DEVELOPMENT OF CRITICAL NITROGEN LOADS USING DIATOM-NITROGEN PROXIES: DISTRIBUTION OF INDICATOR SPECIES IN LAKES OF THE SIERRA NEVADA, CALIFORNIA

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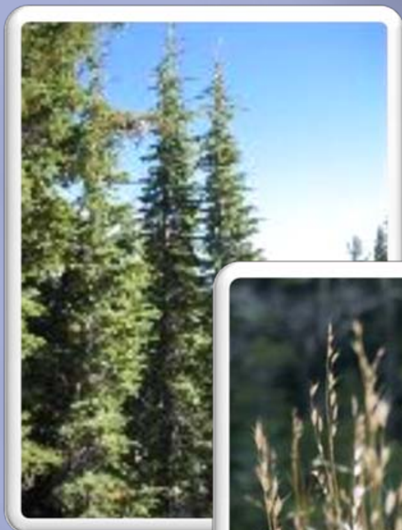
BIOLOGICAL INDICATORS OF ATMOSPHERIC DEPOSITION



- Tree communities

- Plant communities

-Lichens

-Aquatic animals

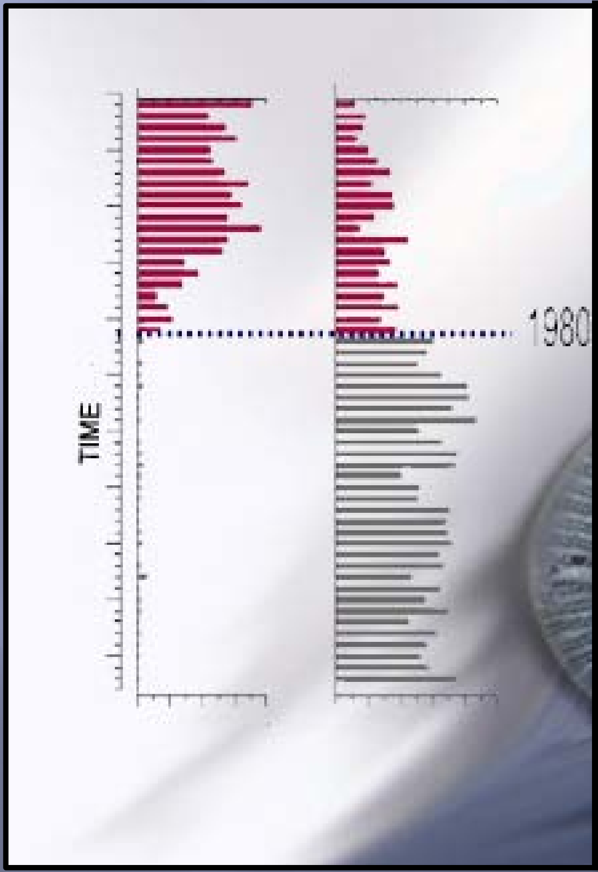
DIATOM INDICATORS

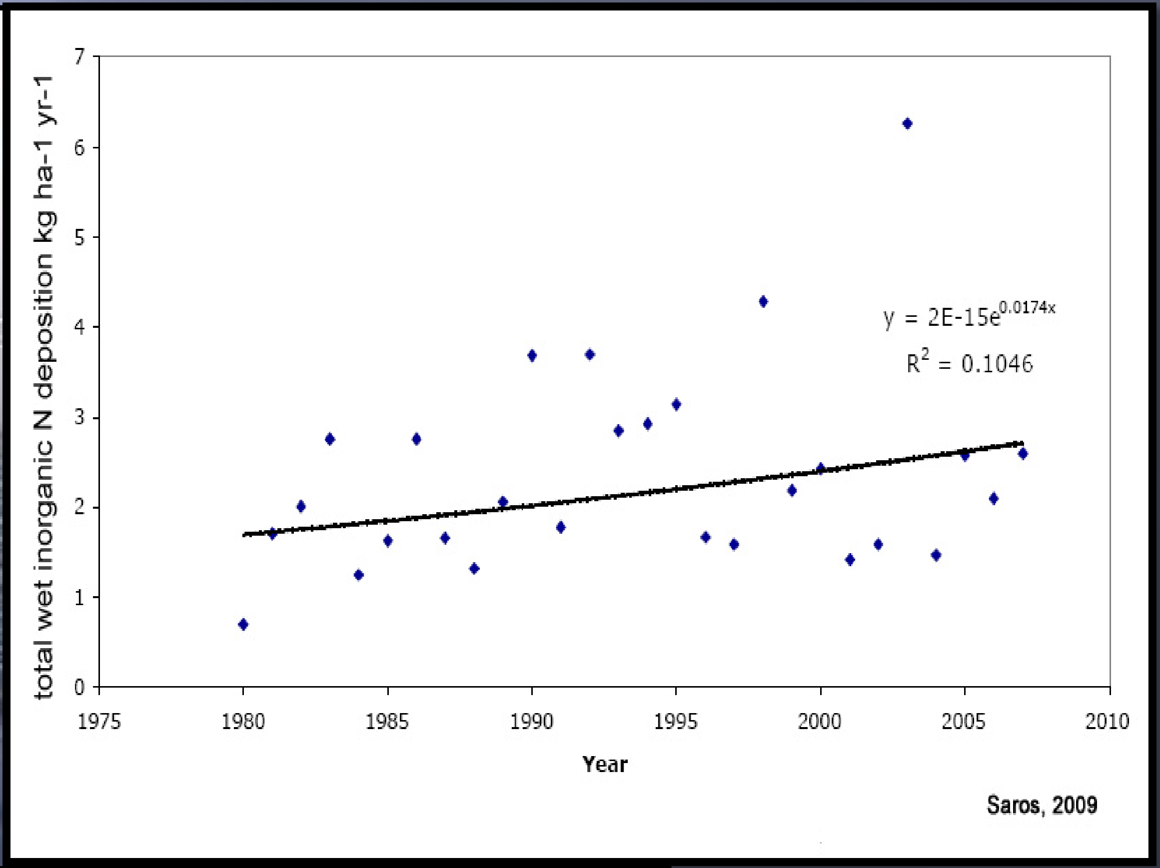
We are going to use reconstructions of past lake chemistry based on diatoms preserved in sediments:

pH (e.g. Charles and Whitehead, 1986; Renberg, 1990; Anderson and Renberg, 1992; Battarbee et al., 1999)

phosphorus (e.g.Anderson et al., 1990; Anderson and Rippey, 1994; Hall and Smol, 1996)

nitrogen (e.g. Saros et al 2003, 2005)





RESEARCH PLANE

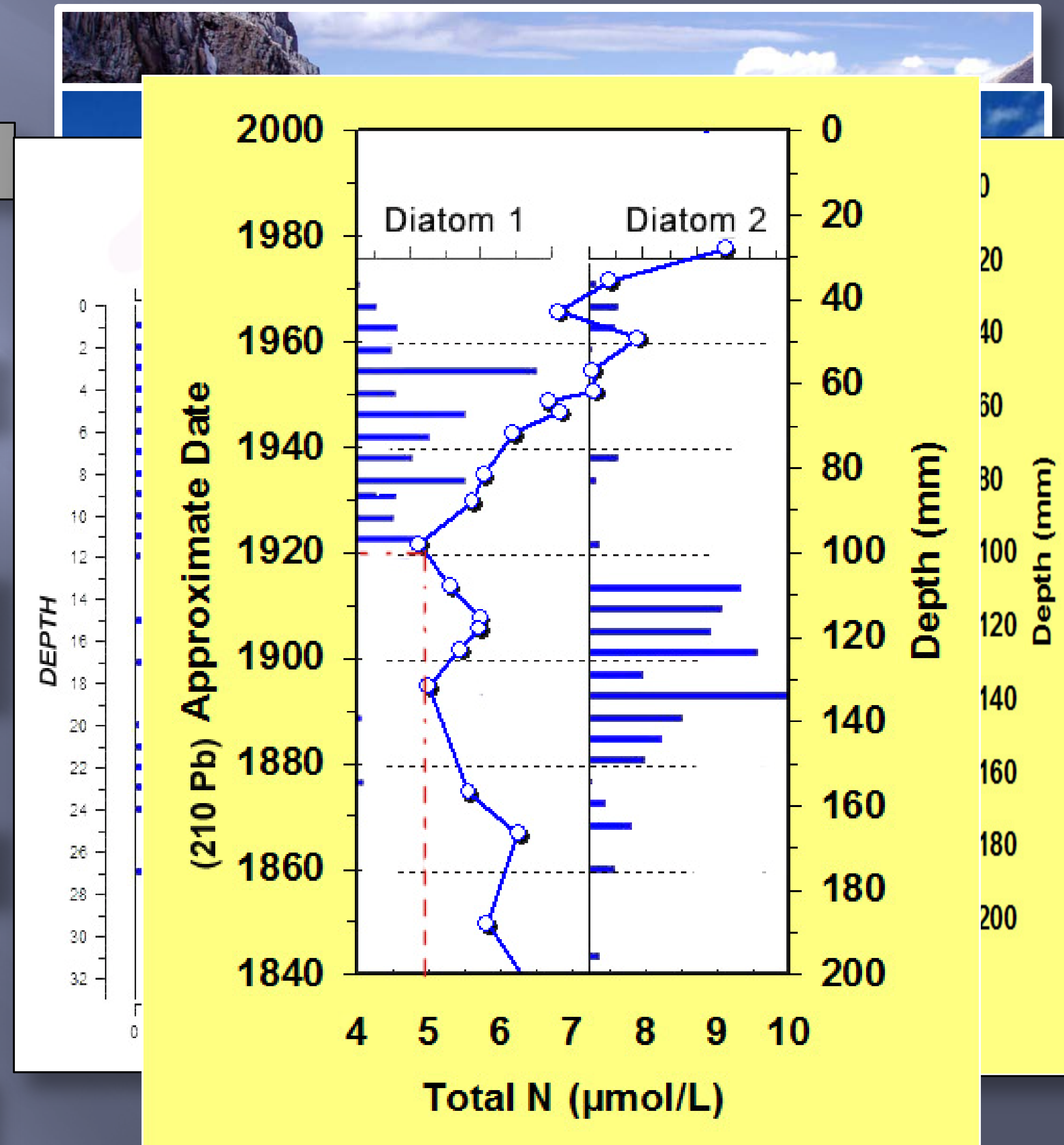
calibration set of lakes

lake sediments/env. data

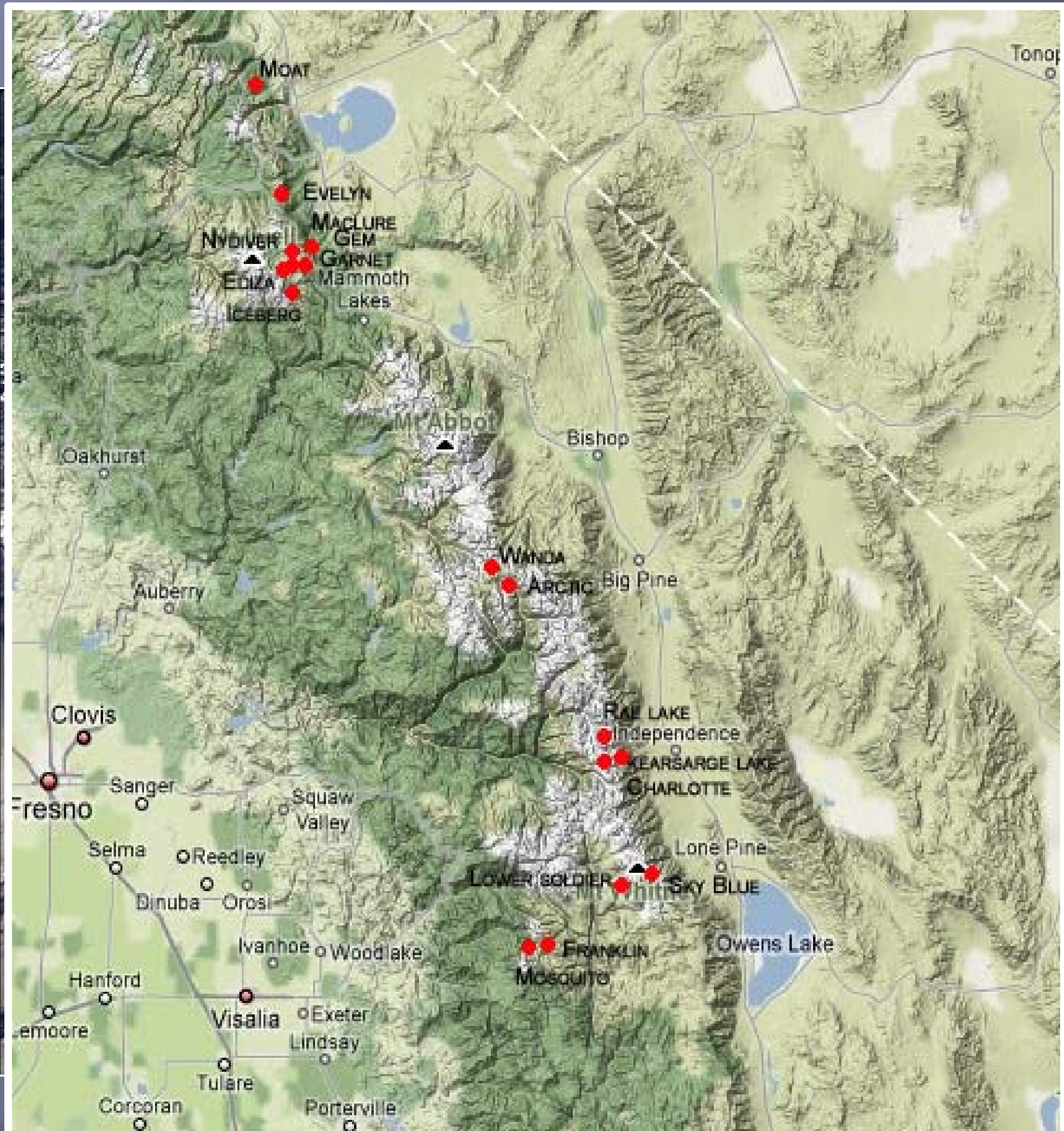
Diatom based model of past environmental conditions

Projection on the past

Develop critical load



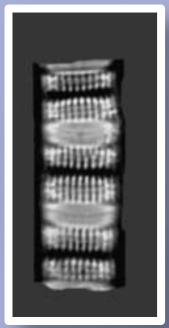
STUDY SITES LOCATIONS- CALIBRATION LAKES



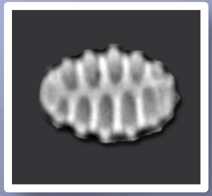
Large variation
in nitrate concentrations

Low buffering capacities

DOMINANT SPECIES- modern data

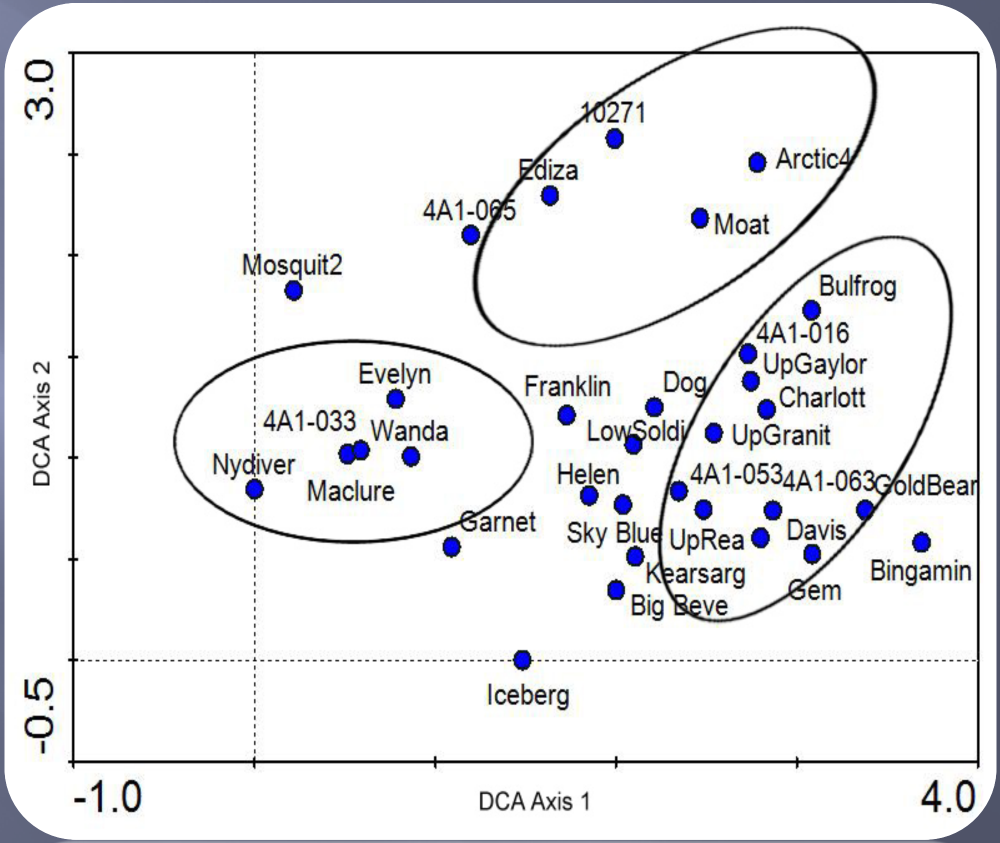


Aulacoseira alpigena
oligotrophic conditions,
Indicating slightly
acidic conditions

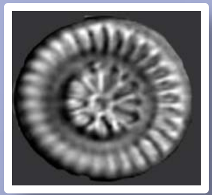


Staurosirella pinnata
alpine diatom, moderate Si
very low N and P
requirements

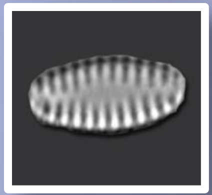
Pseudostaurosira brevistriata
dominant in arctic and alpine lakes



COMMON SPECIES- modern data

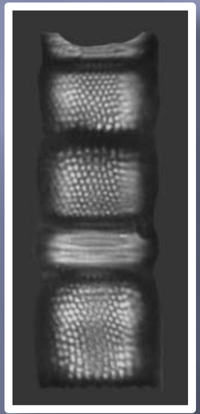


Discostella stelligera
responds positively to slight nutrient enrichment

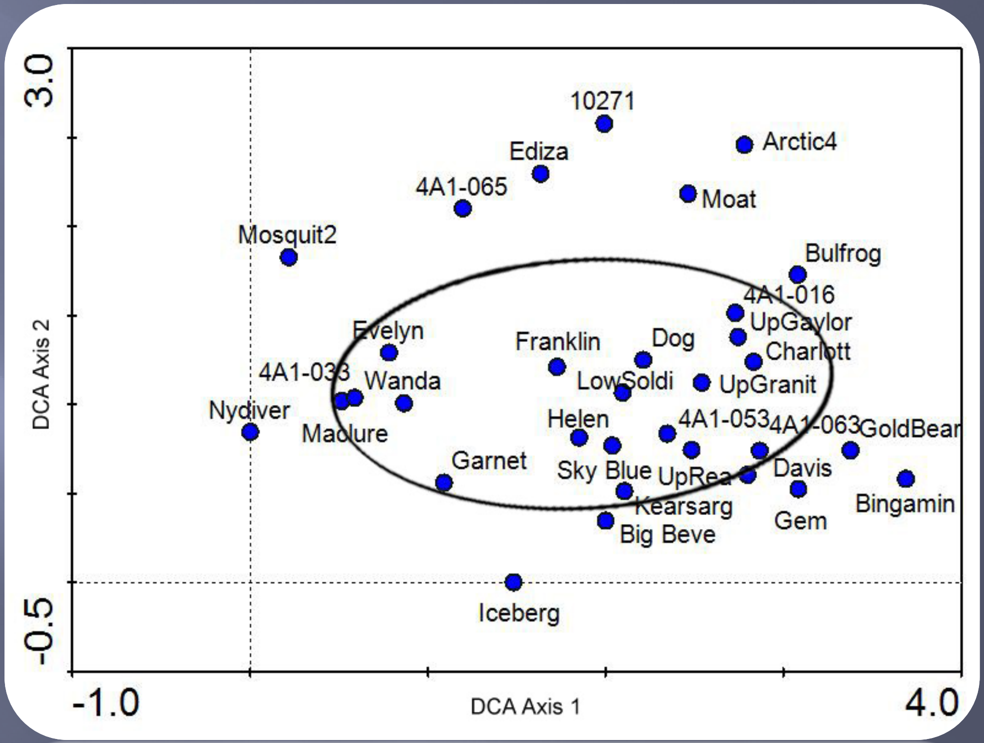


Staurosira construensis var venter
low nutrient levels, but associated with phosphorous

Stephanodiscus minutus
mesotrophic to eutrophic
at low latitudes waters

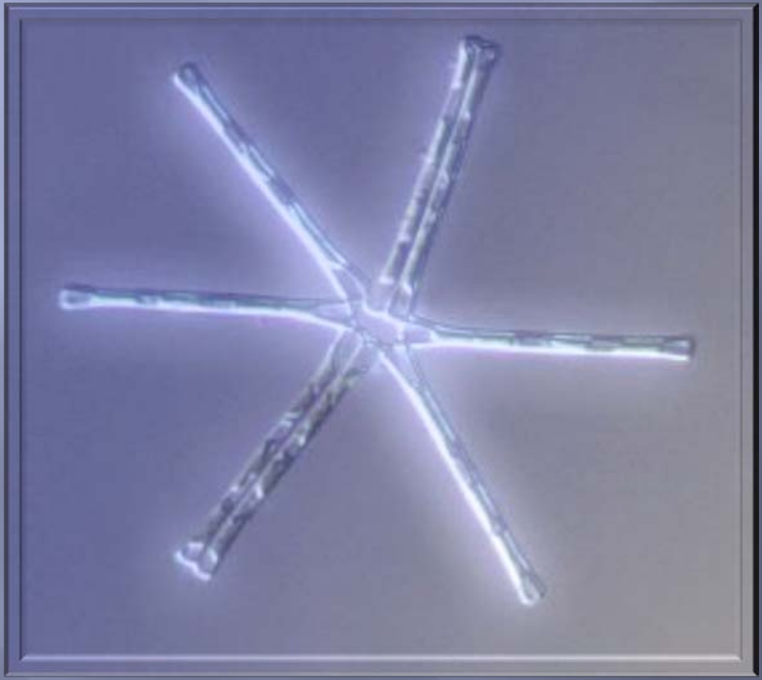


Aulacoseira ambigua
mesotrophic, to slightly eutrophic

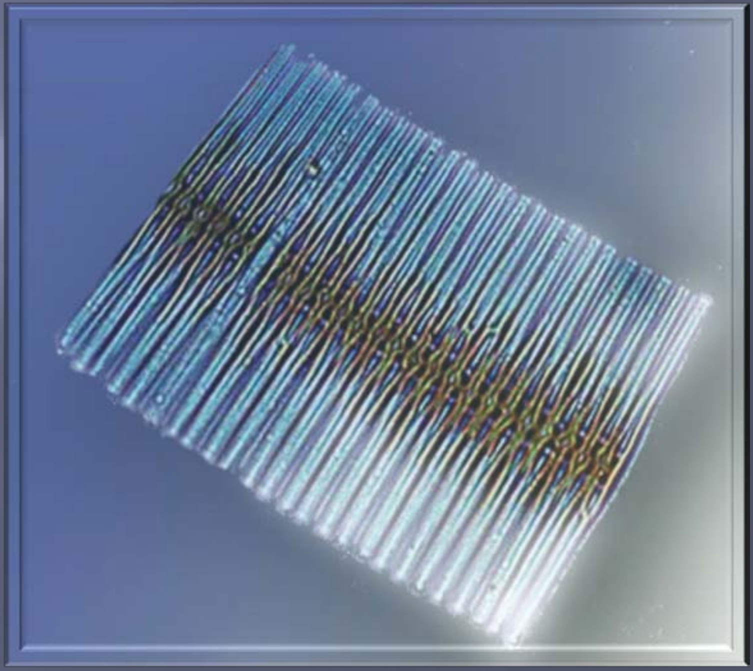


INDICATOR SPECIES

increases in the two diatom taxa *Asterionella formosa and Fragilaria crotonensis,* have been suggested as indicators of N enrichment in N- limited high alpine lakes – (Wolfe et al. 2001;Saros et al. 2003; Saros et al. 2005



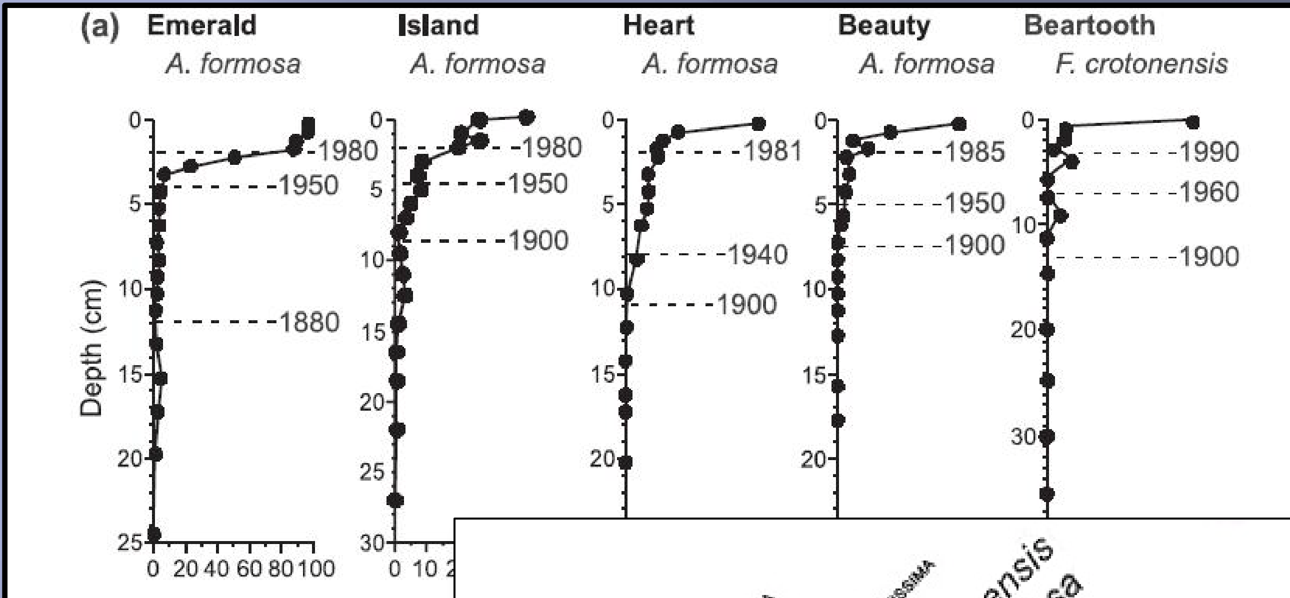
Asterionella formosa Hassall 1850

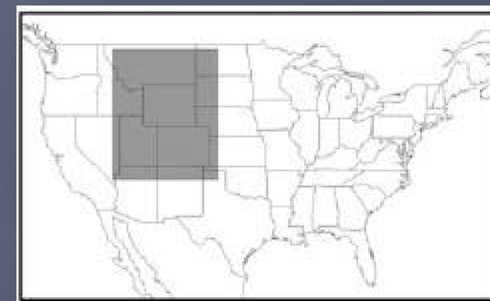


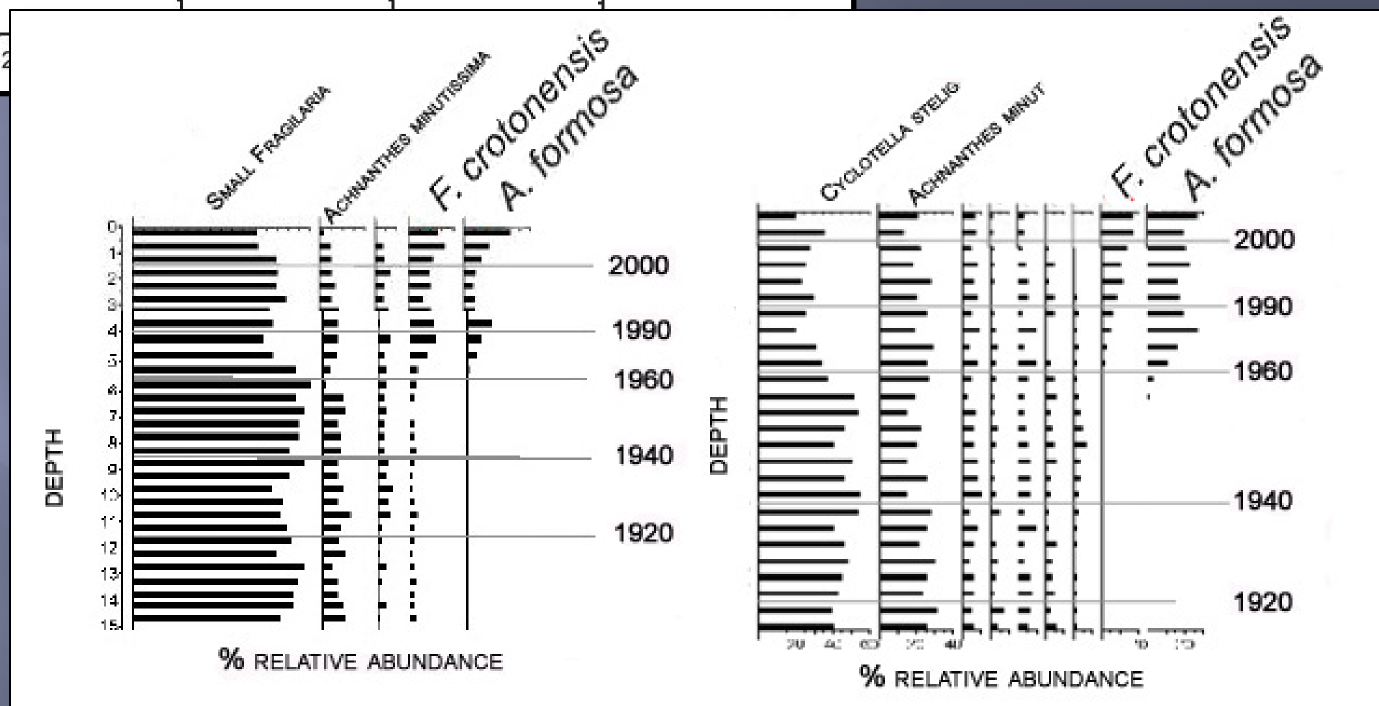
Fragilaria crotonensis Kitton 1869

What others found…

Saros et al., 2005

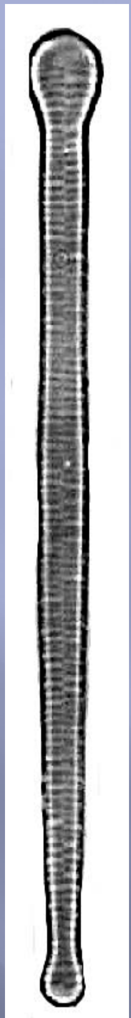


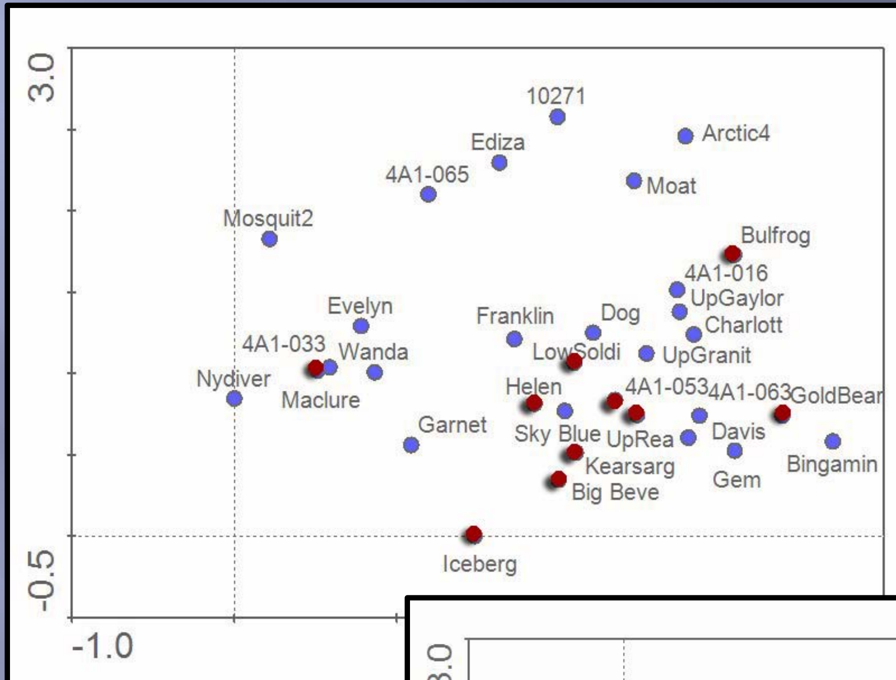


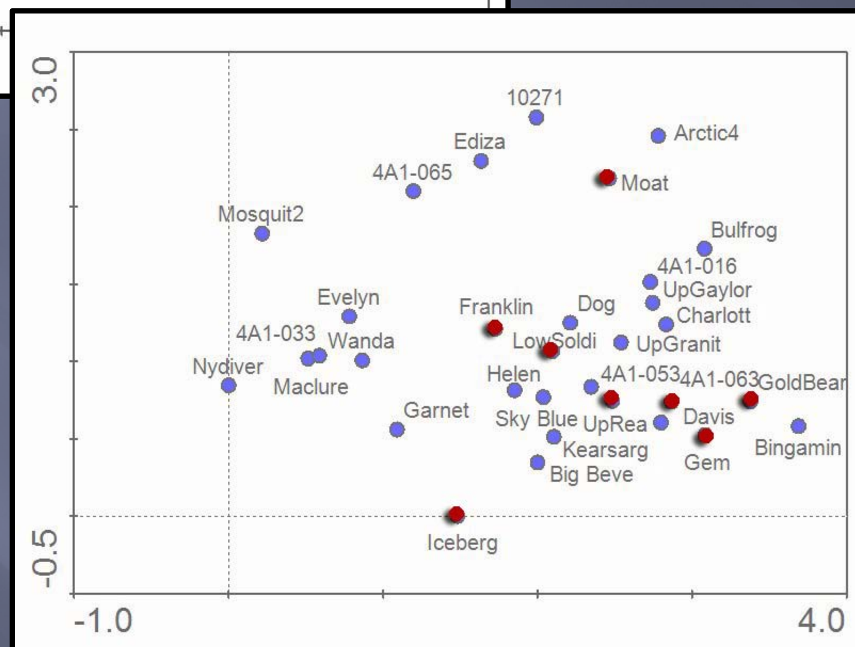


Our study

Asterionella formosa Hassall



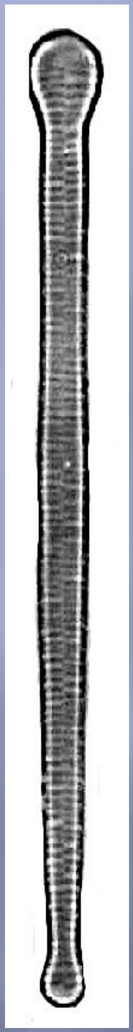


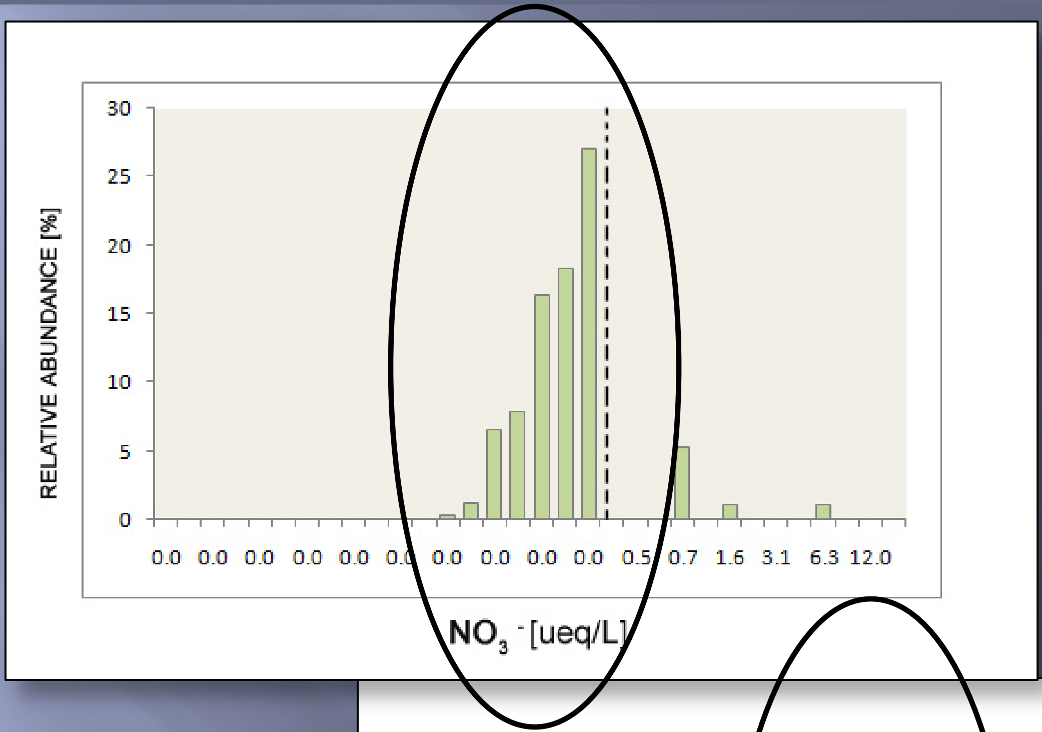


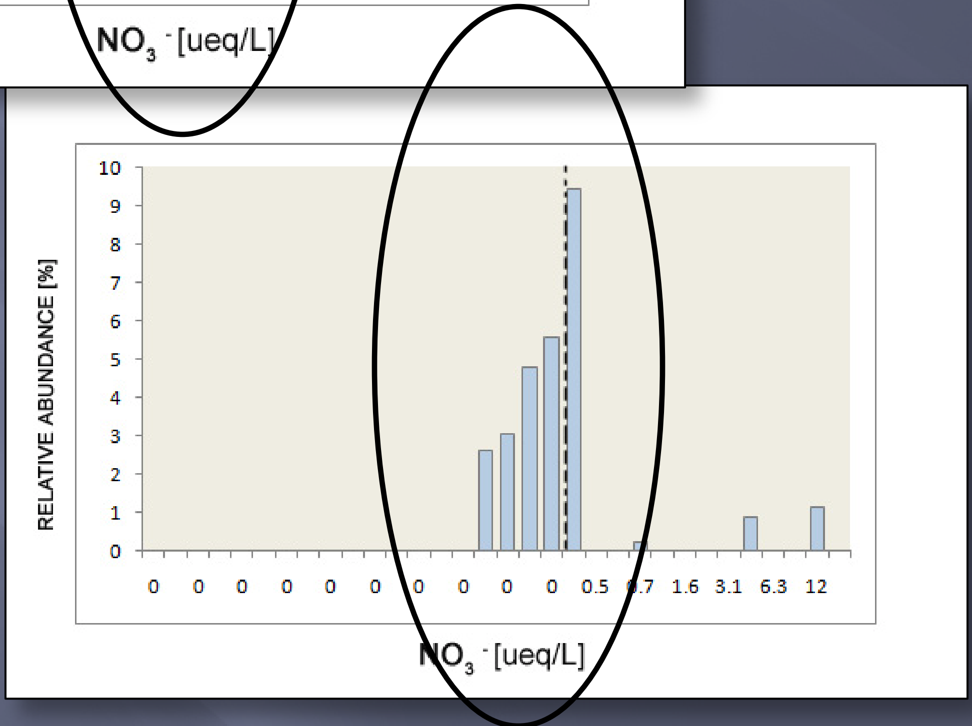
Fragilaria crotonensis Kitton

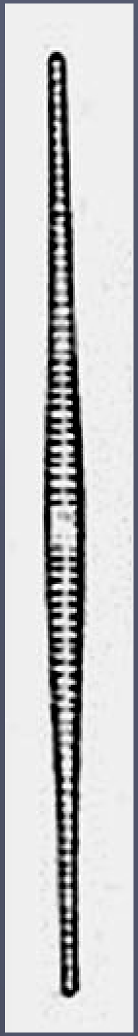
Our study

Asterionella formosa Hassall



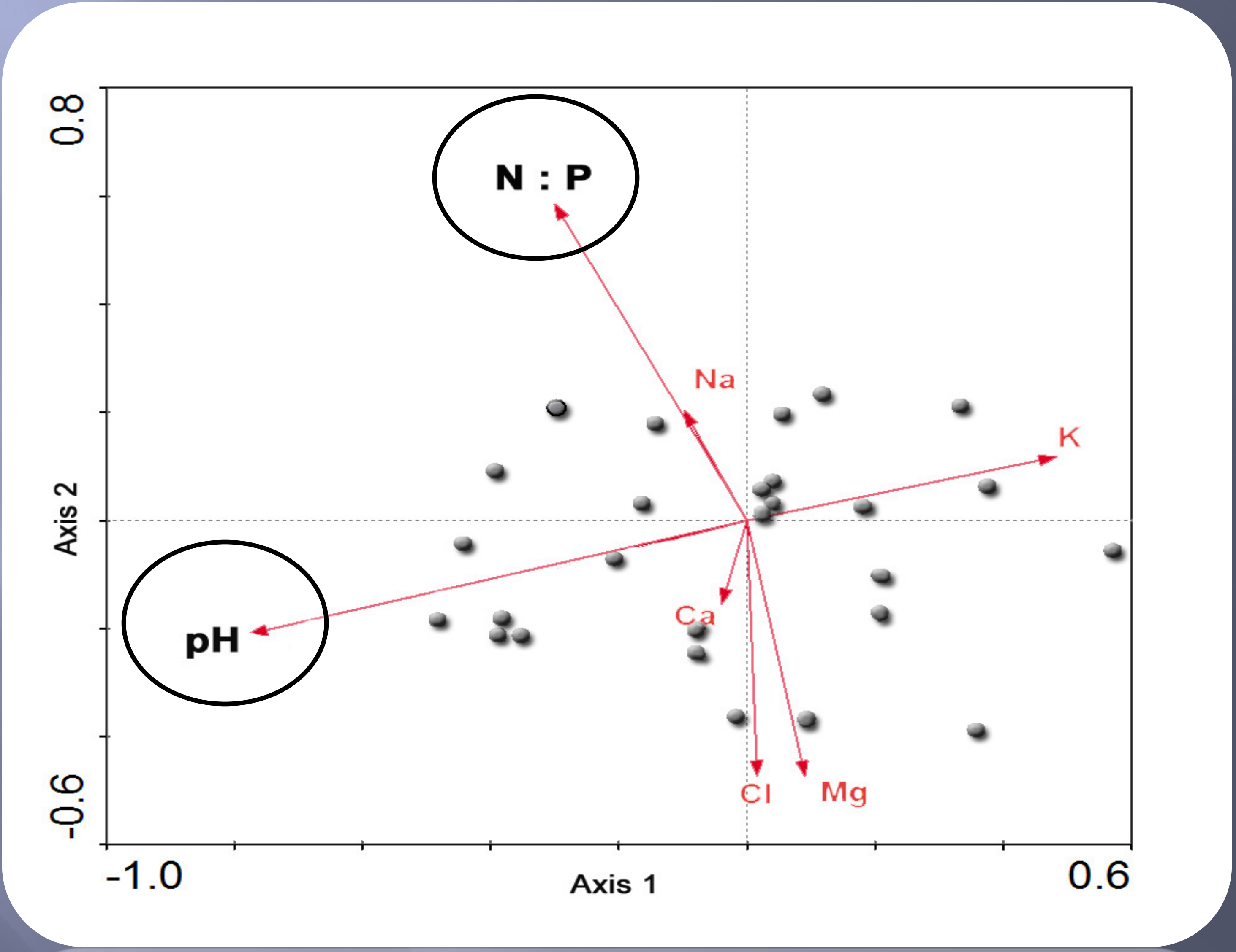






Fragilaria crotonensis Kitton

Environmental variables (CCA)



SOURCES and TYPES of deposition

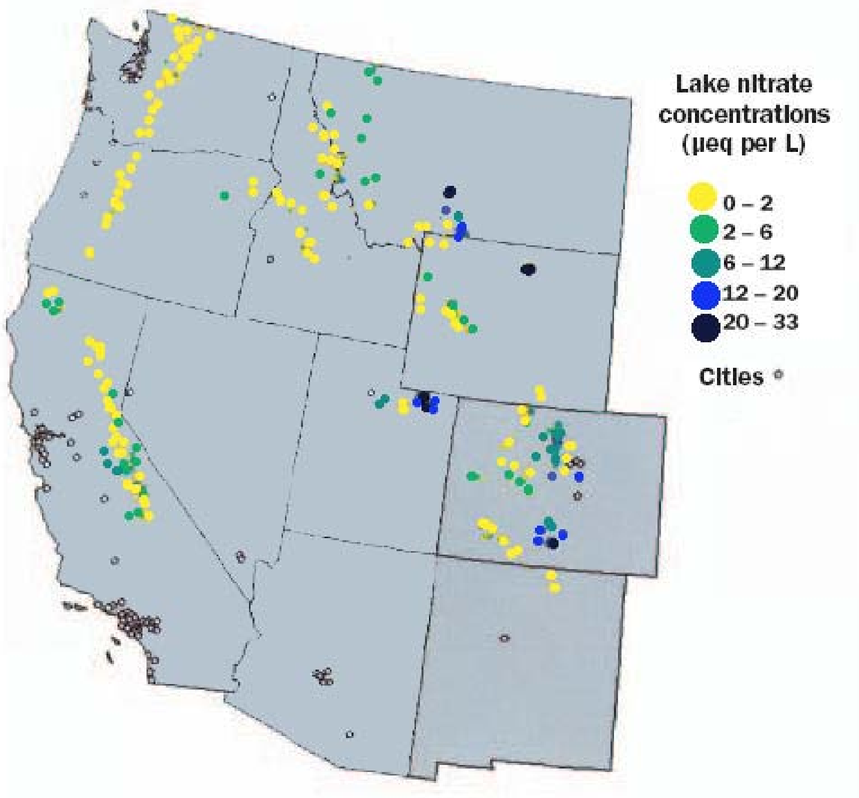


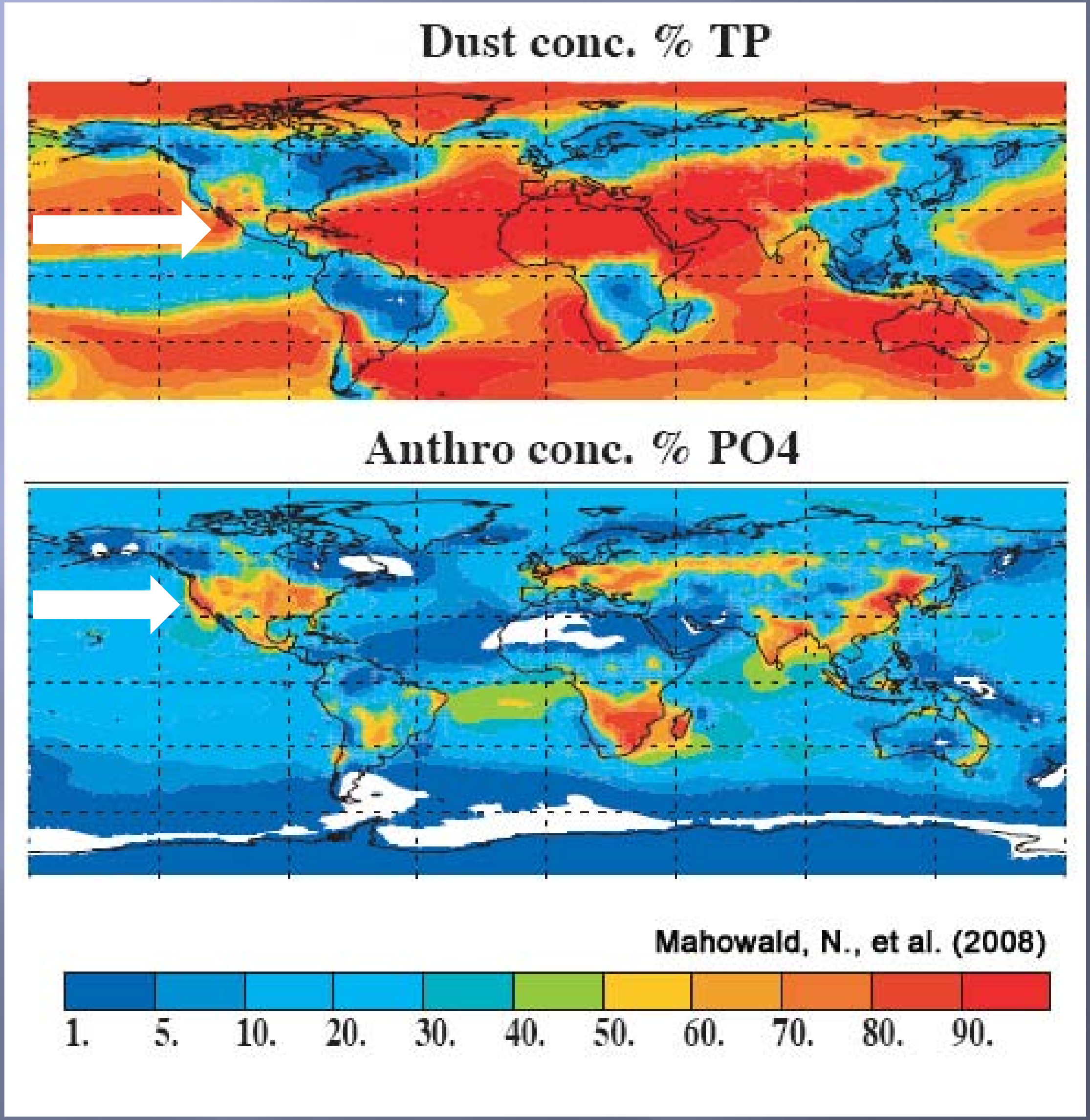
Figure 2. Nitrate concentrations (microequivalents per liter) in high-elevation lakes in western North America. Stars represent cities with a population greater than 100,000.

Fenn et al 2003

<u>N deposition</u>

- metro / agricultural areas
- Pacific air masses

SOURCES and TYPES of deposition



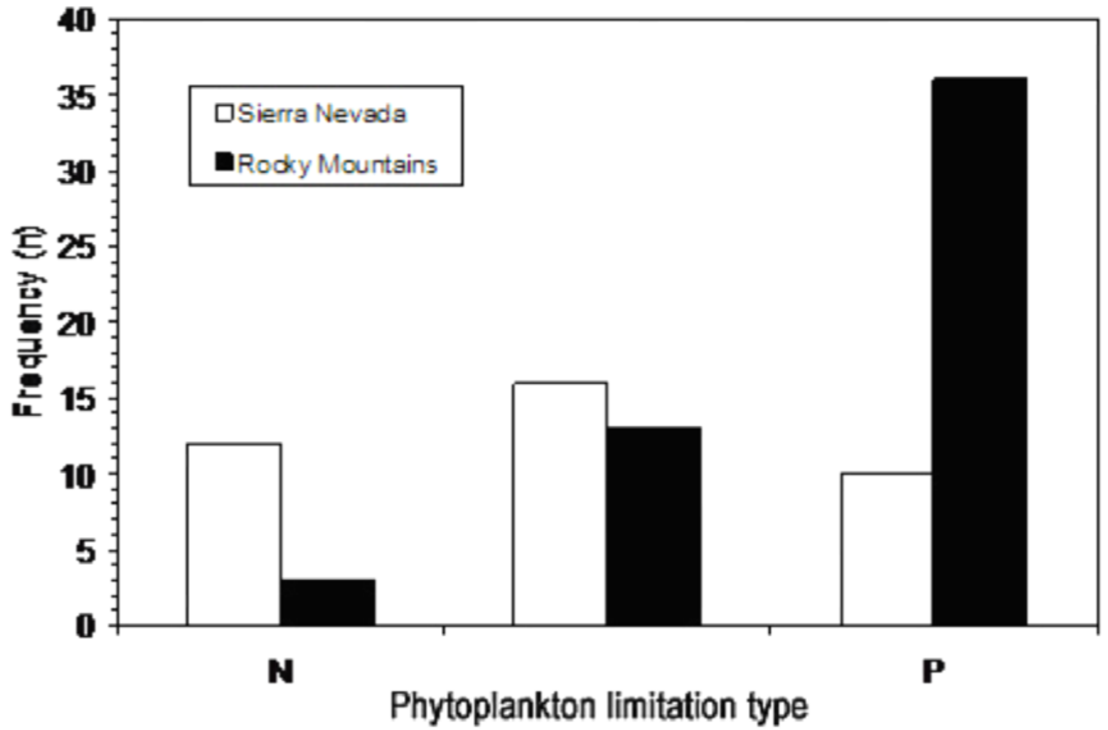
P deposition

- desert storms/dust fall
- anthropogenic sources

Nutrient limitation

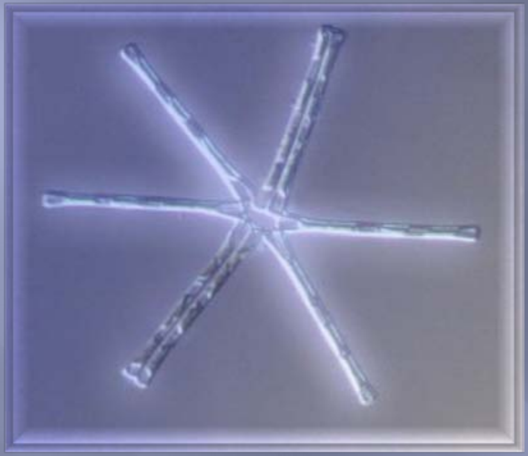
N limitation or **P** limitation

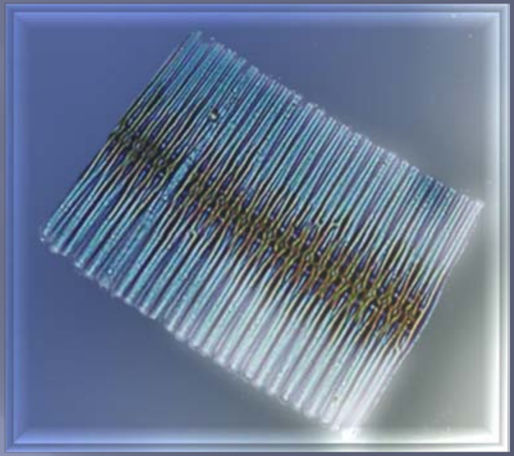
Modern N:P

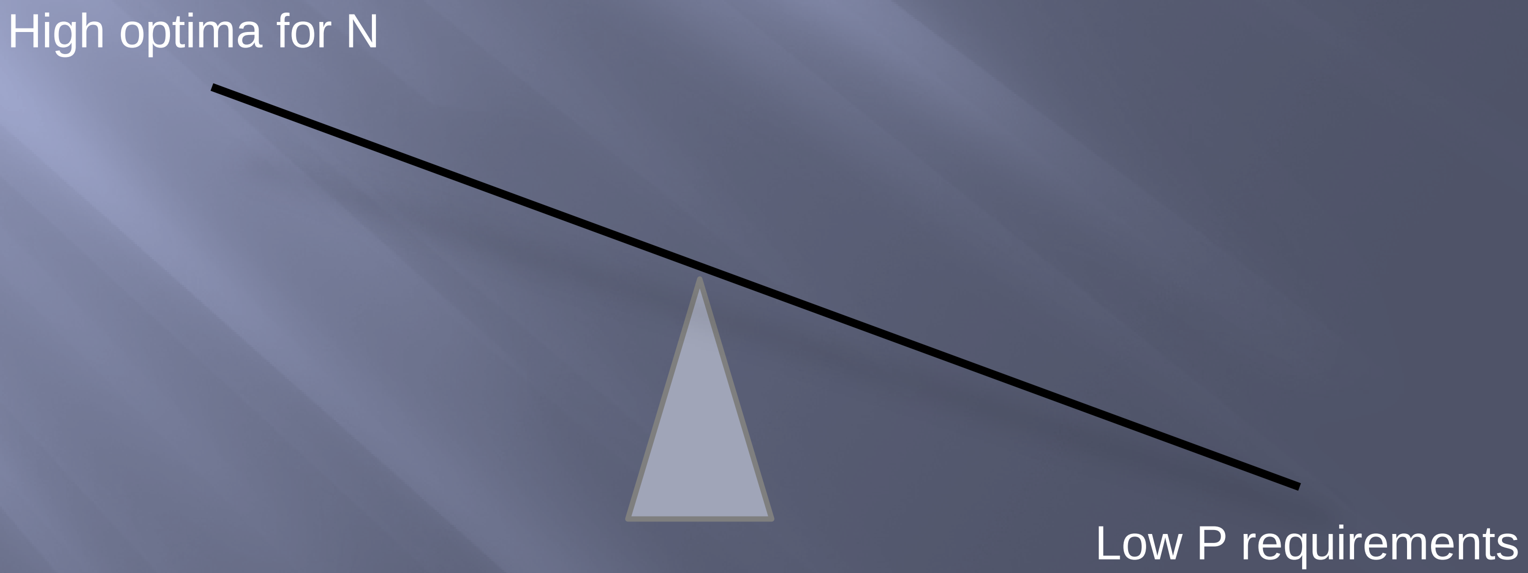


Sickman, 2001

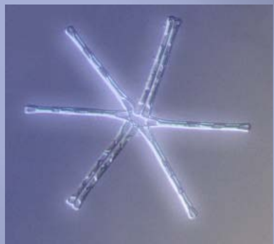
N : P ratio

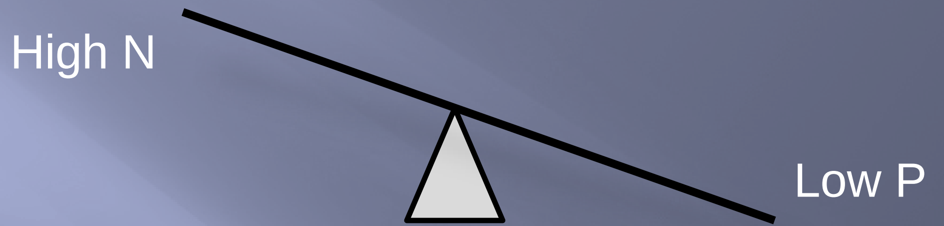


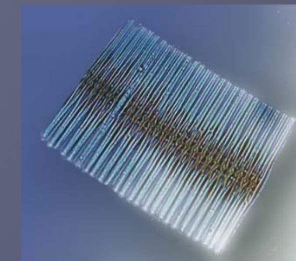


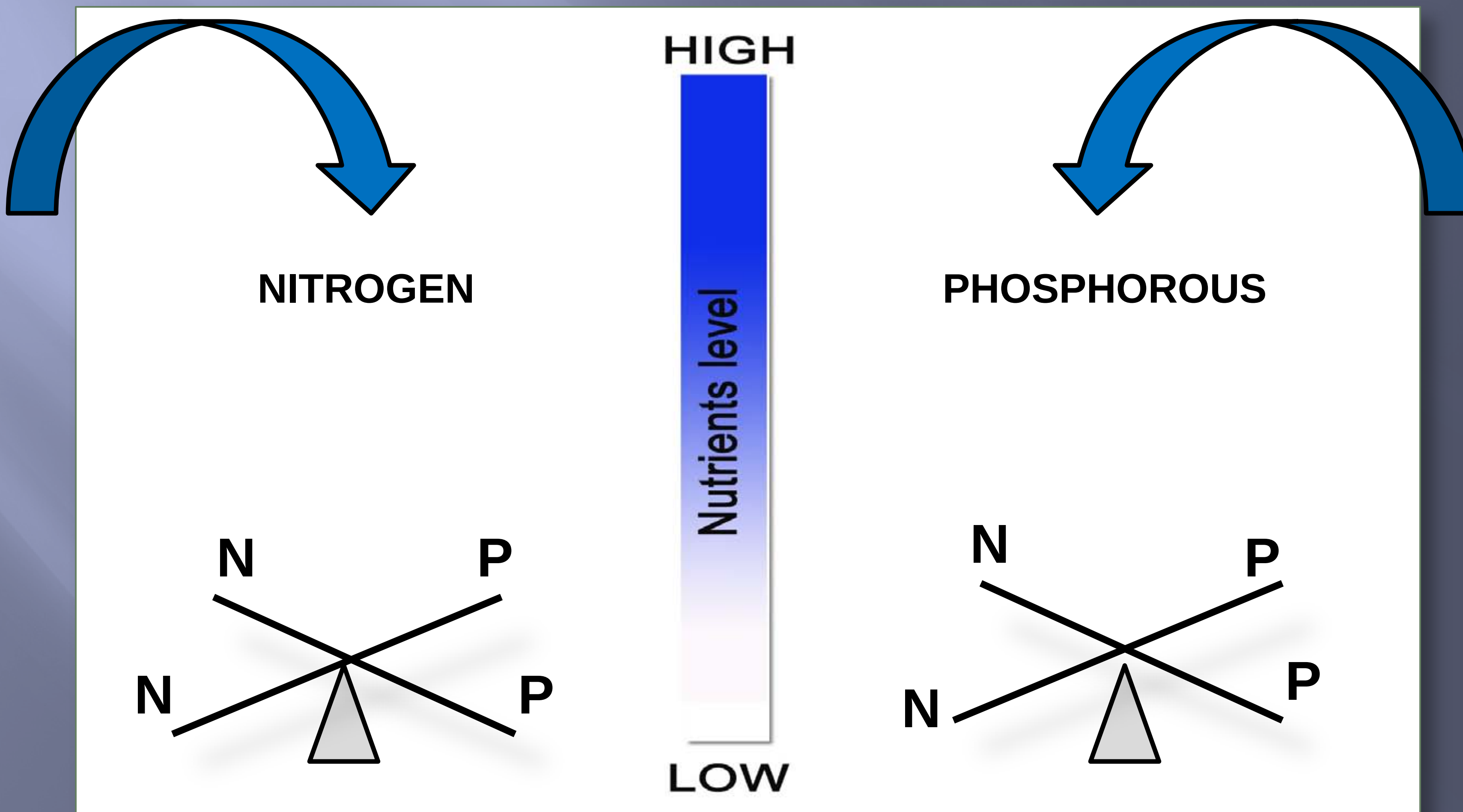


N:P ratio

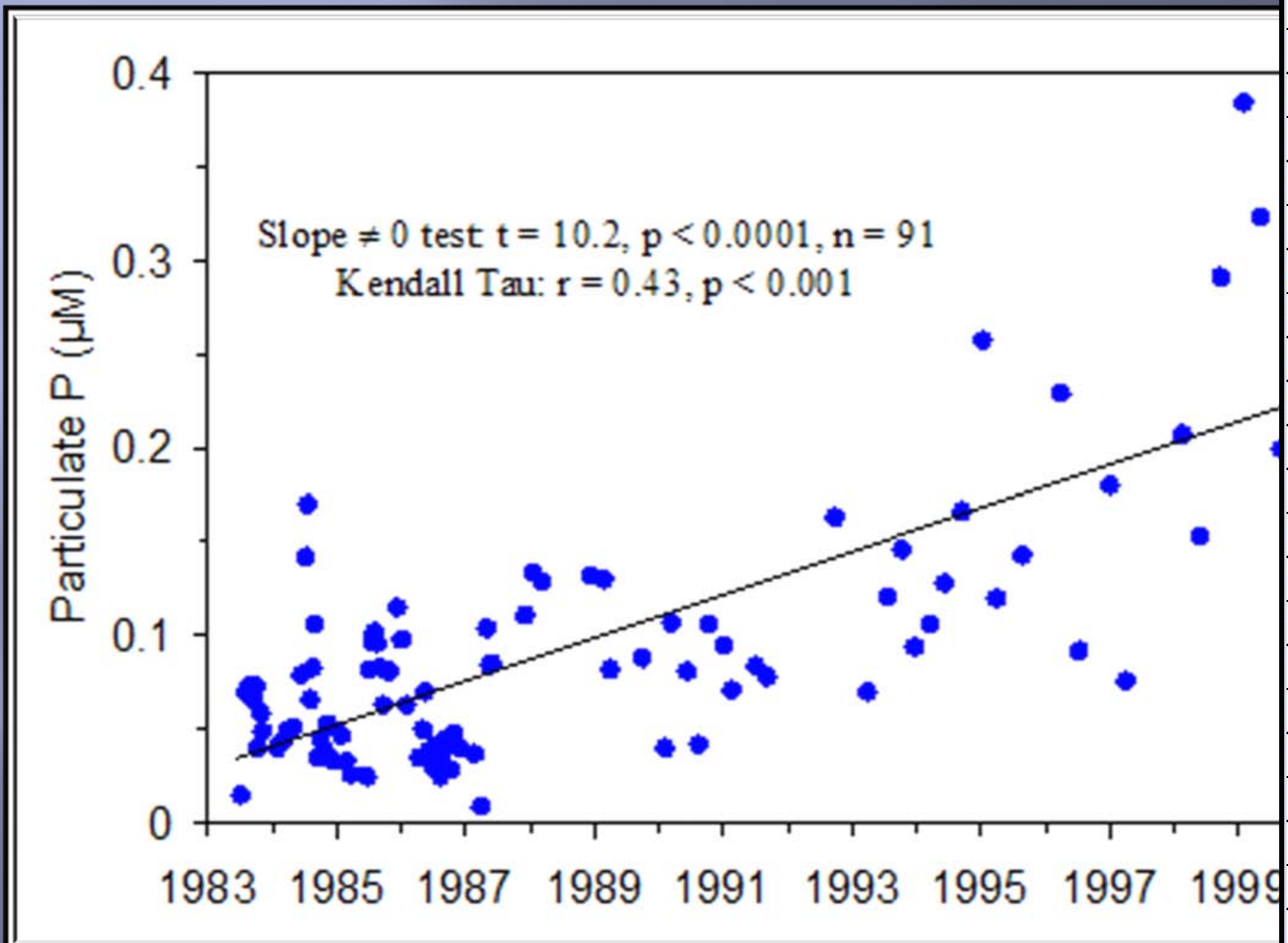



High N
Low P




HIGH
Nutrients level
LOW
NITROGEN
PHOSPHOROUS
N
P
N
P
N
P
N
P

Phosphorous



lake code	PO4 (µM)
10271	0.05
4A1-016	0.07
4A1-053	0.05
4A1-063	0.08
4A1-065	0.09
Big Brewer	0.06
Bingamin	0.07
Bulfrog	0.09
Charlotte	0.06
Davis	0.07
Dog	0.06
Ediza	0.04
Evelyn	0.08
Franklin	0.07
Garnet	0.09
Gem	0.07
GoldBear	0.07
Kearsarge	0.06
Moat	0.06
Mosquit2	0.06
Nydiver	0.06
UpGaylor	0.06
UpGranite	0.06
UpRae	0.05
Arctic4	0.06
LowSoldier	0.06
Maclure	0.08
Sky Blue	0.05

HOW DIATOM RESPOND TO ELEVATED ATMOSPHERIC DEPOSITION

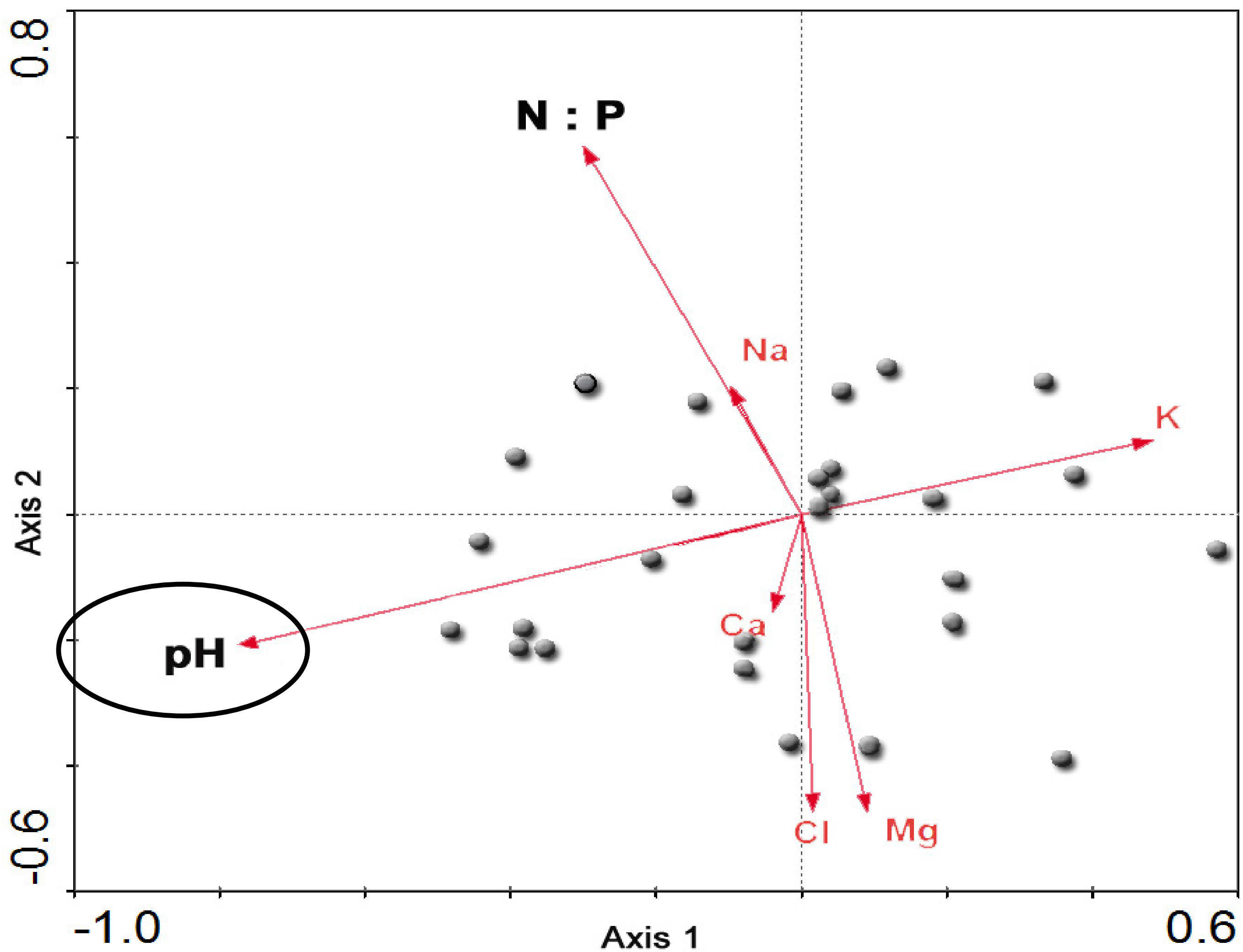
ROCKY MOUNTAINS

Diatom communities in lakes may be more responding to elevated N deposition, due to their initial N limitation (Saros et al.2003).

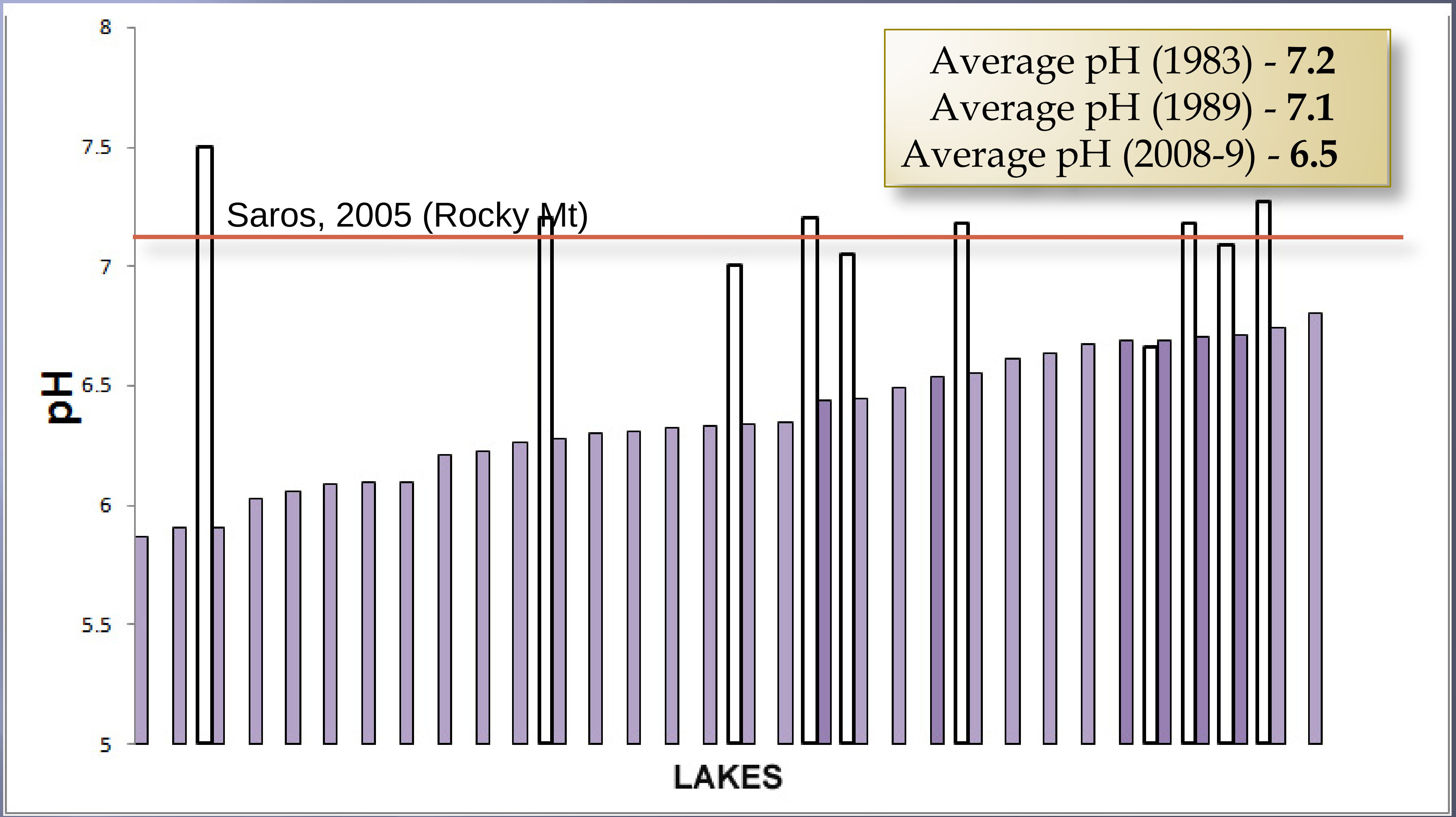
SIERRA NEVADA

Diatom communities respond to both higher rates of N and P deposition, but the P deposition has strongest impact, because lakes were predominantly P limited .

Environmental variables (CCA)



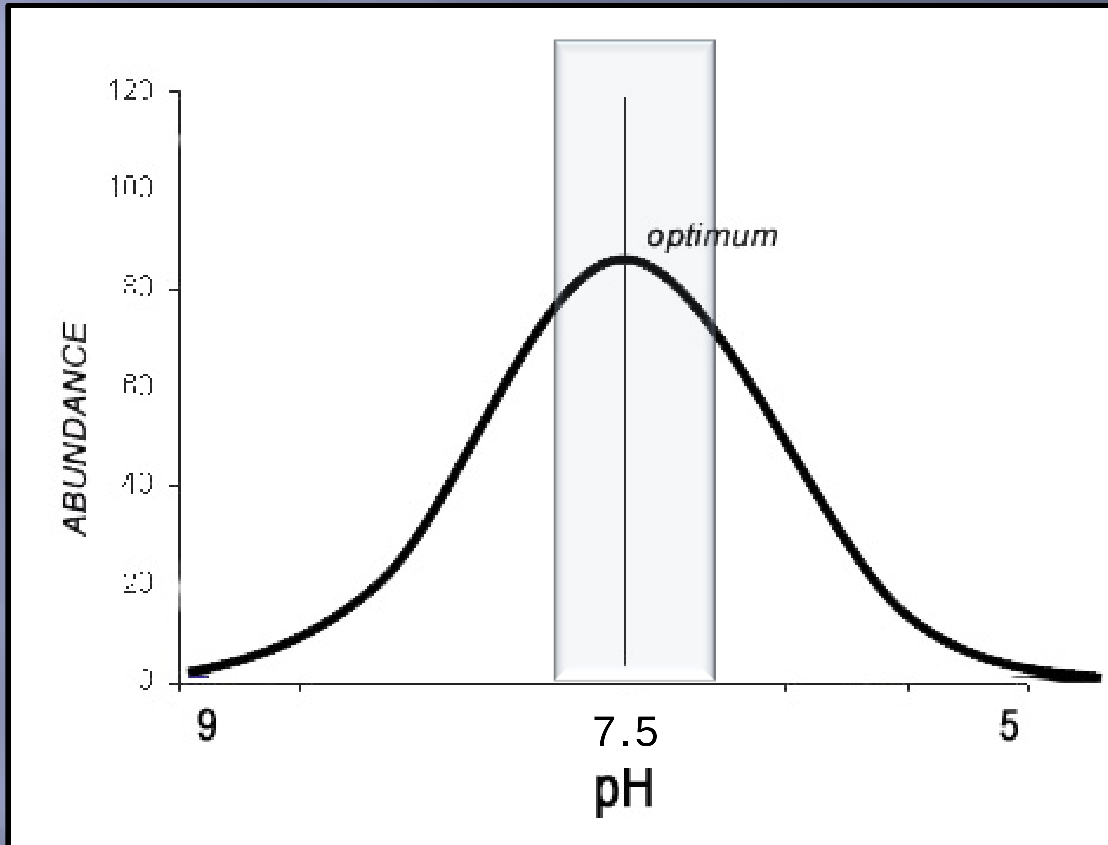
Are we observing decrease in pH?

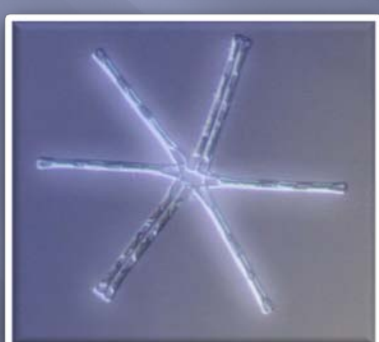


Whiting et al (Whiting et al 1989 (Mean pH averages of all available summer surface water values),1989, and Melack 1983

Our data from summers 2008-2009

SPECIES ENVIRONMENTAL TOLERANCES





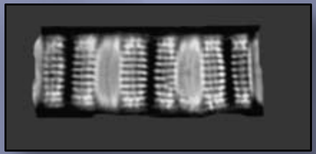
Other acidophilic species

POTENTIAL INDICATORS

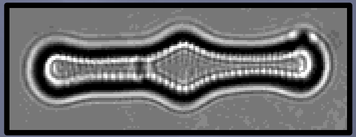
Asterionella formosa

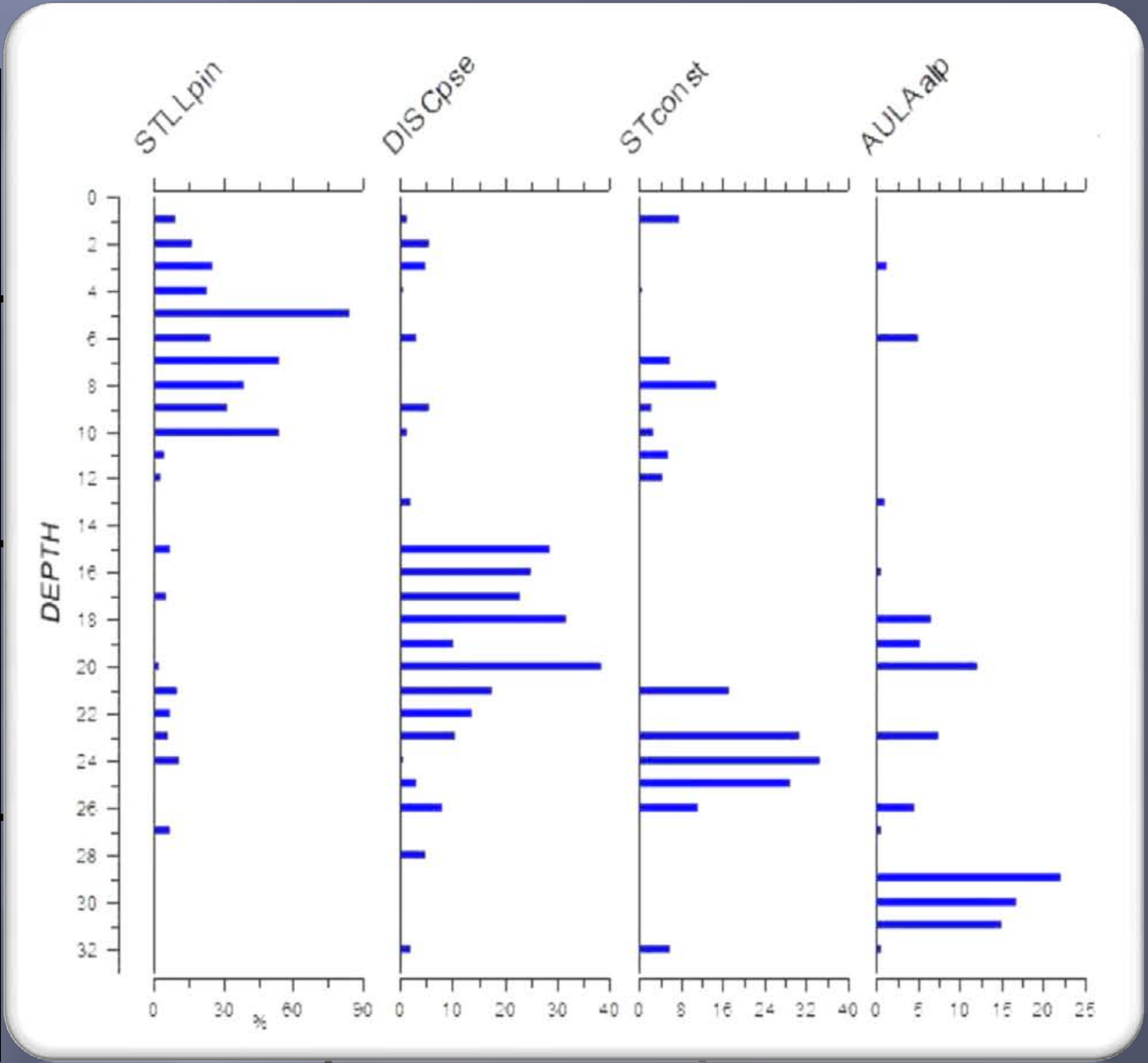
Staurosirella pinnata

Aulacoseira alpigena



Tabelaria flocculosa

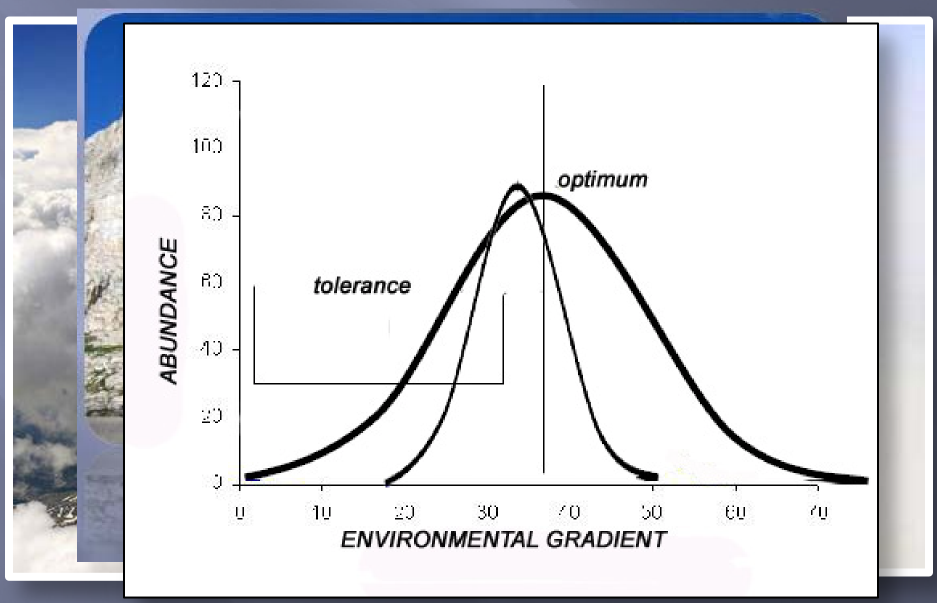




CAN WE USE DIATOMS AS INDICATOR OF ATMOSPHERIC DEPOSITION?

Yes…but

1. acknowledge differences between systems (source and type of deposition)
2. incorporate differences between types of initial nutrient limitations through time
3. interpret species tolerances in relation to broad environmental gradients



Acknowledges

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Mark Brenner -University of Florida
Andi Heard - Ph.D student, University of California Riverside
Dave Clow - U.S. Geological Survey
Thomas Whitmore - University of Central Florida

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QUESTIONS?
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