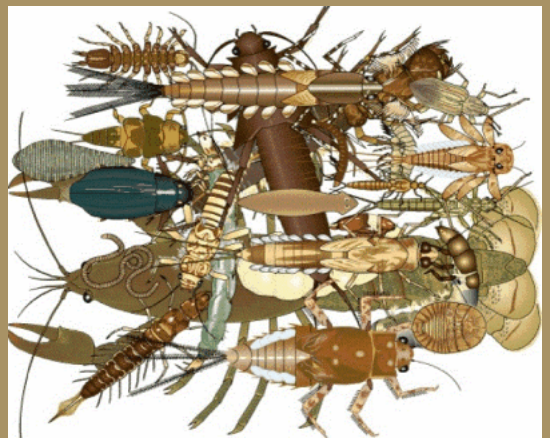
ND=Not Determined



Excess nitrogen in aquatic systems

- Increases above N critical loads for eutrophication in GYE is cause for concern
- Limited GYE-specific monitoring
- Changes in macroinvertebrate biodiversity may be occurring - currently unknown

Increases in algae



Decreases in biodiversity

Studies in the Rocky mountains indicate:

<u>3-4 kg/ha/yr is N critical load for faster growth of alpine grasses</u>: Since current GYA deposition is at or greater than this amount, alpine plants may be affected now…

Air Quality Impact Thresholds

Pollutant Load

SO4, NH4, NO3
Hg, POPs
NOx, SO2

Annual averages
Seasonal patterns

Chemical Variables

ANC, pH, Nitrogen,
Base Saturation, Ca/Al

Annual averages
Seasonal extremes

Biological Responses

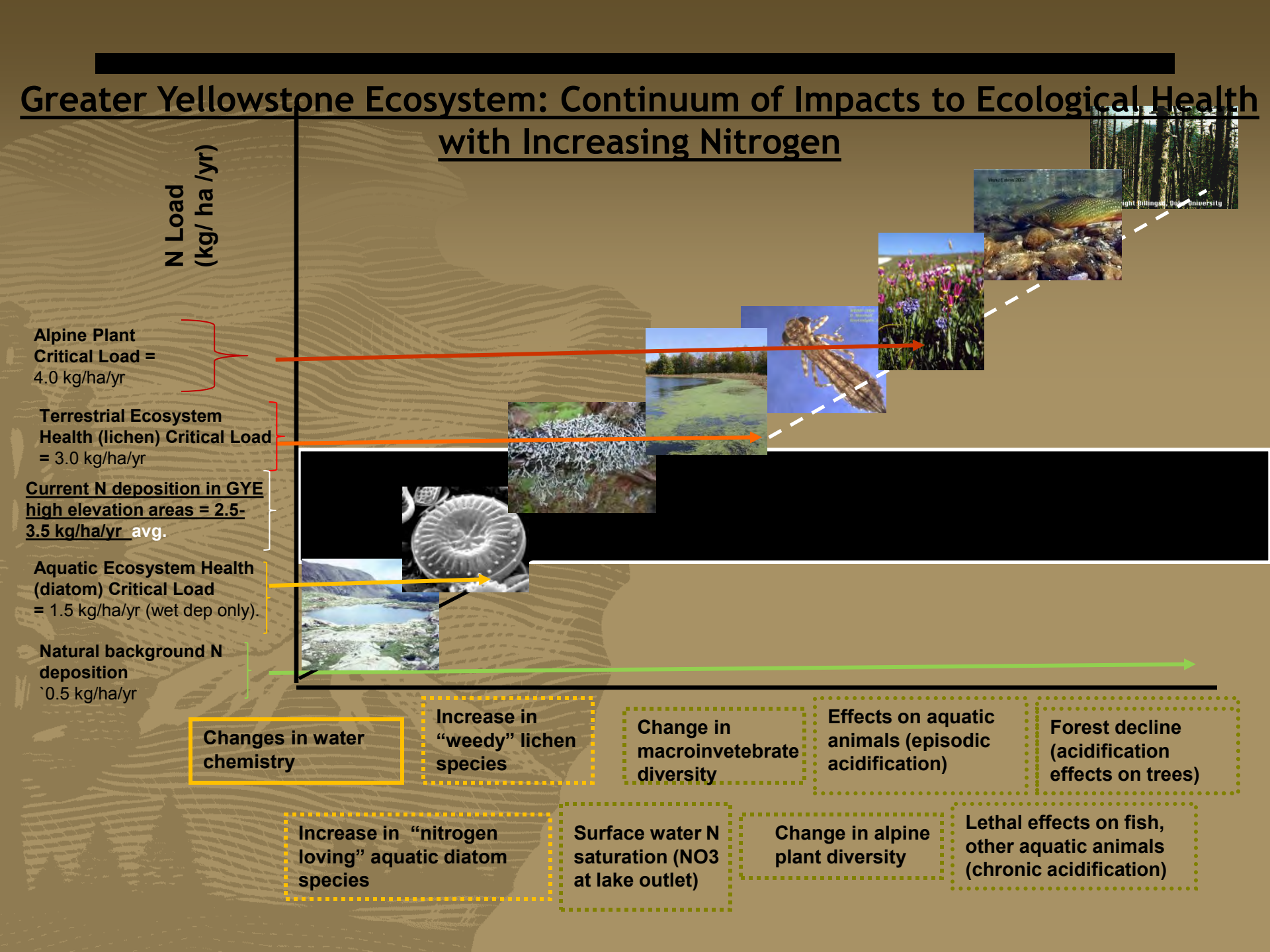
Death of Indicator species, Decline in Condition of individuals
Decreased Reproductive Success

Loss of species
Change in biodiversity

"Critical Load"-
deposition loading at which something happens in an ecosystem

"Ecological Threshold" -
Chemical or biological limit defining when "something happens" in an ecosystem

Greater Yellowstone Ecosystem: Continuum of Impacts to Ecological Health with Increasing Nitrogen



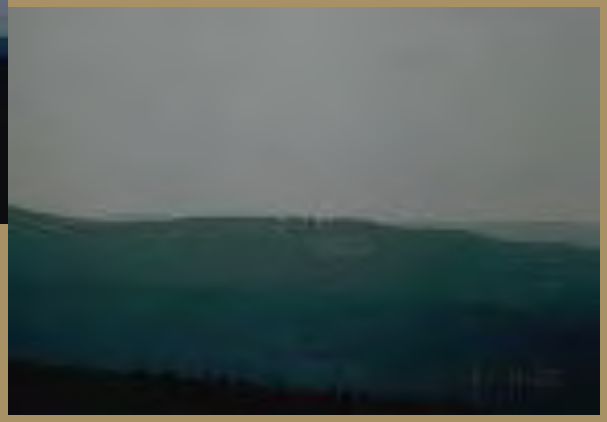
State of the Science in the GYA:

- Nitrogen deposition is increasing in many regions of the GYA
- Some GYA lakes are likely experiencing eutrophication
- Some GYA lakes are beginning to show signs of acidification
- Lake sediment cores show increasing influence of anthropogenic N
- Critical loads of deposition established for other areas suggest that additional effects on lichen, soils, alpine vegetation may soon occur in GYA

Visibility

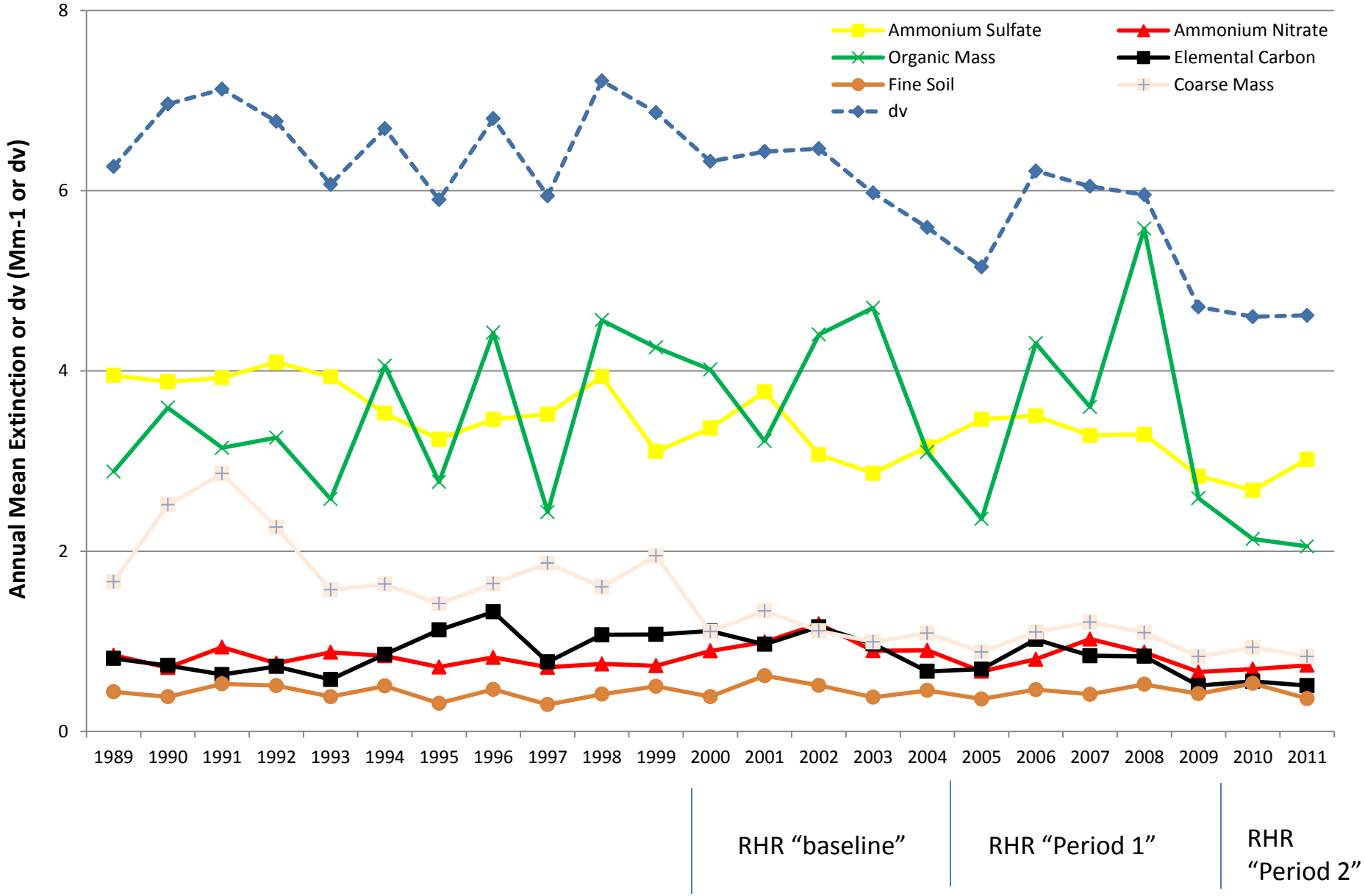
SVR = 350 Km

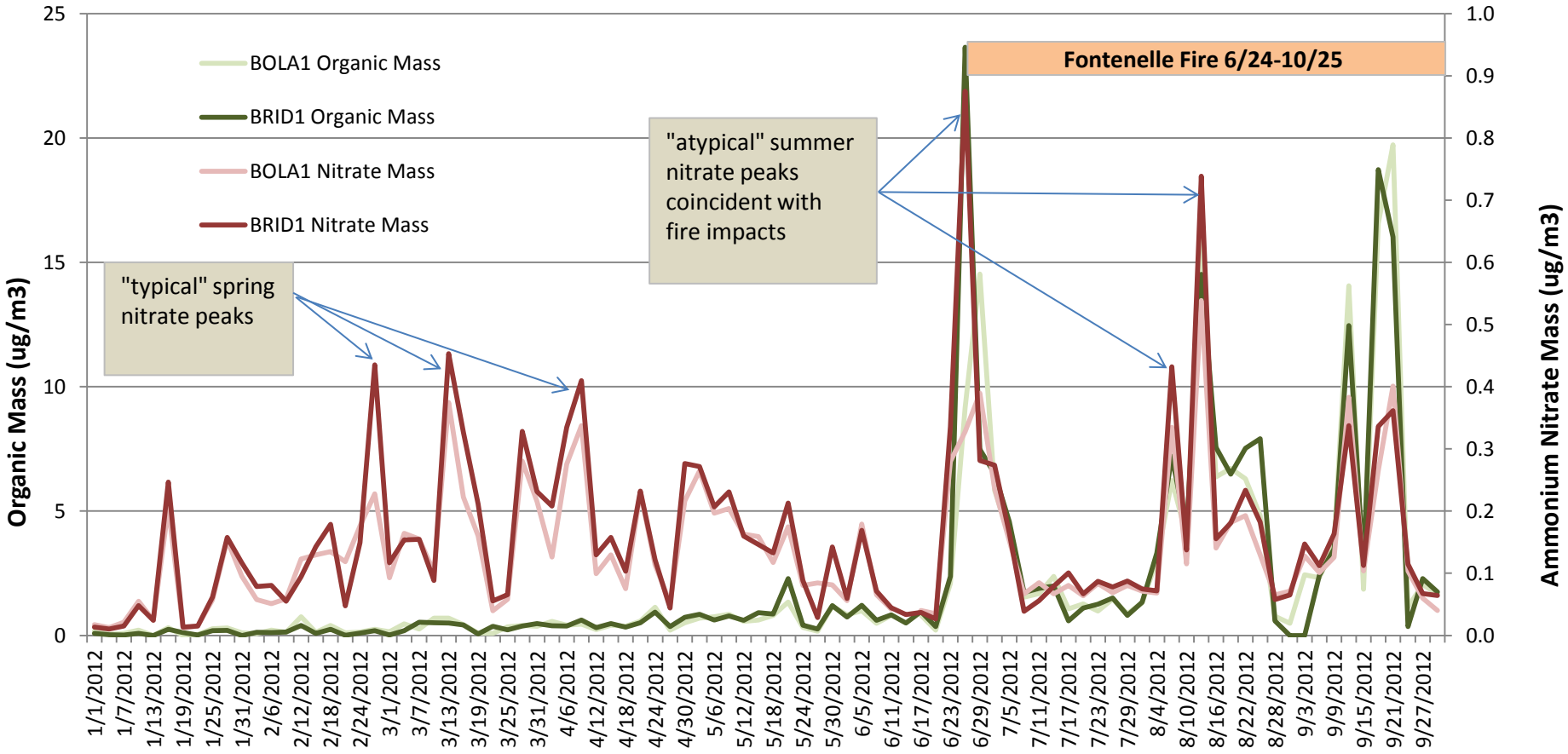
SVR = 60 Km

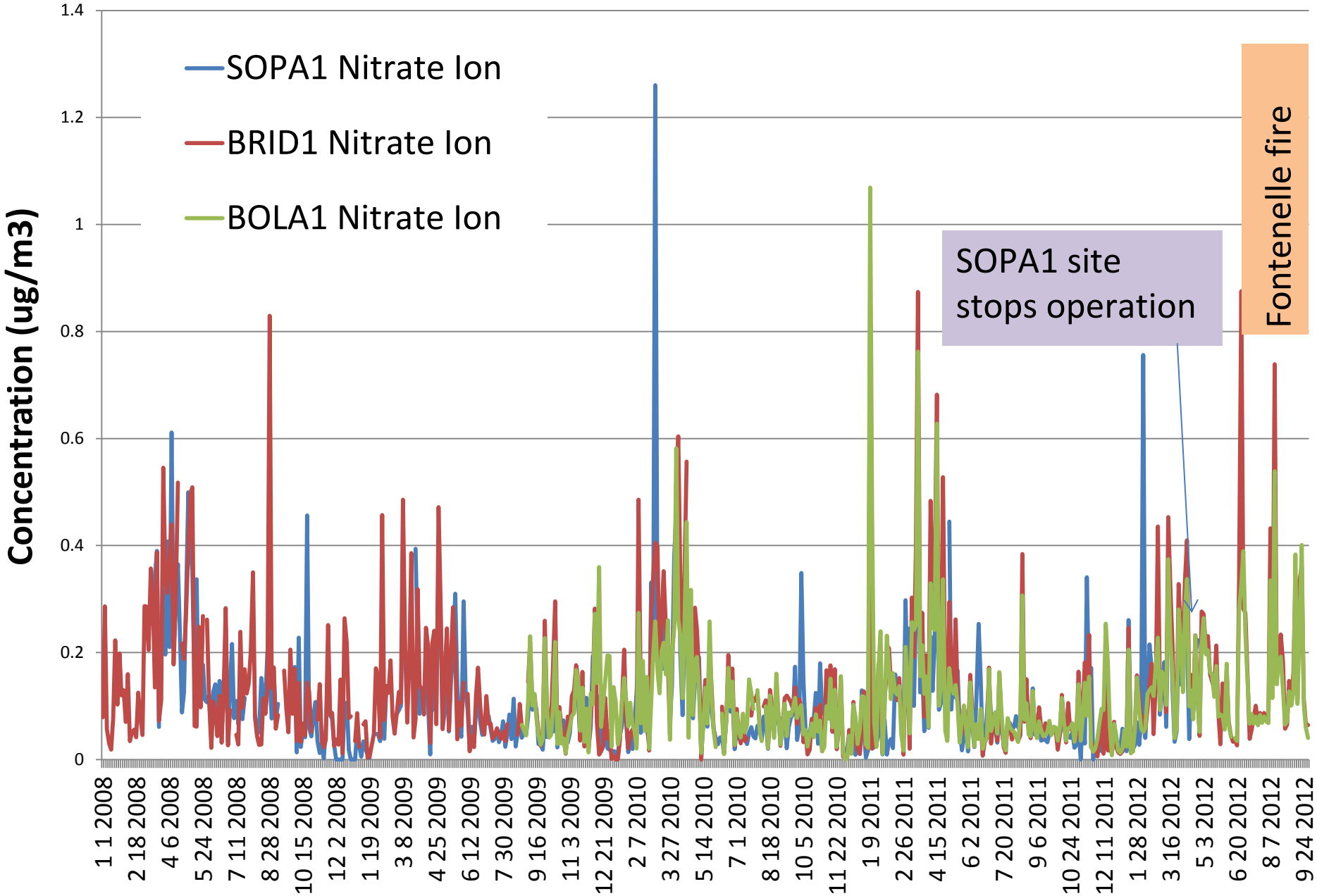


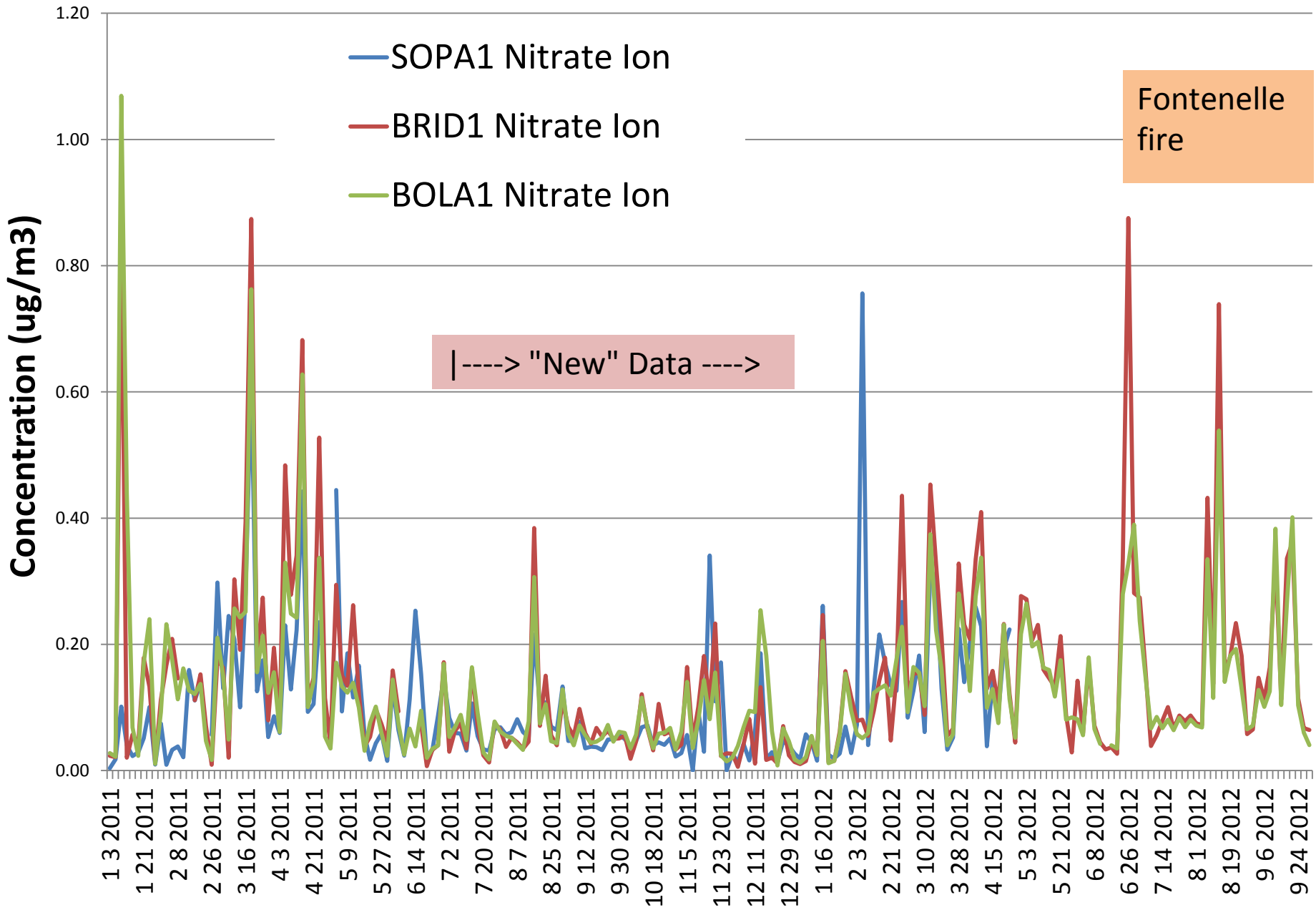
SVR = 20 Km

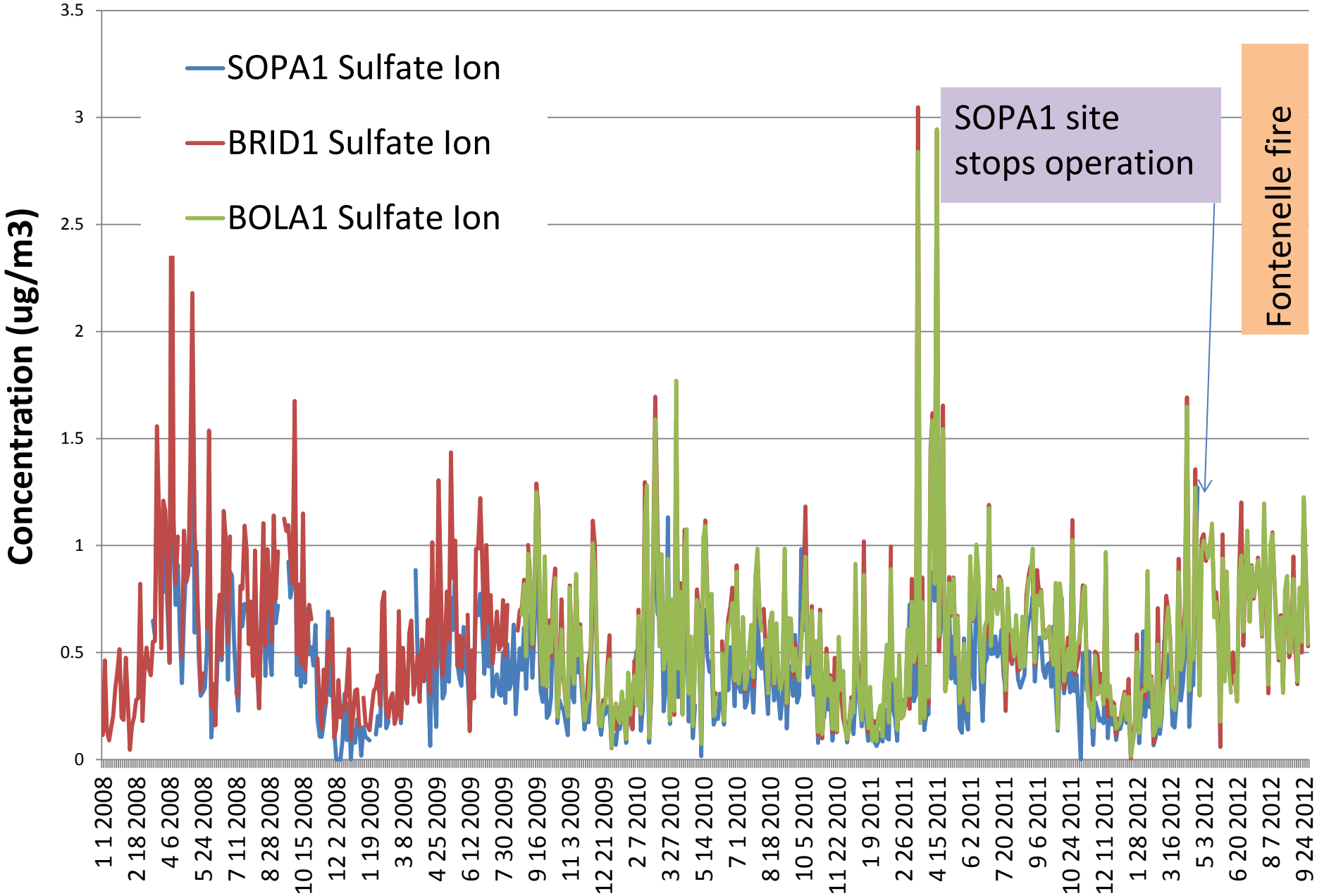
BRID1 IMPROVE Site Long Term Trends

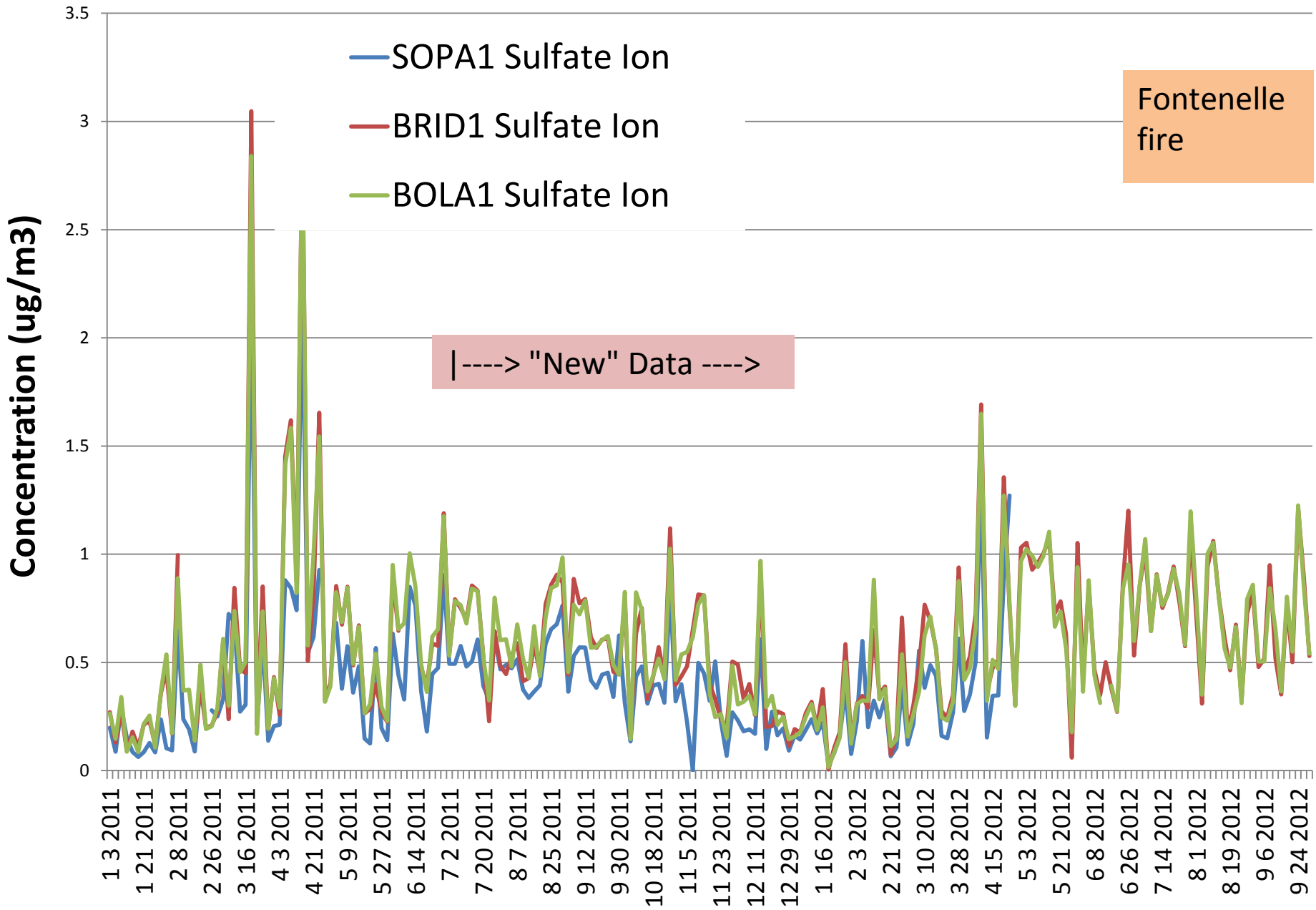



BOLA1 Organic Mass
BRID1 Organic Mass
BOLA1 Nitrate Mass
BRID1 Nitrate Mass
Fontenelle Fire 6/24-10/25
"typical" spring nitrate peaks
"atypical" summer nitrate peaks coincident with fire impacts
Organic Mass (ug/m3)
Ammonium Nitrate Mass (ug/m3)
25
20
15
10
5
0
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1/1/2012
1/7/2012
1/13/2012
1/19/2012
1/25/2012
1/31/2012
2/6/2012
2/12/2012
2/18/2012
2/24/2012
3/1/2012
3/7/2012
3/13/2012
3/19/2012
3/25/2012
3/31/2012
4/6/2012
4/12/2012
4/18/2012
4/24/2012
4/30/2012
5/6/2012
5/12/2012
5/18/2012
5/24/2012
5/30/2012
6/5/2012
6/11/2012
6/17/2012
6/23/2012
6/29/2012
7/5/2012
7/11/2012
7/17/2012
7/23/2012
7/29/2012
8/4/2012
8/10/2012
8/16/2012
8/22/2012
8/28/2012
9/3/2012
9/9/2012
9/15/2012
9/21/2012
9/27/2012


SOPA1 Nitrate Ion
BRID1 Nitrate Ion
BOLA1 Nitrate Ion
SOPA1 site stops operation
Fontenelle fire
Concentration (ug/m3)
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1 1 2008
2 18 2008
4 6 2008
5 24 2008
7 11 2008
8 28 2008
10 15 2008
12 2 2008
1 19 2009
3 8 2009
4 25 2009
6 12 2009
7 30 2009
9 16 2009
11 3 2009
12 21 2009
2 7 2010
3 27 2010
5 14 2010
7 1 2010
8 18 2010
10 5 2010
11 22 2010
1 9 2011
2 26 2011
4 15 2011
6 2 2011
7 20 2011
9 6 2011
10 24 2011
12 11 2011
1 28 2012
3 16 2012
5 3 2012
6 20 2012
8 7 2012
9 24 2012


SOPA1 Nitrate Ion
BRID1 Nitrate Ion
BOLA1 Nitrate Ion
Fontenelle fire
|----> "New" Data ---->
Concentration (ug/m3)
1.20
1.00
0.80
0.60
0.40
0.20
0.00
1 3 2011
1 21 2011
2 8 2011
2 26 2011
3 16 2011
4 3 2011
4 21 2011
5 9 2011
5 27 2011
6 14 2011
7 2 2011
7 20 2011
8 7 2011
8 25 2011
9 12 2011
9 30 2011
10 18 2011
11 5 2011
11 23 2011
12 11 2011
12 29 2011
1 16 2012
2 3 2012
2 21 2012
3 10 2012
3 28 2012
4 15 2012
5 3 2012
5 21 2012
6 8 2012
6 26 2012
7 14 2012
8 1 2012
8 19 2012
9 6 2012
9 24 2012


SOPA1 Sulfate Ion
BRID1 Sulfate Ion
BOLA1 Sulfate Ion
SOPA1 site stops operation
Fontenelle fire
Concentration (ug/m3)
3.5
3
2.5
2
1.5
1
0.5
0
1 1 2008
2 18 2008
4 6 2008
5 24 2008
7 11 2008
8 28 2008
10 15 2008
12 2 2008
1 19 2009
3 8 2009
4 25 2009
6 12 2009
7 30 2009
9 16 2009
11 3 2009
12 21 2009
2 7 2010
3 27 2010
5 14 2010
7 1 2010
8 18 2010
10 5 2010
11 22 2010
1 9 2011
2 26 2011
4 15 2011
6 2 2011
7 20 2011
9 6 2011
10 24 2011
12 11 2011
1 28 2012
3 16 2012
5 3 2012
6 20 2012
8 7 2012
9 24 2012


SOPA1 Sulfate Ion
BRID1 Sulfate Ion
BOLA1 Sulfate Ion
Fontenelle fire
|----> "New" Data ---->
Concentration (ug/m3)
3.5
3
2.5
2
1.5
1
0.5
0
1 3 2011
1 21 2011
2 8 2011
2 26 2011
3 16 2011
4 3 2011
4 21 2011
5 9 2011
5 27 2011
6 14 2011
7 2 2011
7 20 2011
8 7 2011
8 25 2011
9 12 2011
9 30 2011
10 18 2011
11 5 2011
11 23 2011
12 11 2011
12 29 2011
1 16 2012
2 3 2012
2 21 2012
3 10 2012
3 28 2012
4 15 2012
5 3 2012
5 21 2012
6 8 2012
6 26 2012
7 14 2012
8 1 2012
8 19 2012
9 6 2012
9 24 2012

Visibility Trends

- Visibility is improving in line with the Regional Haze Rule
- Nearby fires result in spikes of organic mass and nitrates.
- The Boulder Lake and Bridger sites track very well in normal conditions.
- The Bridger site tends to show higher nitrates than Boulder Lake in smoky conditions.

Three State Study Data Warehouse

- **States**
  - Wyoming
  - Utah
  - Colorado
- **Federal Agencies**
  - USFS
  - BLM
  - NPS
  - EPA
  - FWS

Source	Emissions	Deposition
Combustion: Vehicles Energy development Energy production	NO_x VOCs	NO_3^- HNO_3
Agriculture: Livestock production Crop production	NH_3	NH_4^+

Purpose of the Data Warehouse:

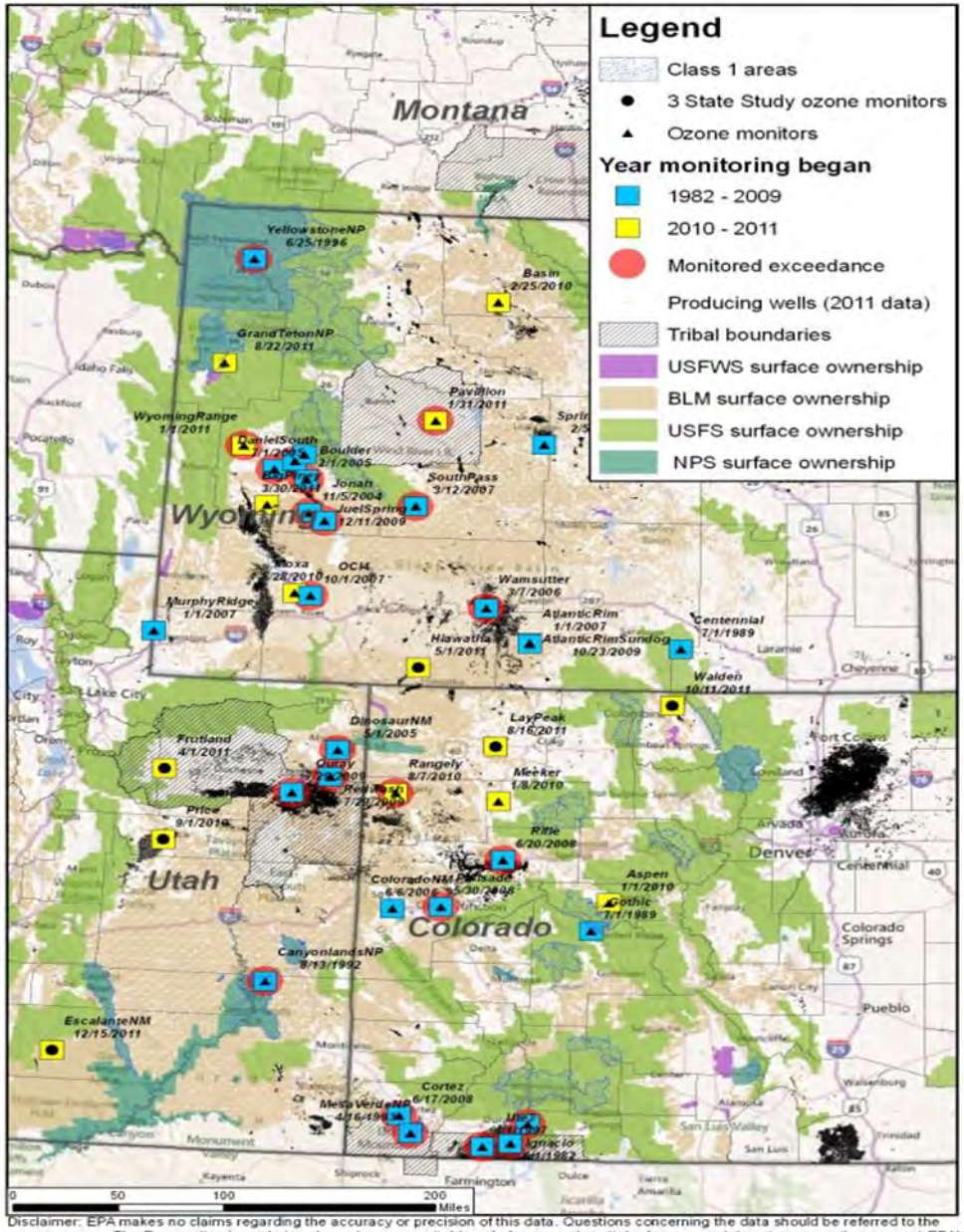
- **Develop a database to:**
  - Get up-to-date emission inventories in 1 place.
  - Provide consistent QA/QC data and metadata for air quality modeling.
  - Provide data for modeling that is validated by the stakeholders.
  - Focus on Ozone, PM and AQRVs.
  - Collecting additional ozone data across the study area for use in modeling.

Benefits of the Data Warehouse:

- Greatly decreases the time needed to conduct emission inventories.
- Saves money.
- Provides consistent, standardized data to be used for air quality models.
- Facilitates regional modeling across large areas vs project by project. (Ozone)
- Implementation (data access) planned for early 2014.

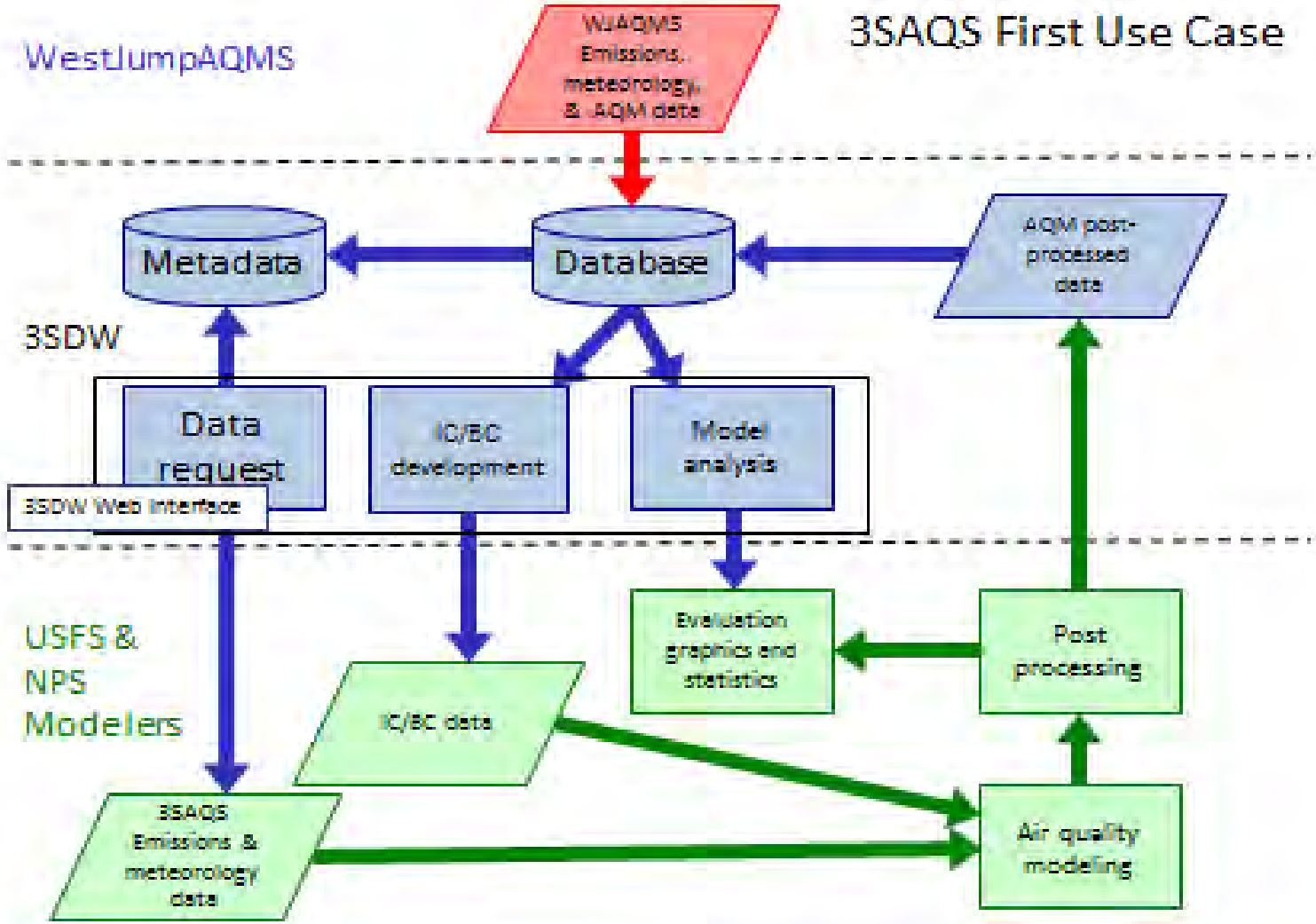
3SAQS Emissions Analysis Domain

Ozone Monitors in the 3 State Study Area

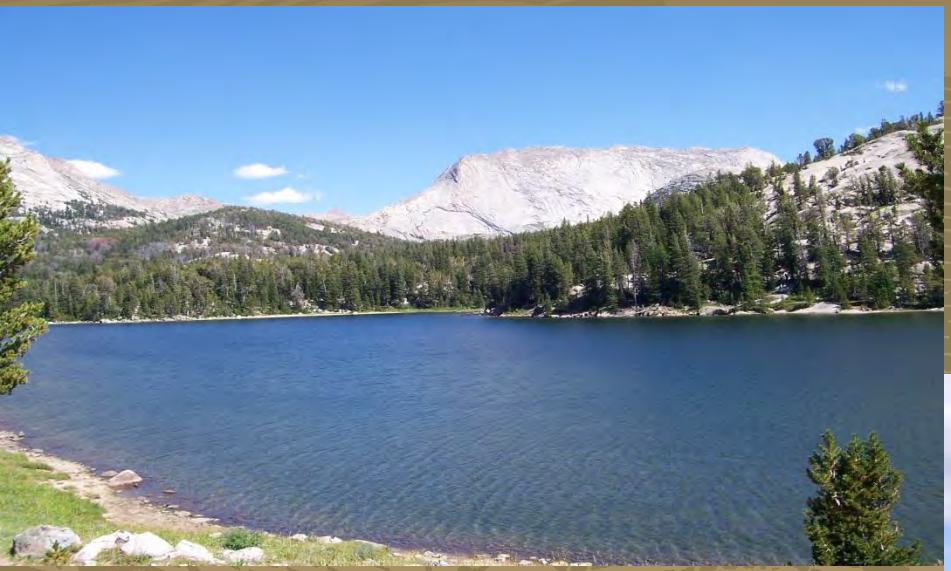


Disclaimer: EPA makes no claims regarding the accuracy or precision of this data. Questions concerning the data should be referred to the source agency. The Reservation boundaries shown here are suitable only for general spatial reference and do not necessarily represent EPA's position on any Indian country boundaries or the jurisdictional status of any specific location. EPA programs should consult the Office of Regional Counsel for legal advice before making decisions regarding jurisdiction on or near any Reservation.

3SAQS First Use Case



Questions?



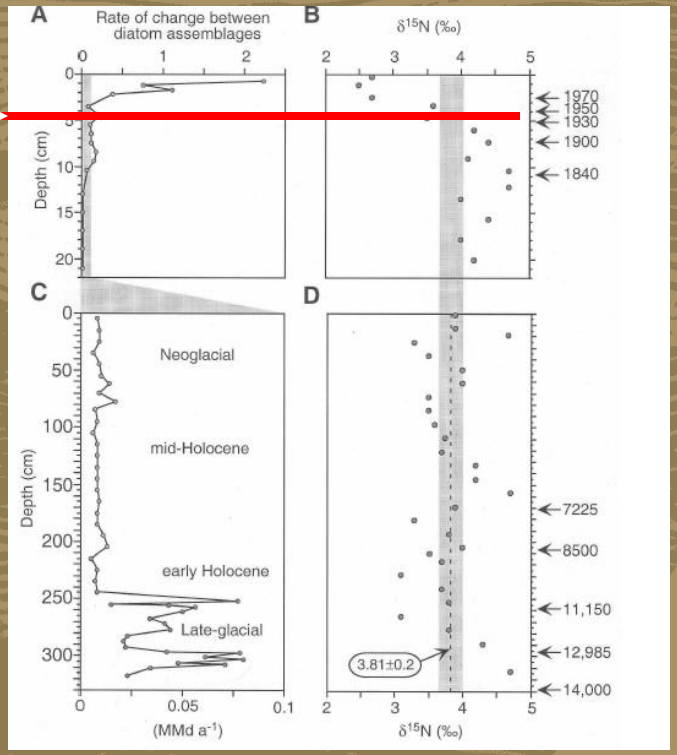
EXPERIENCE YOUR AMERICA

Lake Sediments: Time machines to see Past Environmental Changes

Changes in aquatic plant species represent biological evidence that some high elevation lakes have shifted from undisturbed to disturbed (weedy) systems- which are unnatural–

Sediment Cores Show sensitive Rocky Mountain lakes have Changed More in past few decades than Previous 14,000 Yrs

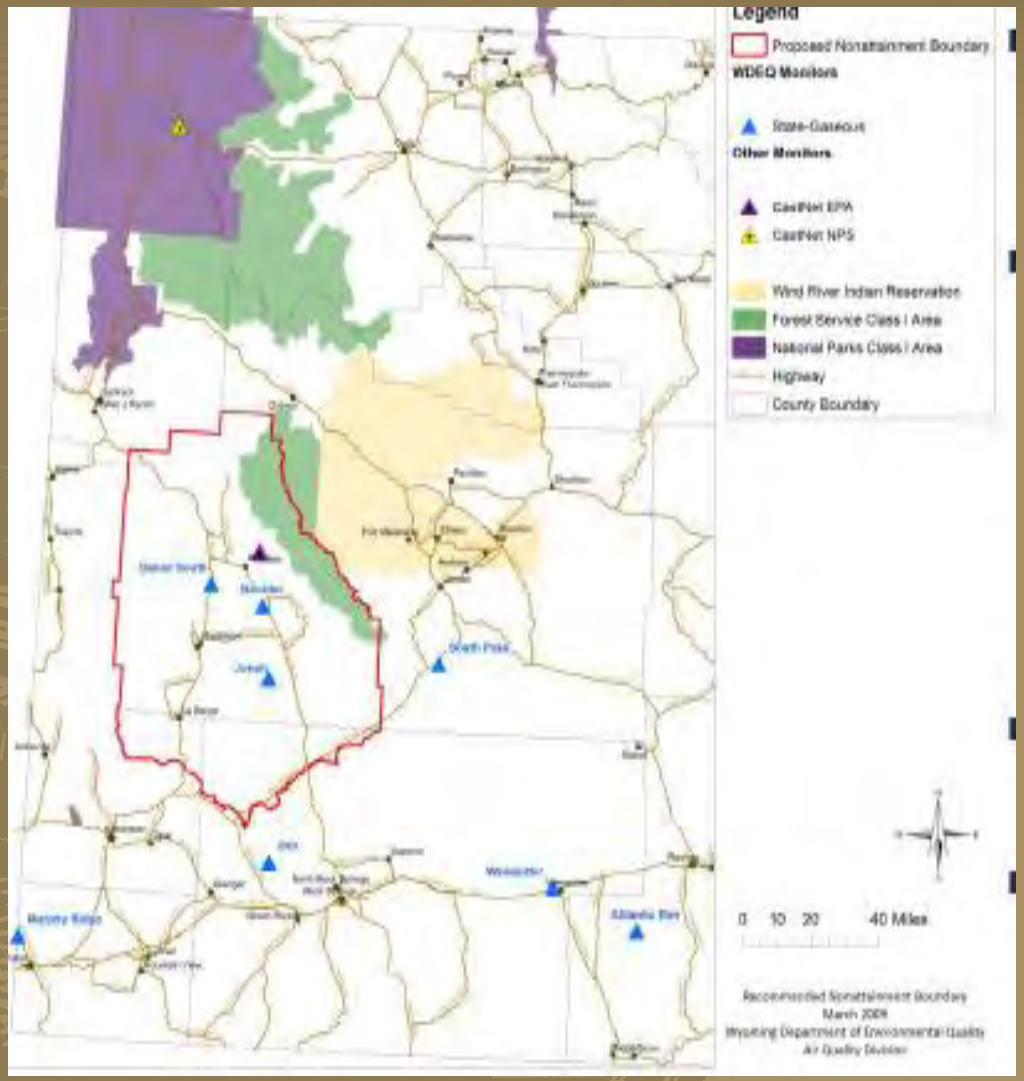
1980s in GYA



- Species shift to 2 disturbance species: *Asterionella formosa* and *Fragilaria crotonensis.* (indicators of nutrient-rich waters)
- GYA data supporting this is from Absaroka-Beartooth wilderness

Wolfe et al 2003; Baron, 2006: Saros 2003

Upper Green River Basin Wintertime Ozone Ozone Nonattainment Area



- Winter 2008 had 14 exceedances of Ozone NAAQS (75ppb)
- March 2009 WY-DEQ NAA Recommendation to EPA
- 120 day Letter from EPA December 9, 2011
- Final Designation July 21, 2012
- NAA includes Sublette County and parts of Lincoln and Sweetwater Counties
- Ozone Standard will be reviewed by EPA again in 2013 (lowered?)
- High ozone can lead to plant damage and decreased growth, as well as human respiratory problems

EXPERIENCE YOUR AMERICA

Summary of N-Deposition Trends in the GYA:

Type of Monitoring	Location & Impact	# Sites	Source Implications?
N deposition in rain & snow	↑ GYA-wide	6/8	Effects are widespread in GYA
Ammonium (NH4) conc. in rain & snow	↑ GYA-wide	11/11	Agriculture likely contributor
Wet nitrate (NO3) conc.	Local increases at some GYA sites	3/11	Combustion local contributor
Air conc. of nitrate (NO3)	↑ Bridger (winter) ↑ Yellowstone (all year)	2/2	?
Bulk deposition of Total N, NH4, and NO3	↑Wind River Range	2/2	Emissions are reaching sensitive ecosystems

Weight of evidence approach

Summary of N concentration changes in GYA lakes

Impact to Lakes:	Location	# Sites
Lake water N ↑ (Eutrophication)	Wind River Range – (Ross, L. Saddlebag, Black Joe, Hobbs)	4/6
Lake water ANC↓ (Acidification)	Wind River Range (Ross, Hobbs & L. Saddlebag lakes)	3/6
Sediment N source change from natural to man-made	Grand Teton NP (high-elev. Lakes)	7/7

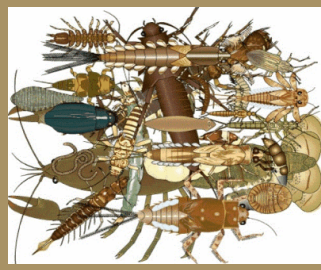
Lichen, aquatic plants, alpine grasses: at CL so likely affected also…

Are GYA Ecosystems “sick”?

Test results:
for N effects on GYA ecosystems

Warning signs of unhealthy resource conditions, will get worse if left untreated

Identified gaps in science:

GYA Critical Loads Science Workshop held April 5-6, 2011 in Jackson, WY (Funded by a grant from GYCC)

- ✓ Complete **lake nutrient project** at Grand Teton NP
- ✓ Complete **lichen critical loads project** in GYA
- ✓ Develop **estimates for "total deposition"** at high elevation areas
- ✓ Continue **atmospheric monitoring work to assess sources of N**
- ☞ Conduct analysis of existing 25 yrs of **macroinvertebrate & zooplankton data** in Wind River Range (unfunded)
- ☞ Determine whether the N increases observed in Wind River lakes contribute to **excess phytoplankton productivity/** eutrophication (unfunded)