Stormwater management practices as control points for salt transport and impacts

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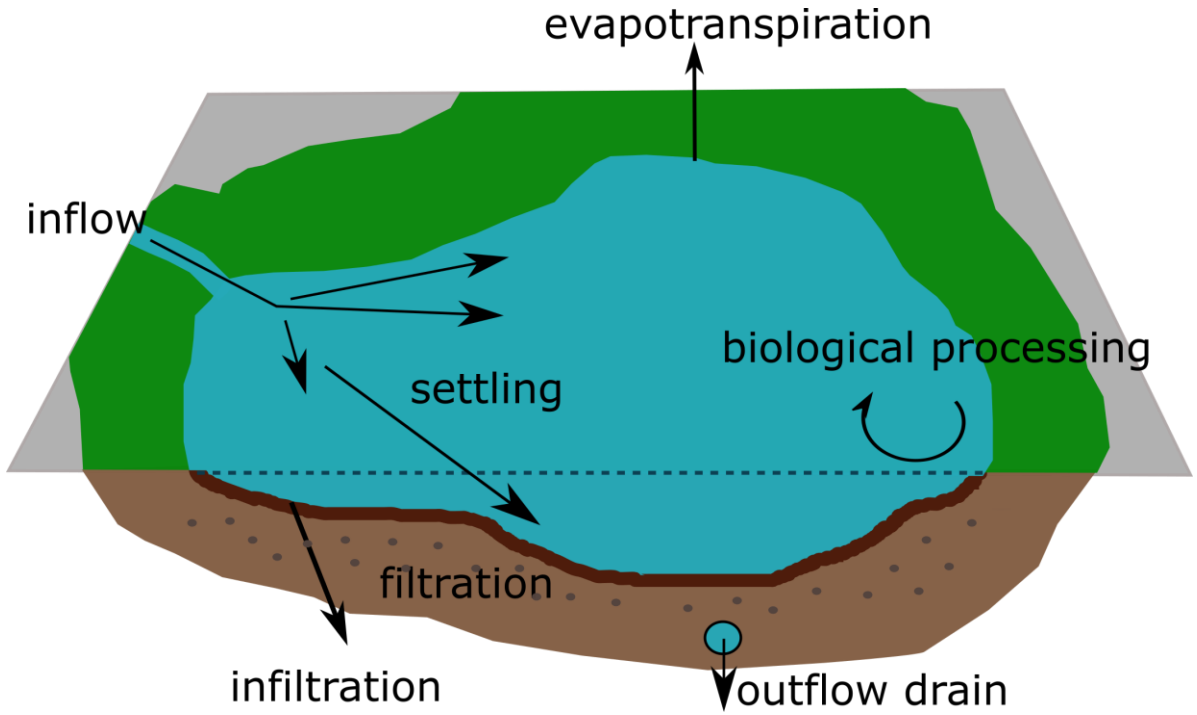
What are stormwater management practices primarily designed to do?

- Reduce volume & peak flow rates of runoff from impervious surfaces
- Remove pollutants in the runoff



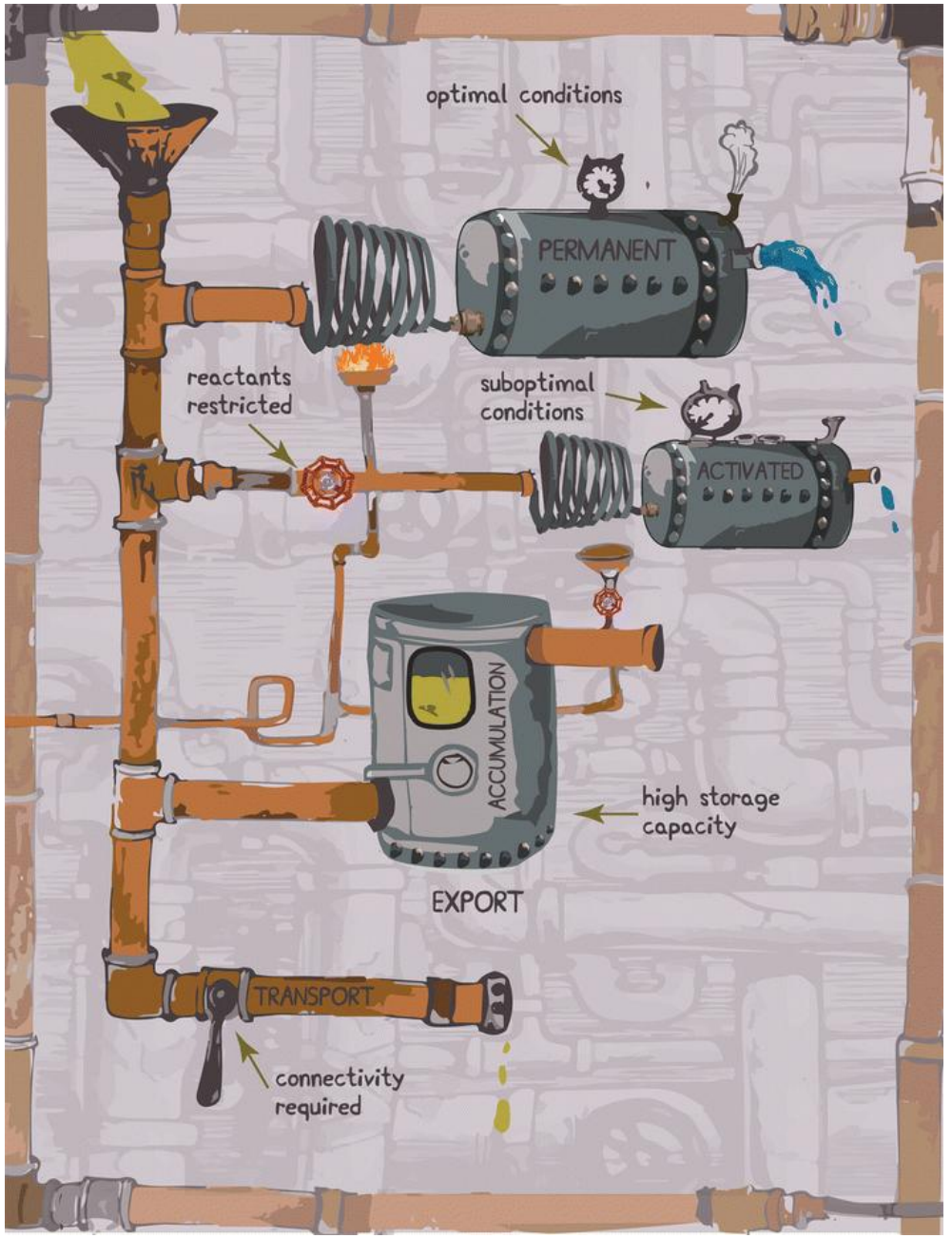
We like to think about them when they look like this

…but the reality is that we can’t ignore what’s happening in winter!

What’s happening with de-ciers in between the roads/sidewalks/parking lots + streams/groundwater?

It often routes through stormwater management practices

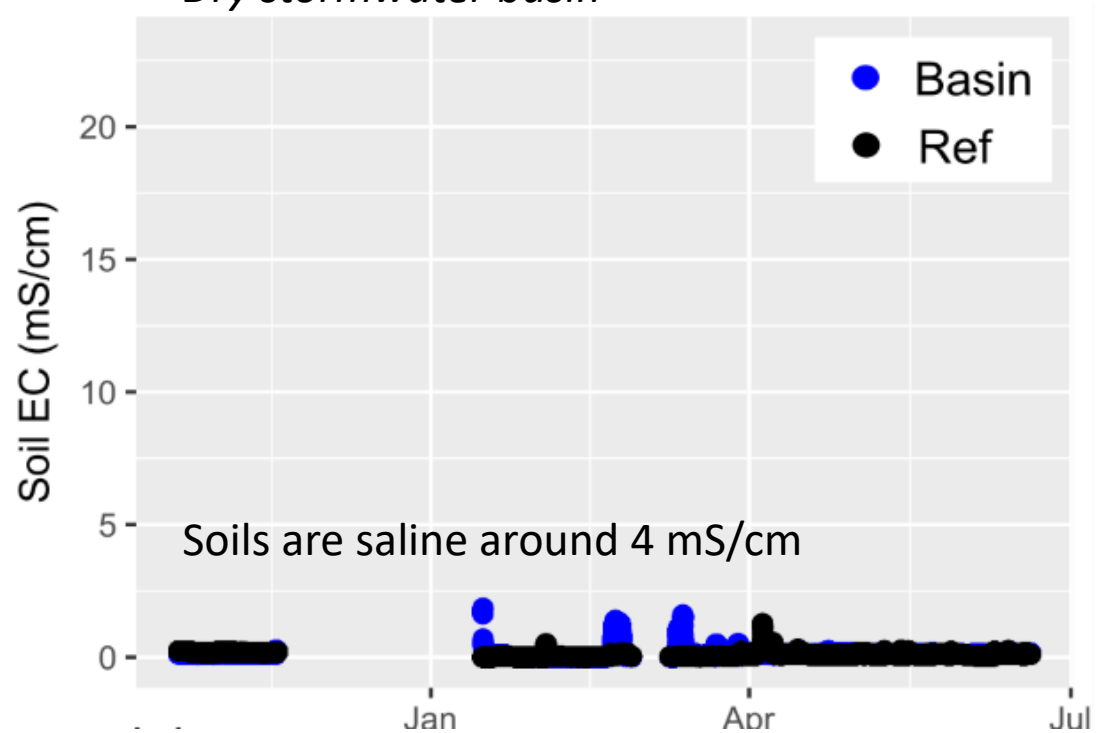
Stormwater management practices are important control points for salt transport, (limited) retention, and impacts



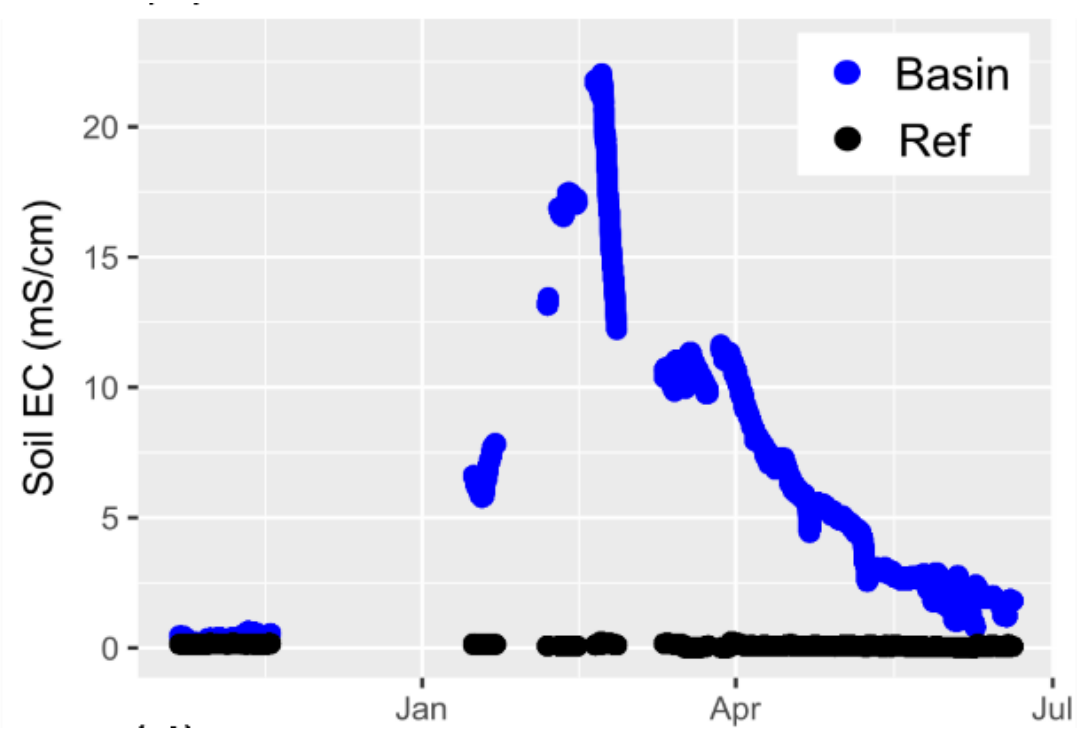
Bernhardt et al. 2017 *Ecosystems*

Stormwater basins are intercepting salt and temporarily storing it

Dry stormwater basin



Wet stormwater basin



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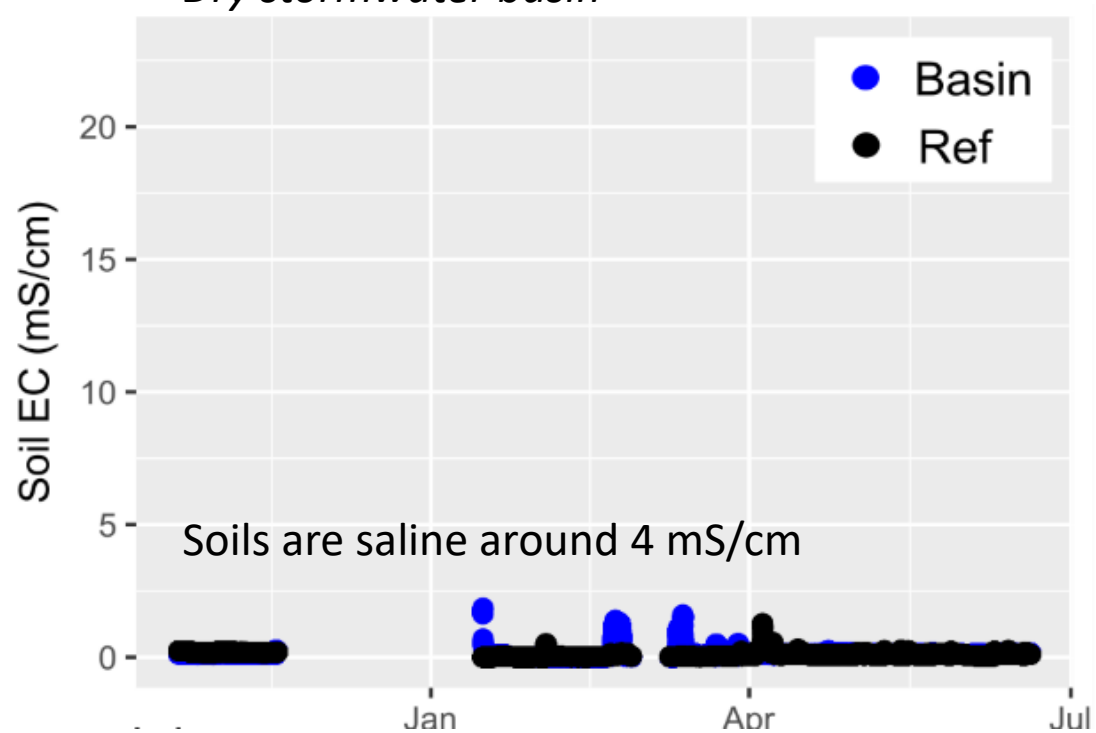

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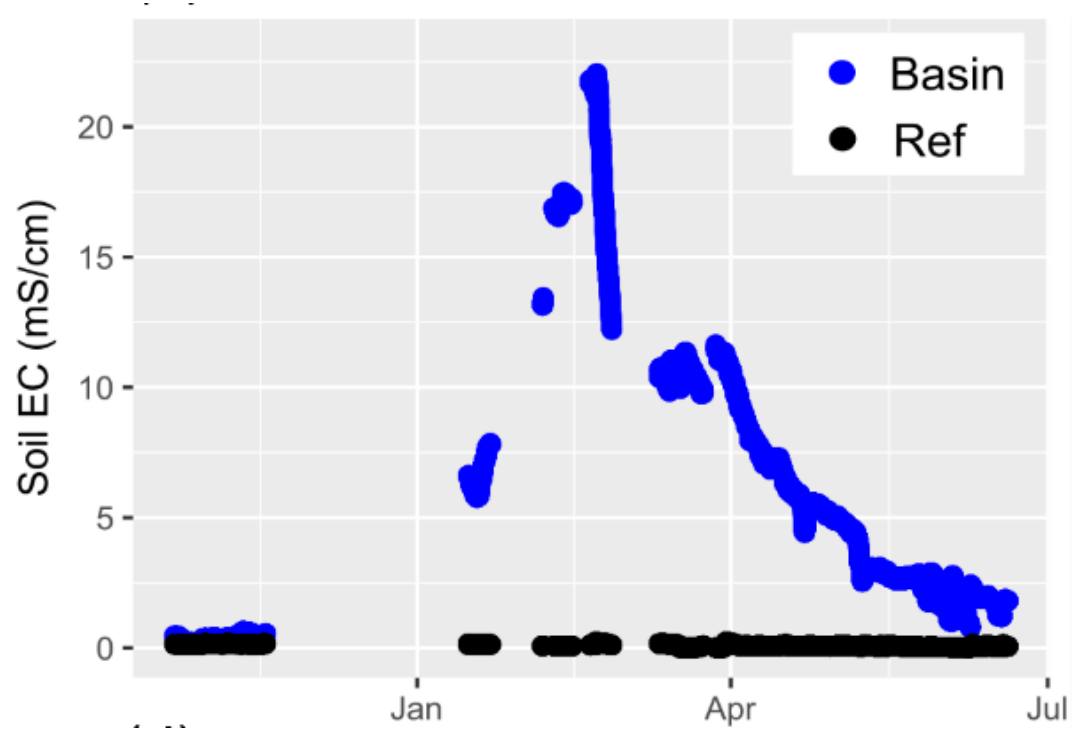


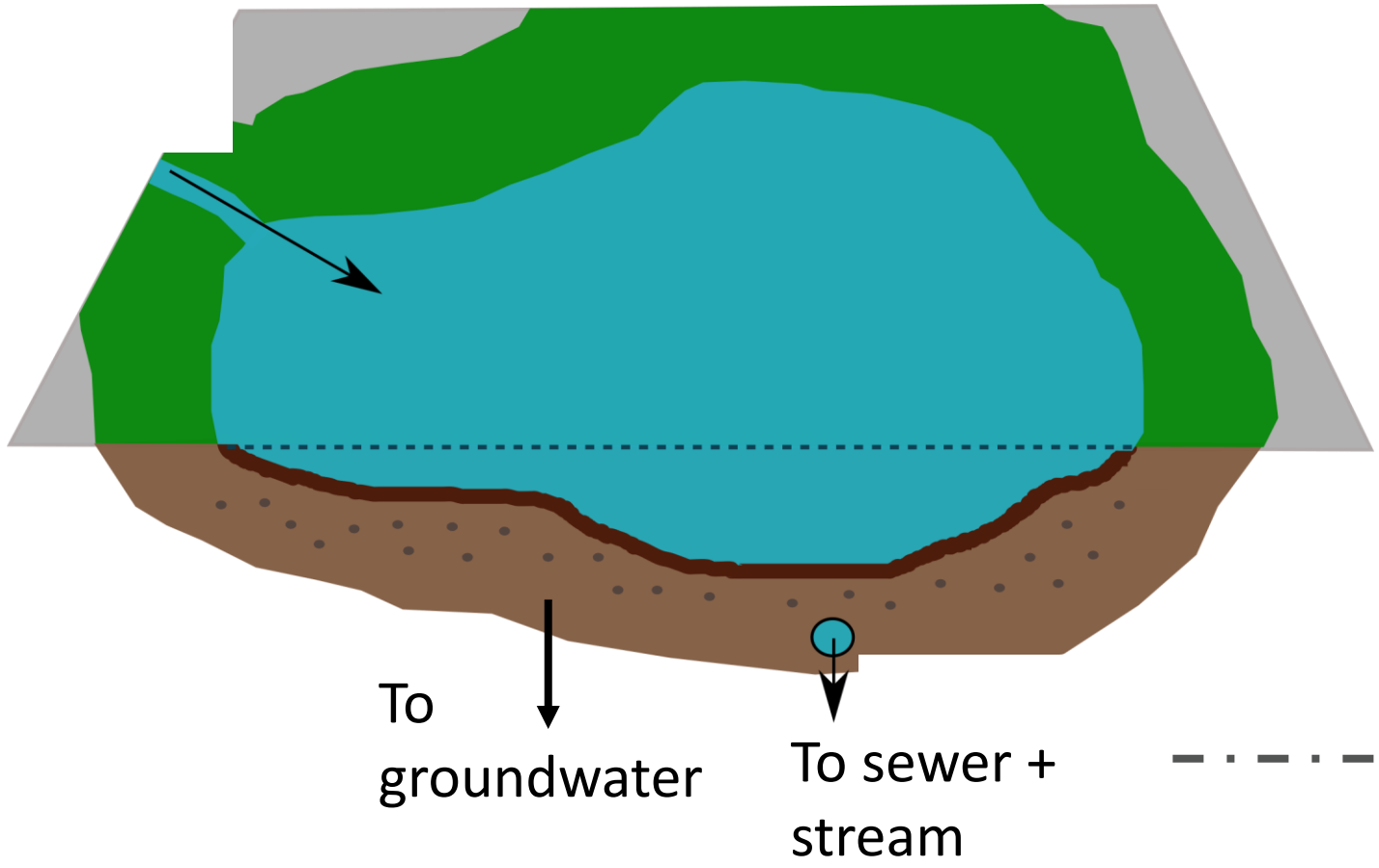
Wet basins store it longer, and can get very salty!

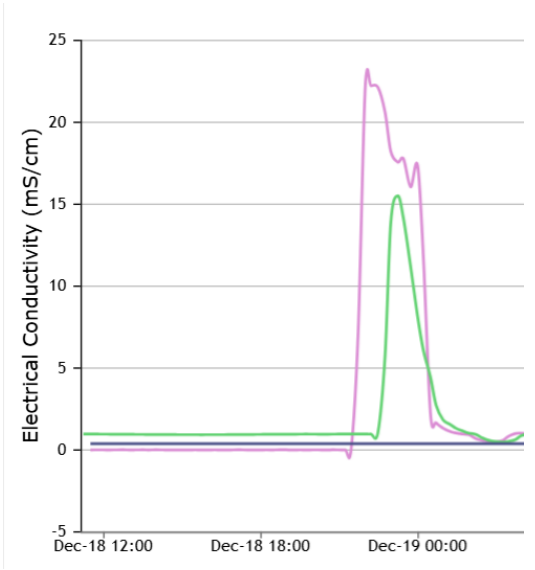
There are limited opportunities for permanent sinks of salt

A few plant species can phytoaccumulate salt, but this is a limited part of the salt budget,~5%

Reference: Long, Rippy et al. 2025, *Science of Total Environment*

Depending on basin design, the salty water may head downstream, or to groundwater…
….which has implications for downstream salt patterns





So what are the impacts of all this salt moving through stormwater basins?

Potential impacts of de-icing salts

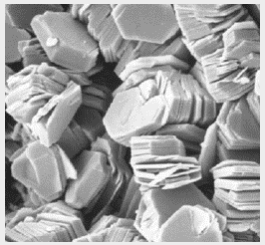
Biological

Cl and Na kill bacteria and plants, reduce denitrification, assimilation

Physical

Clay dispersion

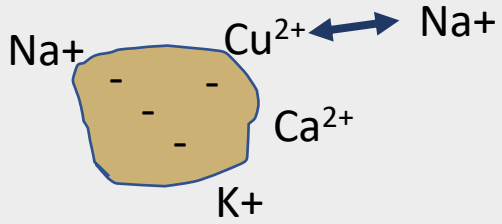
Colloid transport



Clogging

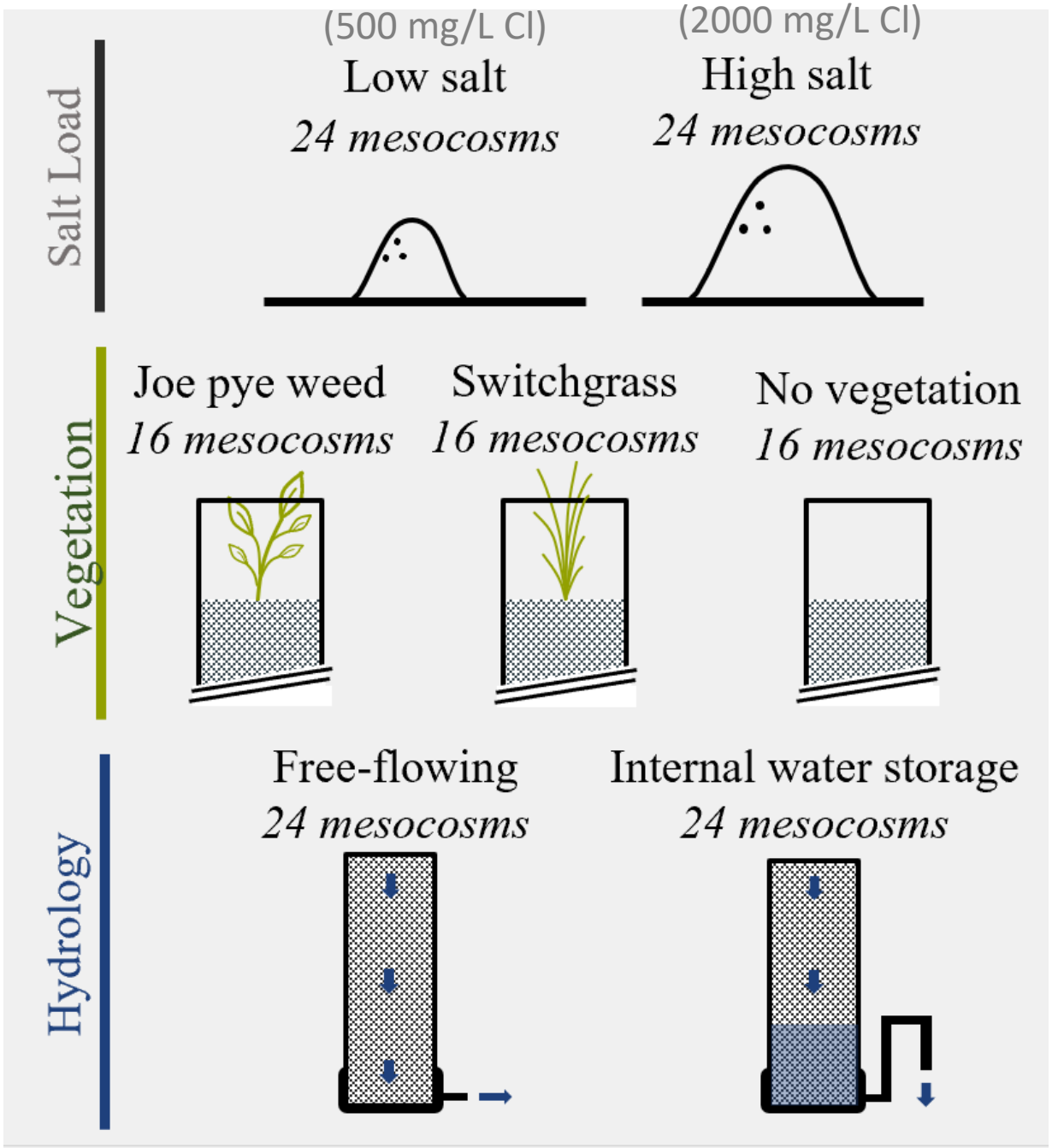
Chemical

Sodium competes with other cations, and can exchange with metals previously sorbed to soils

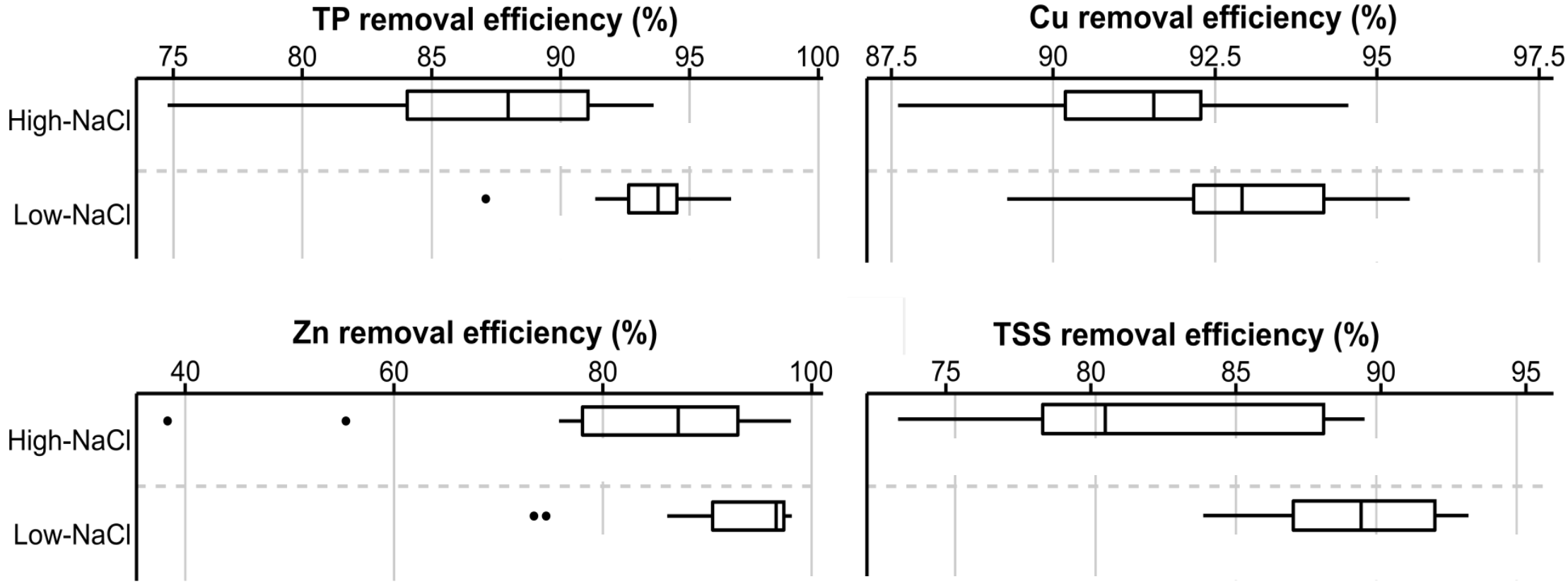


Chloride complexes with heavy metals

Insights from a controlled study to look at interactions between salt load, design, plant type on water quality performance



Higher salt load led to reduced TSS, P, and metals removal



Reference: Brown, Hoffman, McPhillips 2024, *ES& T Water*

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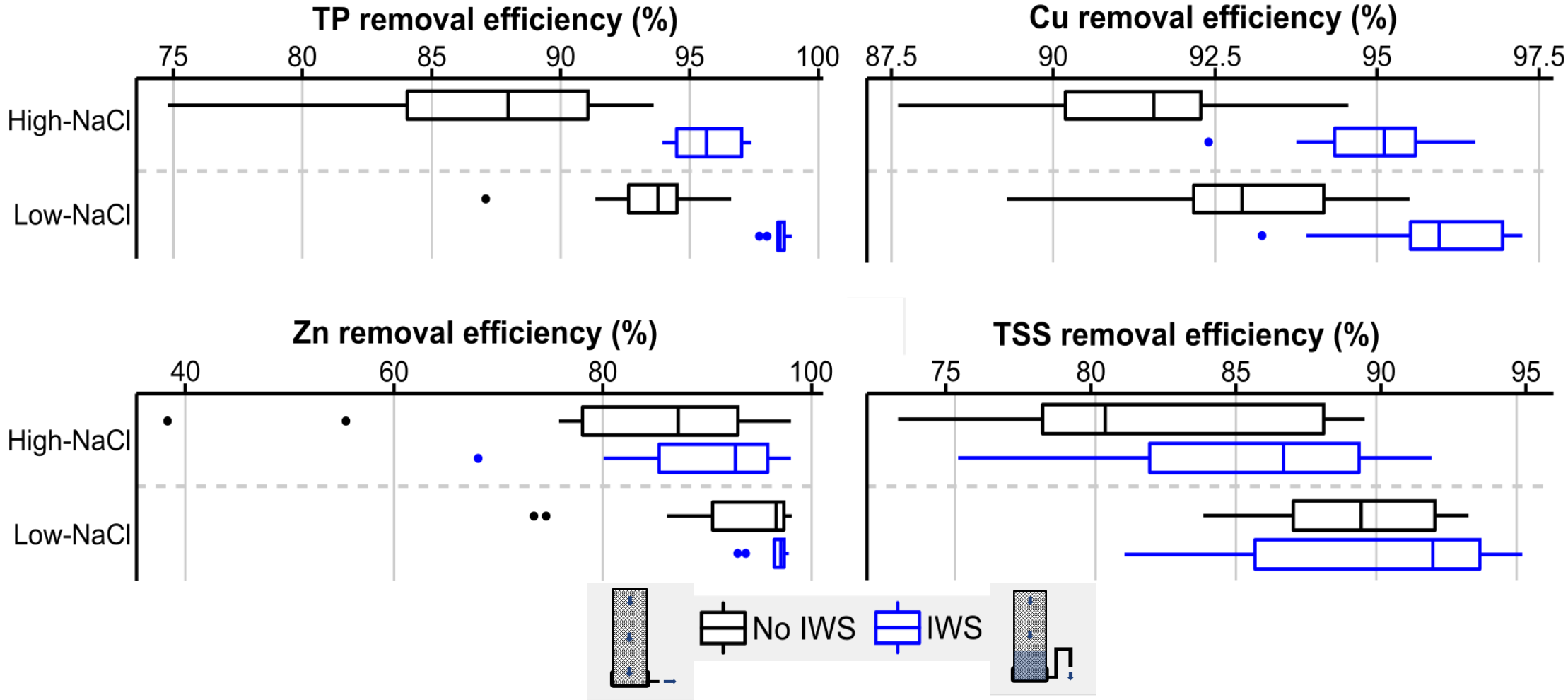
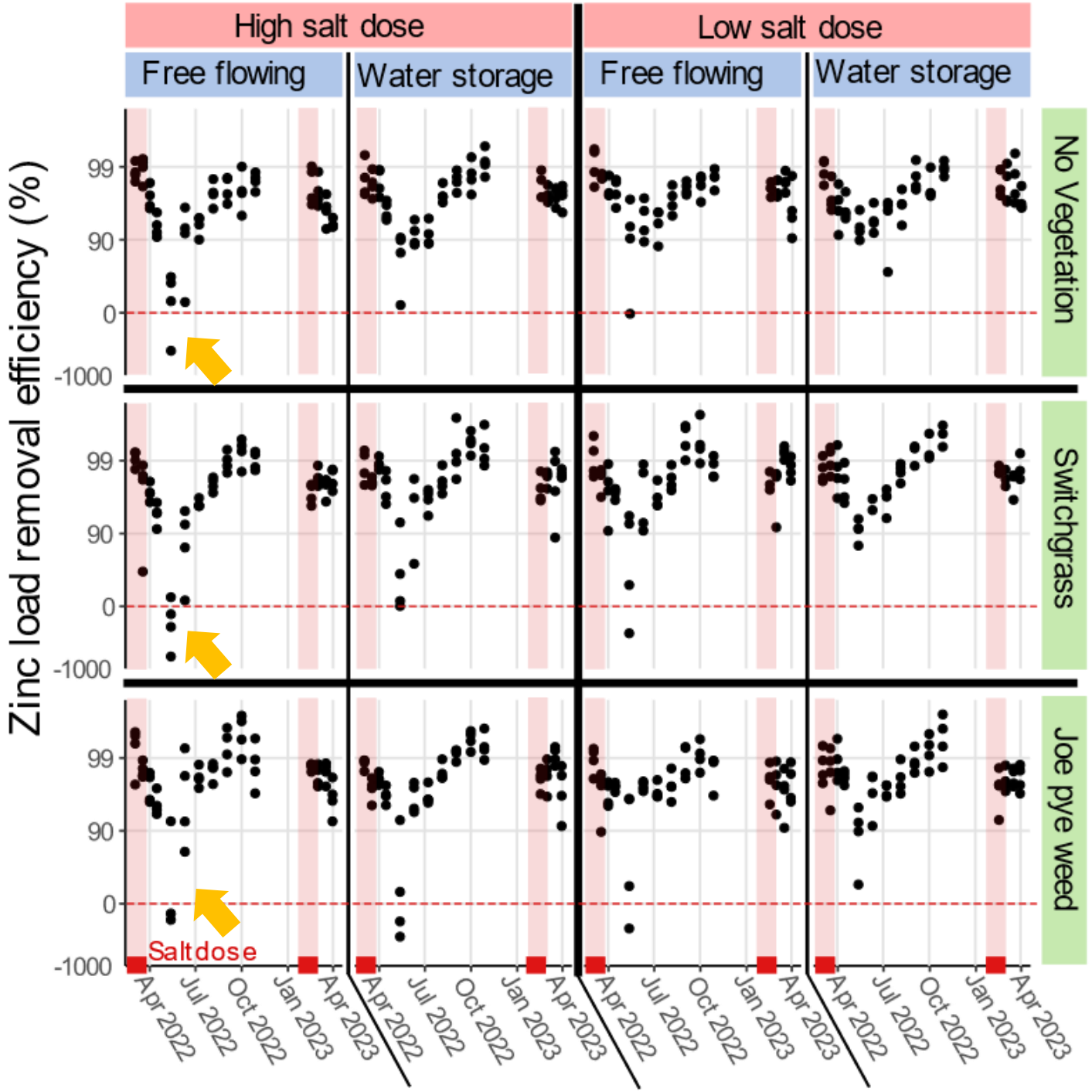
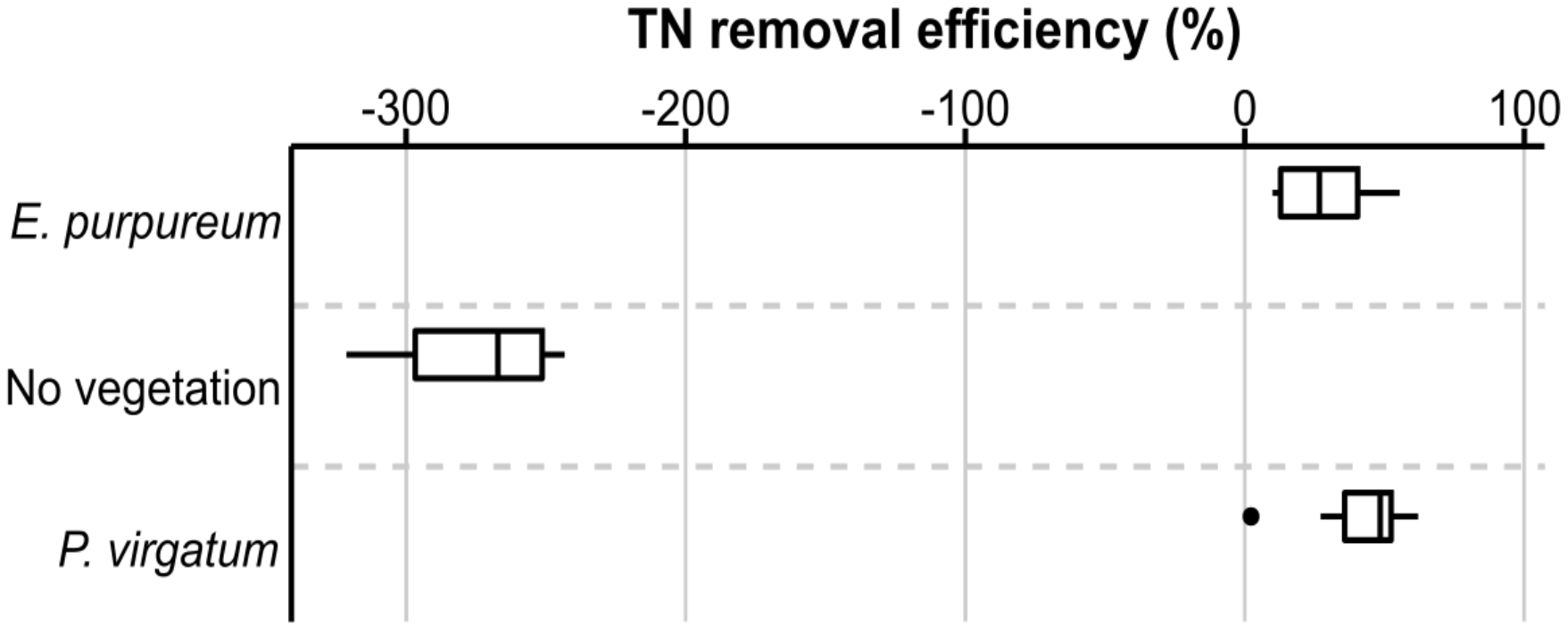


Internal water storage (IWS) buffered some salt impact

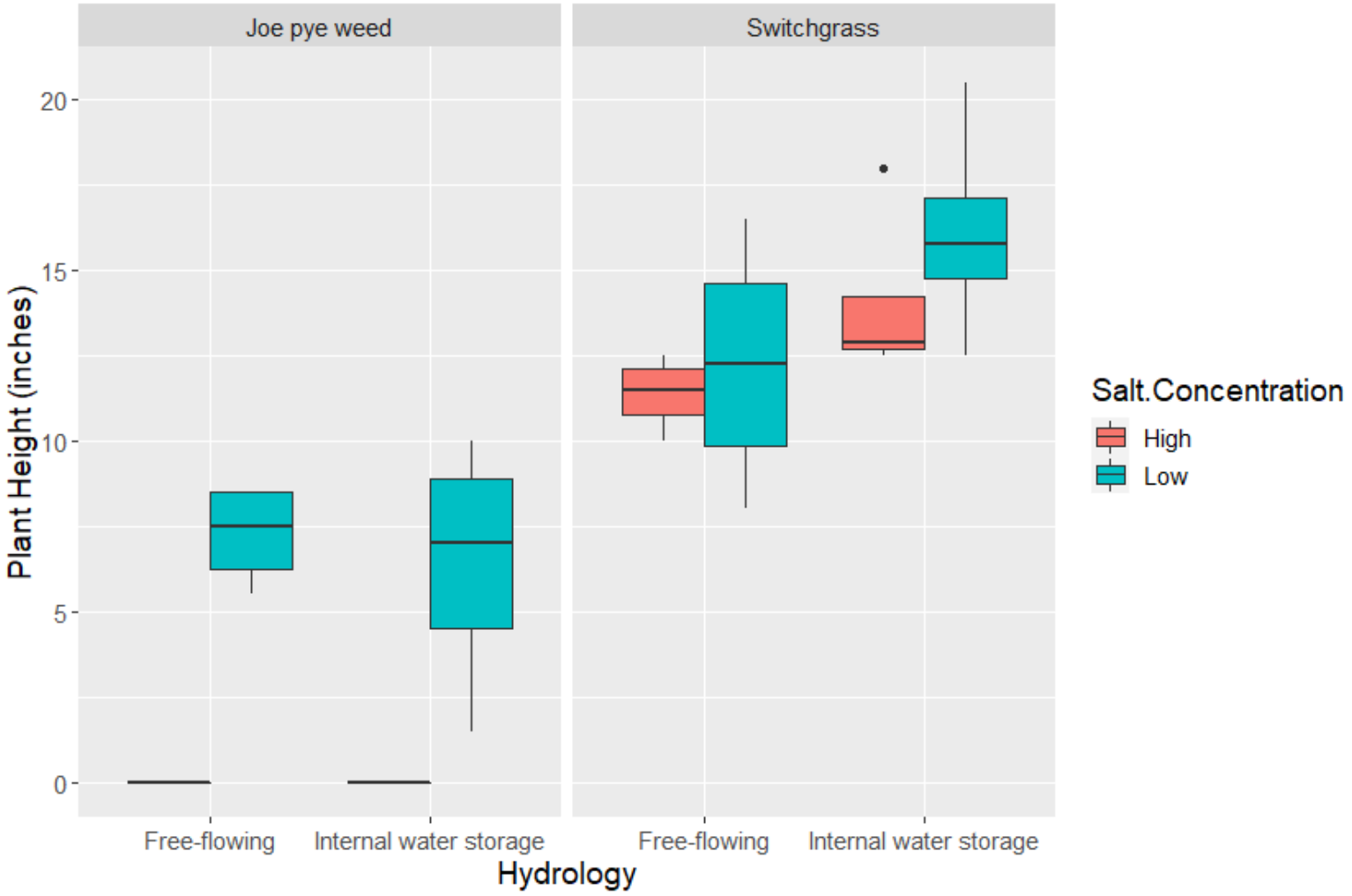
Poor Zn performance was driven by acute leaching events, occurring shortly after the last salty stormwater dosings



Salt load did not strongly impact N retention overall (though did have indirect effects via plant health)



While switchgrass was fairly resilient, Joe Pye Weed was strongly affected by higher salt inputs



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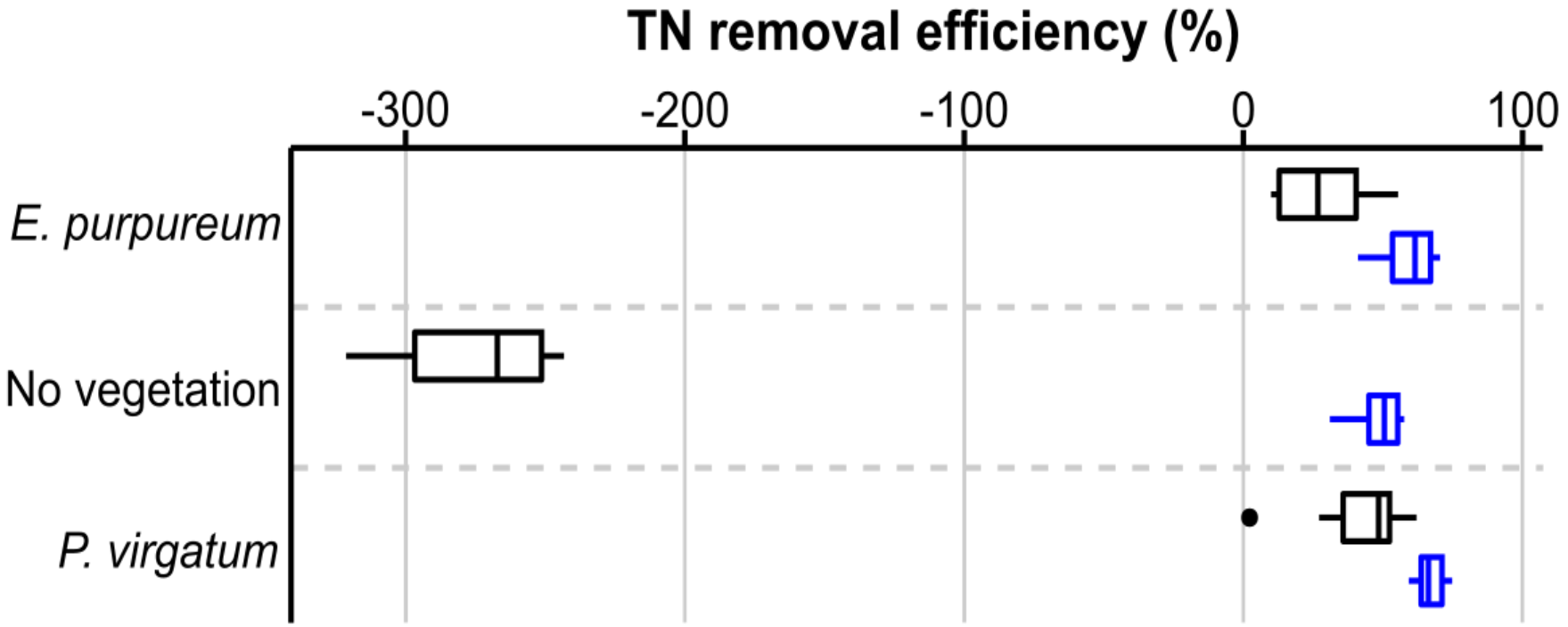
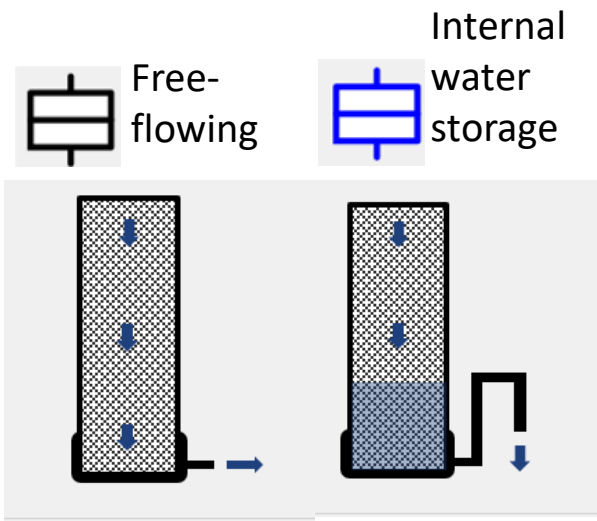
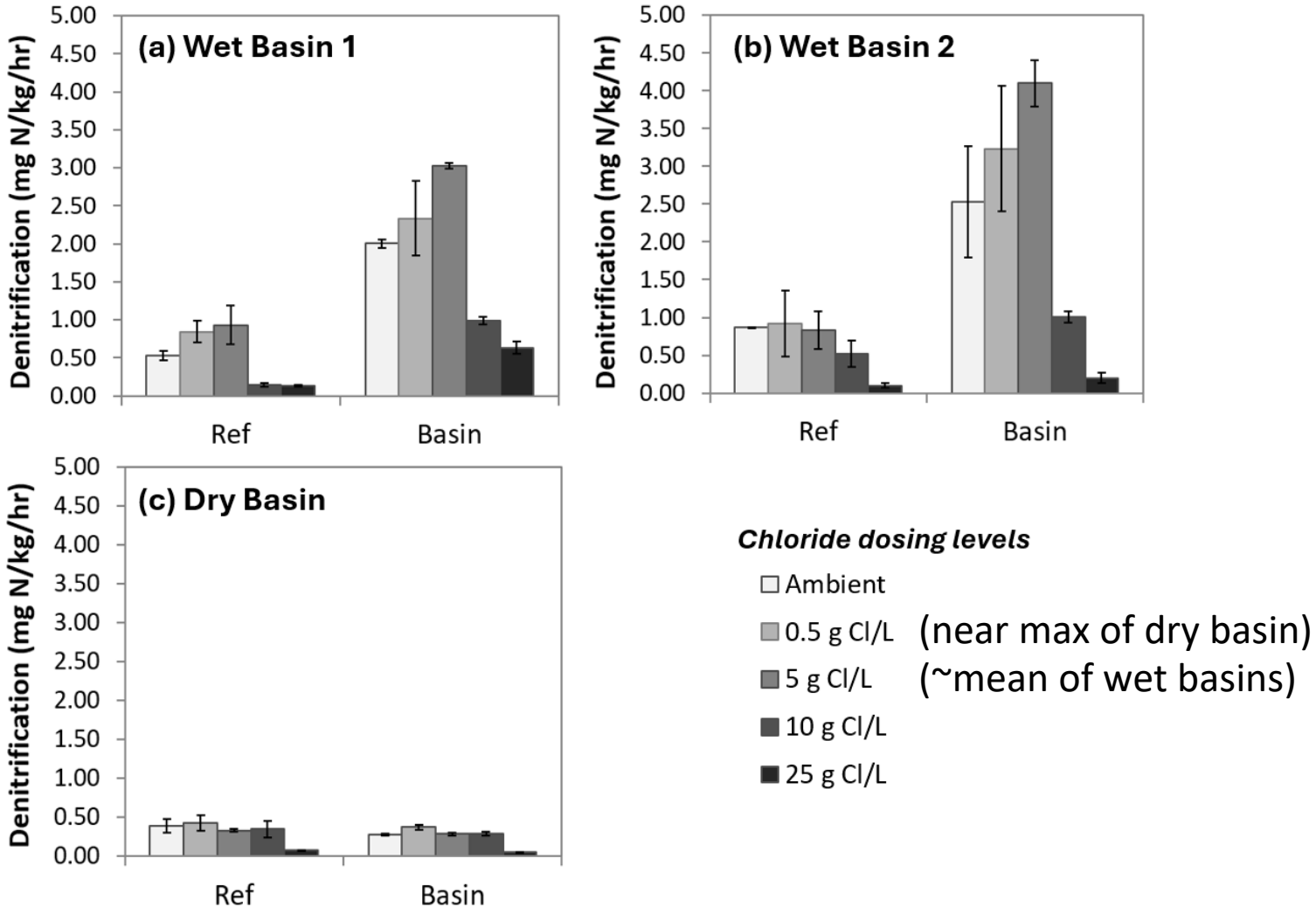
Internal water storage universally improves N retention





Stormwater basin soils do seem to demonstrate resilience in some microbial processes like denitrification



(near max of dry basin)

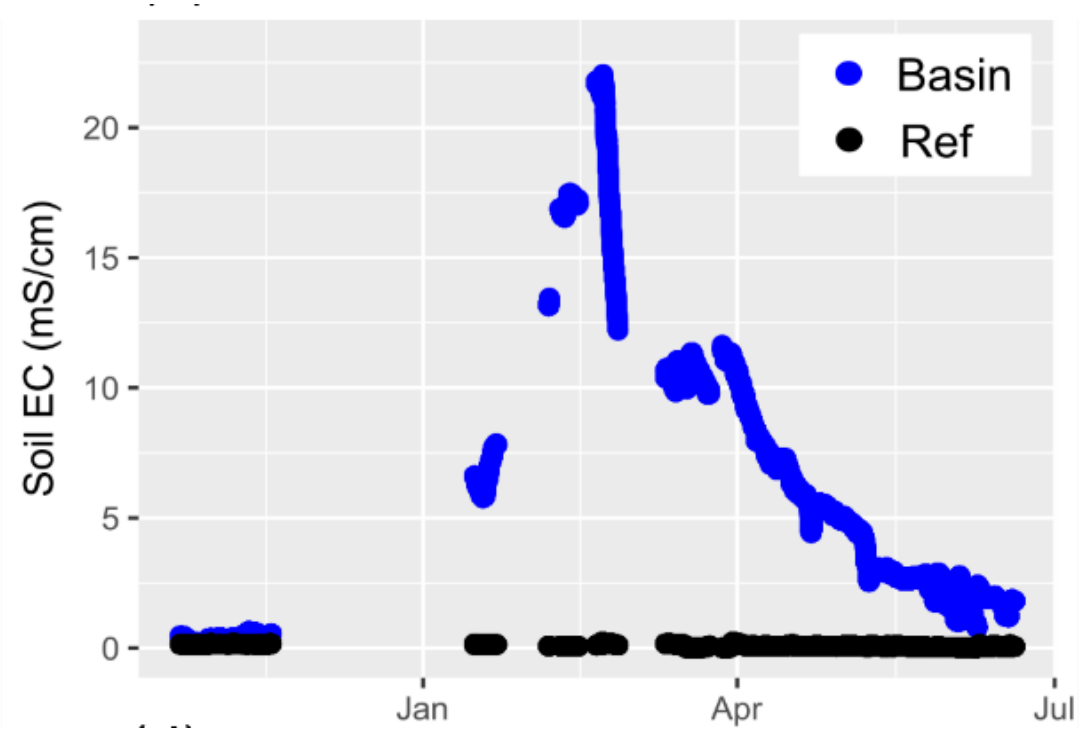
(~mean of wet basins)

Summary points:
salt transport & retention

Salt flushes through some stormwater basins in months, either exporting to groundwater or downstream water bodies

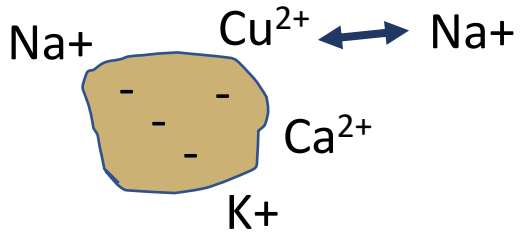
But wet basins/ponds delay and retain some over longer term

Could consider more intentional management of salt pulses w/ stormwater management practices



Summary points:
salt impact on water quality

NaCl deicing salt negatively affects performance of stormwater management practices



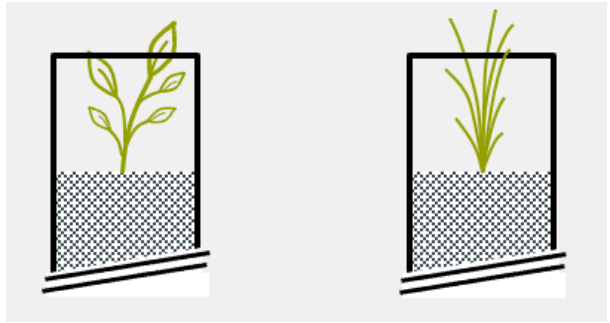
More salt loading led to….

- Reduced sediment and phosphorus retention
- Episodic zinc leaching
- Plant stress & death
- Reduced infiltration and clogging

Summary points: *design implications*

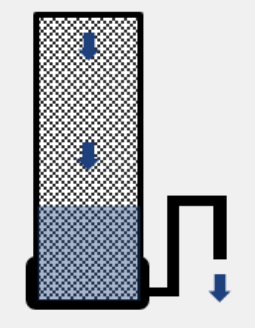
Presence of healthy plants is key for nitrogen retention

- Selecting salt-tolerant plants is important
  - May mean looking beyond native plants
  - Should consider some salt accumulating plants



Internal water storage ….

- Can help buffer some negative salt impacts
  - Was essential for consistently strong nitrogen retention



Soil media tweaks may also help buffer impacts

But there's not an easy way to capture large proportion of salt (w/o energy cost)

Thank you!!

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Questions?

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