SALT IN OUR STREAMS: WHERE IT COMES FROM AND WHERE IT GOES

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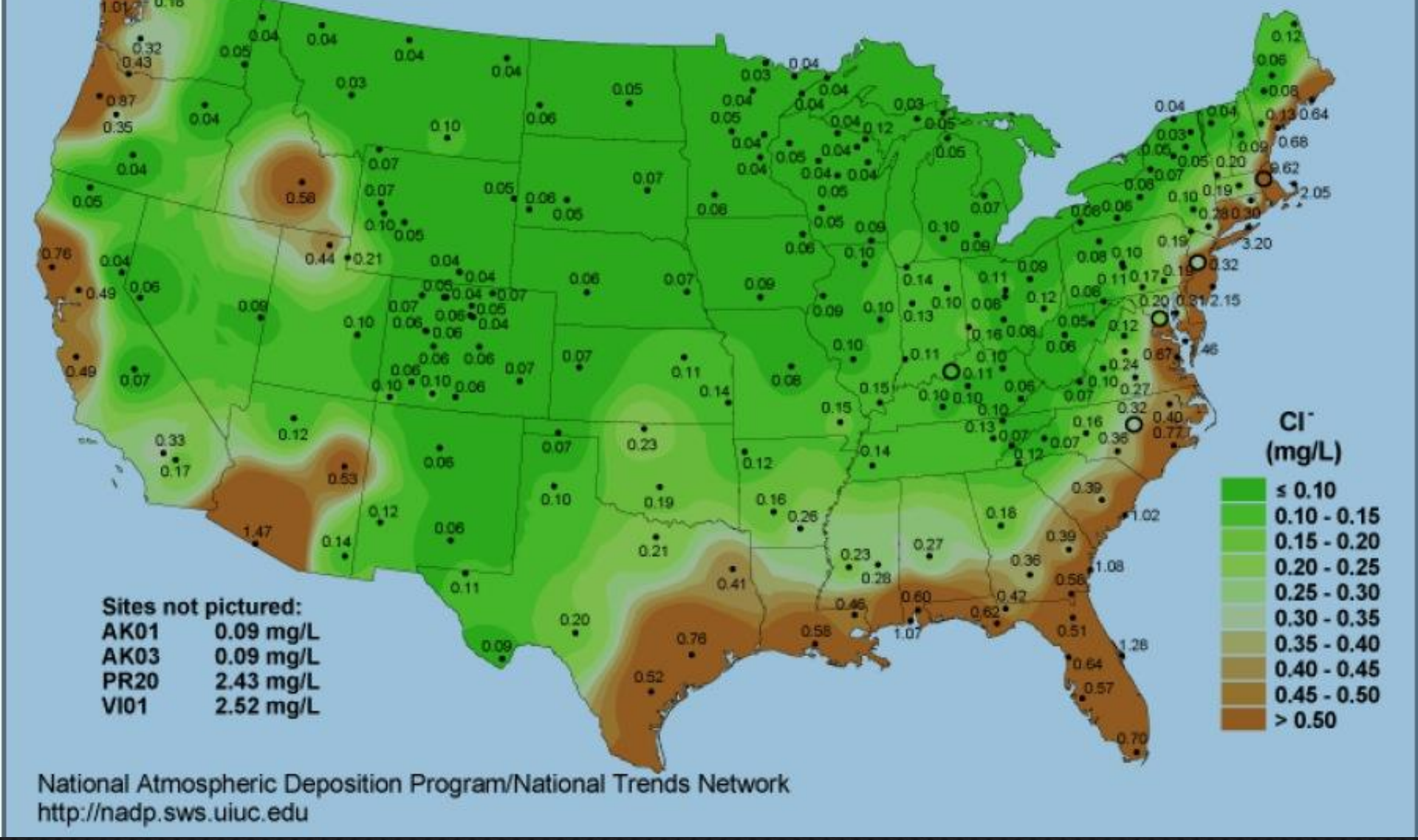
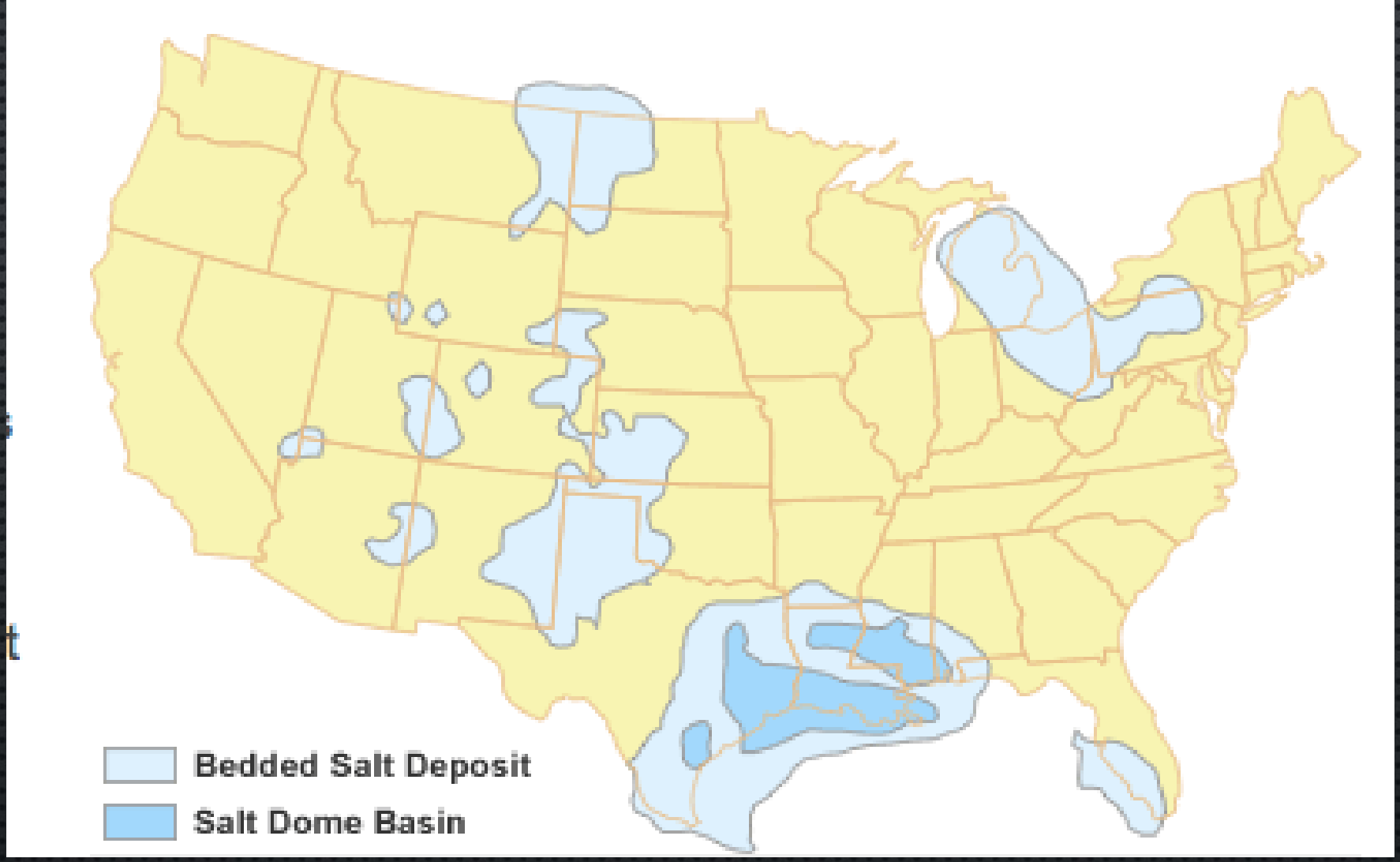
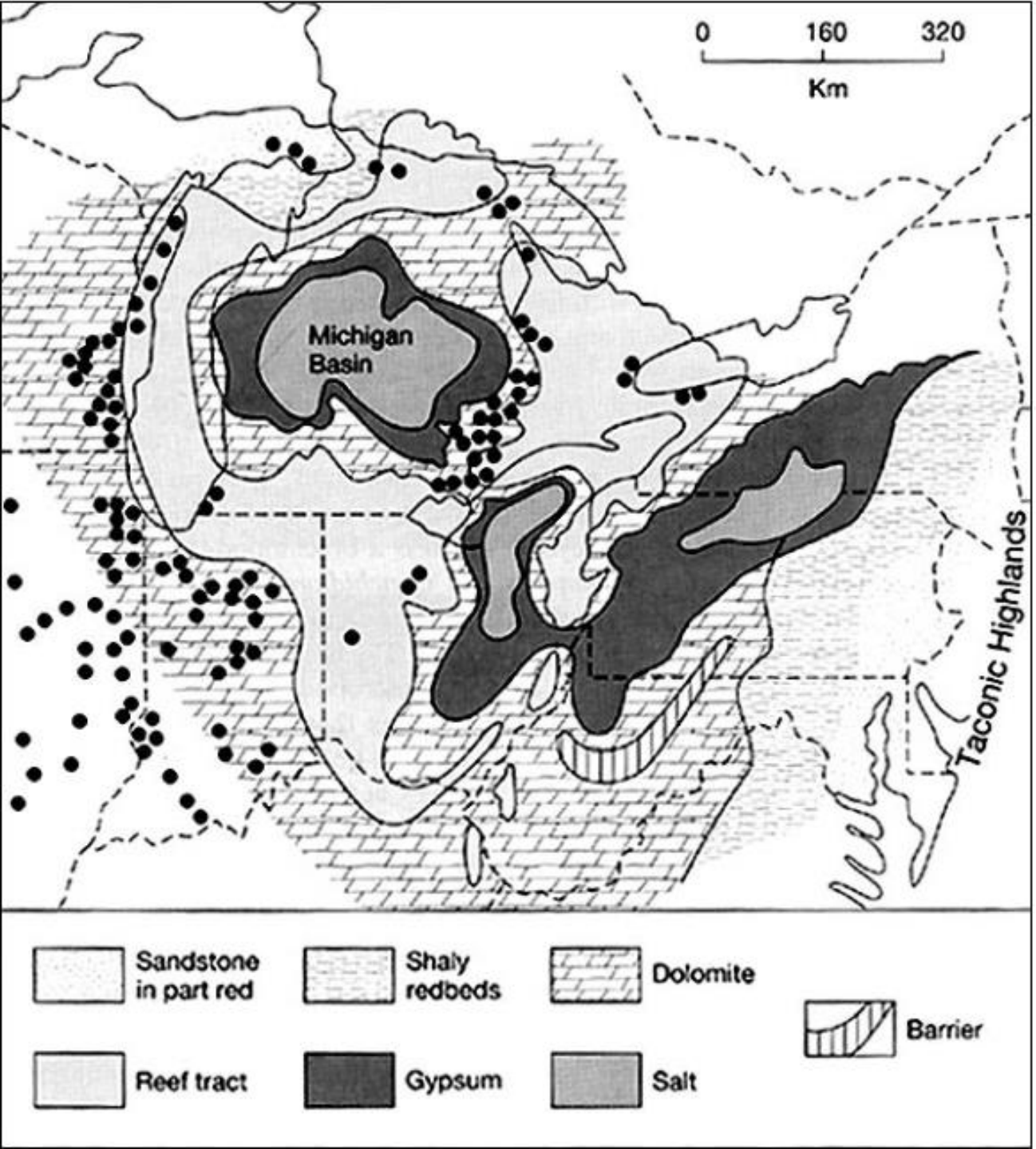


There are many different kinds of salt, but for simplicity sake, sodium chloride (NaCl) in particular will be the topic of discussion.

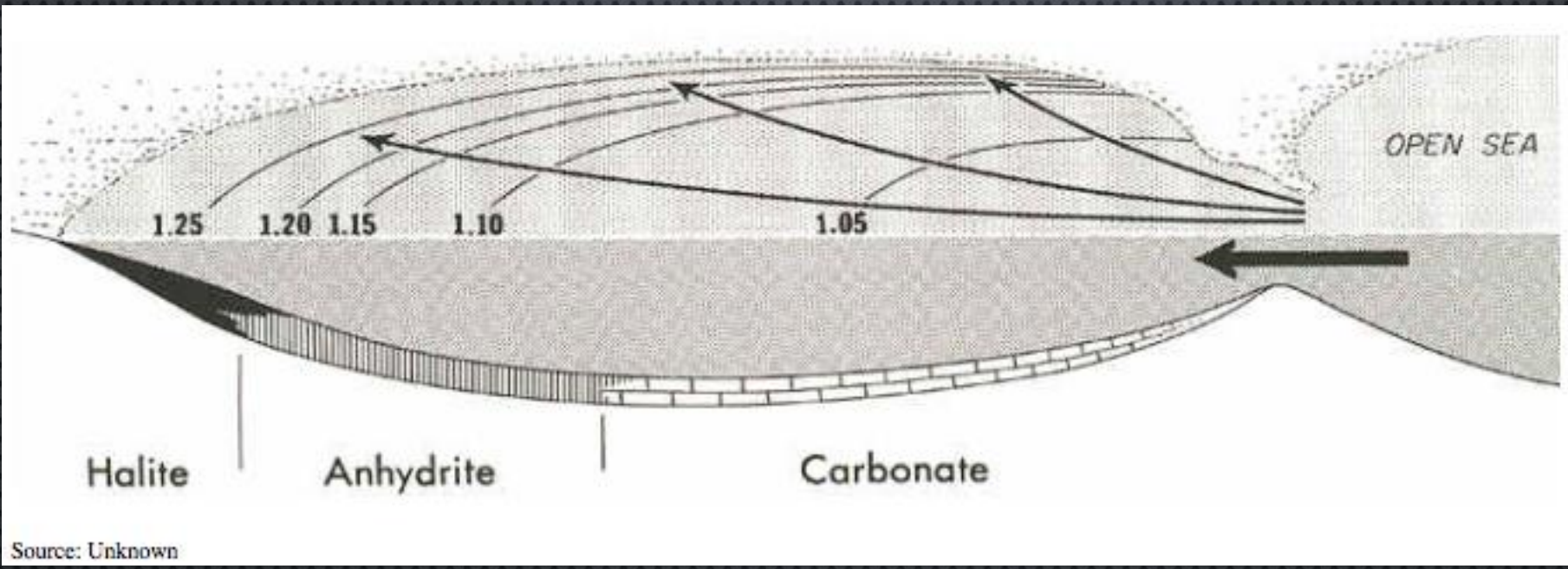
- NaCl comes from both natural and anthropogenic sources.
  - Naturally occurring NaCl comes from the atmosphere (stemming from pollution) and from salt deposits in sedimentary rocks.
- **The figure above illustrates how atmospheric chloride concentrations are highest in coastal areas.**



- Geologic salt deposits can contribute to increased chloride concentrations regionally.
- The map above outlines several major geological salt deposits across the continental United States.
    - Although the map does not clearly show it, one of these deposits sits beneath Tompkins county and a significant portion of Central New York.

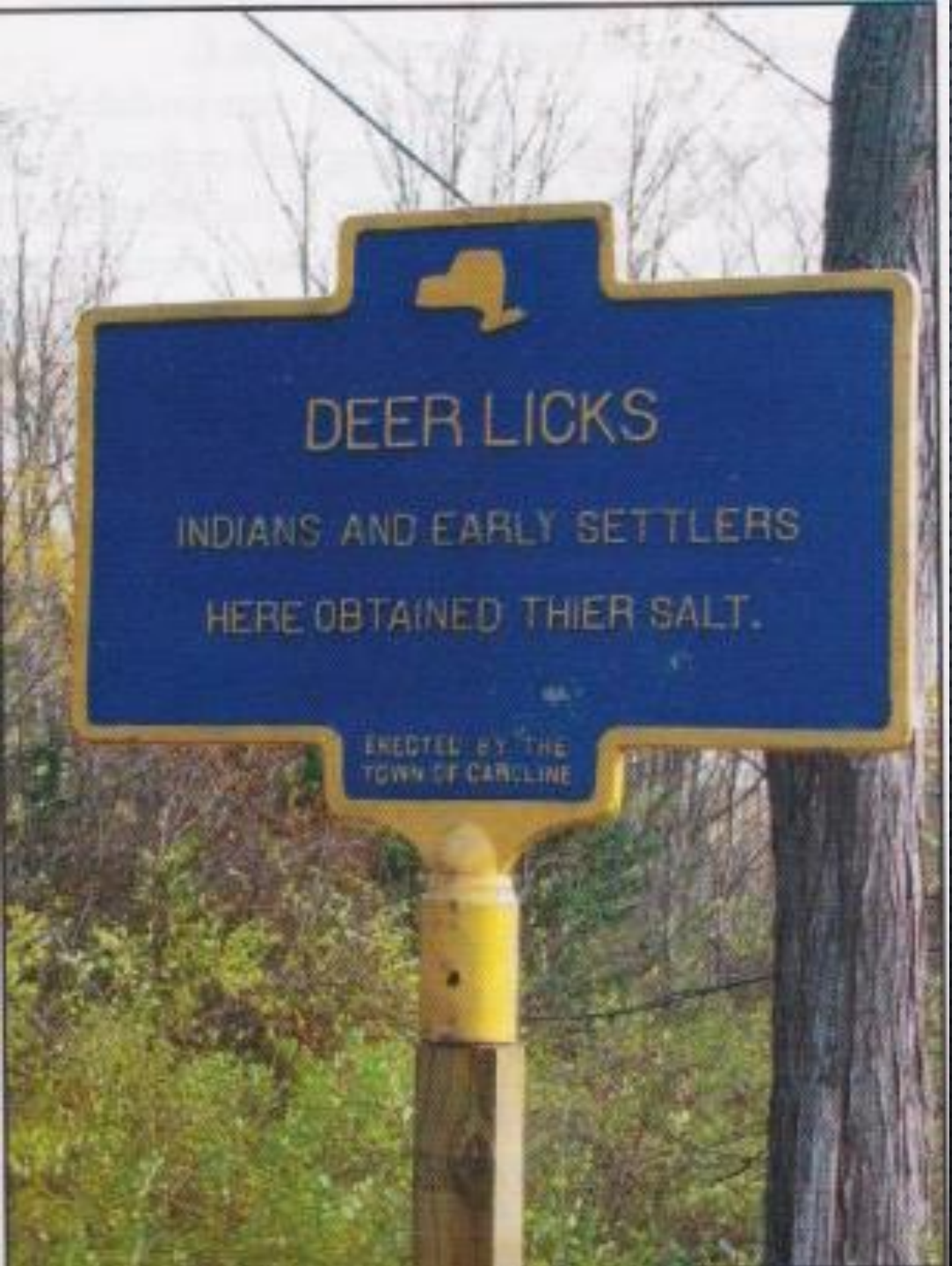


- The illustration shows the distribution of sedimentary evaporite minerals in the great lakes region.
- Central and western New York include gypsum, shaly redbeds (which consists of sandstone, siltstone, and shale that have a distinctive red coloring due to the presence of iron oxides), dolomite, and salt.



Source: Unknown

- Halite (NaCl) is one of the last evaporite minerals to precipitate out of the water column allowing NaCl deposits to reach further inland than other evaporite minerals such as anhydrite (gypsum) and carbonate (limestone and dolomite).



- Salt is transported from a salt bed to streams through erosion when the salt bed is either exposed or travels through cracks in the rock to infiltrate groundwater.
- There is evidence of this phenomenon in Tompkins County.
  - The Six Mile Salt Lick located in the Town of Caroline was used in the past as a source of salt for Native Americans and early settlers.
  - There is some anecdotal evidence of salty water in wells throughout the area.
  - Though interesting, this geological source of salt is not a player in increasing stream salt concentration over time.

TABLE 1. Estimated Average Input from Different Sources of NaCl (kg/year) to the East Branch of Wappinger Creek at the Cary Arboretum (Institute of Ecosystem Studies), Millbrook, NY (1986–2005 except Dry Deposition, which is 1993–1999)

source	input (kg/year)
road salt	1 180 231 (83%)
parking area salt	113 094 (8%)
sewage	52 414 (4%)
water softeners	43 594 (3%)
wet deposition	18 319 (1%)
rock weathering	13 717 (1%)
dry deposition	442 (<1%)
total input	1 421 811

- Kelly *et al.* found that over 90% of salt input comes from road and parking lot salt.
  - **Table from:** Kelly V. R., *et al*. "Long-Term Sodium Chloride Retention in a Rural Watershed: Legacy Effects of Road Salt on Streamwater Concentration." *Environmental Science and Technology*. 2008. 42(2) p. 410-415
    - http://www.caryinstitute.org/sites/default/files/public/reprints/Kelly_et_al_EST_2008.pdf

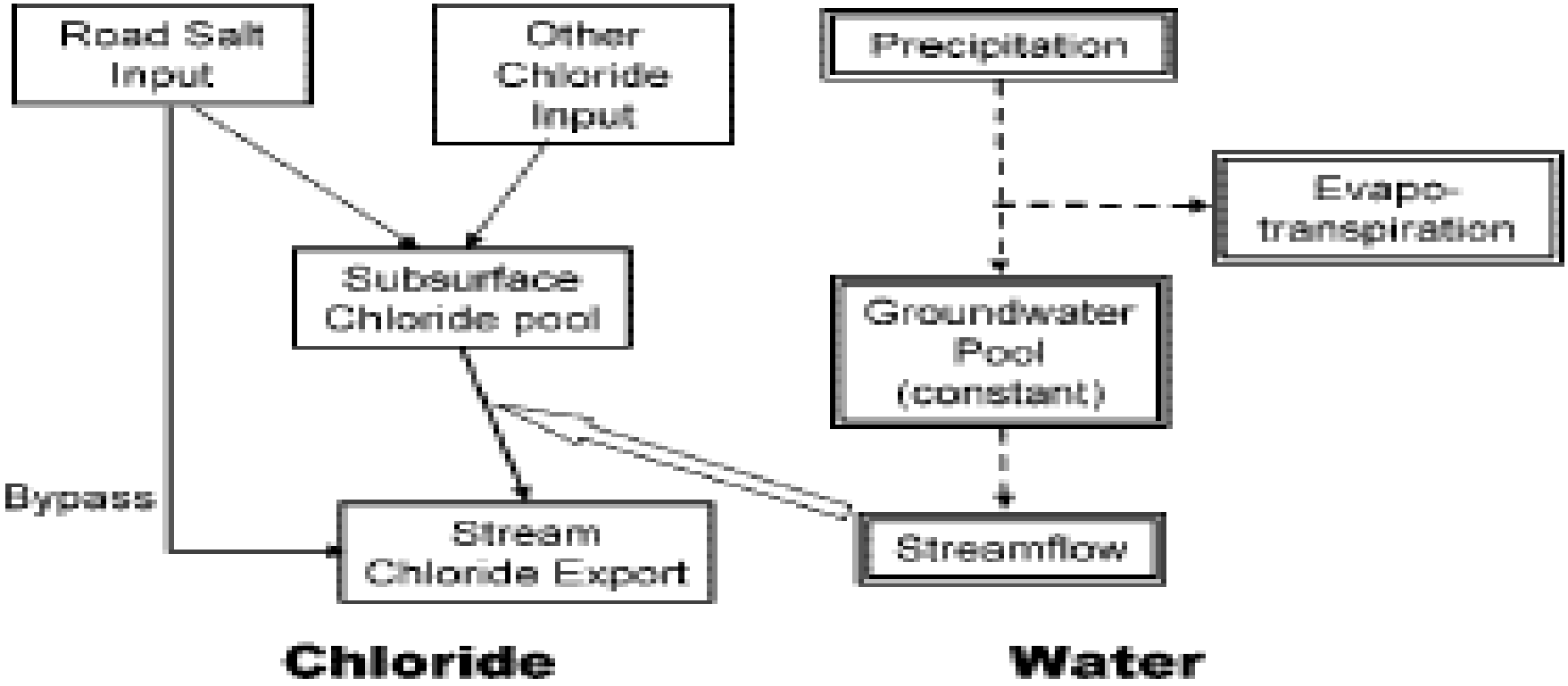


FIGURE 1. Watershed chloride model. Left hand side represents chloride pools and fluxes (single lines), and right-hand side represents water pools and fluxes (dashed lines). Block arrow indicates that streamflow is used in the calculation of chloride export.

- **Flowchart from:** Kelly V. R., *et al*. "Long-Term Sodium Chloride Retention in a Rural Watershed: Legacy Effects of Road Salt on Streamwater Concentration." *Environmental Science and Technology*. 2008. 42(2) p. 410-415
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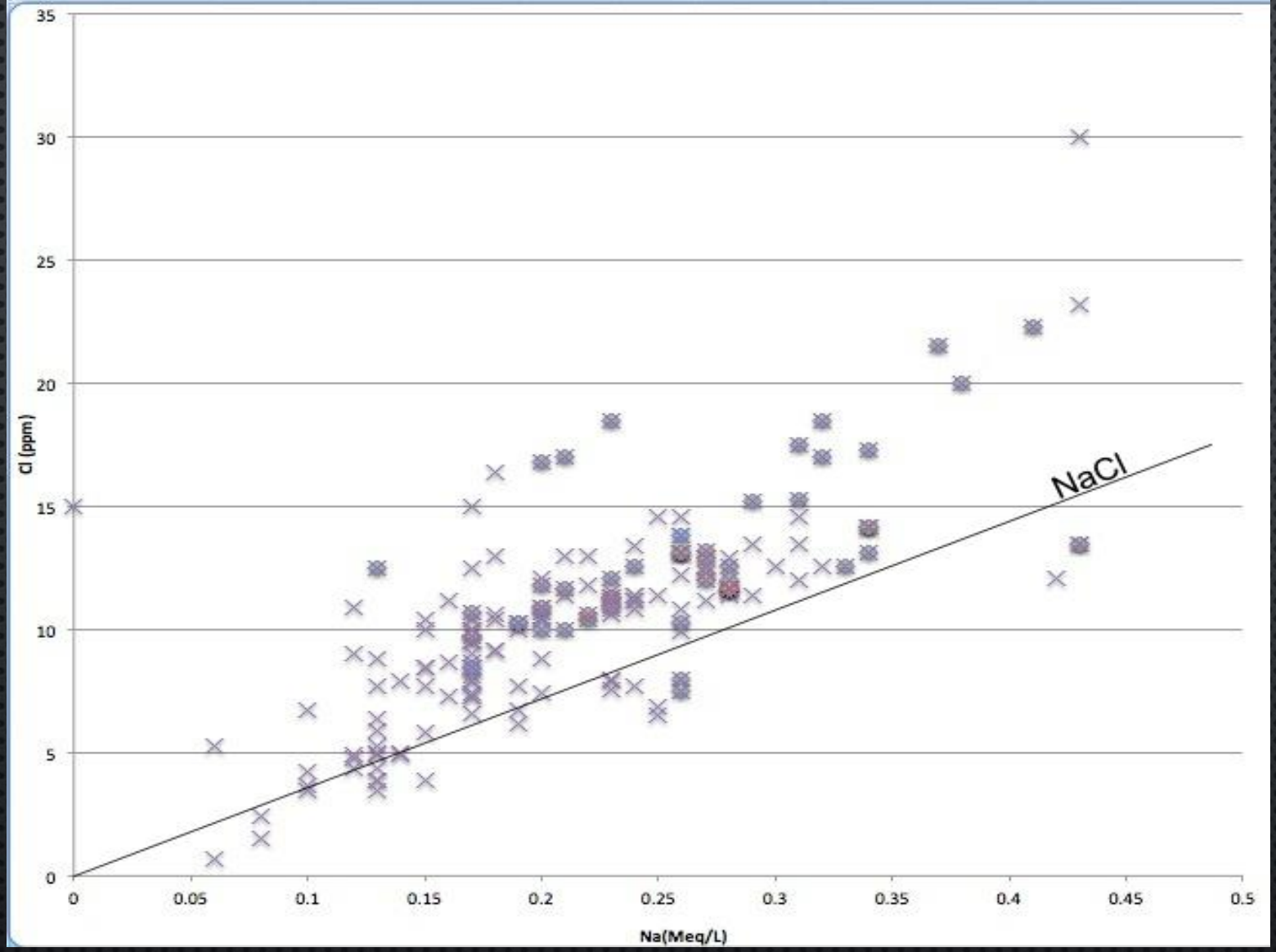
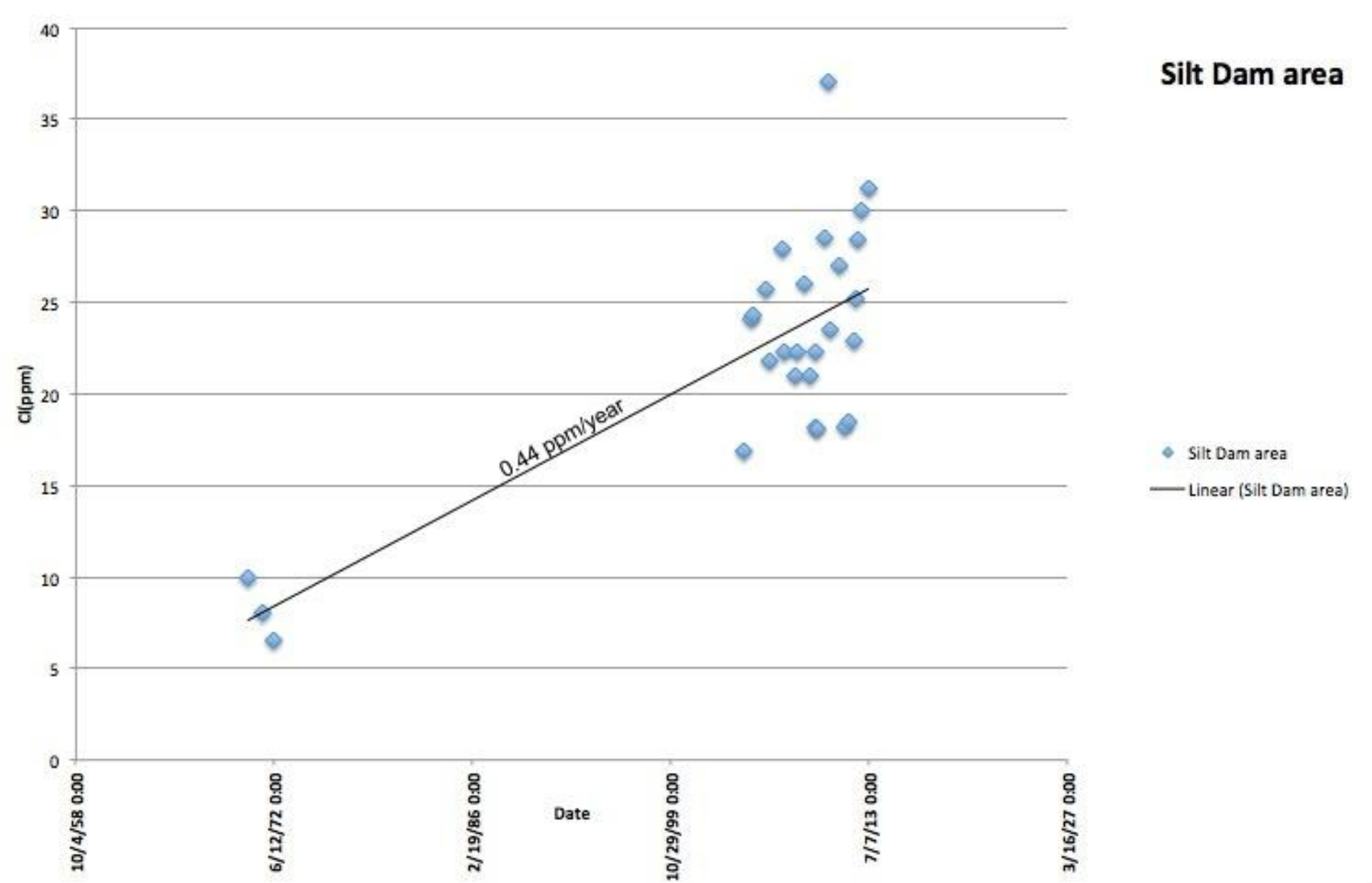
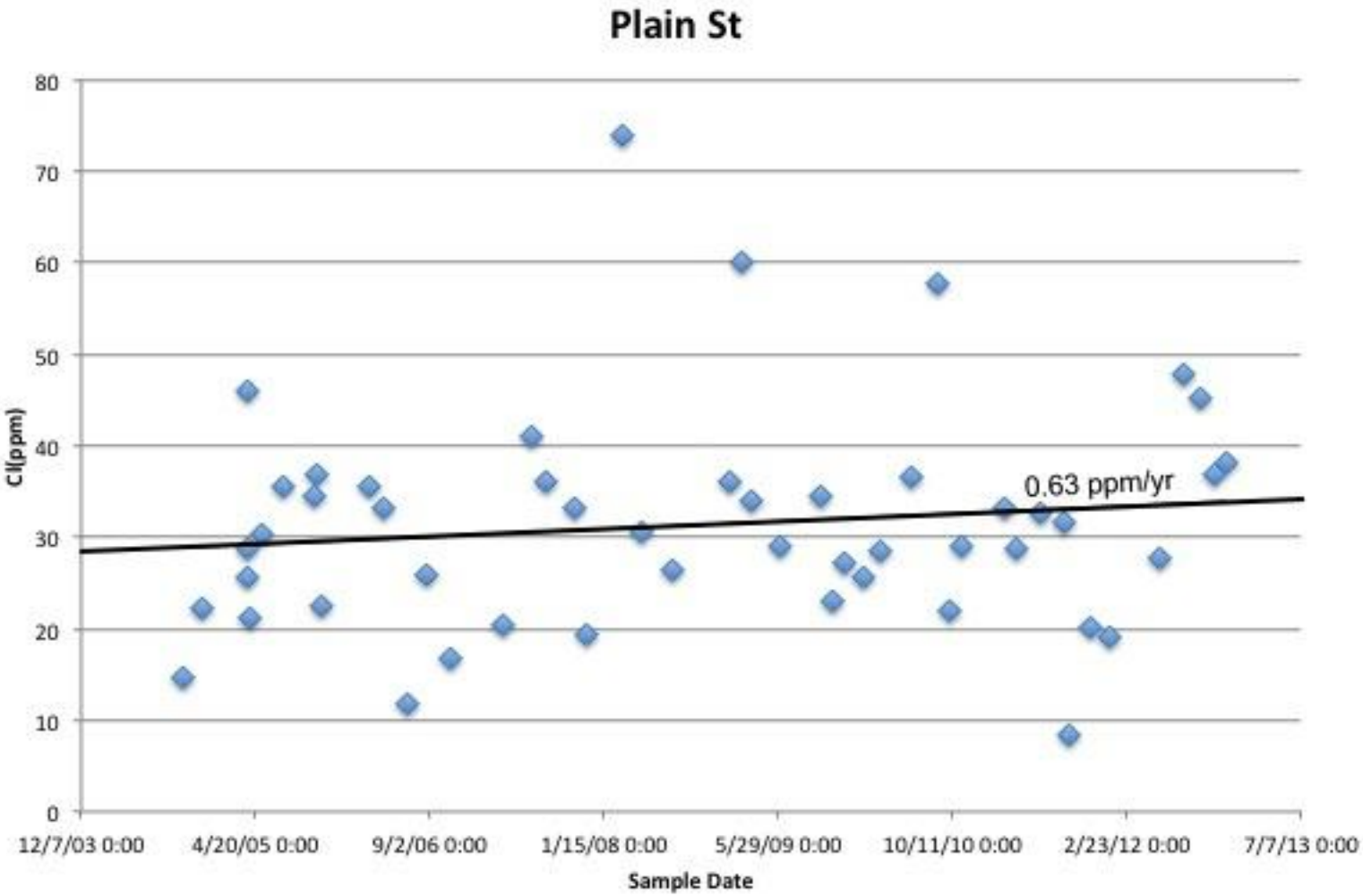


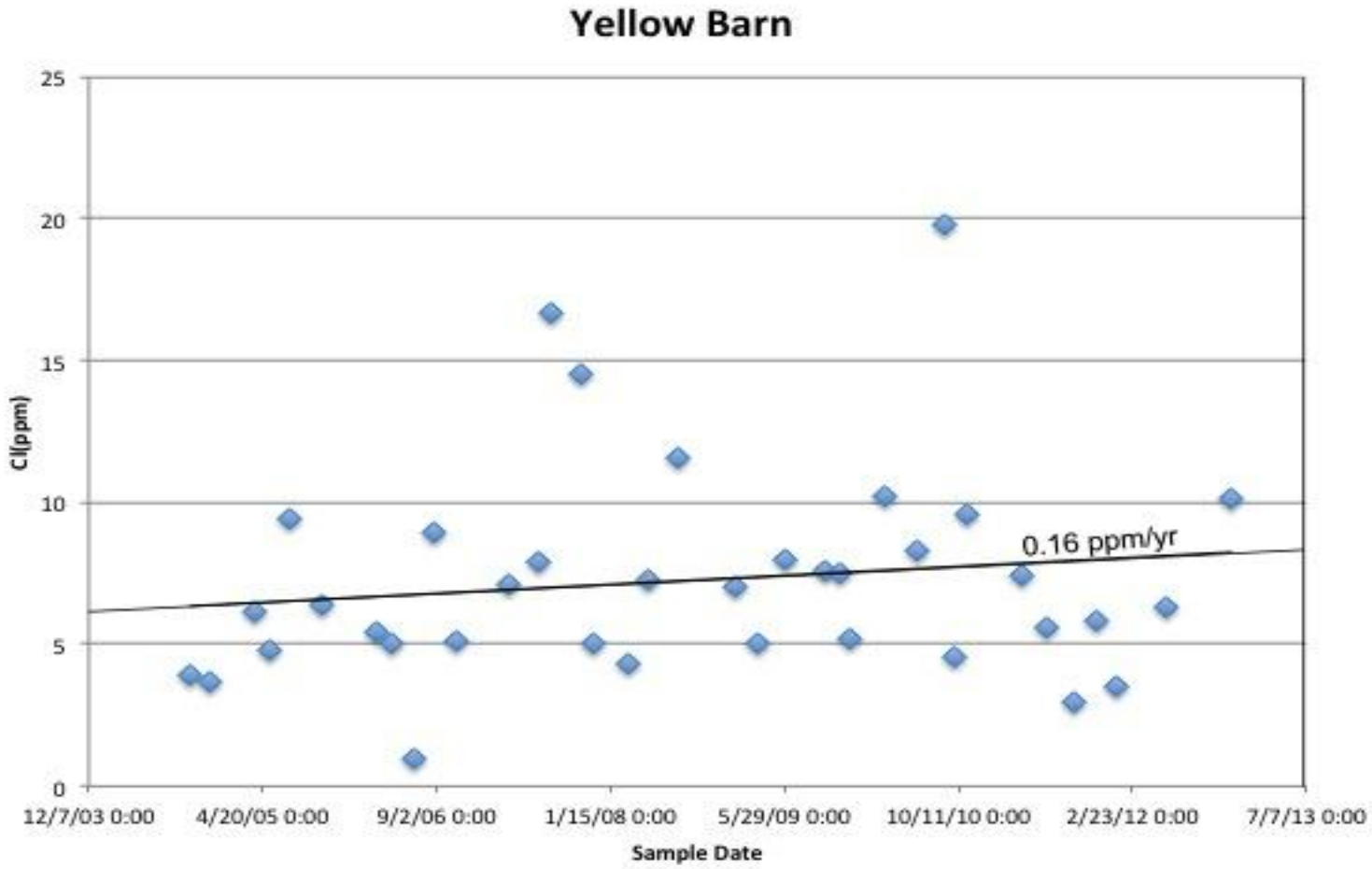
- When investigating salt in the Cayuga Lake watershed, researchers have measured either sodium or chloride but seldom both. If only NaCl were present, then all data points should fall on the solid line due to the constant atomic weight ratio between Na and Cl. They don't, indicating other Na and chloride compounds are present. Therefore chloride measurements do not necessarily represent sodium concentrations accurately.



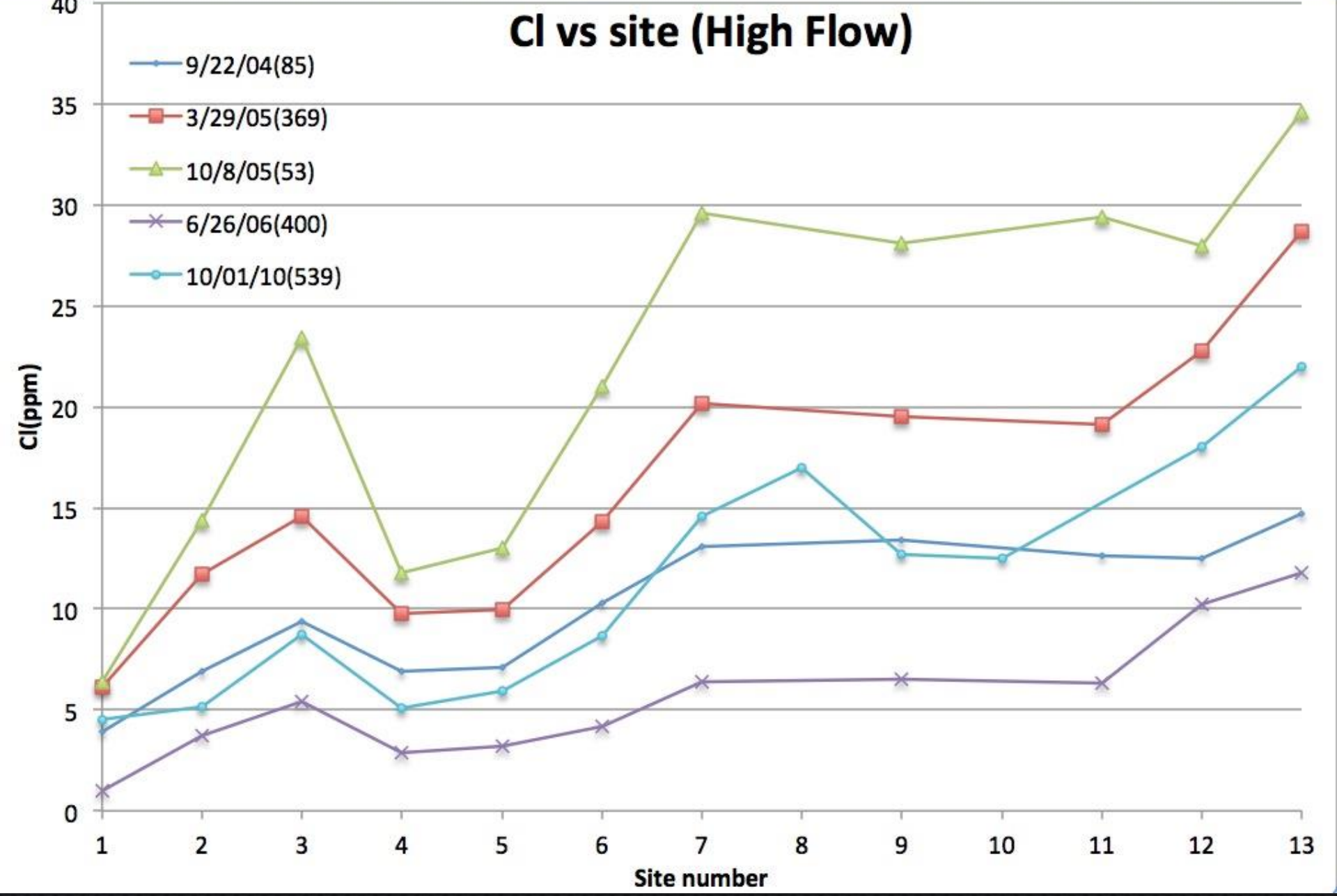
- Samples collected near the Silt damn on Six Mile Creek showed an increase in chloride of ~0.44 ppm/year from 1972 to 2013. Data from 1972 is from the City of Ithaca water plant. Rest are from CSI



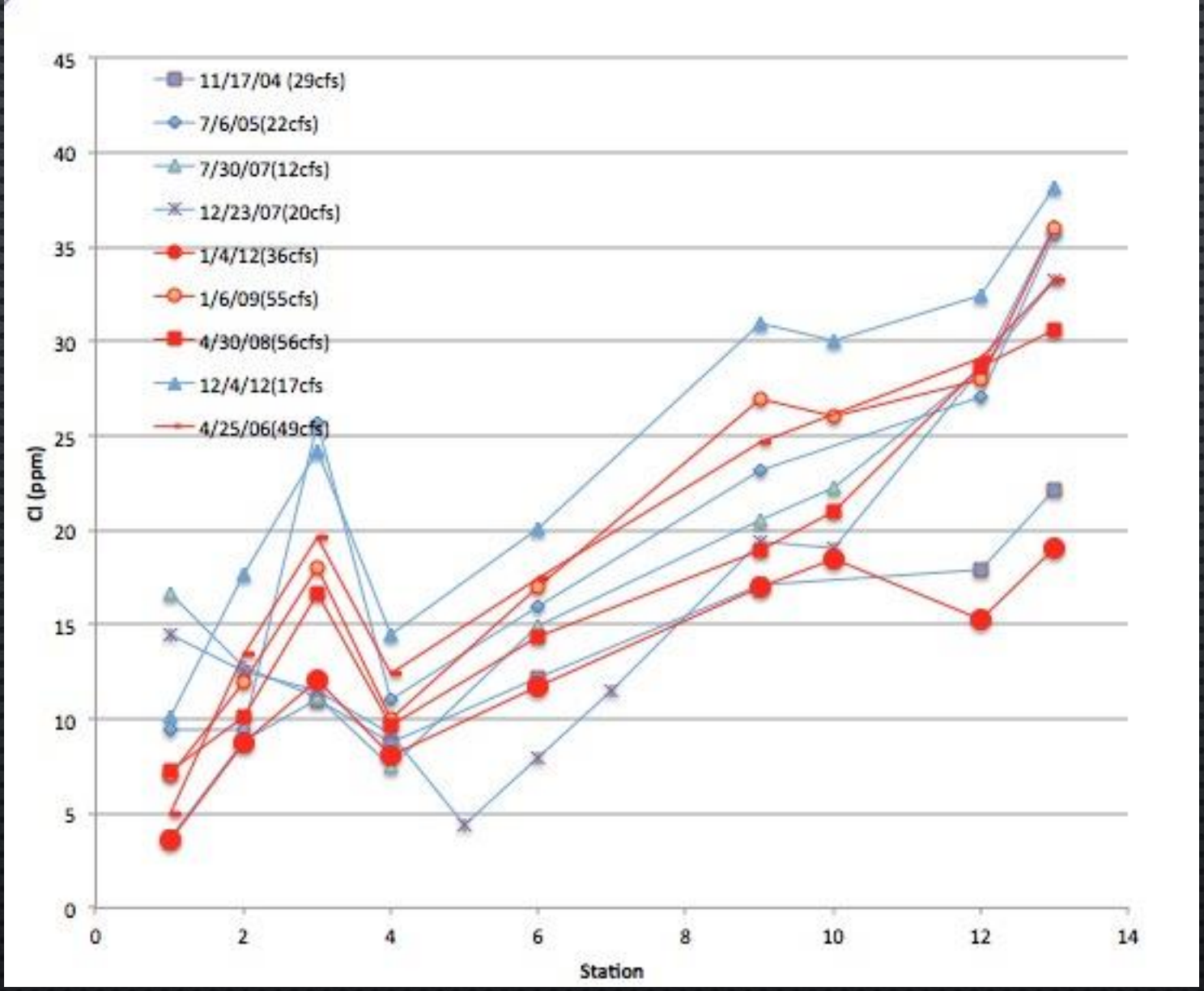
- The mouth of Six Mile Creek (Plain St.) showed a chloride increase of ~0.63 ppm/yr from 2004 to 2013.



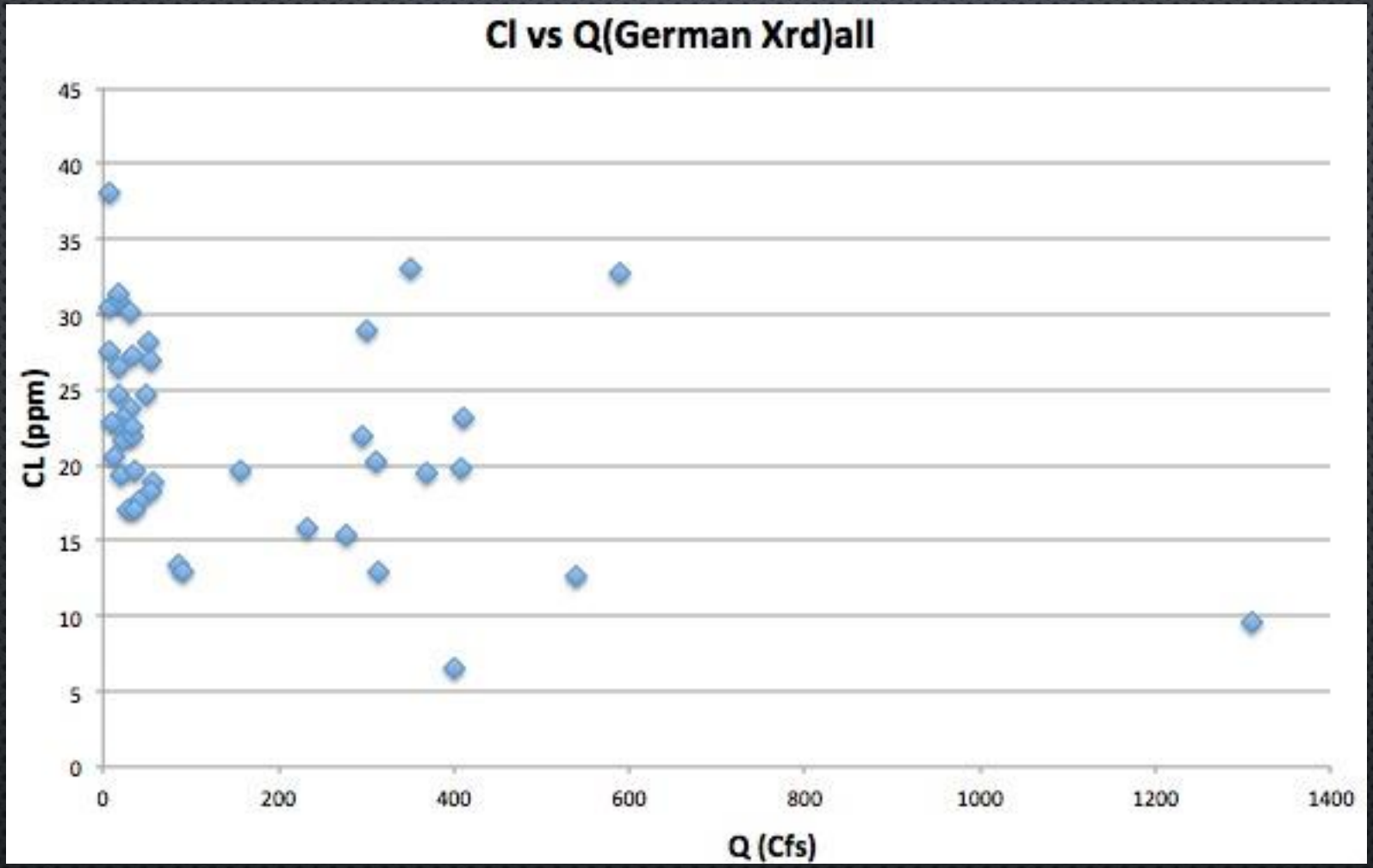
- The headwaters of Six Mile Creek (Yellow barn) showed a chloride increase of ~0.16 ppm/yr from 2004 to 2013, which is significantly lower than the rate of chloride increase at the mouth of Six Mile Creek. Note that the chloride content is also much lower.



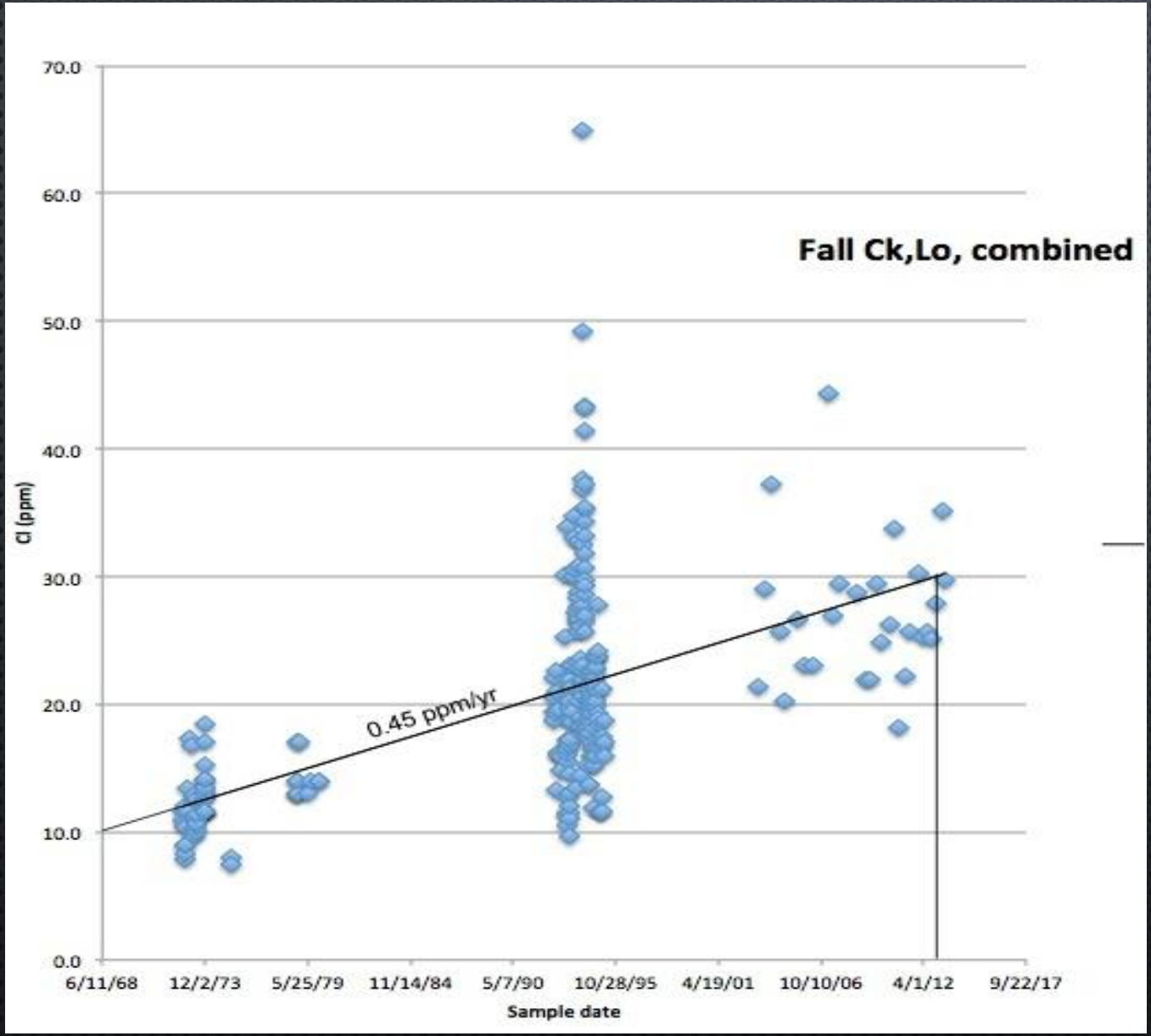
Chloride concentration increases from upstream to downstream in Six Mile Creek under high flow conditions. High chloride at #3 (Midline) reflects local housing and the jump between 6 and 7 is due to a natural salt seep.



Chloride concentration also increase from upstream to downstream under base flow conditions in Six Mile Creek.



Chloride concentration tends to decrease with increasing stream flow (Q) in Six Mile Creek.



- Fall Creek shows a similar increase to Six Mile Creek in chloride concentration over time.

Conclusions

- Chloride in local streams is increasing and the likely source is road salt.
- One study predicts an equilibrium of about 40 ppm will be reached in the next few decades based on road density and the amount of salt needed to service the roads.
- Chloride is still well below the threshold where it can potentially damage biota.
- However, sodium greater than 20 ppm should not be ingested by people on severely restricted sodium diets.