Road Salt and the Salinization of Surface Waters and Groundwater of the Chicago Region

Walt Kelly (Illinois State Water Survey)
Sam Panno (Illinois State Geological Survey)
Keith Hackley (Illinois State Geological Survey)

Prairie Research Institute
University of Illinois at Urbana-Champaign

ILLINOIS
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

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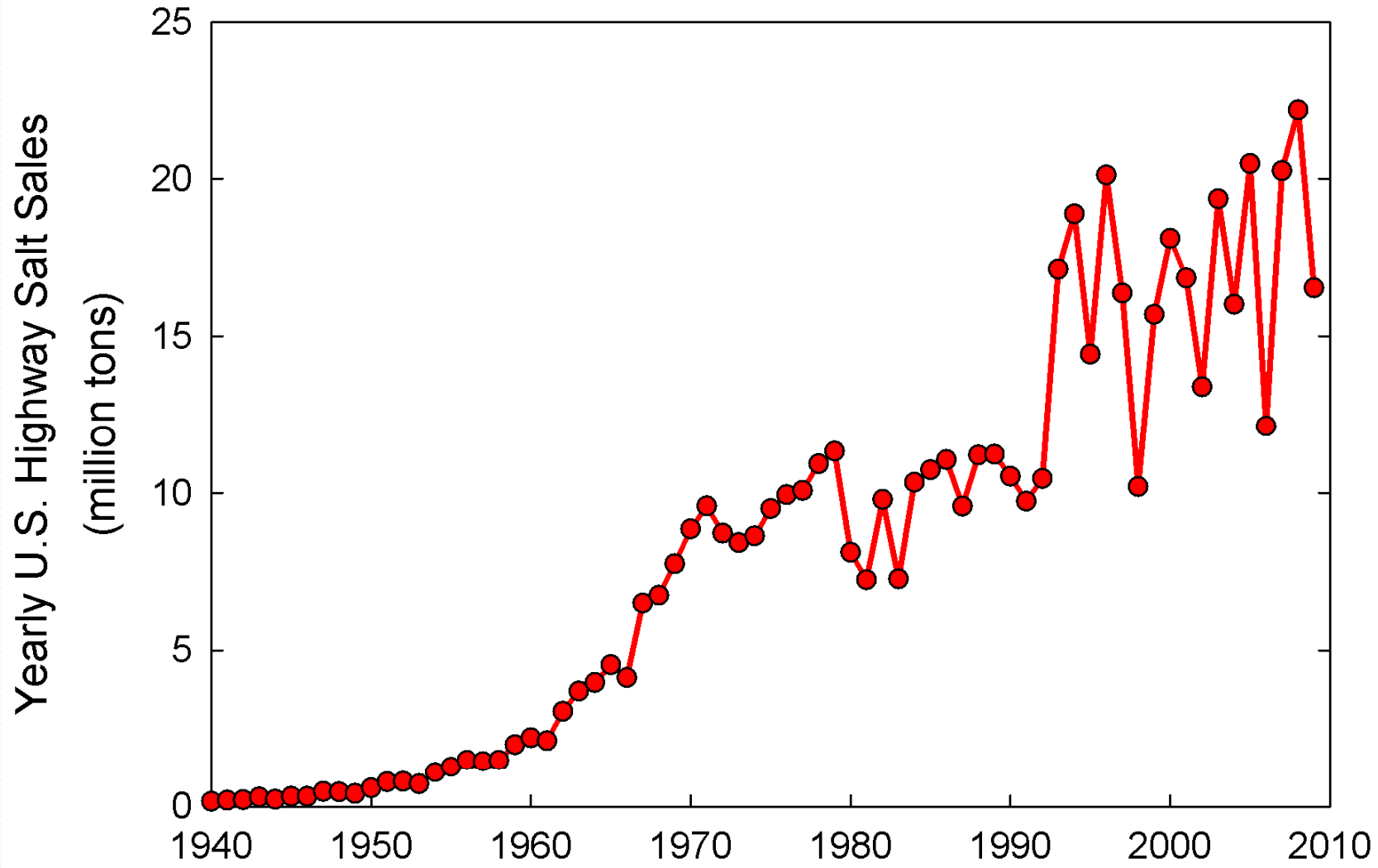
U.S. Road Salt Sales



Source: Salt Institute

Sodium and Chloride Properties

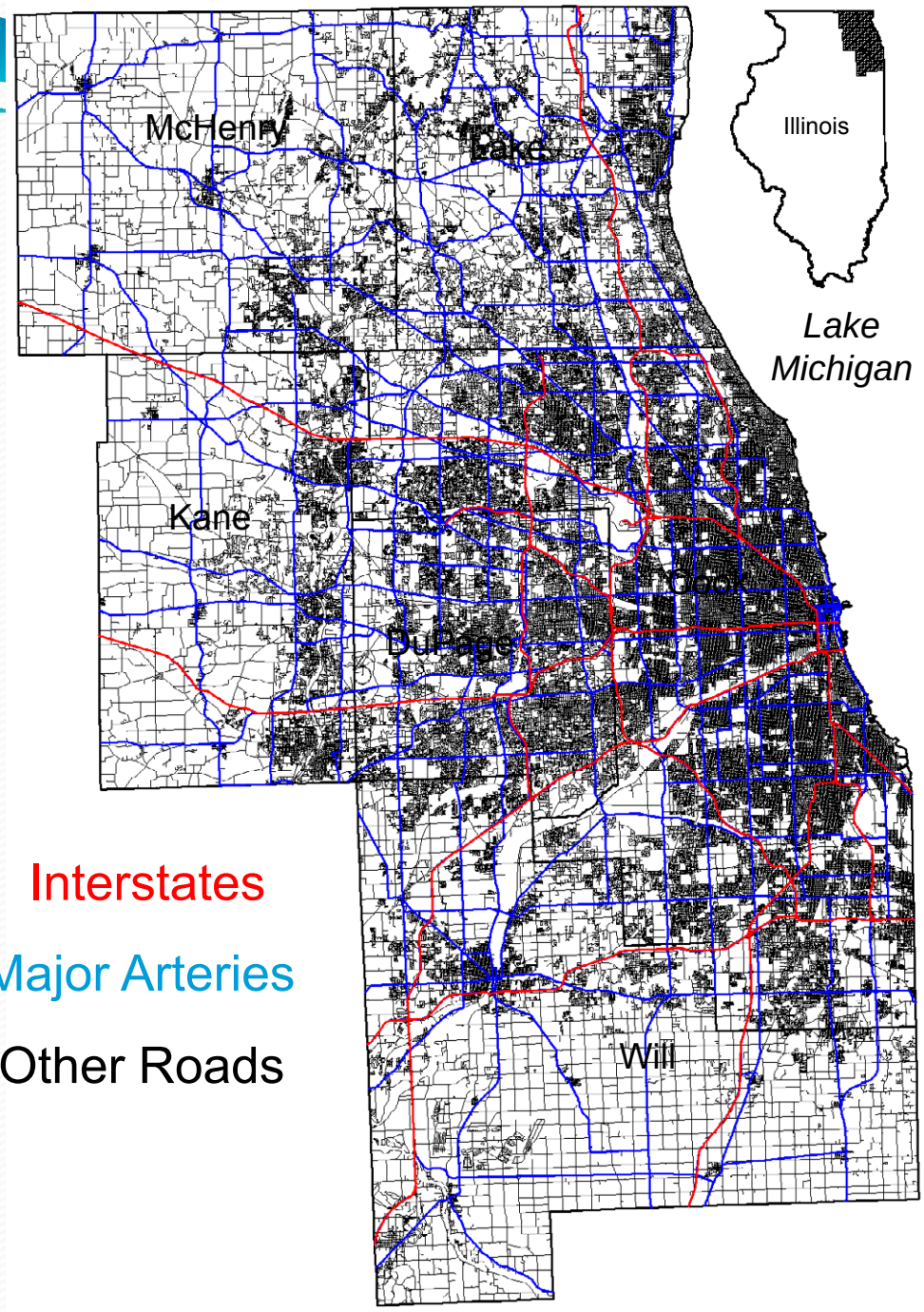
- Neither are toxic to humans
  - Cl^- has a U.S. secondary drinking water standard of 250 mg/L
  - Na is on USEPA's Contaminant Candidate List; currently recommend < 20 mg/L for people with hypertension
- Cl^- can be toxic to aquatic life
  - USEPA has chronic and acute criteria (230 mg/L and 860 mg/L once and < once/3 years)
- High salt levels reduce biodiversity
  - Salt-tolerant species out-compete

Sodium and Chloride Properties

- Cl^- major corrosive
  - Steel reinforcement in concrete
  - Can accelerate corrosion of metallic pipes and structures
- Transport properties
  - Cl^- conservative
  - Na non-conservative; subject to adsoption and cation exchange processes

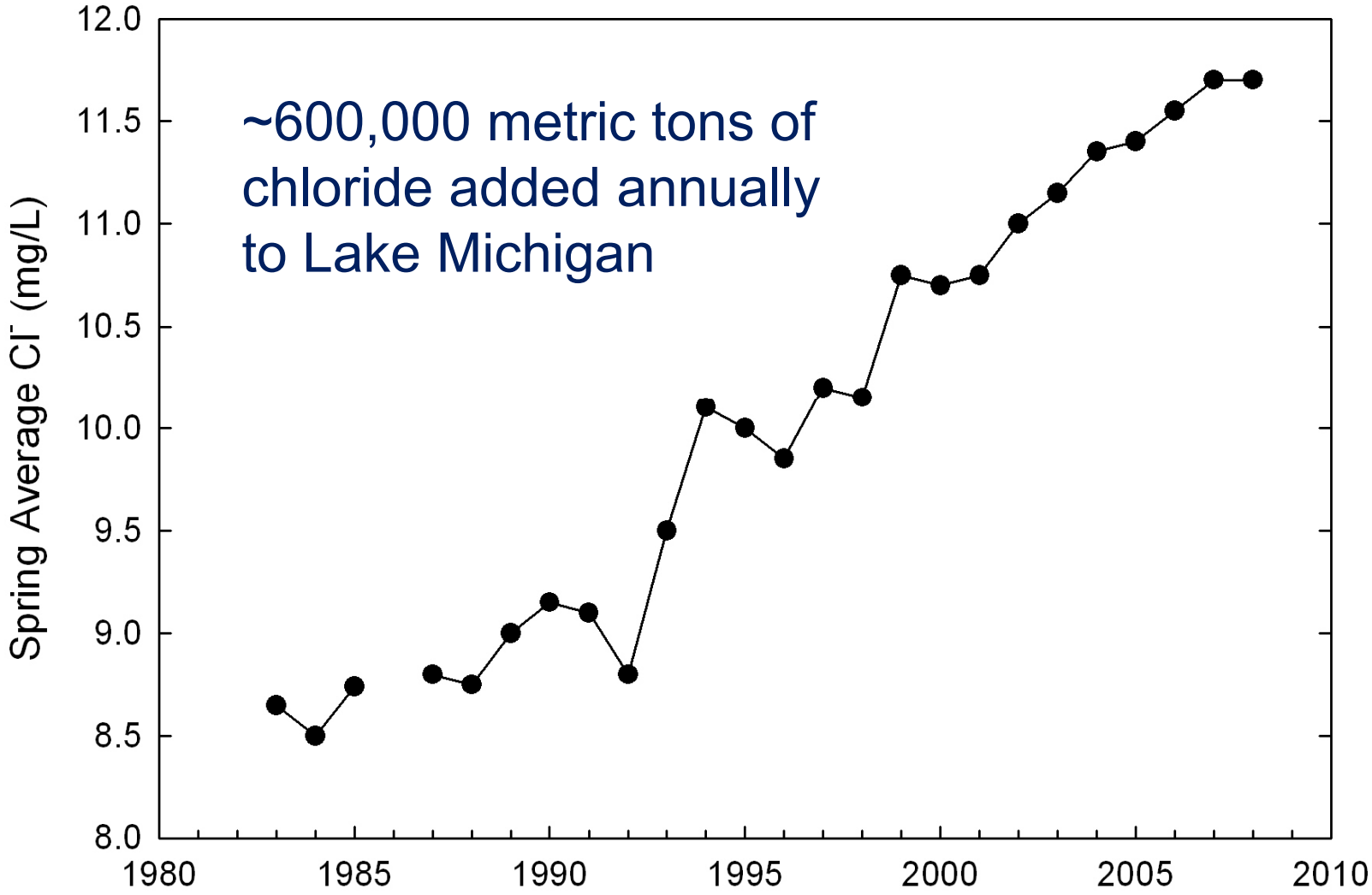
Chicago Metropolitan Area

- Population > 8 million
  - Increased ~3 million in last 50 yrs
- 55,000 lane miles of roads

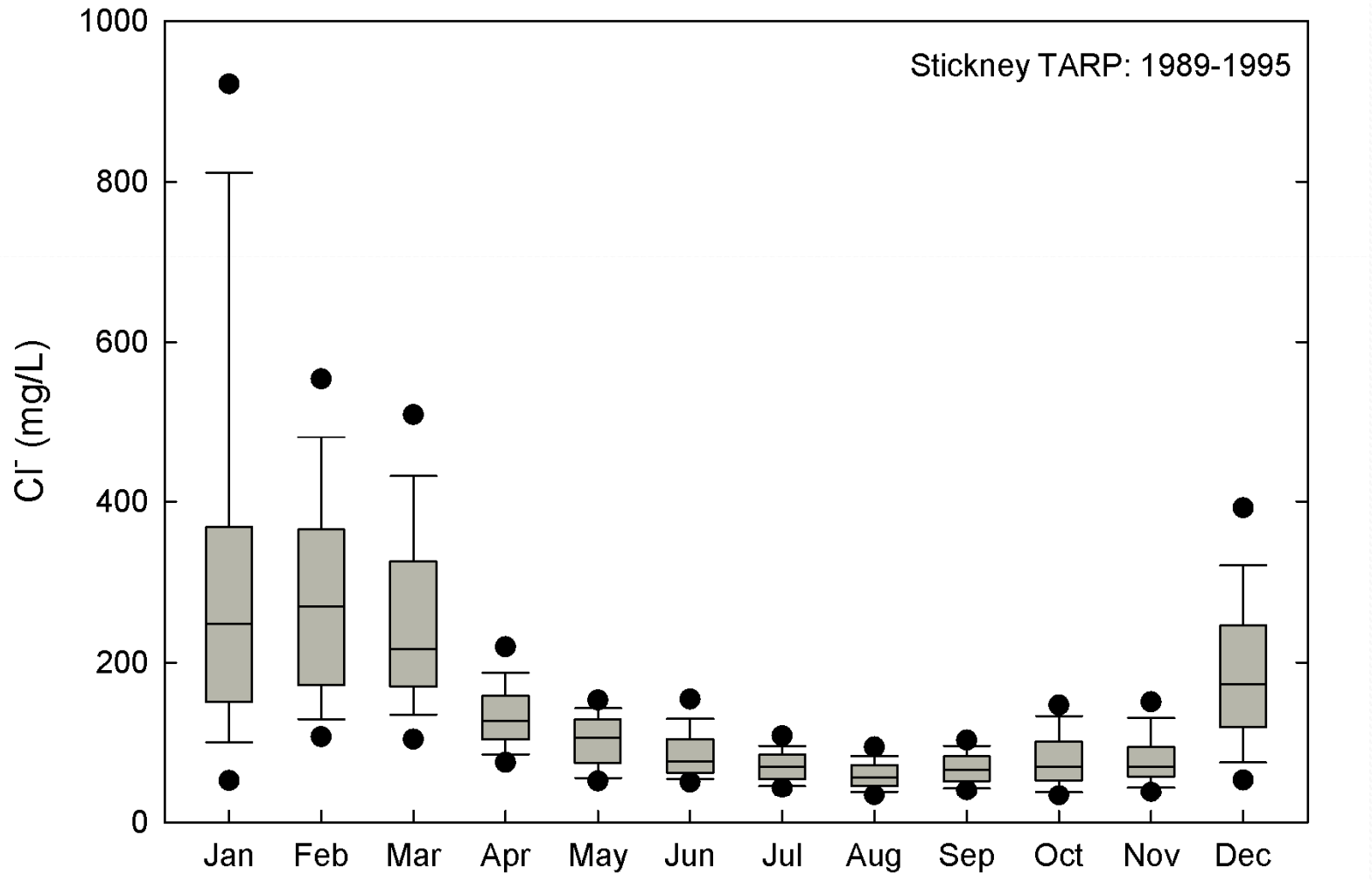


Annual average snowfall: 38 inches (97 cm)
Annual average road salt application: > 350,000 metric tons

Lake Michigan (USEPA data)



Cl^- in Stormwater (Chicago TARP)



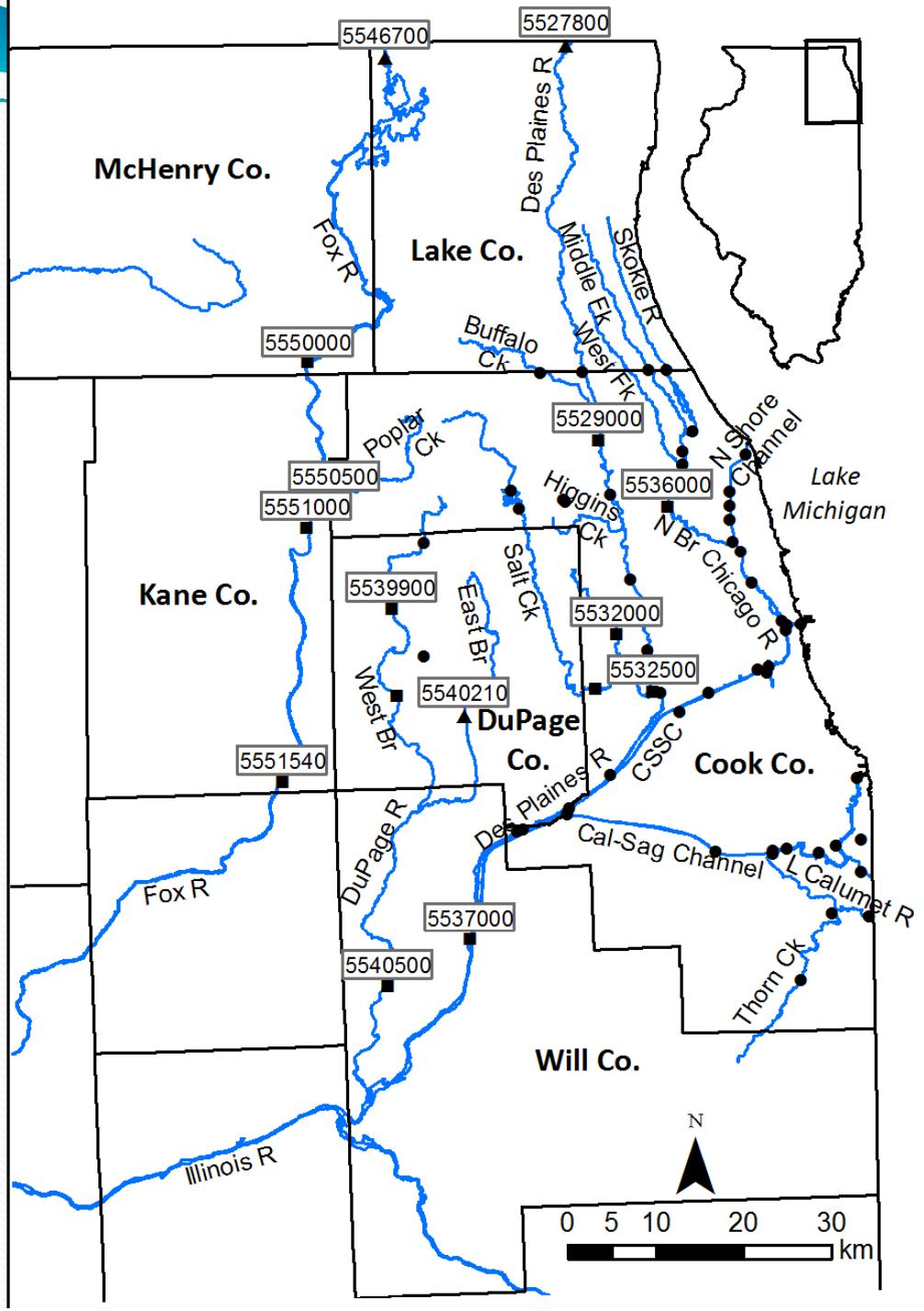
TARP = Tunnel And Reservoir Plan

Chicago Region Waterways

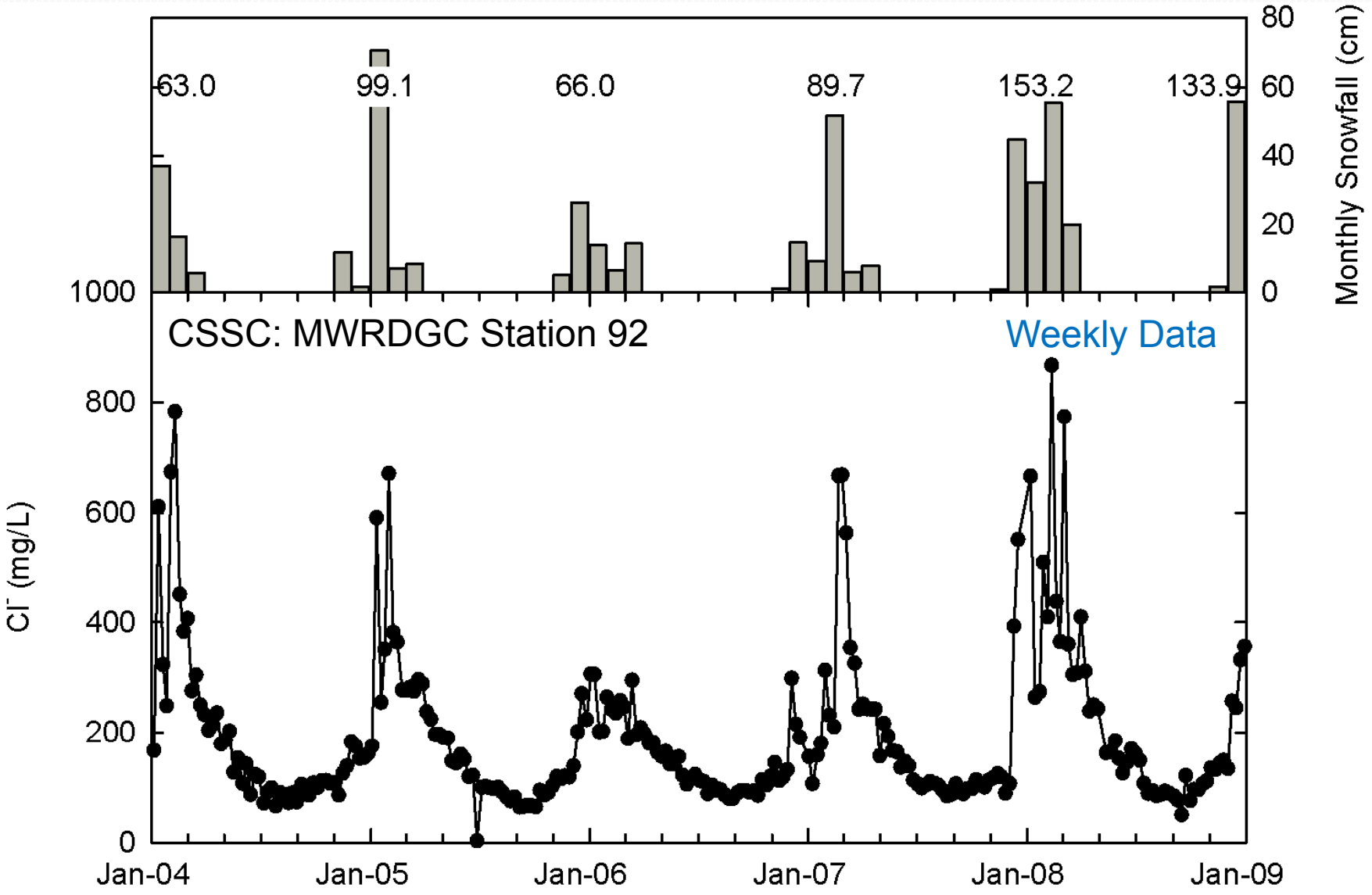
- Metropolitan Waste Reclamation District of Greater Chicago (MWRDGC)

USGS

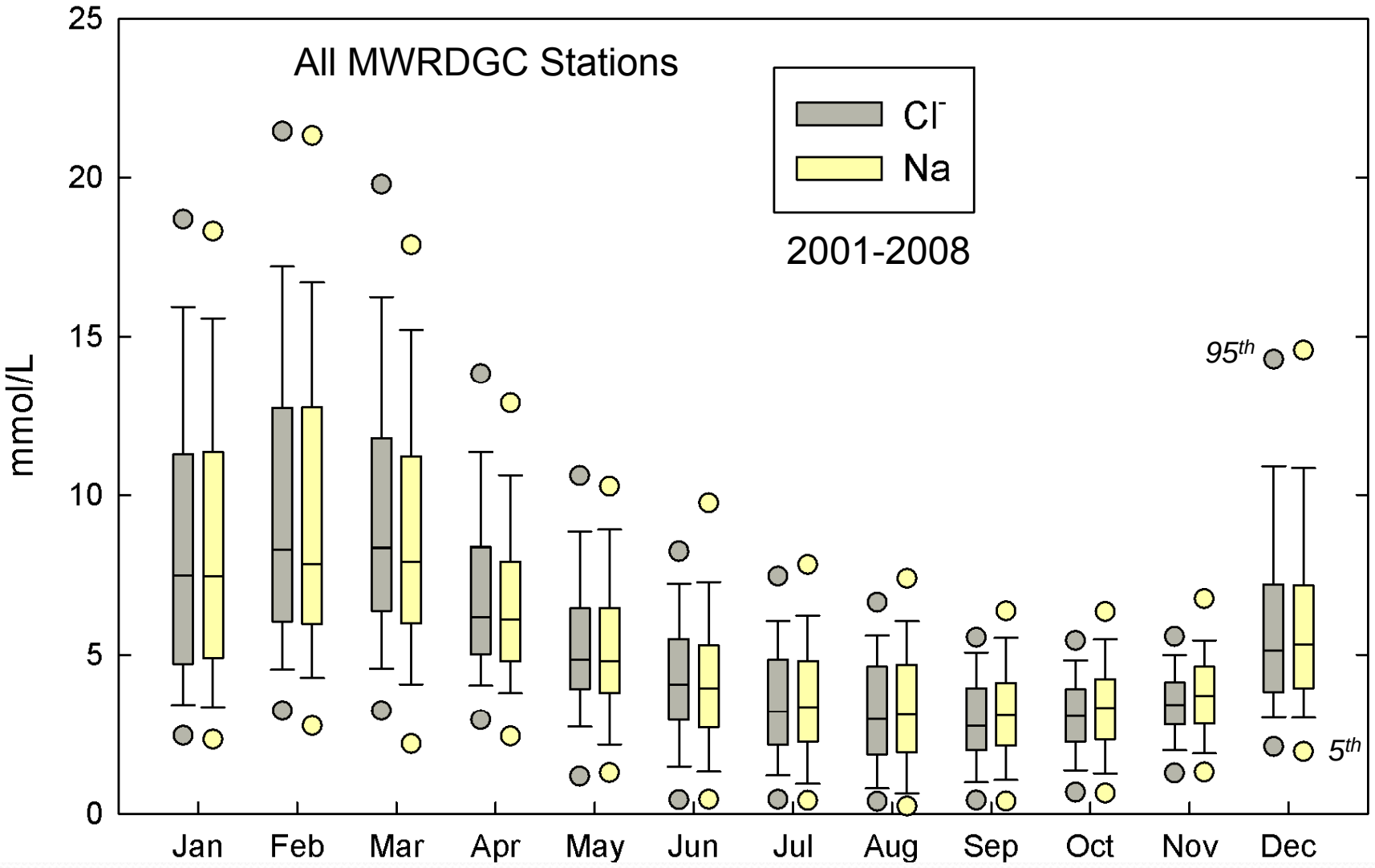
▲ USGS (no data > 1997)



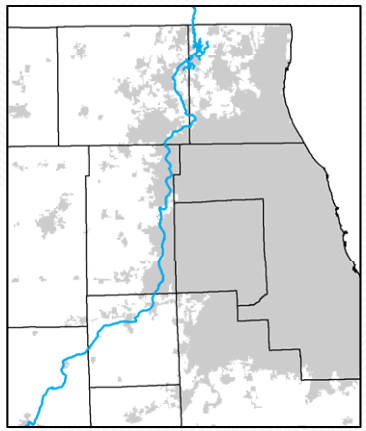
Seasonal Cl^- in Rivers

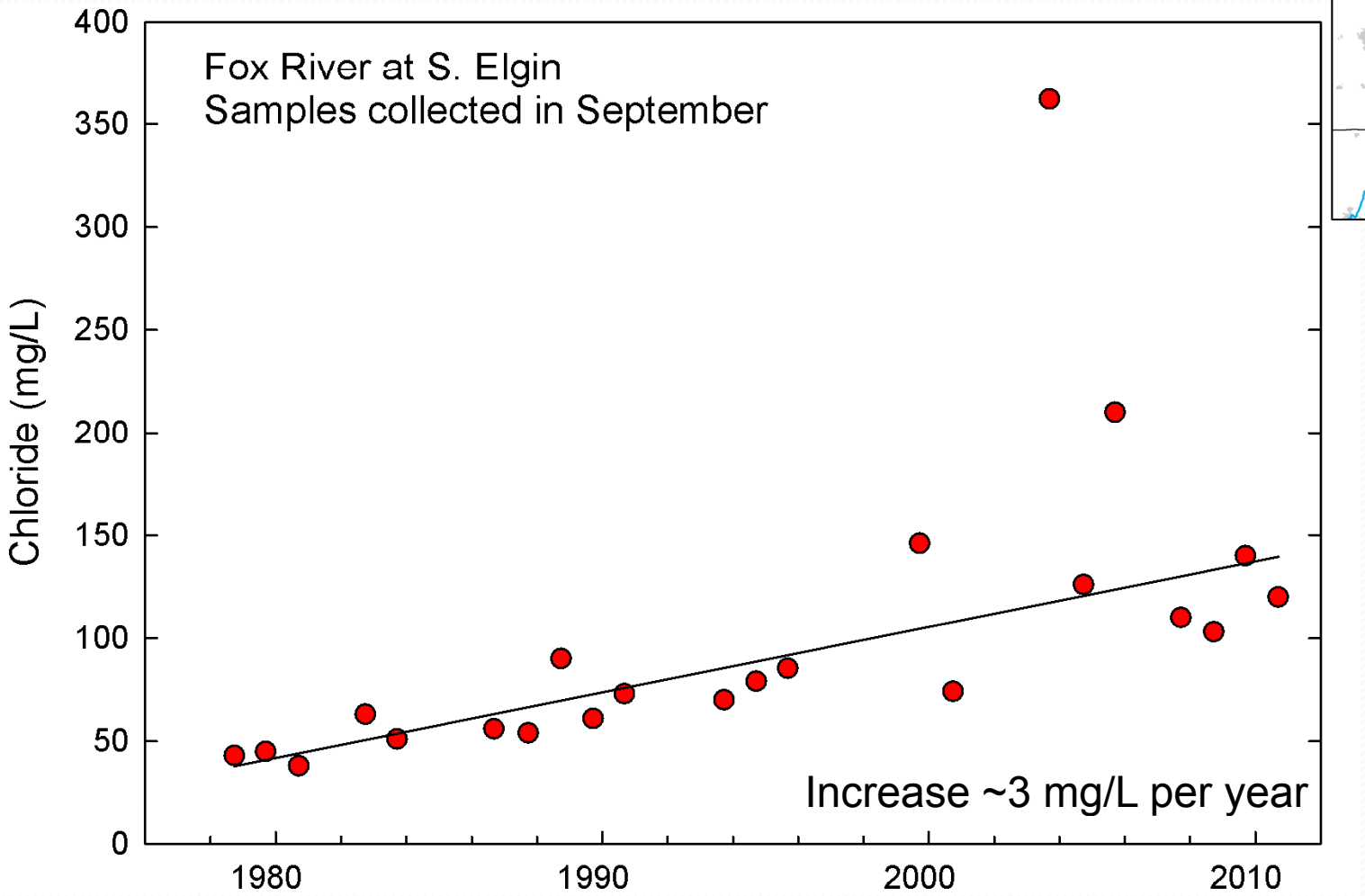


Cl^- and Na: Equimolar concentrations



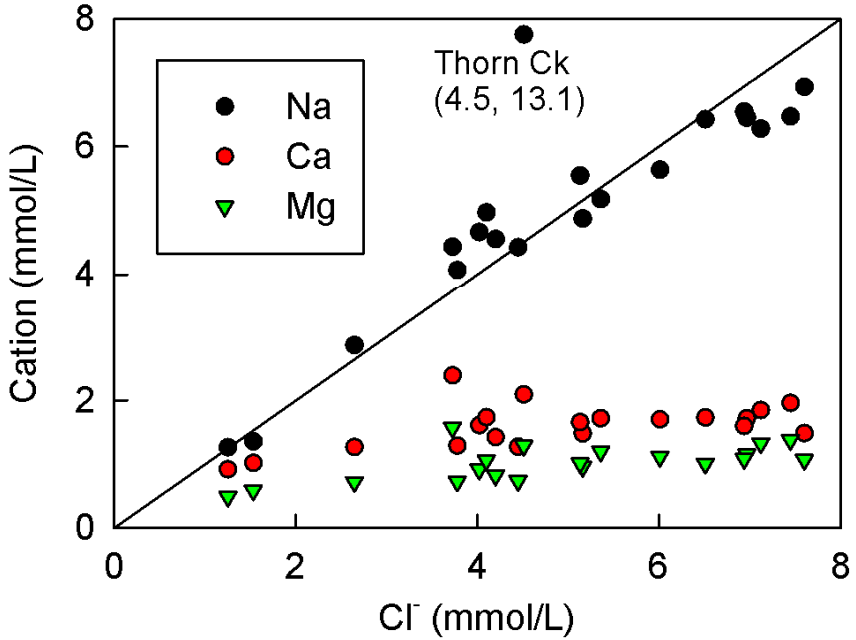
Increasing Cl^- in Baseflow

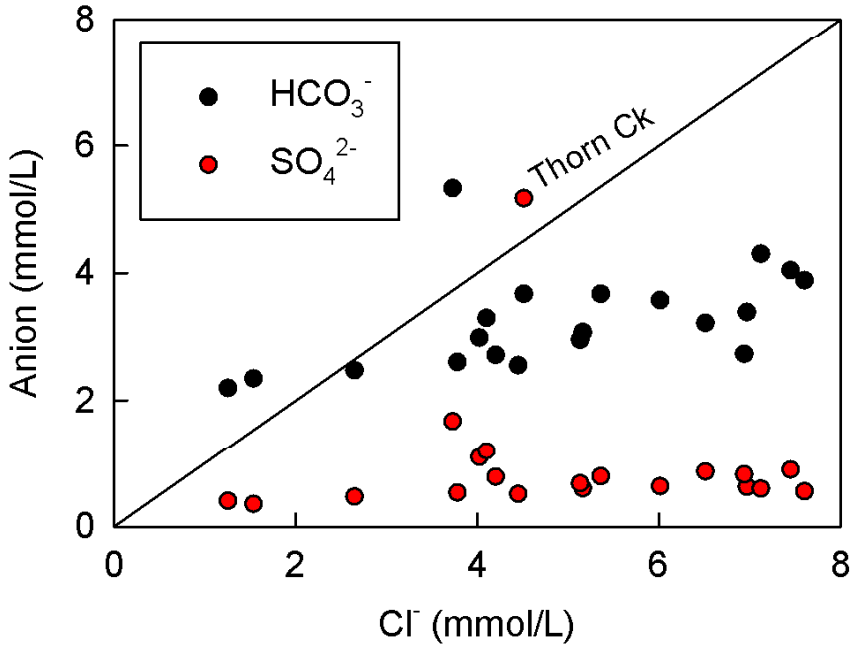




Chloride vs. Other Major Ions

MWRDGC Stations
Median Values: 2007-08



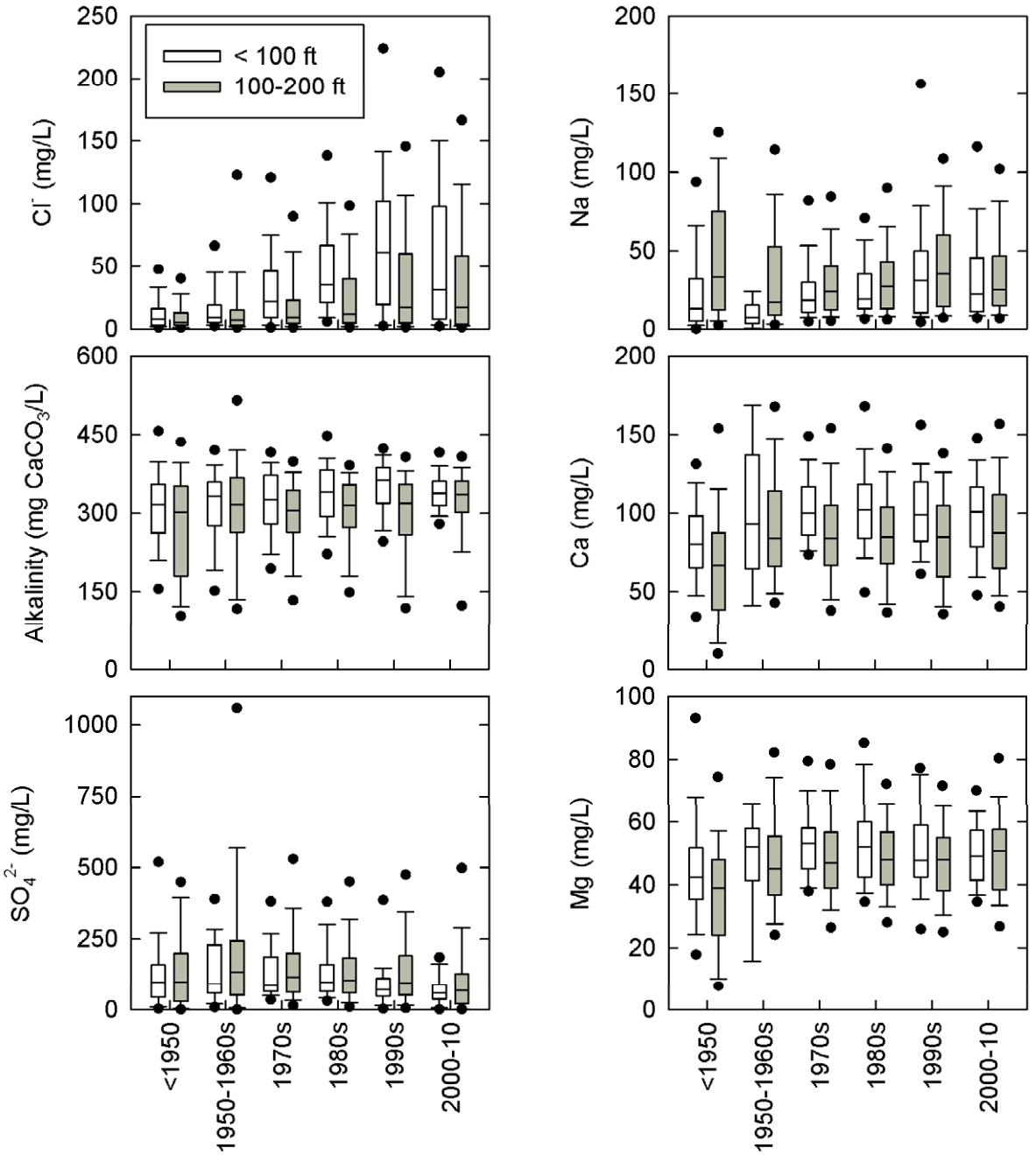


Annual Road Salt Balance Using Cl^-

- Considering all sources of chloride in the Des Plaines River watershed
  - Road salt, wastewater, natural baseflow, water conditioning salt, KCl fertilizer, livestock, groundwater withdrawals
  - Annual inputs = 544,000 metric tons
  - River discharge = 500,000 metric tons
- Assuming all wastewater and baseflow that enter the system leave, about 14% of Road Salt (and other anthropogenic sources) remains in relatively long-term storage

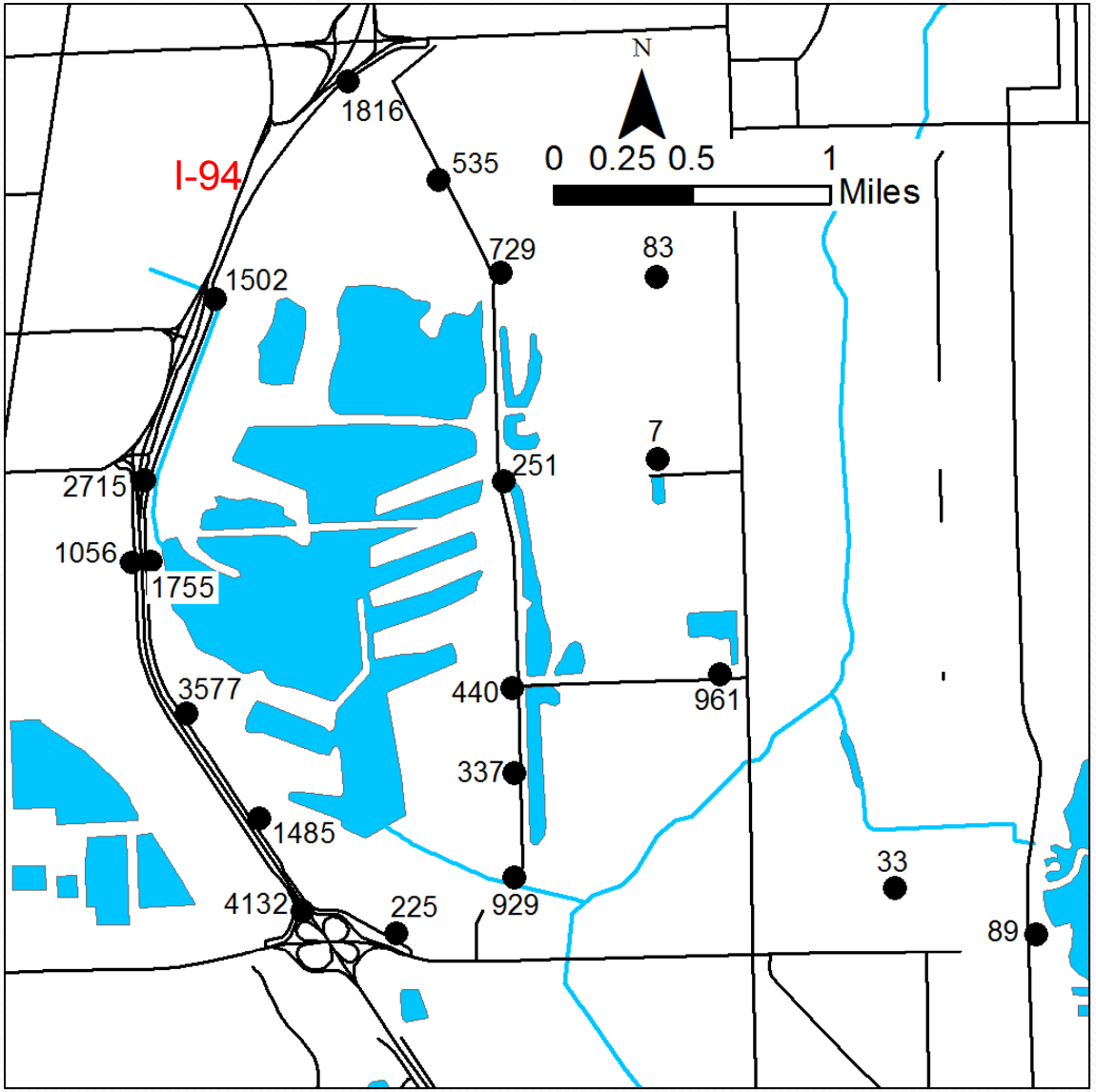
Major Ion Data: Shallow Groundwater

All Samples
Water Quality
Database
(Wells ≤ 200 ft)

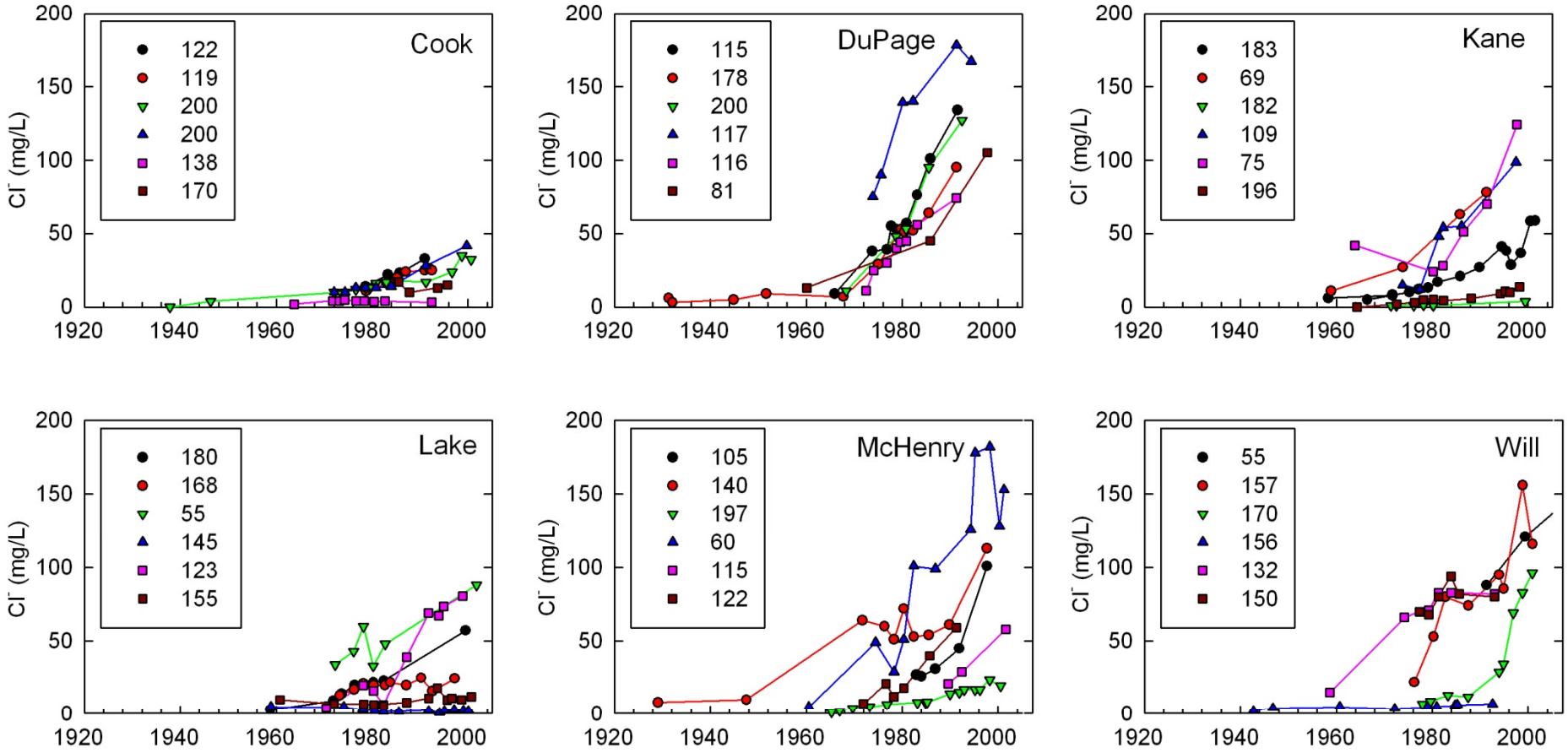


Lake Calumet Region (South Chicago)

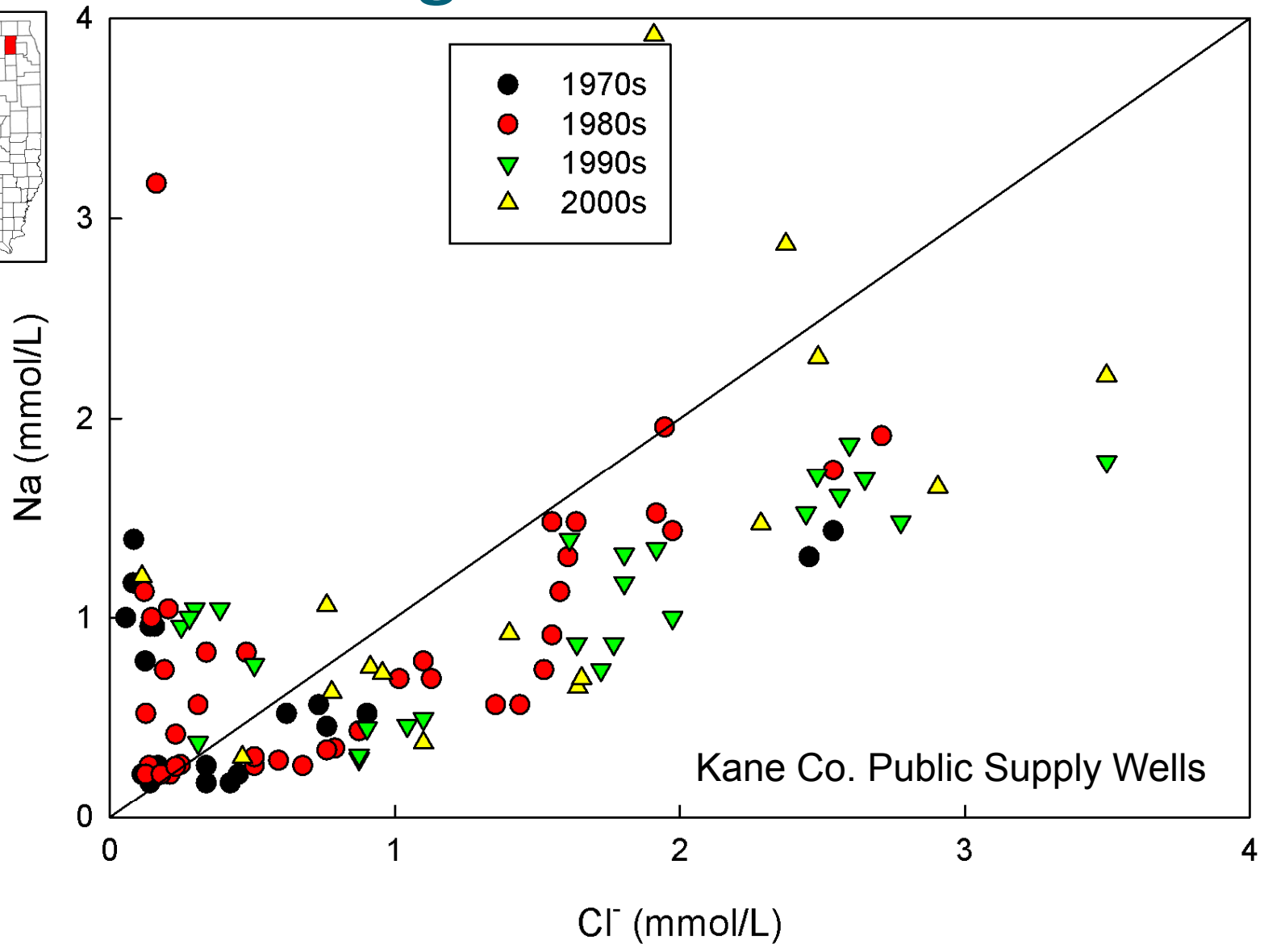
Shallow Monitoring Wells
Cl^- concentrations (1991)



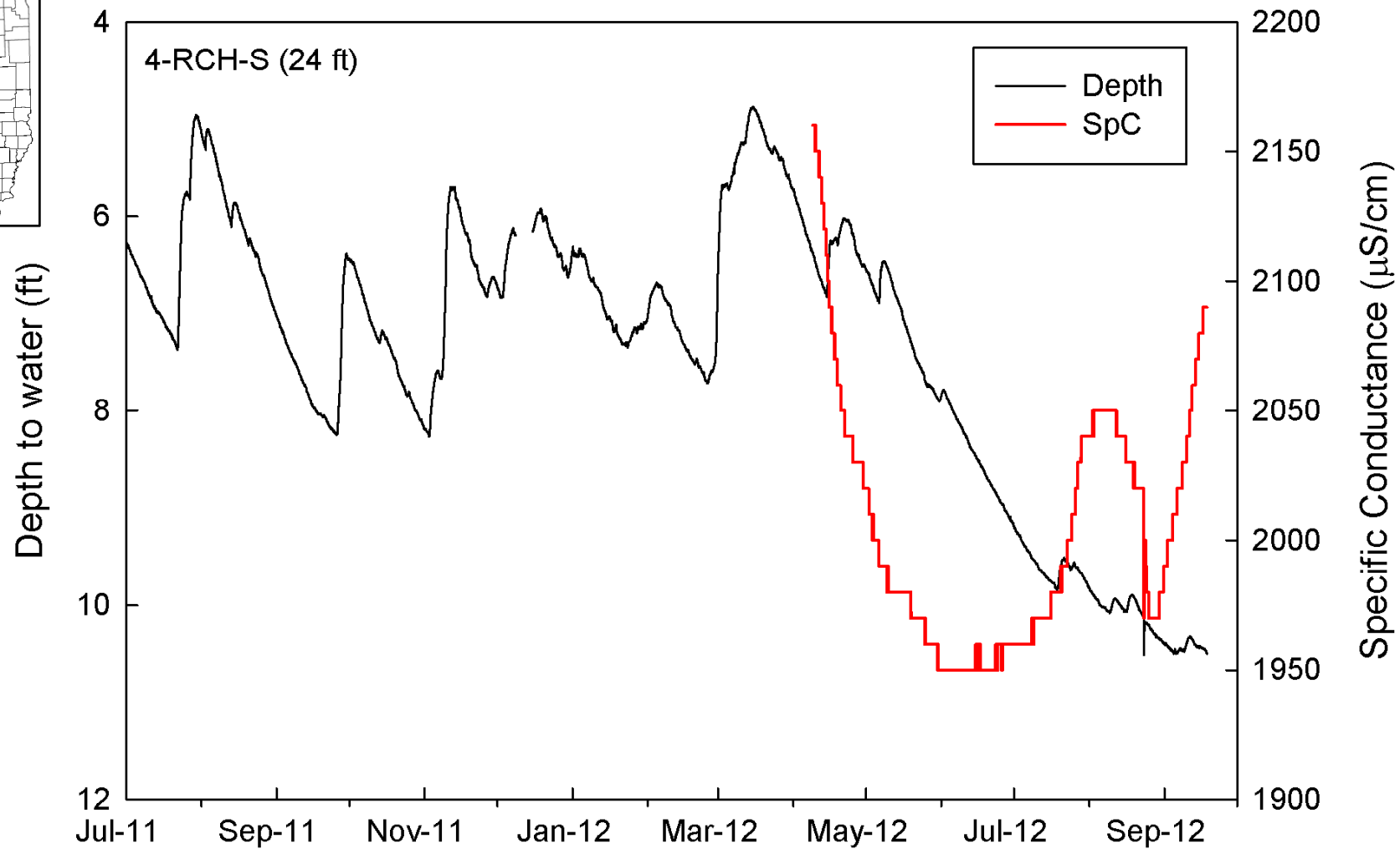
Cl^- in Individual Public Supply Wells



Cl^- increasing relative to Na



USGS Monitoring Wells: McHenry Co.



Effects of Road Salt Runoff on Water Resources

- Increased treatment costs for drinking water
- Increased costs due to corrosion
- Loss of use of some water resources
- Ecological costs?
  - 7 of 13 streams in Milwaukee area exhibited toxicity to *Ceriodaphnia dubia* and *Pimephales promelas* due to road salt runoff

    [Corsi et al. *Env. Sci. Tech.* 2010]

Deicing: It Needs to be Done

- Public authorities liable for negligence in the failure to remedy snow and ice hazards on highways
- Defense of public agencies for negligent snow and ice removal do not appear to include immunity for governmental action
- The defense that snow and ice control is a "discretionary activity" and immune from liability appears to be inapplicable

Source: Transportation Research Board

Managing Road Salt Runoff with Respect to Water Resources

- Due to its solubility, almost all road salt enters the hydrologic cycle
- Where do we want it to go?
  - Stormwater?
    - Direct runoff?
    - Wastewater?
  - Infiltration?

Road Salt: What Does the Future Hold?

- Updated Road Salting Policies are calling for decreased salt use
  - Based on vehicle density
- Improved deicing materials/techniques available, but NaCl still predominates (cheap)
- In Chicago region (and many other northern metro areas), increasing urbanization, road density, traffic expected for the foreseeable future