Changes in Atmospheric Nitrogen Deposition Linked to Silica Cycling on Five Appalachian Forest Basins

by

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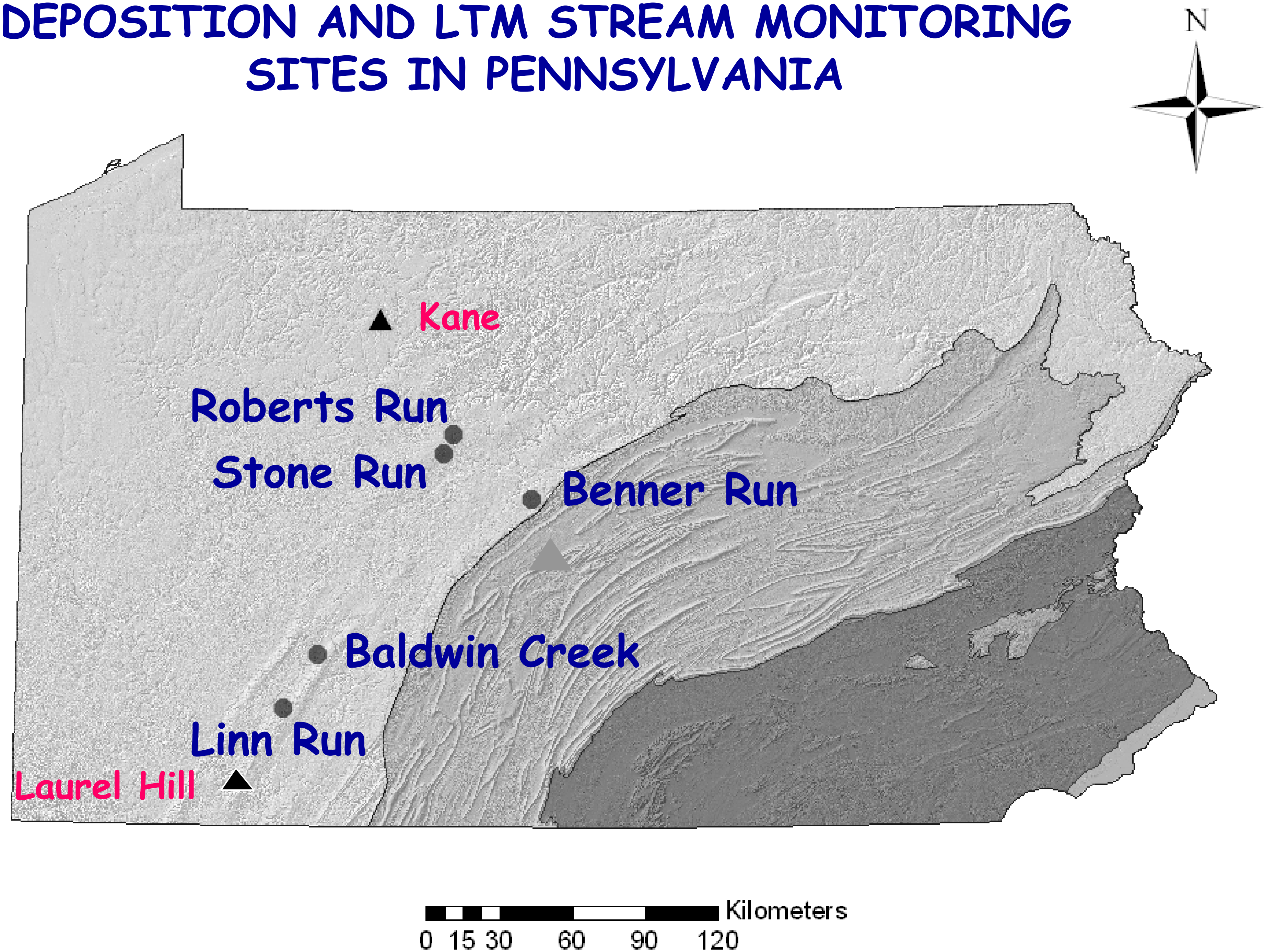
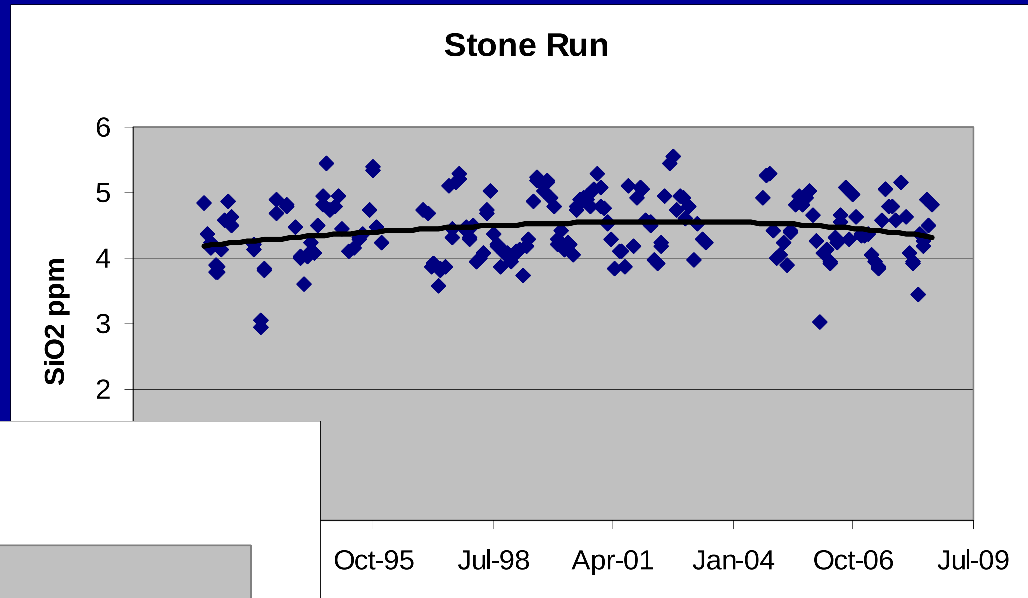
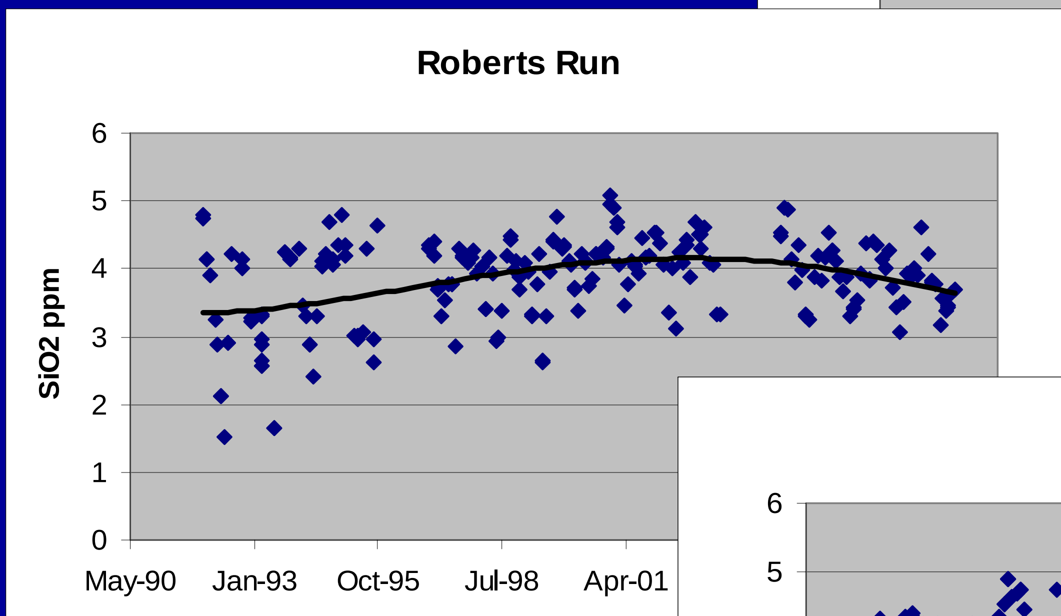
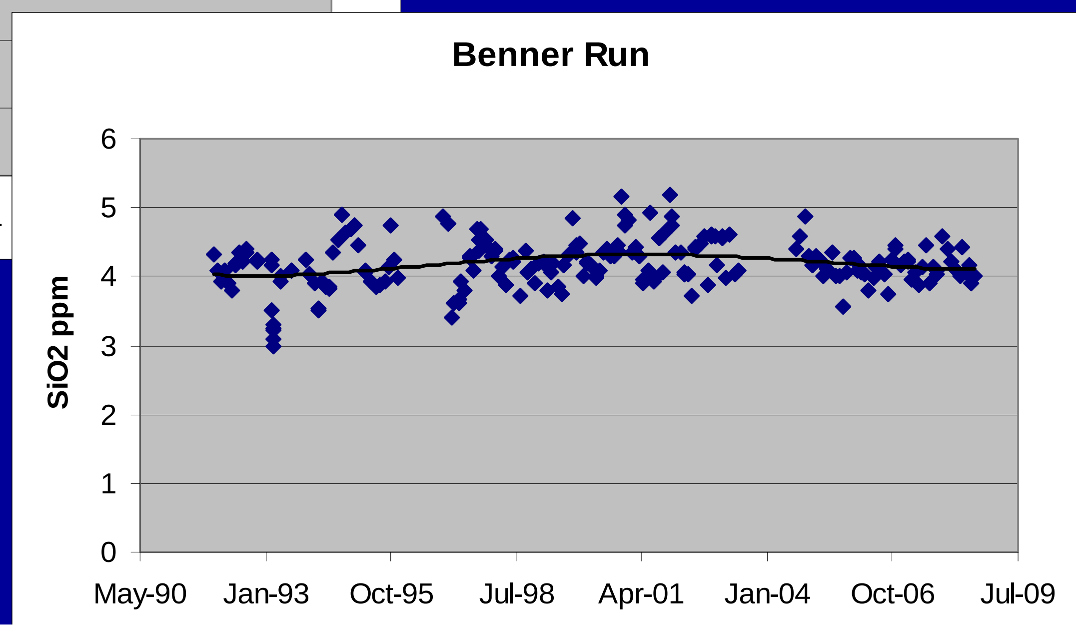
DEPOSITION AND LTM STREAM MONITORING SITES IN PENNSYLVANIA



Silica Trends

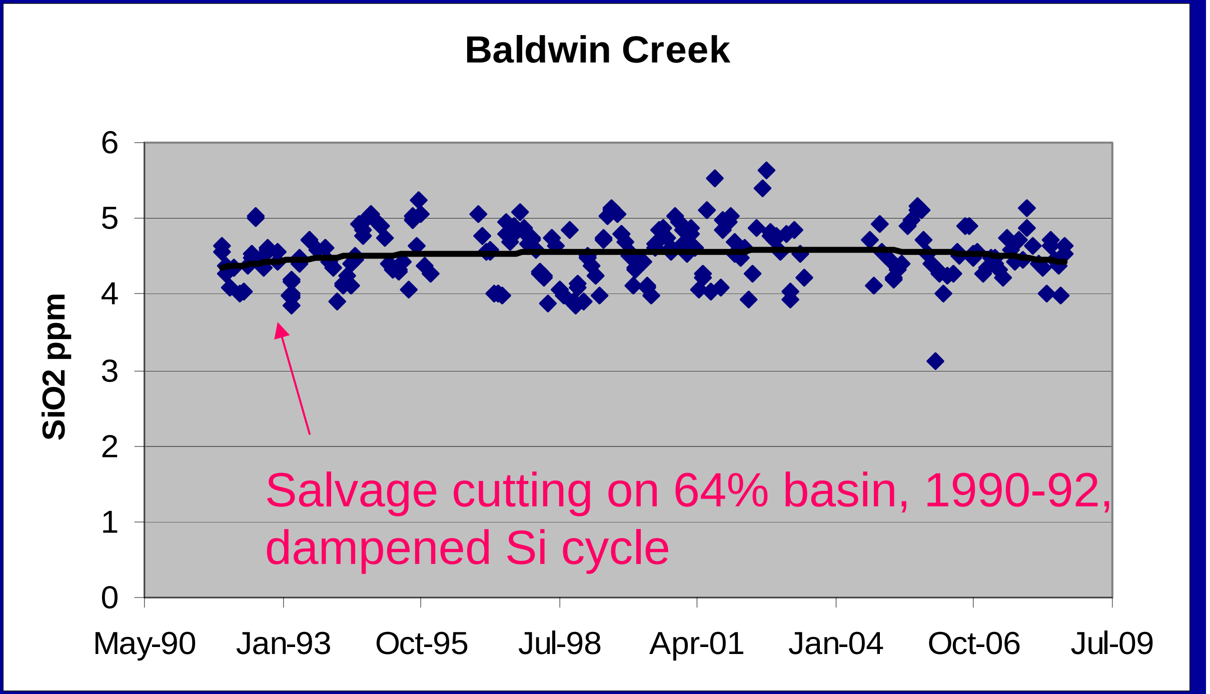


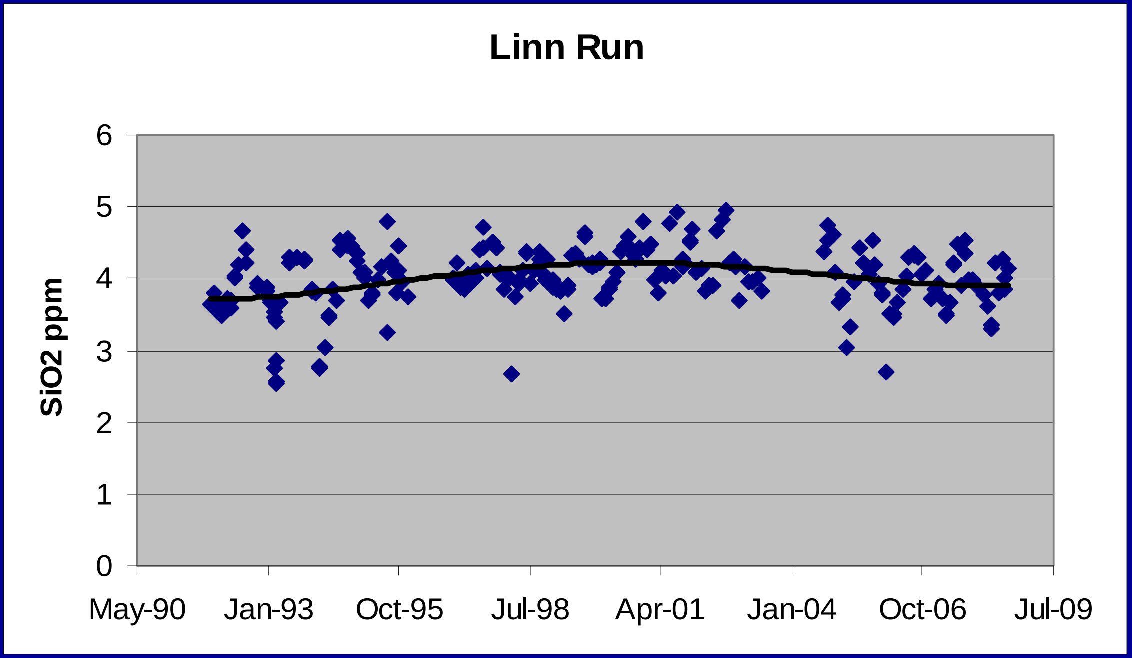




All streams show Si increases followed by decreases.

More Silica Trends





Peak Si occurred around 2001-02

Possible Linkage of Silica Trends to Atmospheric Deposition

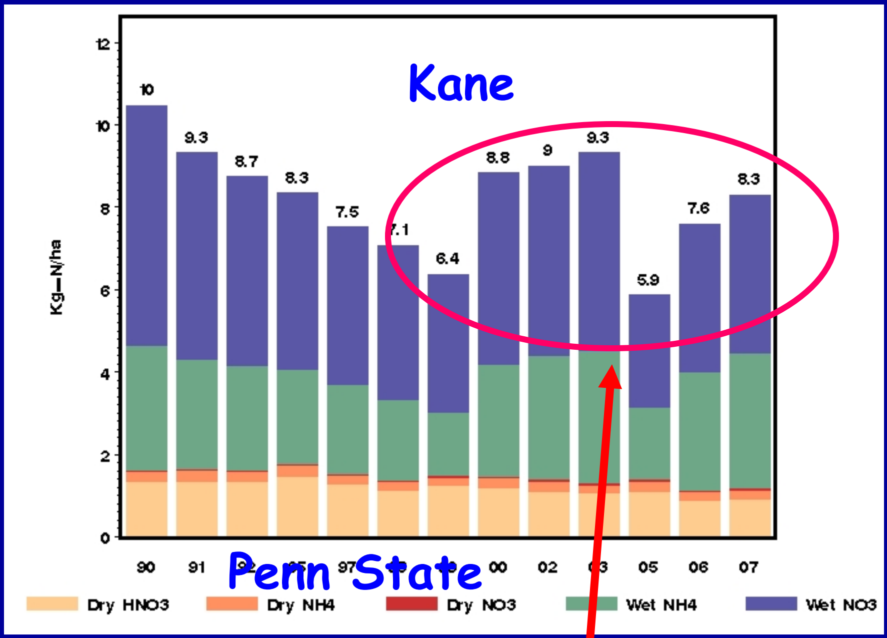
- Mineral weathering rates-reduced N depositiion causes increases in soil heterotroph respiration leading to increased weathering rates and increased Si, recent decreasing Si implies N availability has increased or a non-linear heterotroph response occurs

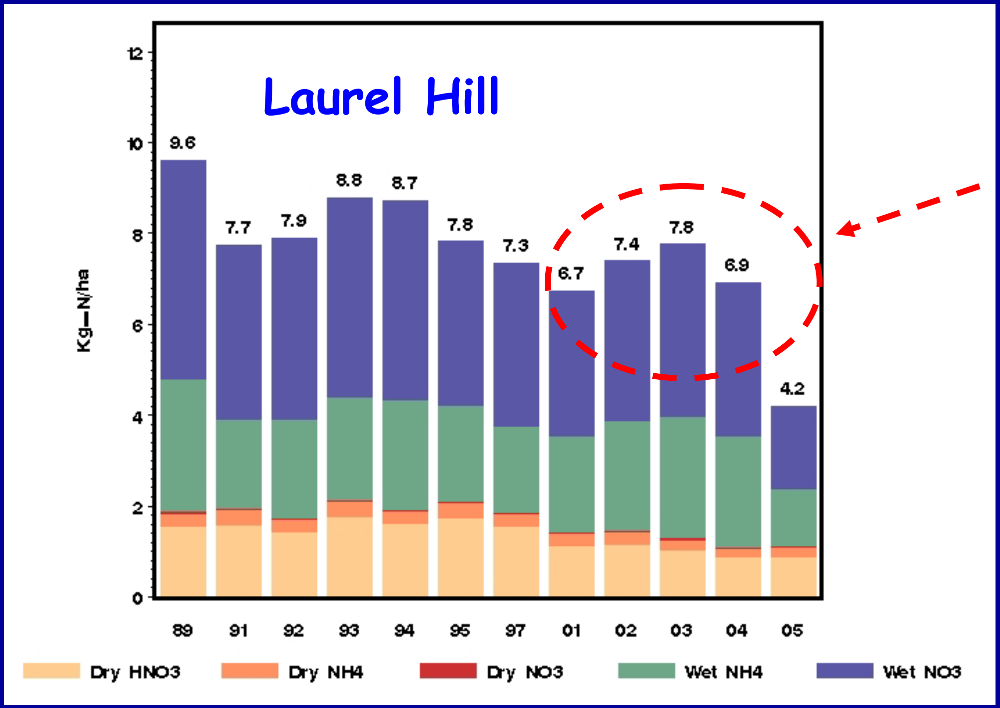
- Phytolith dissolution-reduced N deposition by same process above causes greater dissolution of phytoliths and greater Si export, again recent lowered Si also would imply increased N or non-linearity

- Ecosystem assimilation-reduced N deposition directly reduces productivity of terrestrial and aquatic ecosystems leading to reduced assimilation and higher export of Si, increased N deposition would lead to lower stream Si

N Deposition Trends

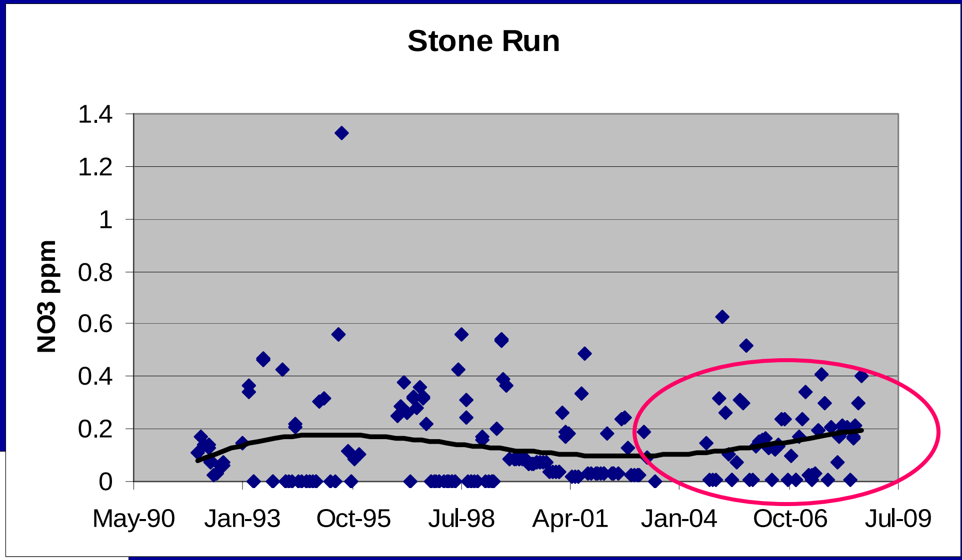
N deposition is generally declining in region which is consistent with Si increases

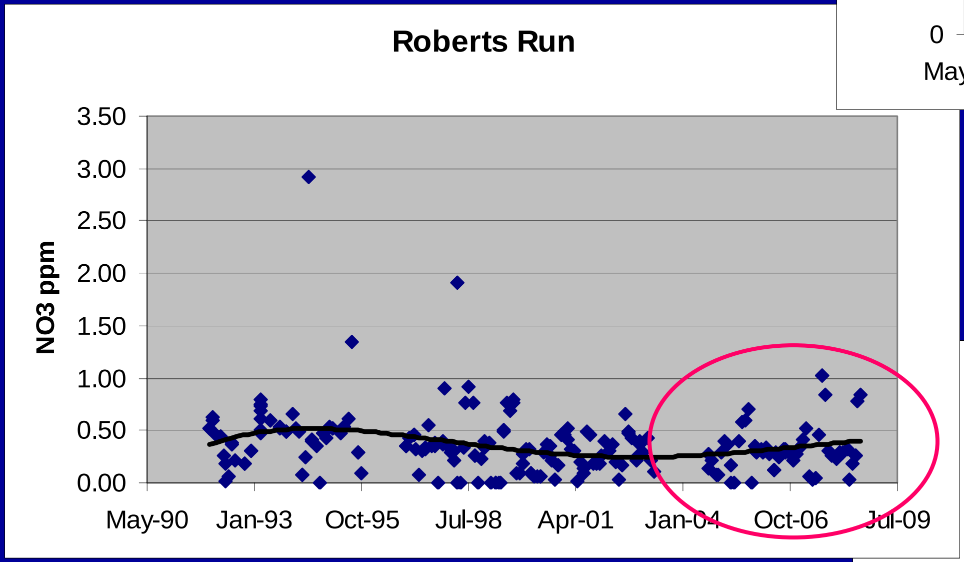


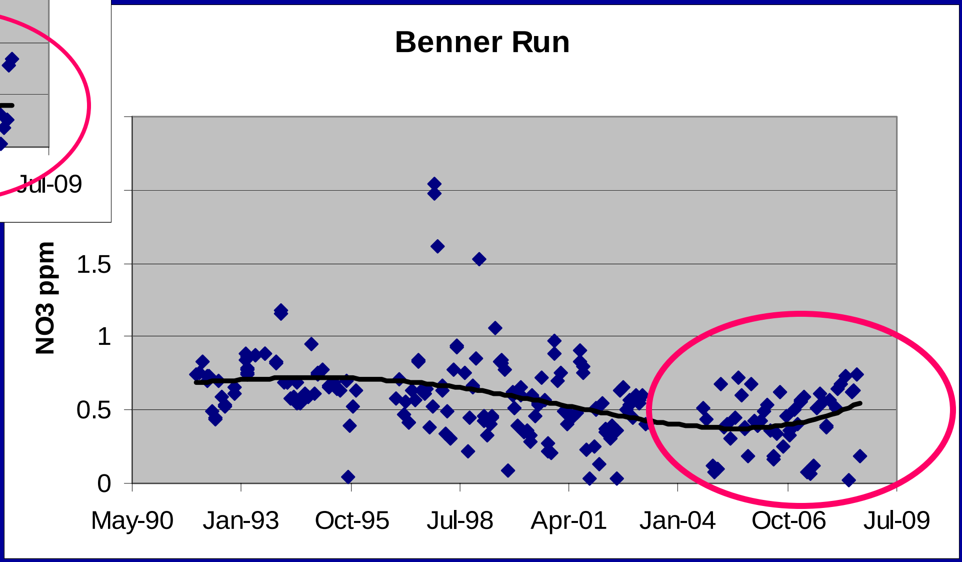


Recent N deposition increases, which could help explain Si decreases, were significant in north-central PA but small in south-west PA

Stream Nitrate Trends

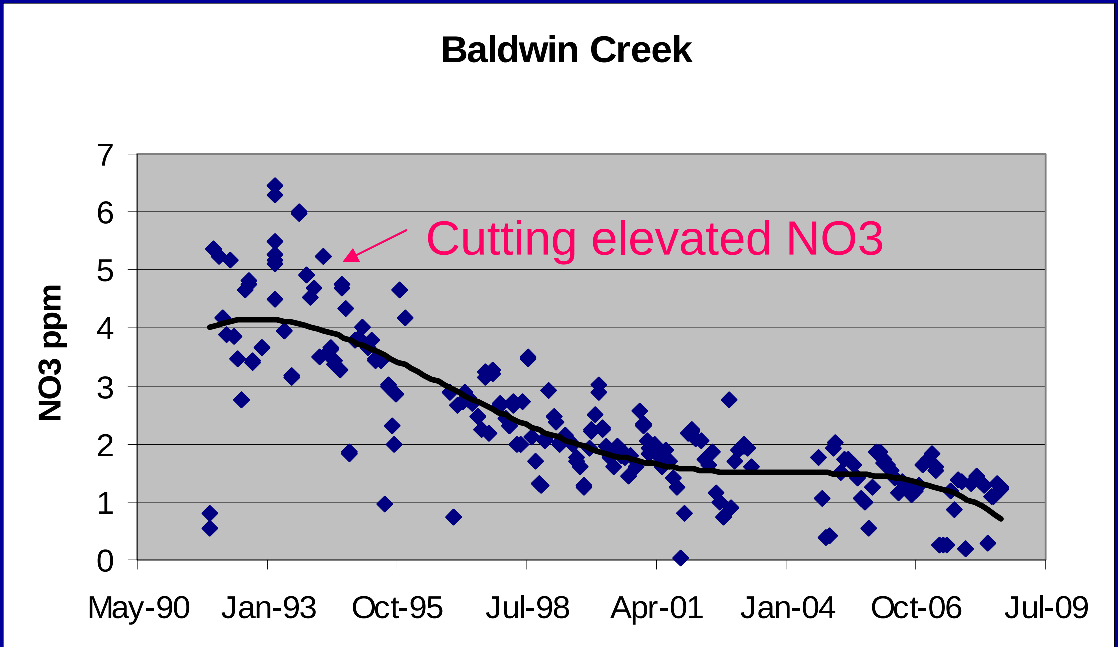


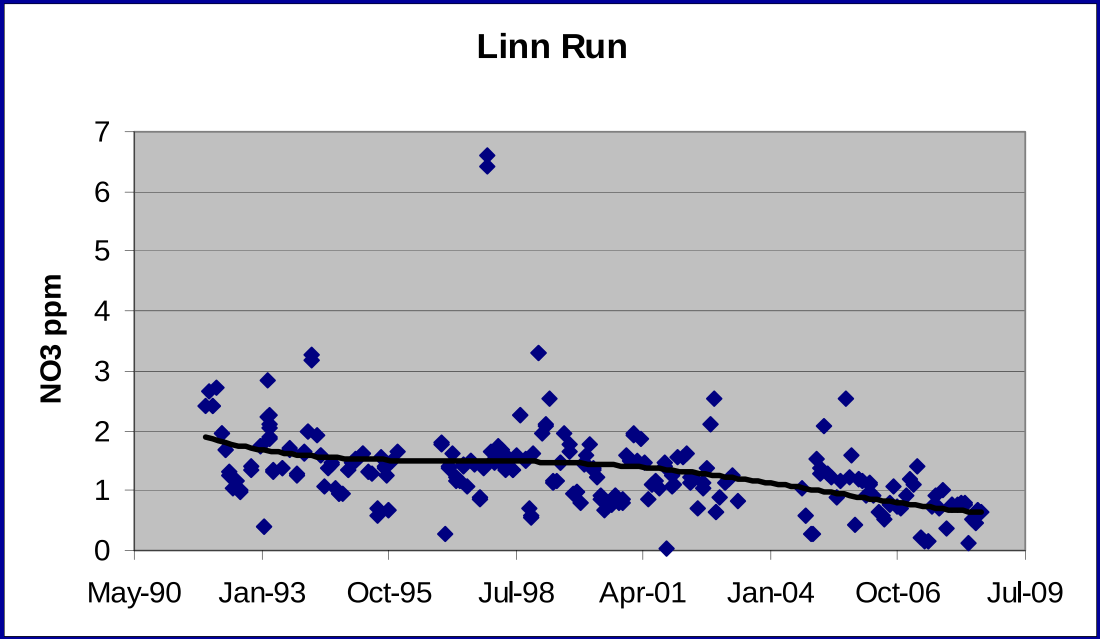




<u>Northcentral stream NO3 data also suggest decreasing then increasing N availability has occurred</u>

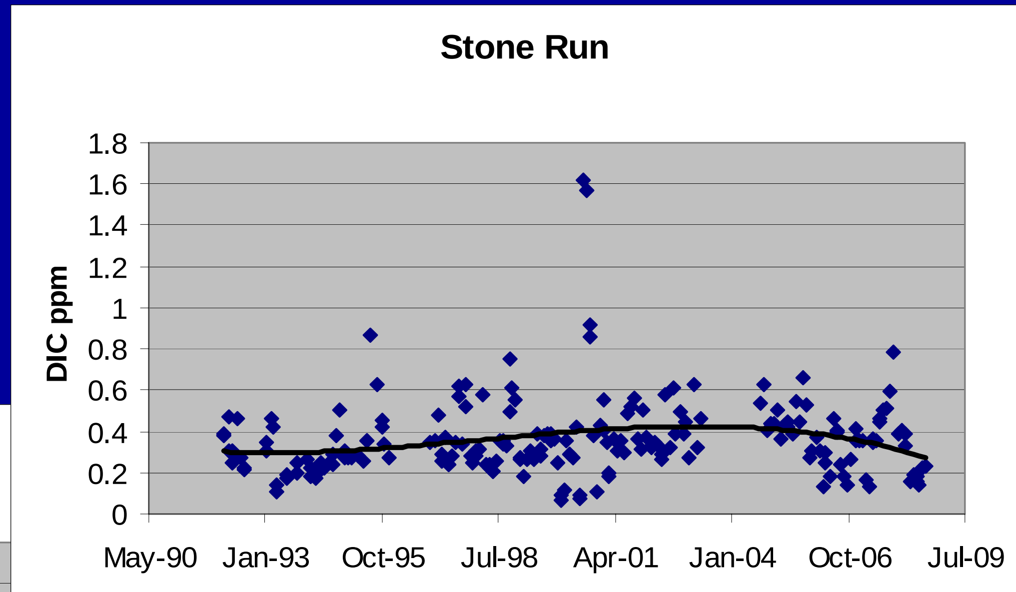
More NO3 Trends

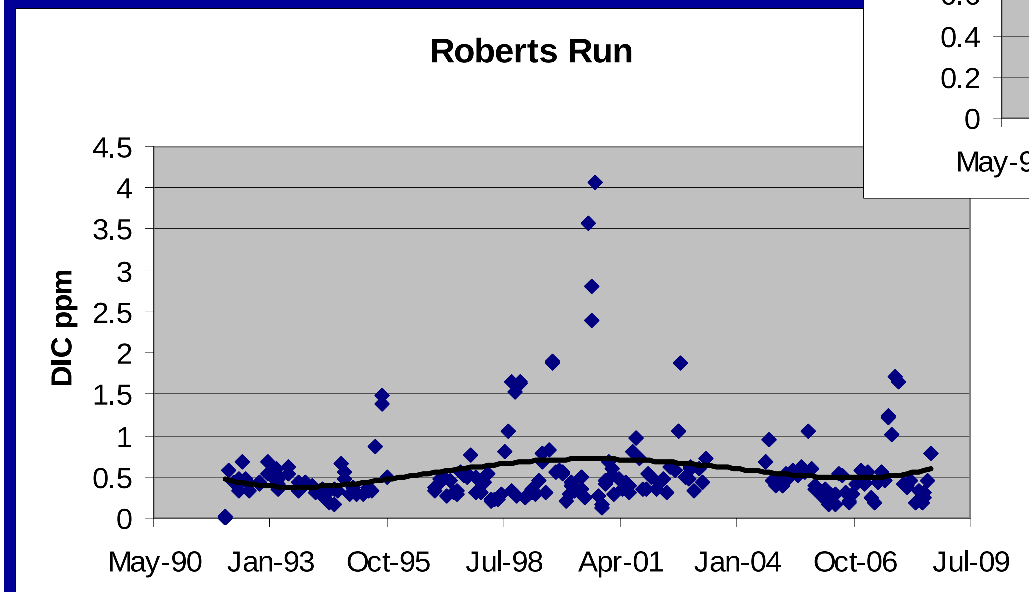


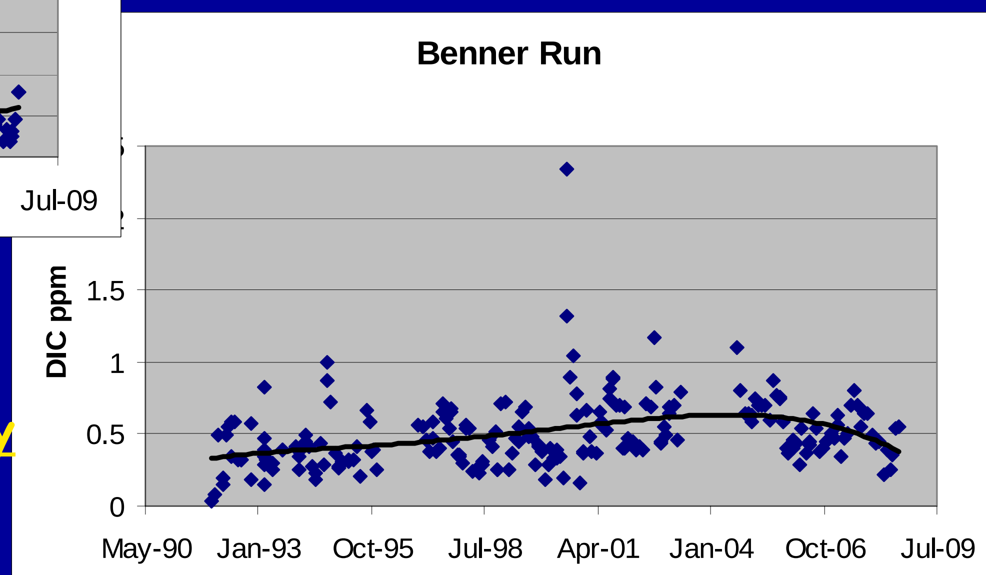


Southwest PA streams only show continuing NO3 decline in later years

Stream Dissolved Inorganic Carbon- as indicator of weathering

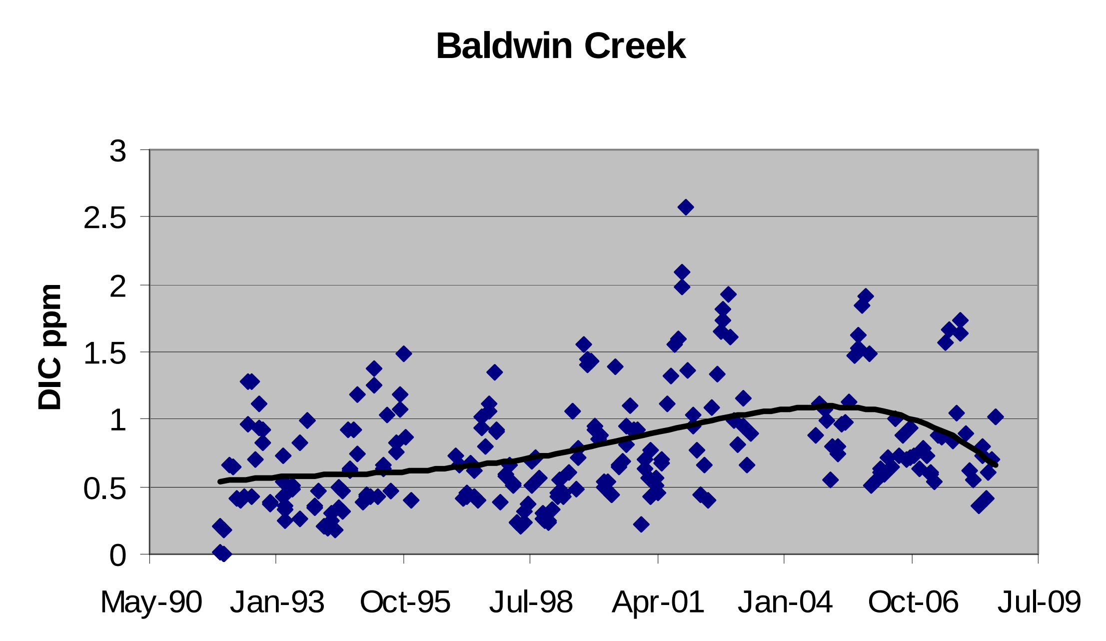


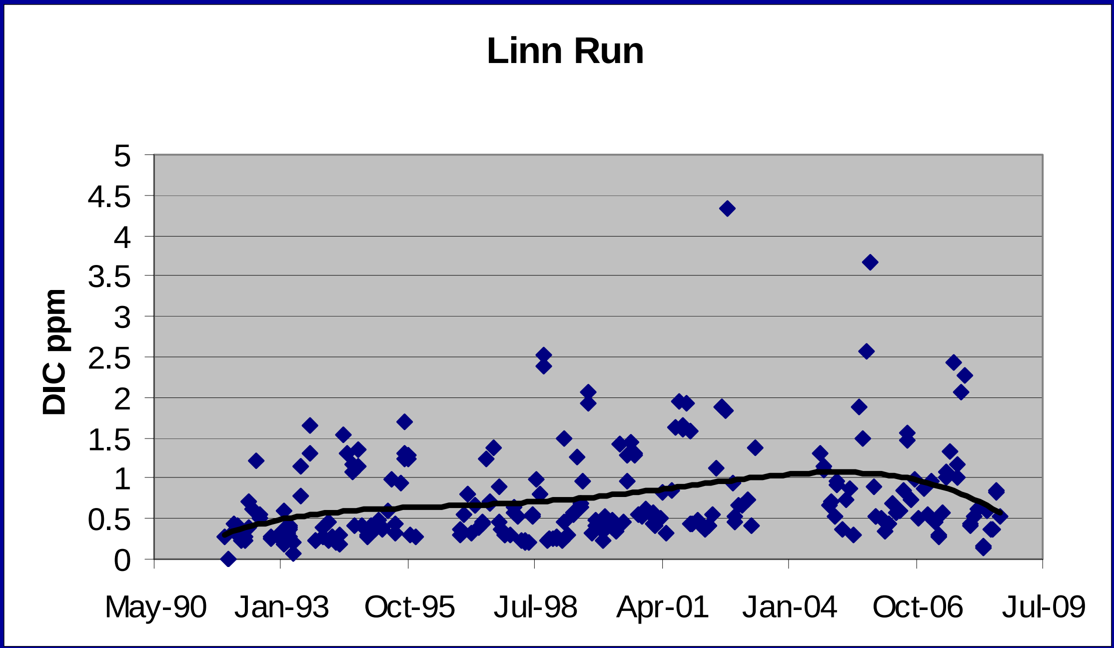




All streams show DIC trends which suggest that weathering rates have increased then decreased in synchrony with stream Si

More DIC Trends





Even south-west streams showed DIC cycle.
Peak DIC did appear to lag behind peak stream Si

Diatom Redfield Ratios

- C:Si:N:P = 105:15:16:1
- Si:N ~ 1

Stream	BWN	BNR	LNN	RBT	STN
Median Si:N	4.2	13	6.0	16	29

- Si:N >> 1 in streams, therefore N is limiting relative to Si, diatom productivity and assimilation should respond to N availability changes

Other Causes

- Increasing Atmospheric CO2- Si increase/decrease renders this unlikely cause, Mauna Loa CO2 increased from 355 to 388 ppmv during period which implies relatively small increases in weathering rates

- Climate Change-no related cycles in regional air temp or precip occurred during period, small 0.13 deg C air temp increase and 6% annual precip increase occurred during period, no trends in streamflow were observed

- Land-Use Change-salvage logging on Baldwin Creek during 1990-91 may have increased initial stream Si and dampened observed Si cycling, otherwise no other land-use changes occurred

Conclusions

- Increases in stream Si appear to be linked to reductions in atmospheric N deposition due to:

  1) increased soil heterotrophic respiration leading to increased mineral weathering and phytolith dissolution and/or

  2) reduced ecosystem productivity causing reduced assimilation of Si by terrestrial and aquatic plants

- Recent Si decreases in streams are not completely supported by available data and may be due to increases in N deposition (northcentral region), a non-linear heterotroph response to changing soil N conditions, or lack of site-specific deposition data.

Conclusions (cont'd)

- Partial salvage logging on Baldwin Creek basin early in the monitoring period muted the stream silica cycle possibly due to release of phytolith Si after cutting
- Si:N ratios >> 1 in all streams, suggesting that diatom productivity and Si assimilation should be responsive to changes in atmospheric N deposition
- Critical experiments along with continued monitoring of stream response are needed to better understand relationships between Si export and N deposition in this region.