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ADVANCING KNOWLEDGE AND STEWARDSHIP OF FRESH WATER SYSTEMS THROUGH RESEARCH, EDUCATION, AND RESTORATION
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Ecological Significance of Specific Conductance in Streams – Part 2

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EnviroDIY
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Stroud Water Research Center

Terms Describing Salt in Fresh Water

Salinity (ppm)

Total Dissolved Solids (TDS, ppm)

Electrical Conductivity or
Specific Conductance (µS/cm)

Salt (mg/L)
($NaCl$, KCl, $CaCl_2$, $MgCl_2$)

Chloride (mg Cl/L)

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Points to Remember

- Electrical Conductivity/Specific Conductance measures dissolved salt concentration
- SC does not tell you about specific salts (NaCl vs $MgCl_2$)
- SC naturally varies 100 – 200 µS/cm in response to precipitation, and 500 – 1000 µS/cm with a region
- Natural spatial variation (geology) may be more important than natural temporal variation (dilution events)

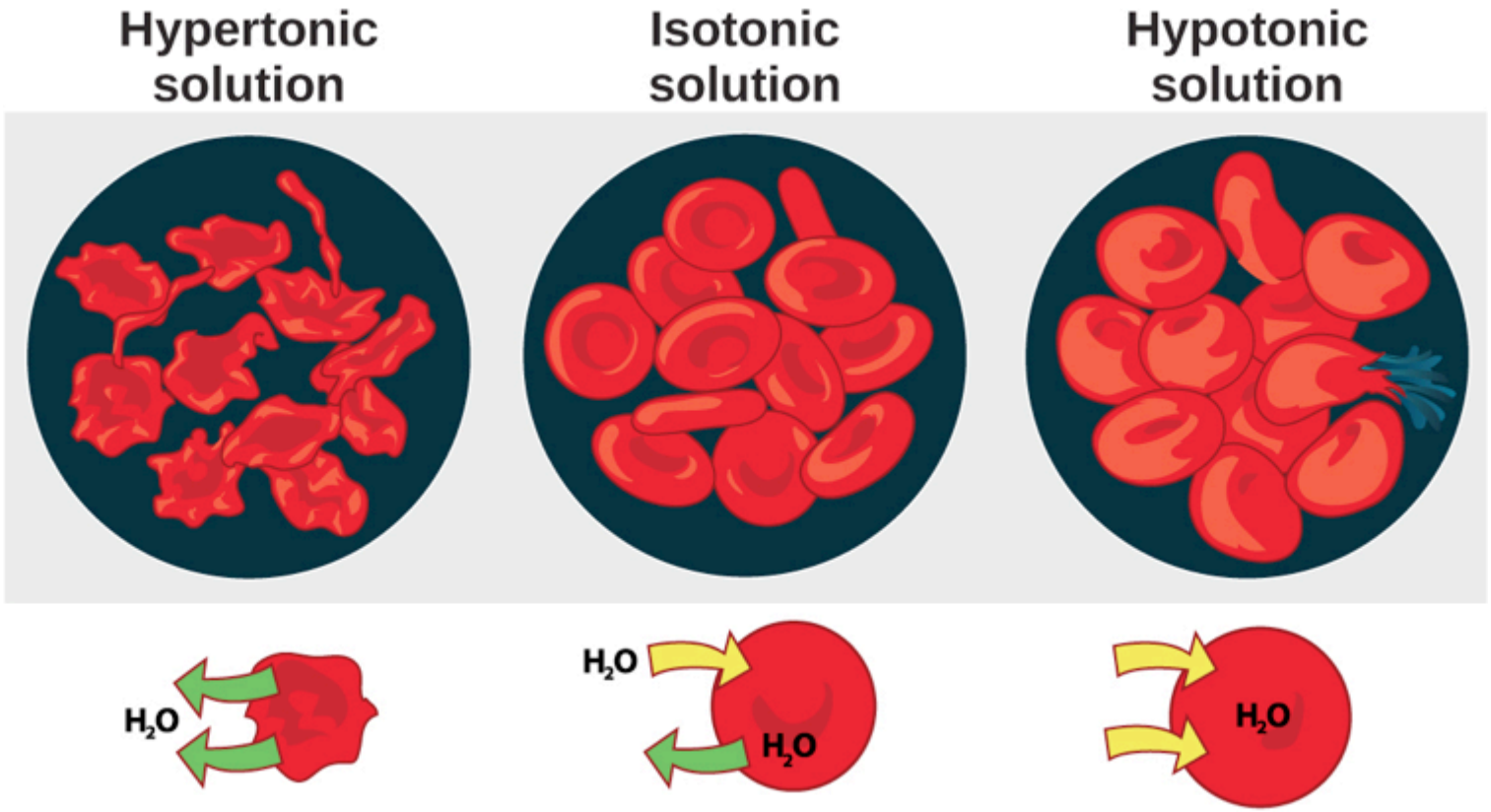
Why is Electrical Conductivity Important to Aquatic Organisms?

- Electrical conductivity is a measure of salt concentration – as ions, cations, anions
- Ambient salt concentration affects water balance & ion inside the aquatic organism
  - Internal ion balance is important to normal physiological processes
- Potential mechanisms for salt toxicity not clear

Osmoregulation

- maintaining salt and water balance -

Salty water

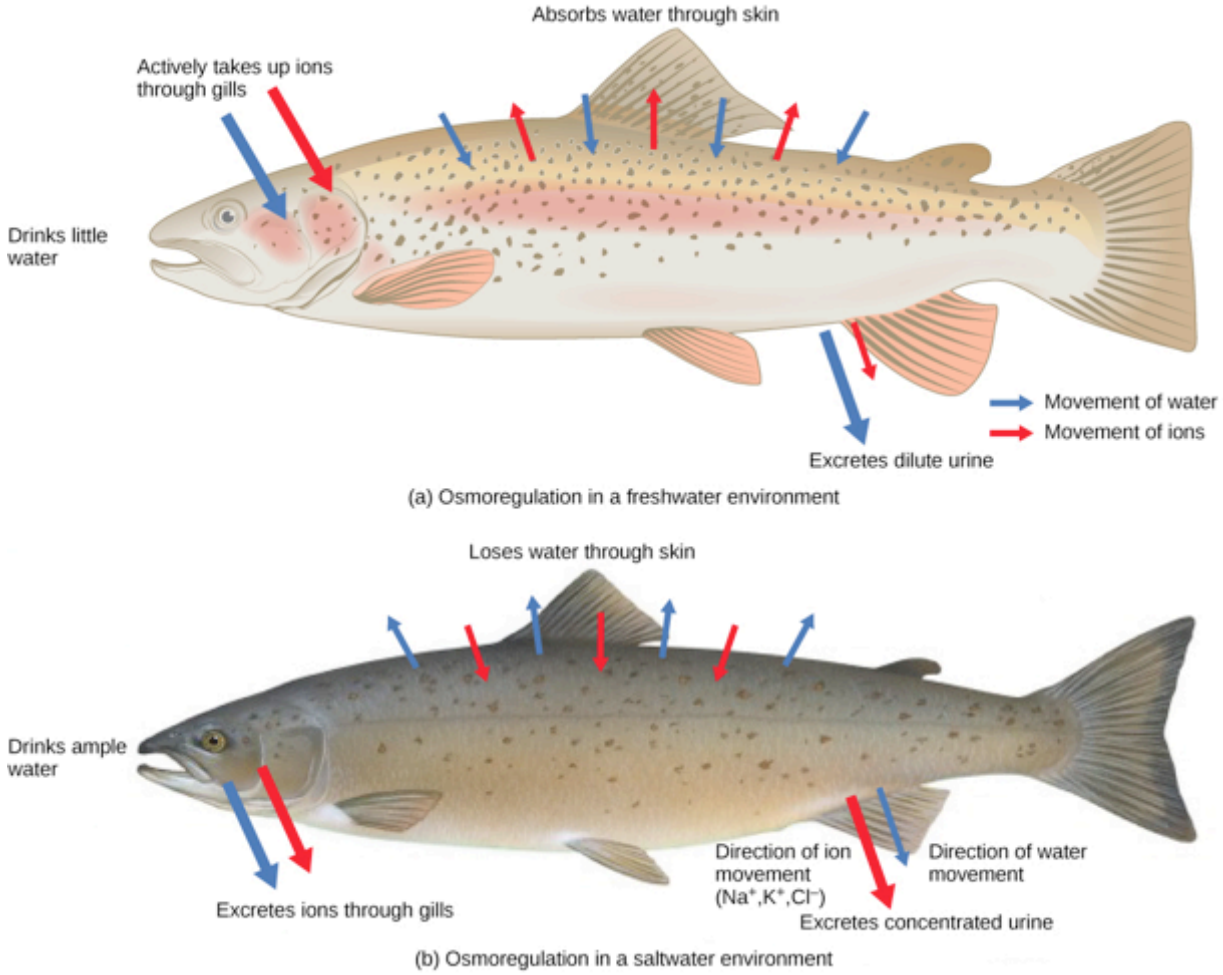


Rain water

Cells placed in a hypertonic environment shrink due to loss of water. In a hypotonic environment, cells swell due to intake of water. The blood maintains an isotonic environment so that cells neither shrink nor swell. (credit: Mariana Ruiz Villareal)

http://organismalbio.biosci.gatech.edu/nutrition-transport-and-homeostasis/animal-ion-and-water-regulation-i/

Osmoregulation



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Migratory fish must use different physiological mechanisms to survive in (a) freshwater or (b) saltwater environments.

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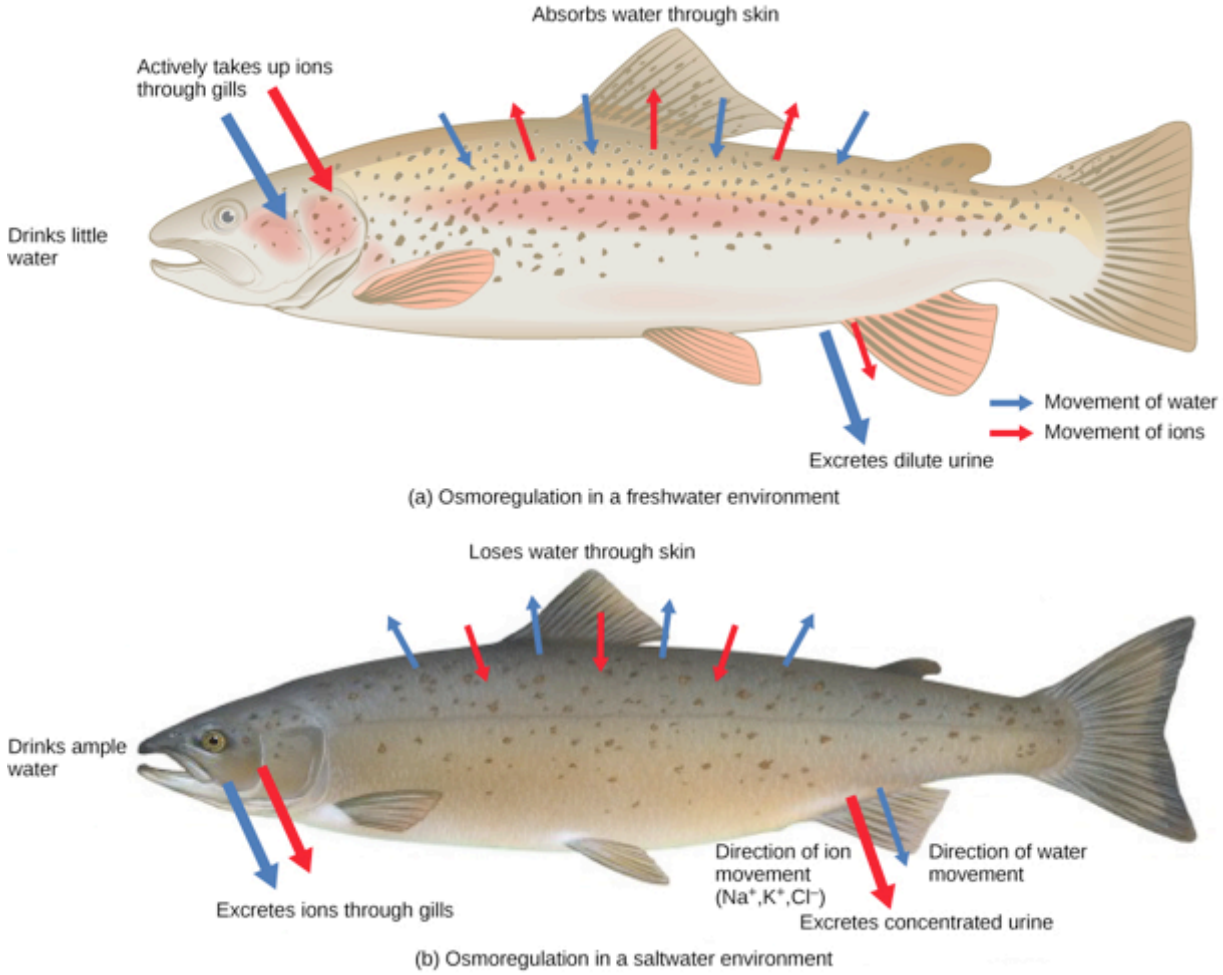
Osmoregulation



http://organismalbio.biosci.gatech.edu/nutrition-transport-and-homeostasis/animal-ion-and-water-regulation-i/

Most freshwater organisms do not have the ability to move from fresh water to salt water

They can tolerate some increase in salinity, but have limited ability to adapt to great increases in salinity

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Why does salt physiology matter?

Streams are becoming saltier

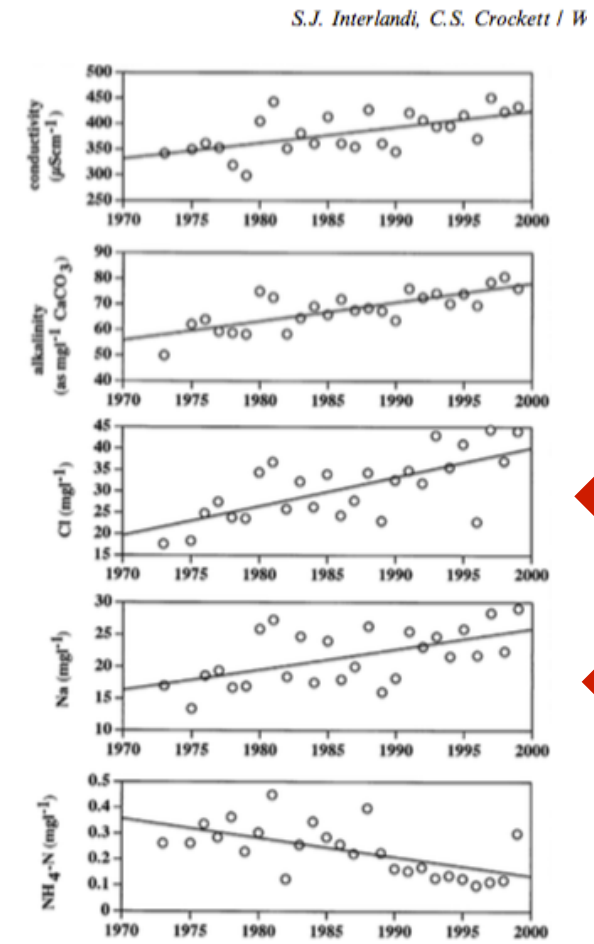


Fig. 3. Long-term trends in annual mean water quality measures in the Schuylkill River. Samples were collected from 1973 through 1996 by the USGS and from 1990 through 1999 by PWD. The location for USGS acquired samples is directly adjacent to the Belmont intake, depicted in Fig. 1. All linear trends depicted were statistically significant. Linear slopes and associated statistics are included in the text.

Schuylkill River @ Philadelphia

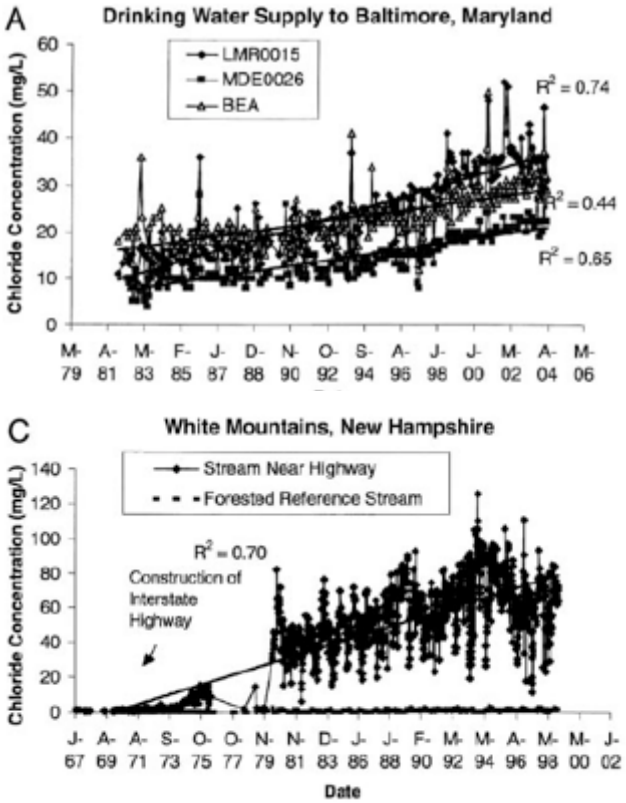
Chloride

Sodium Doubled 1973 - 1999

Interlandi & Crockett 2003

Increased salinization of fresh water in the northeastern United States

Sujay S. Kaushal*†‡, Peter M. Groffman*, Gene E. Likens*‡, Kenneth T. Belt§, William P. Stack¶, Victoria R. Kelly*, Lawrence E. Band‖, and Gary T. Fisher**



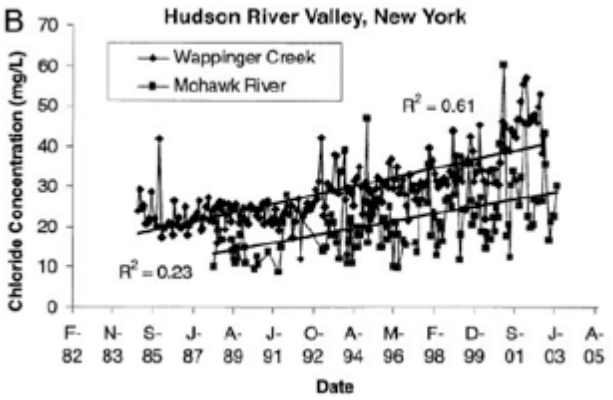
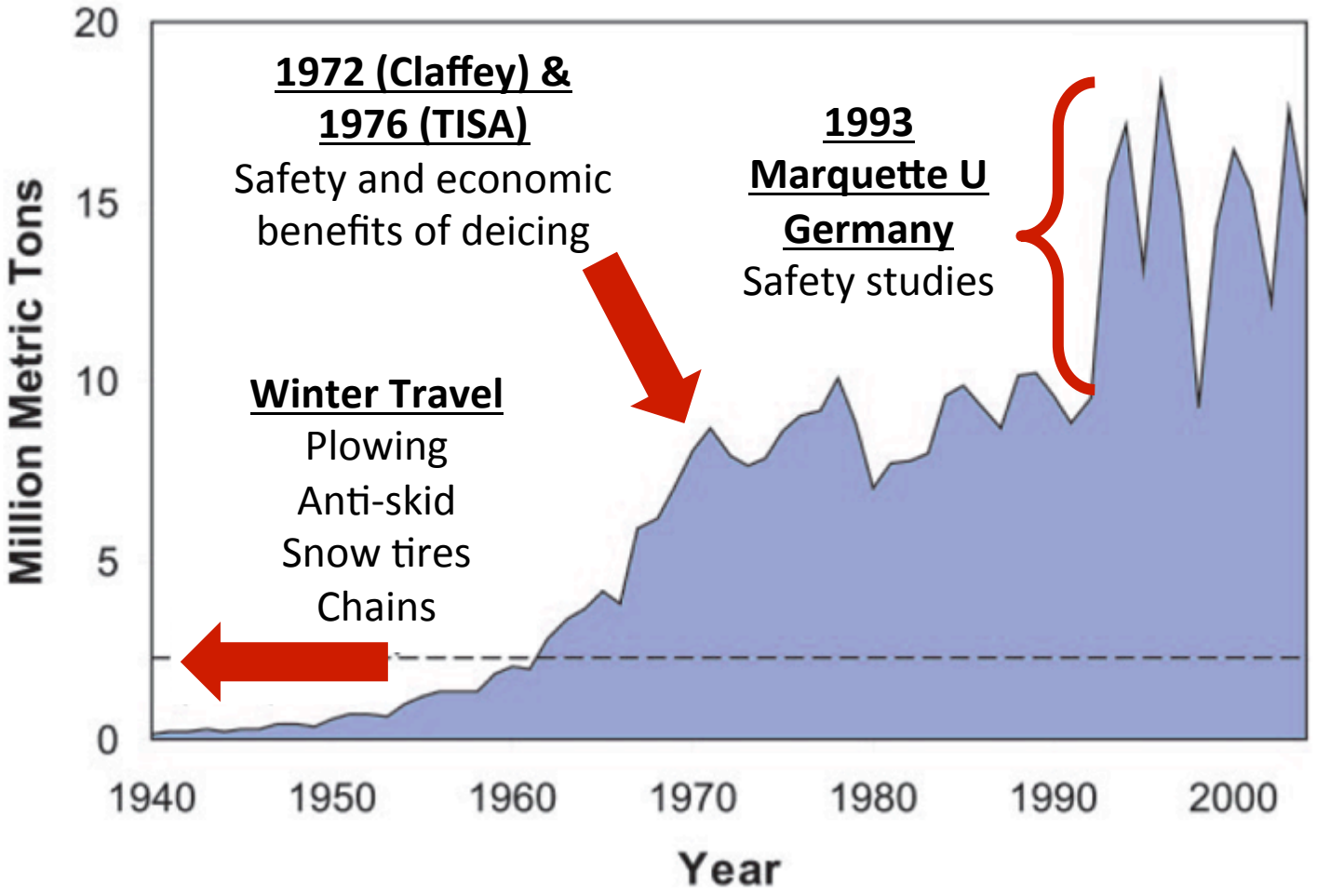


Fig. 1. Examples of significant, long-term increases in baseline concentration of chloride for streams and rivers of the northeastern United States. The R^2 values are given for linear regressions. All streams and rivers are located in rural areas but contain roads within their watersheds. (*A*) LMR0015 (Little Morgan Run), MDE0026 (Middle Run), and BEA (Beaver Run) are sampling stations for tributaries to Liberty Reservoir, a drinking water supply for Baltimore. (*B*) Wappinger Creek and the Mohawk River are tributaries to the Hudson River in the Hudson River Valley. (*C*) The streams in the White Mountains drain into Mirror Lake; one is located near an interstate highway in the Hubbard Brook Valley, and the forested reference stream is watershed 6 of the Hubbard Brook Experimental Forest (10).

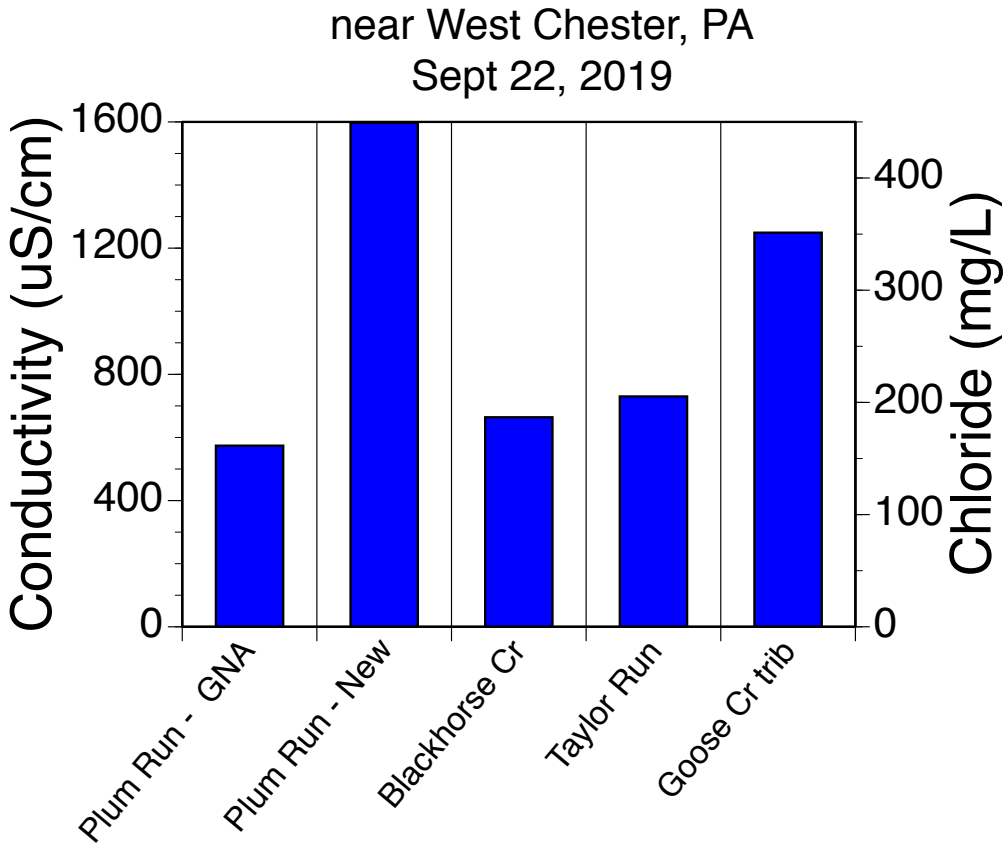
History of Road Salt Use in US

Now

23



Salt concentration in urban streams is always elevated

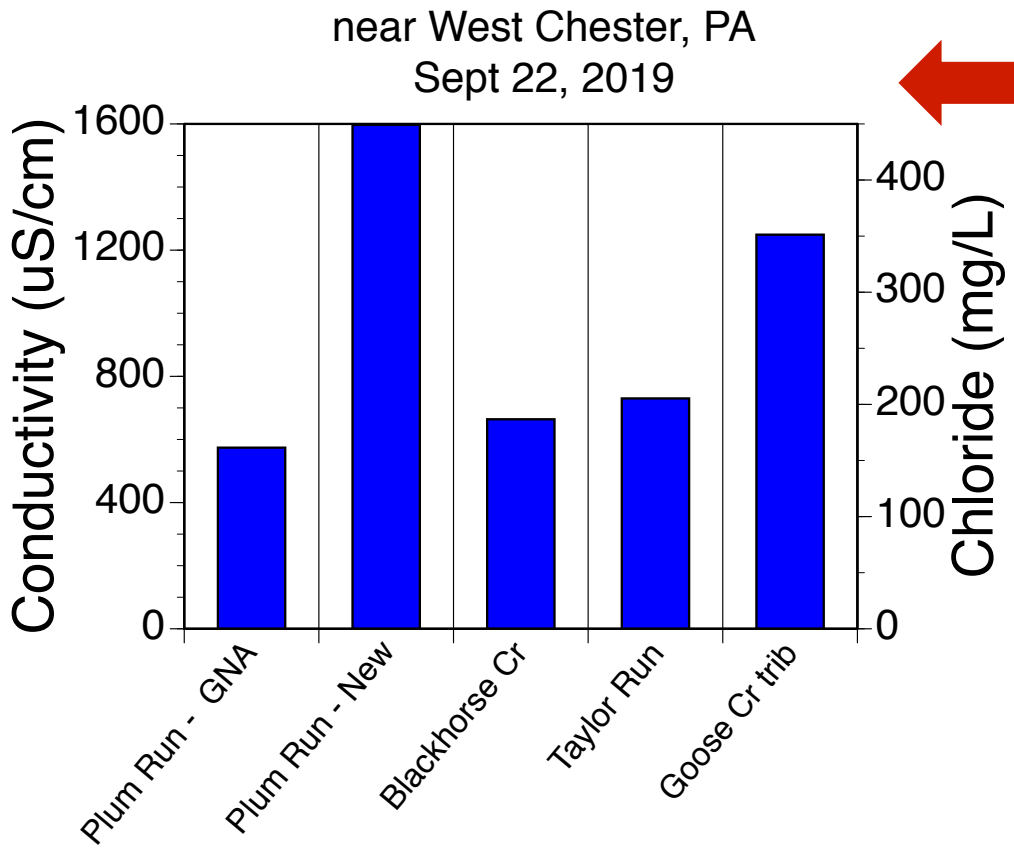


Patty Haag

WCU MS Student

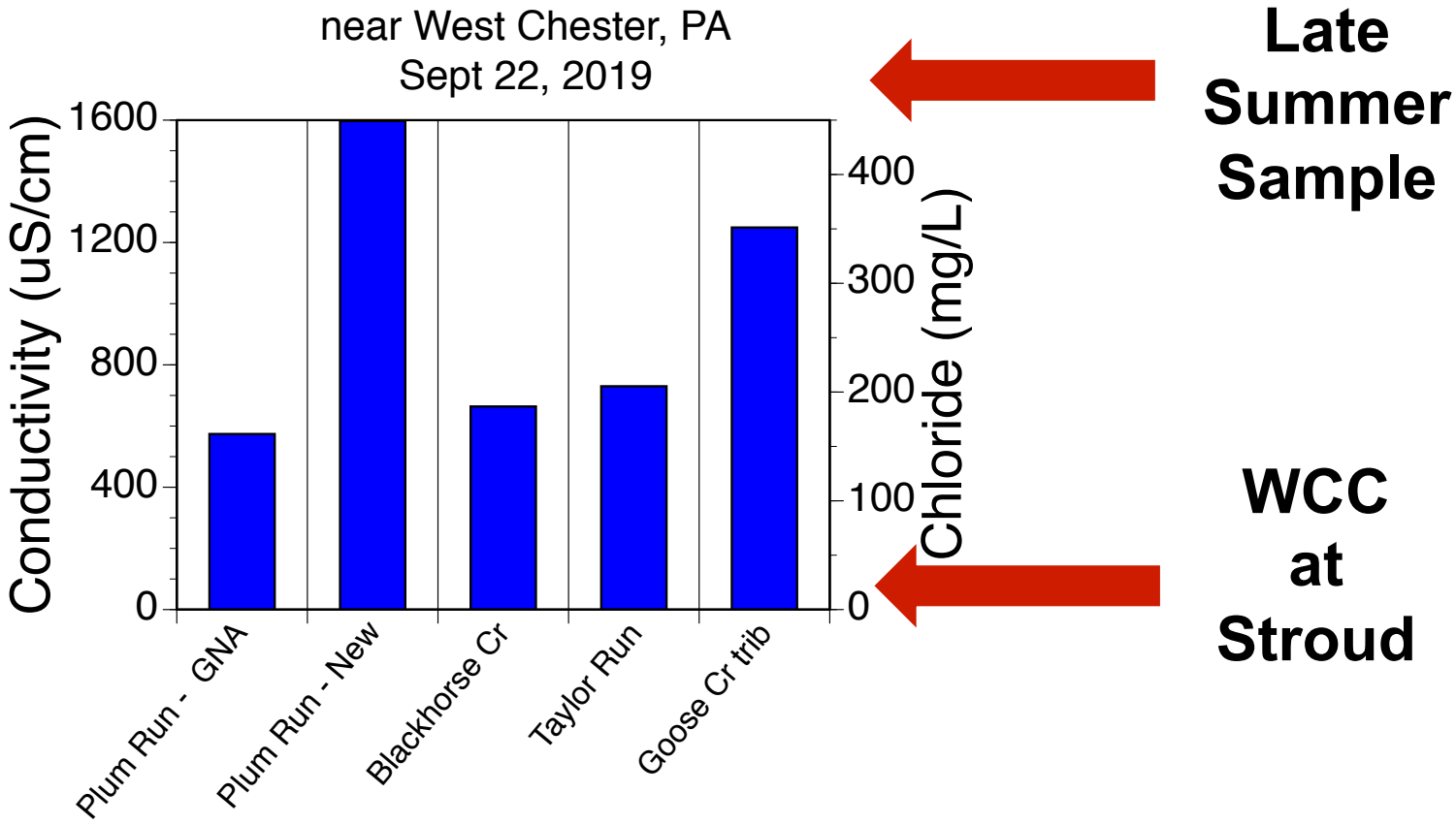
Chester Co Master Watershed Steward

Salt concentration in urban streams is always elevated

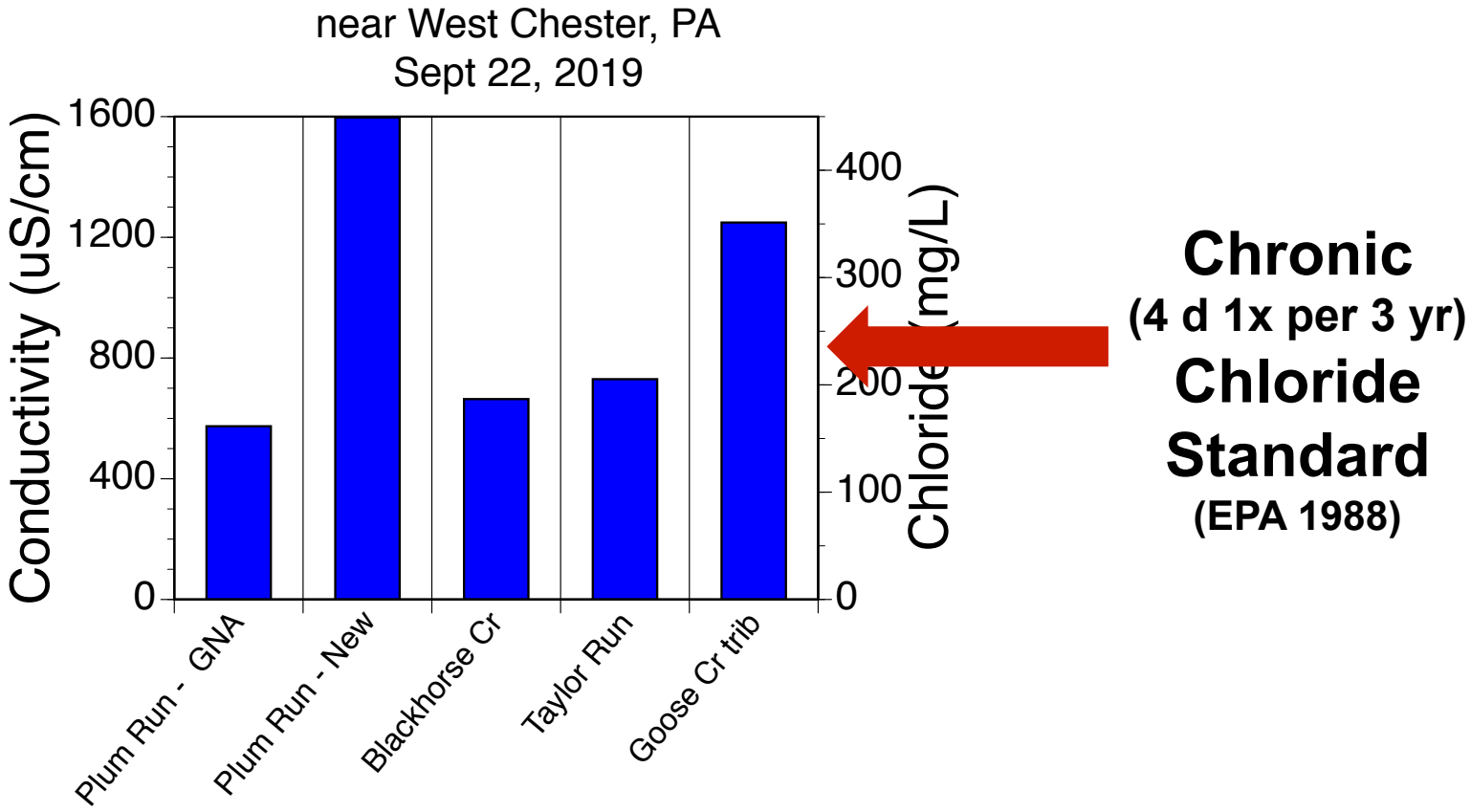


Late Summer Sample

Salt concentration in urban streams is always elevated



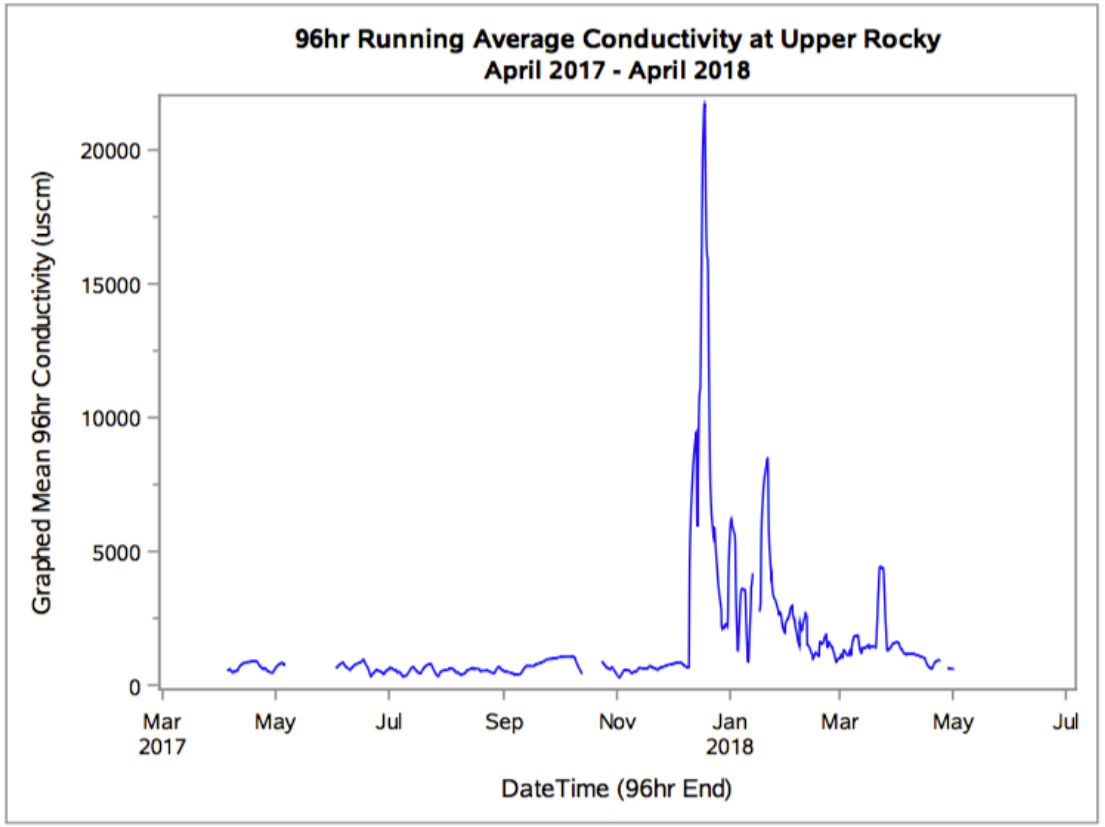
Salt concentration in urban streams is always elevated



Salt concentration always elevated, but highly variable

Peaks at 20,000 to 40,000 µS/cm

Seawater 55,000 µS/cm



TNC Stream Stewards

First State National Historic Park

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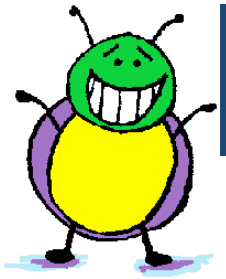
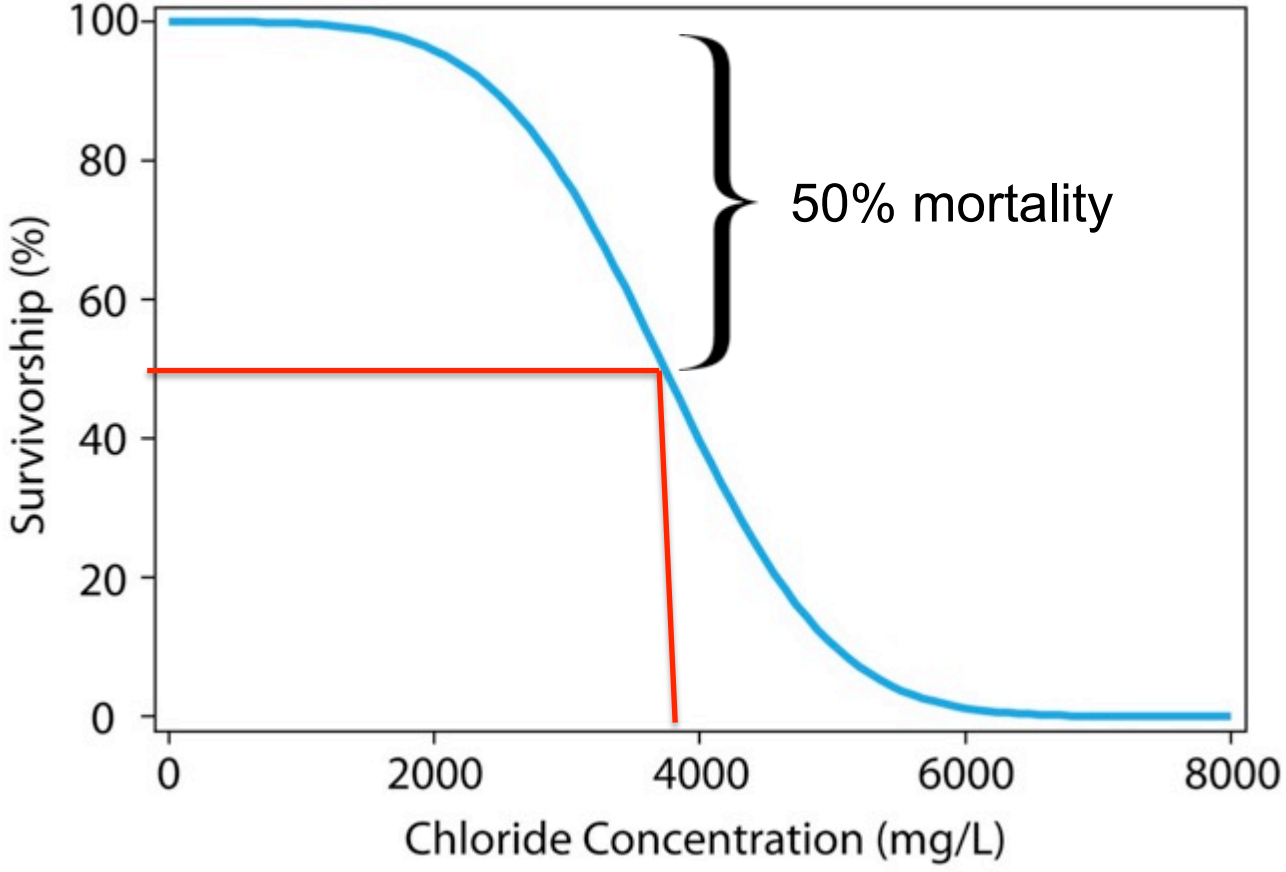


Assessing salt toxicity

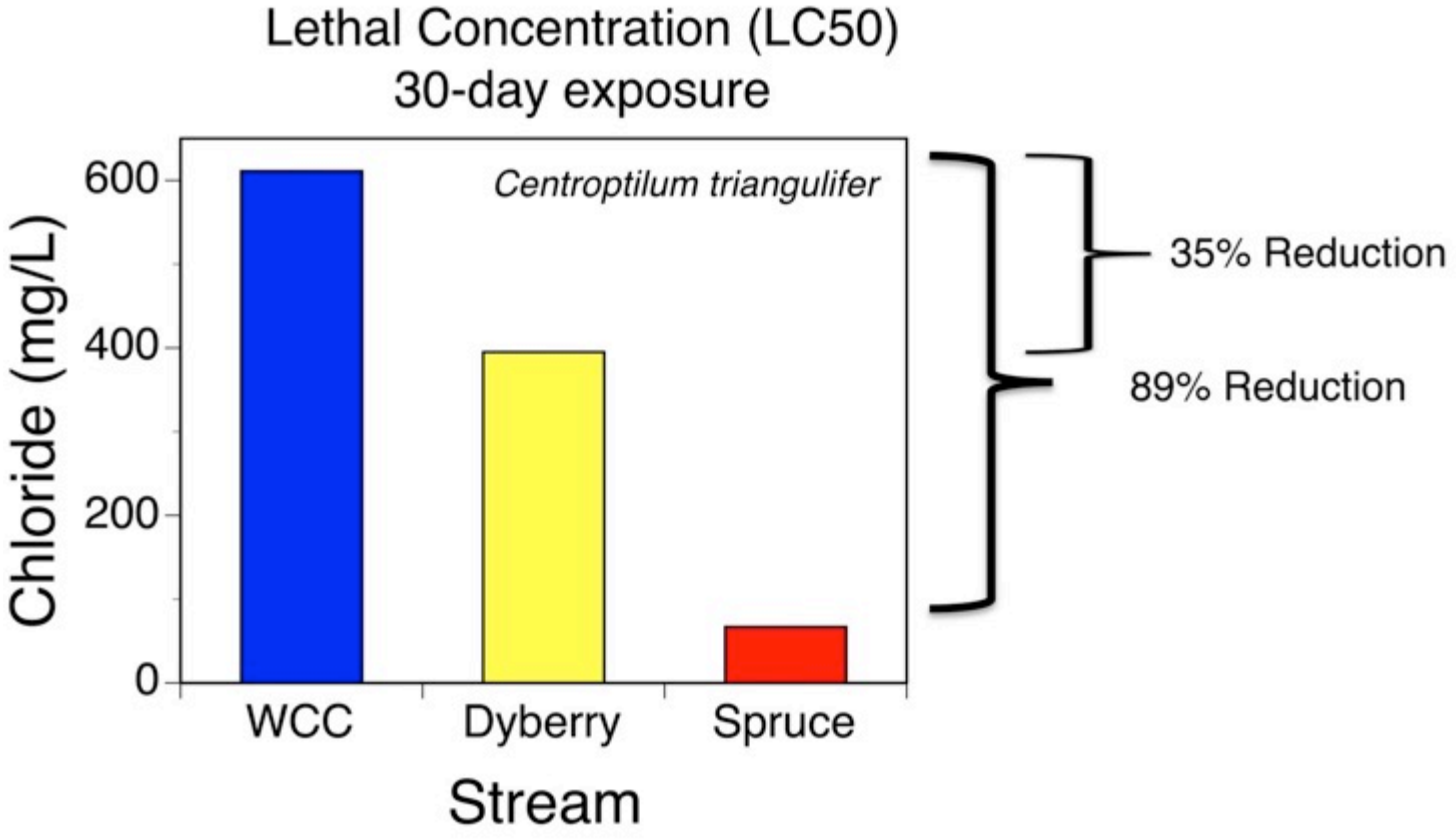
Dose Response Curve



LC50

Lethal Concentration that results in 50% mortality

Toxicity decreases with increased hardness



Moderately Hard ← Soft

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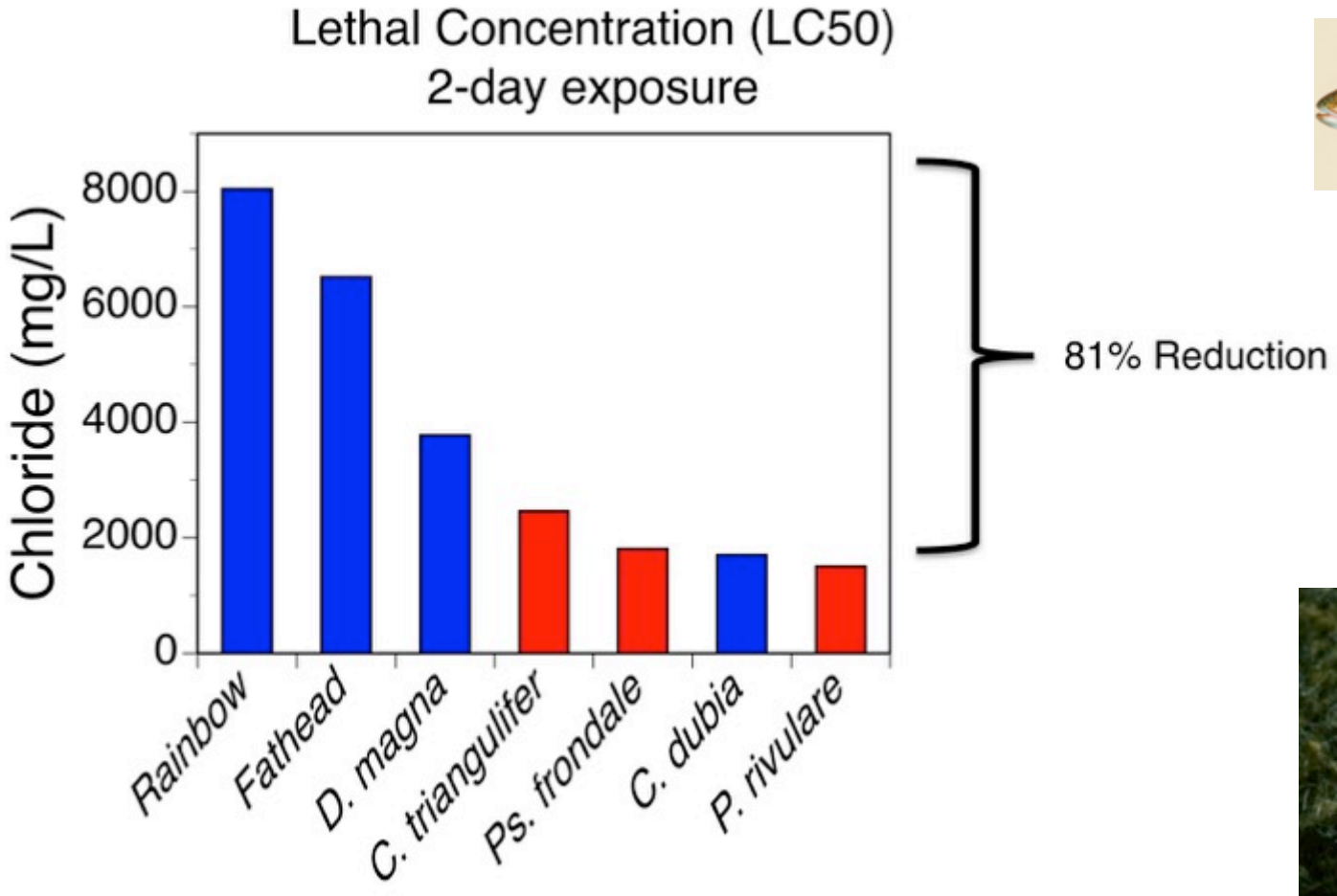
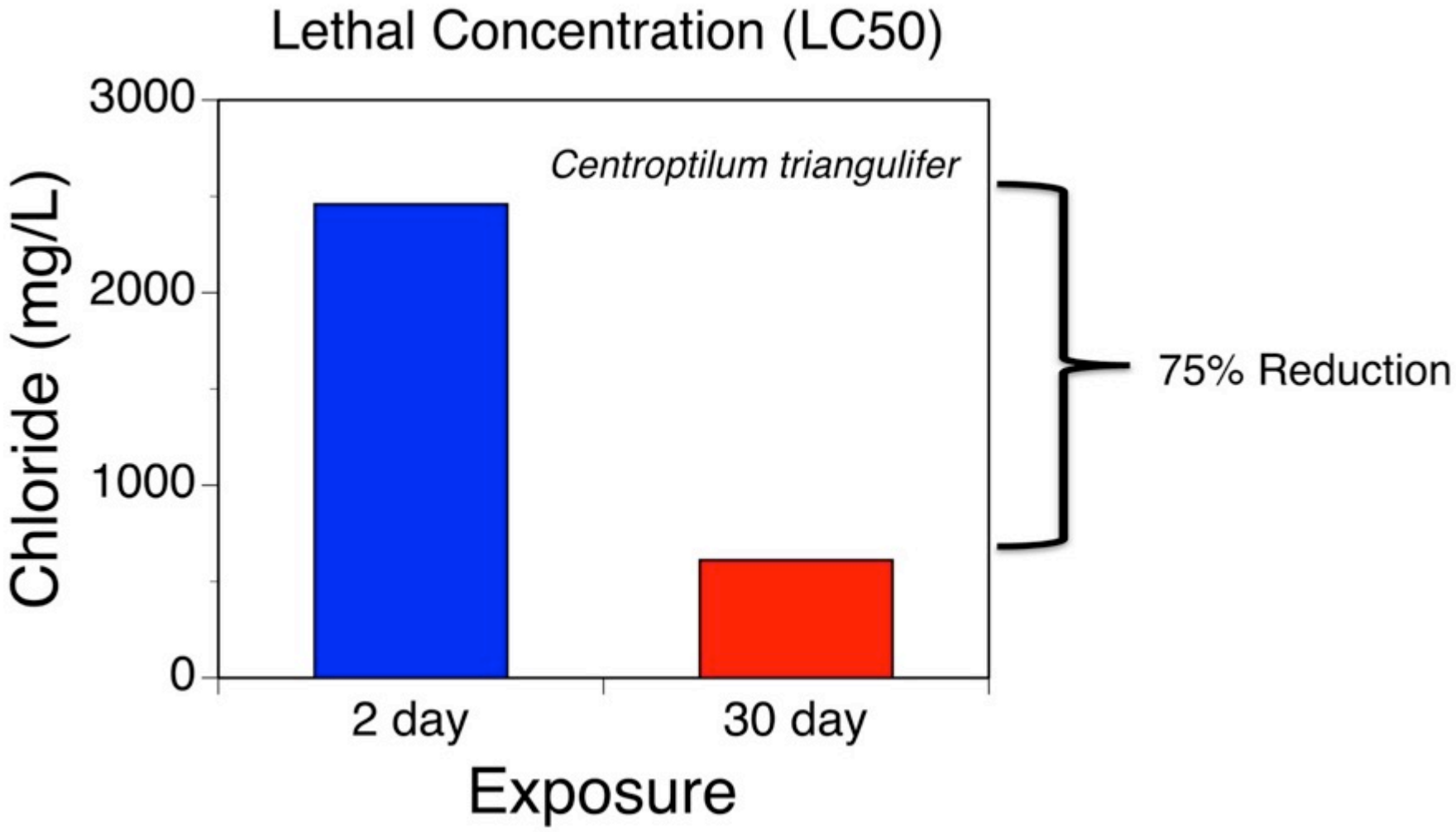
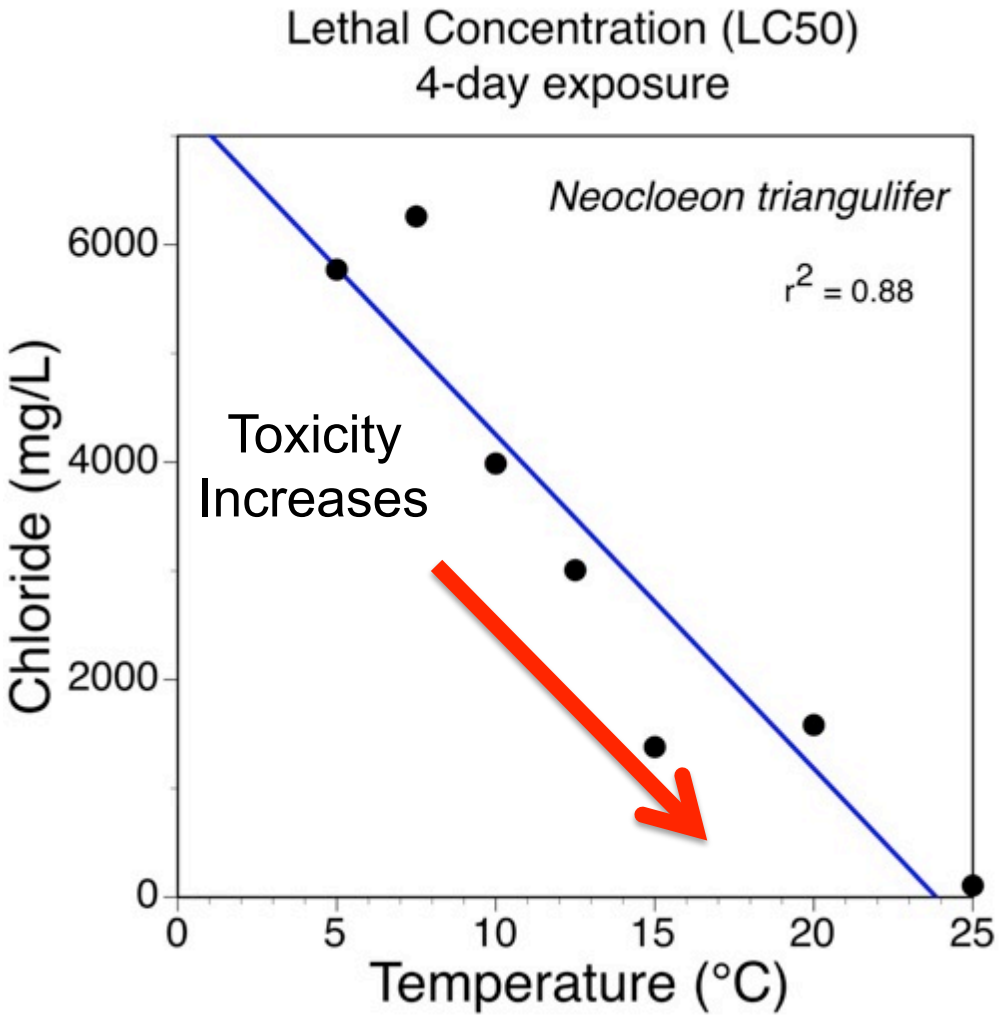
Not all species are sensitive



Toxicity increases with exposure duration



Toxicity is less in cold water



75% reduction

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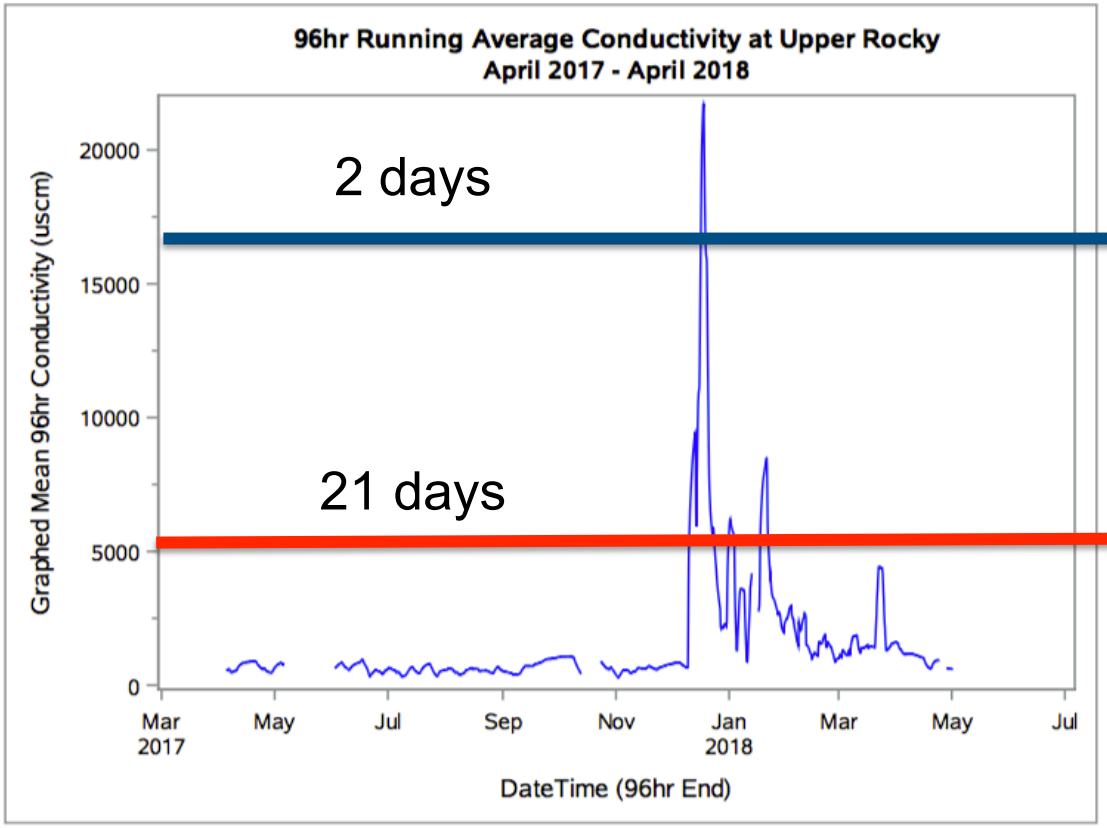
Salt concentration always elevated, and temperature matters



N. triangulifer

Acute LC50 @ 5°C

Acute LC50 @ 20°C

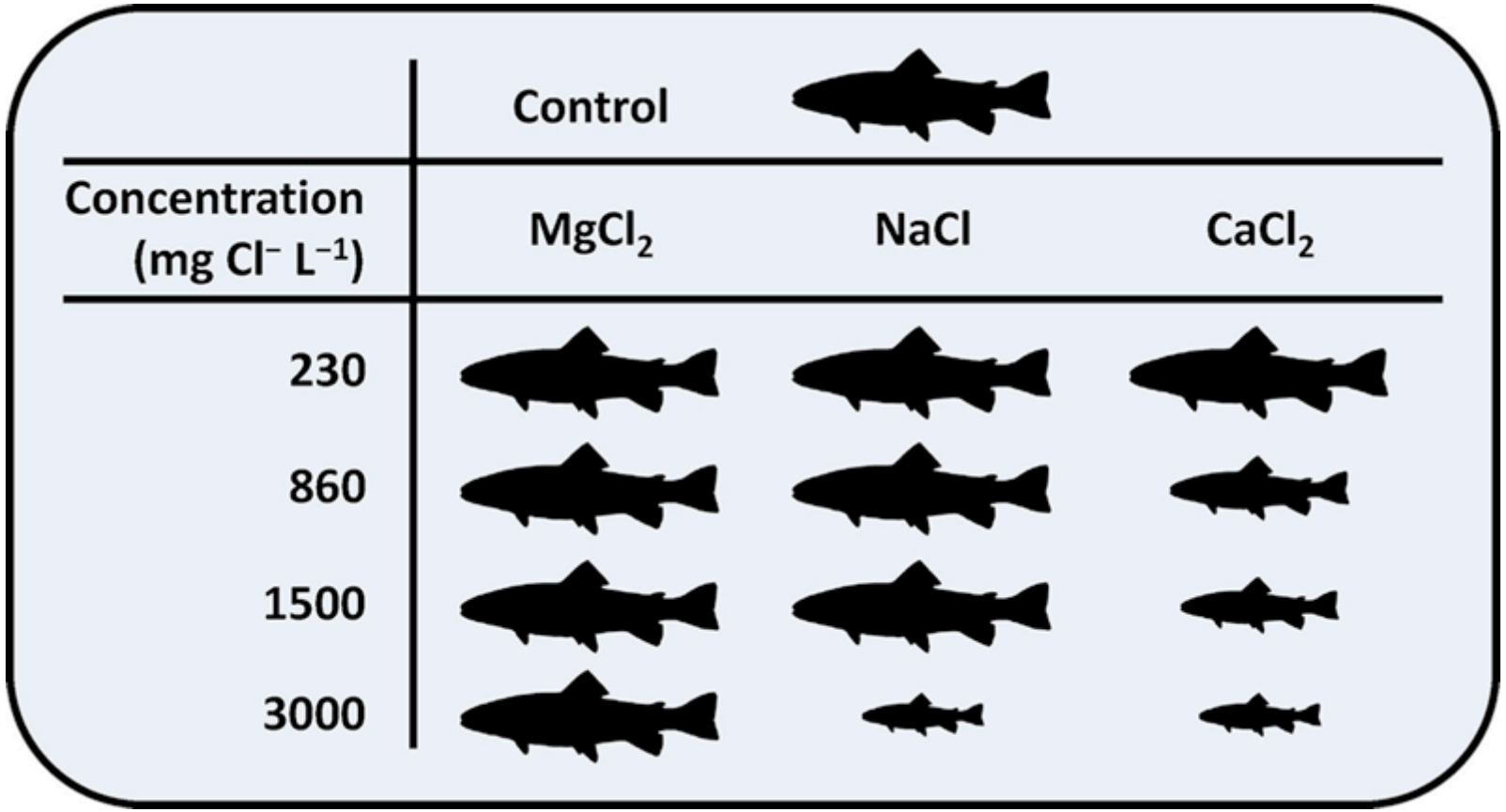
Not all salts are equal

Acute toxicity (48 h)

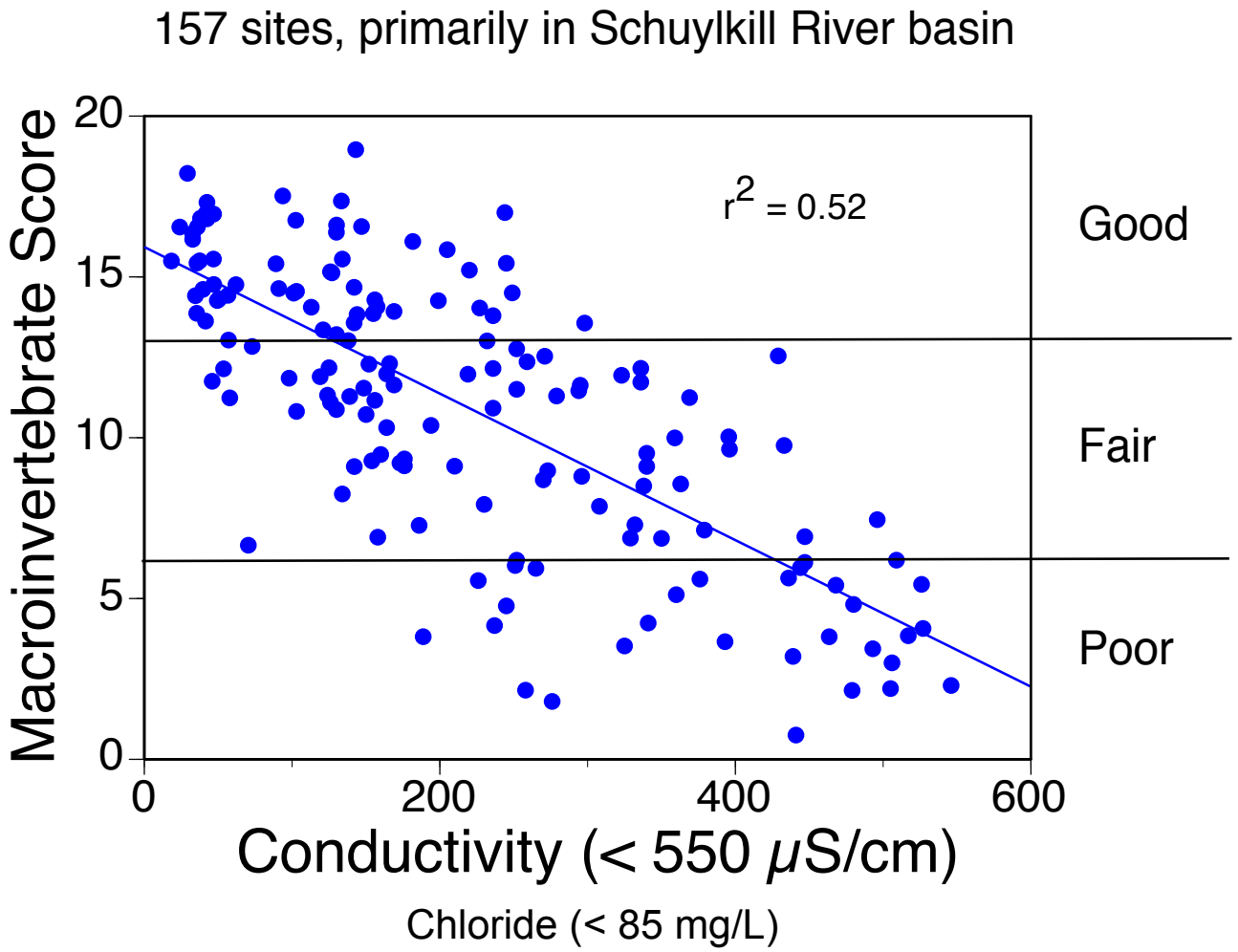
	Ceriodaphnia dubia LC50 (mg Cl/L)	*Daphnia magna* LC50 (mg Cl/L)	*Pimephales promelas* LC50 (mg Cl/L)
NaCl	1,960	4,770	6,510
$MgCl_2$	880	1,330	2,840
$CaCl_2$	1,830	2,770	>6,560

Not all salts are equal

Rainbow trout – growth (25 d)

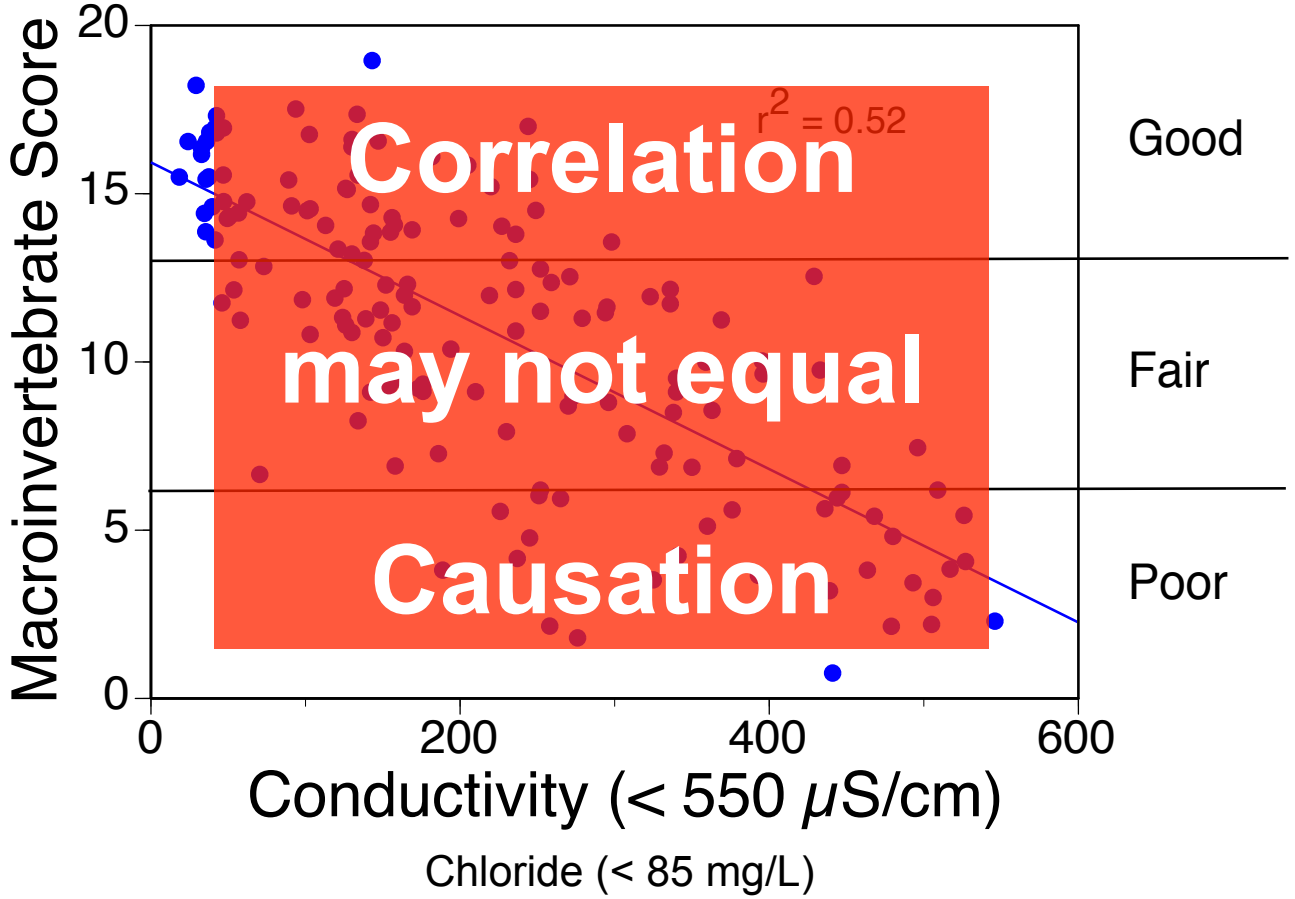


Conductivity Correlates with Degradation



Conductivity Correlates with Degradation

157 sites, primarily in Schuylkill River basin



Salt Illustrates Land/People Connection to Water:

Toxins:

Salt

Oils

Metals

Sealants

Herbicides

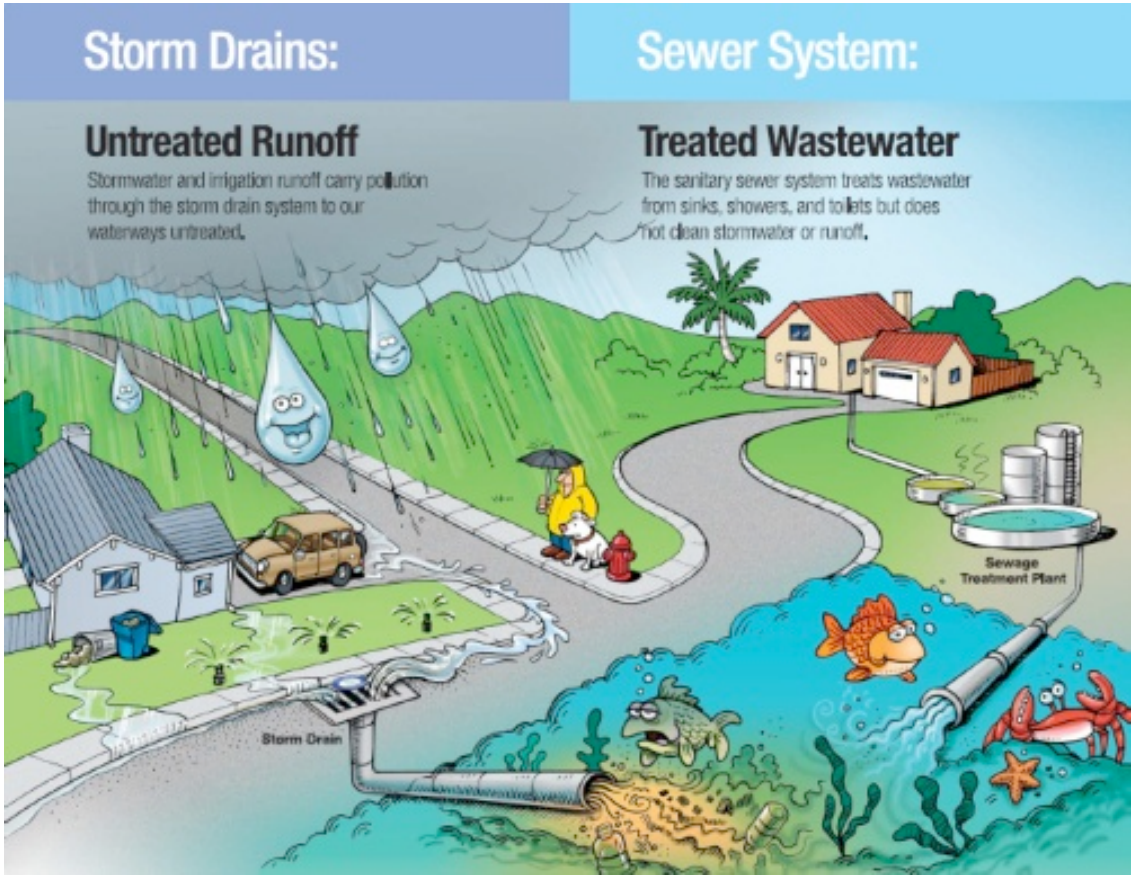
Insecticides

Soaps

Drugs

Personal Care

Fertilizers



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There are new pollutants of concern today

Winter deicing salts (2003)

PAHs in coal tar seal coats (2003)

6PPD-quinone from tires (2020)

Salt Levels of Concern

LC 50s for a few mayflies

moderately hard water at 20°C

	Chloride (mg/L)	Conductivity (uS/cm)
Acute (96 h)	311-2894	1013-8603
Chronic (30 d)	151-898	543-2738

Points to Remember

- Salt in streams is increasing, especially urban streams
- Elevated salt can cause physiological stress or even be toxic for aquatic organisms. Brief salt spikes in winter are not well understood.
- Impact of elevated salt depends on concentration, stream hardness, exposure duration, type of salt, water temperature, and species


Questions?


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