

Nutrient Cycling and Water Quality on California Rangelands

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Core Research Team

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Urban-Wildland-Agricultural Interface







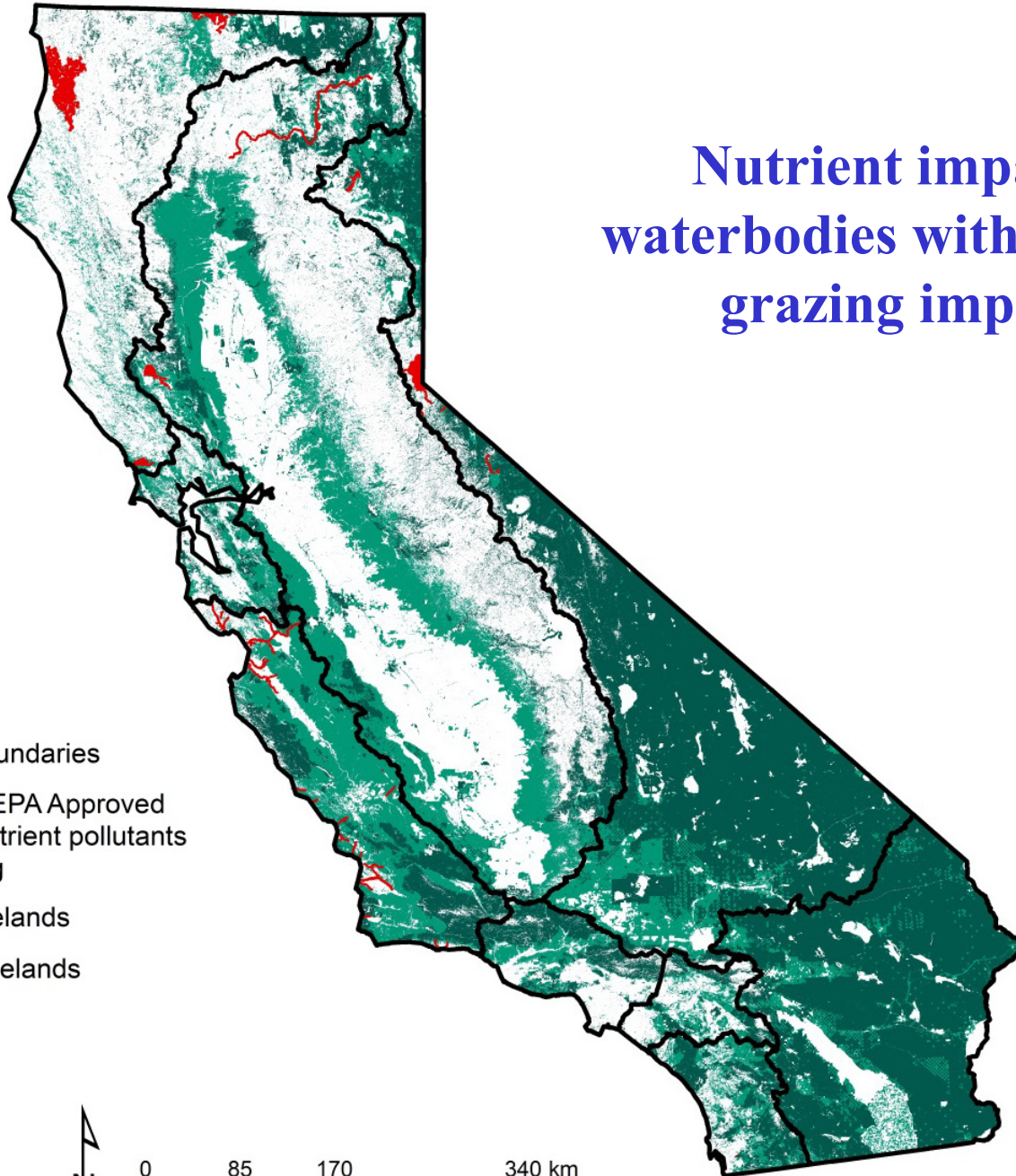
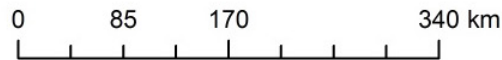
80% of Reservoirs



Nutrient impaired waterbodies with possible grazing impacts

Legend

-  RWQCB boundaries
-  2010 303d EPA Approved listing for nutrient pollutants from grazing
-  Public rangelands
-  Private rangelands



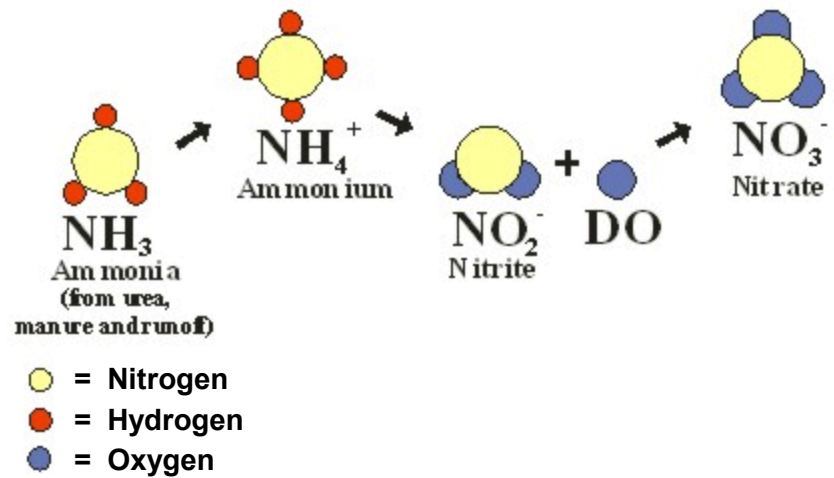
Nutrient Pollution

Nitrogen

- organic forms
- ammonium ($\text{NH}_3/\text{NH}_4^+$)
- nitrate (NO_3^-)



Organic N



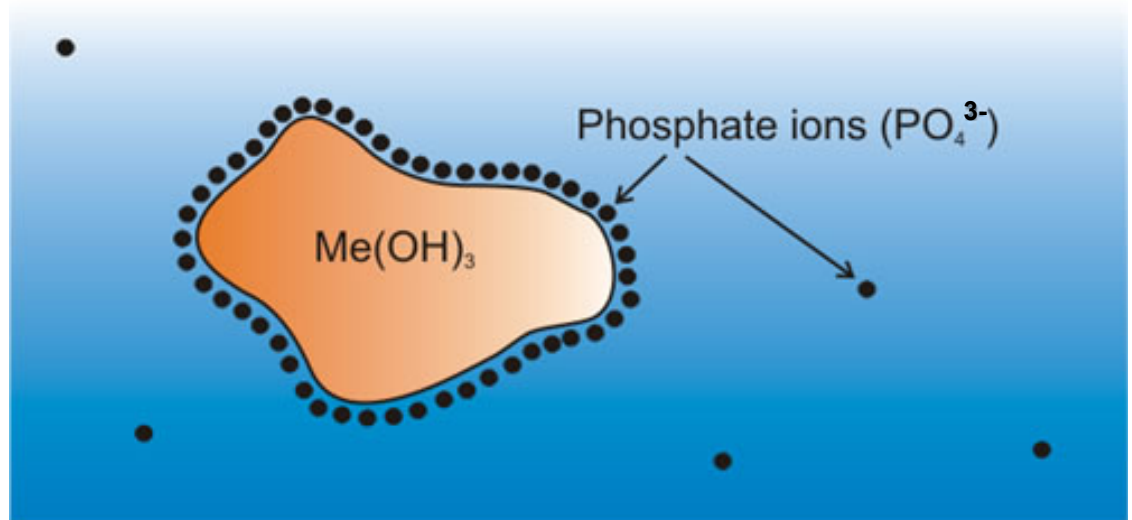
Nutrient Pollution

Phosphorus

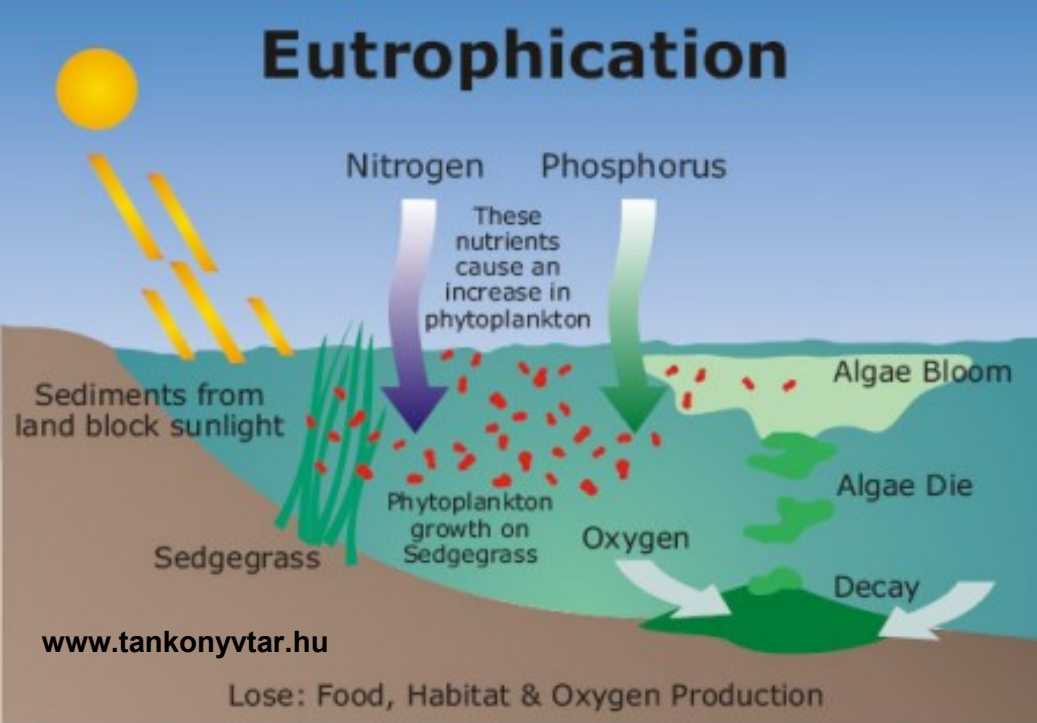
- organic forms
- adsorbed to particles
- dissolved phosphate (PO_4^{3-})



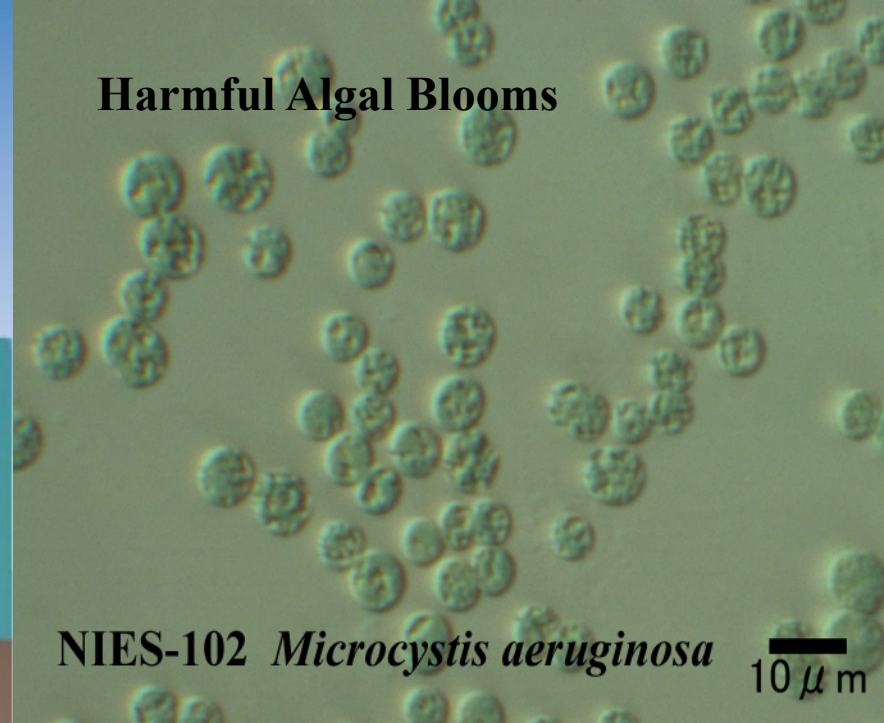
Organic P



Eutrophication

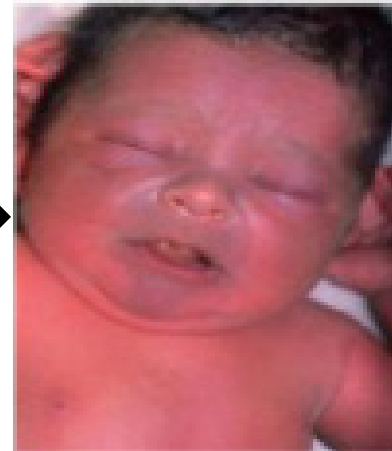


Harmful Algal Blooms



Nitrate in drinking water

Water Quality Standard = 10 mg N/L



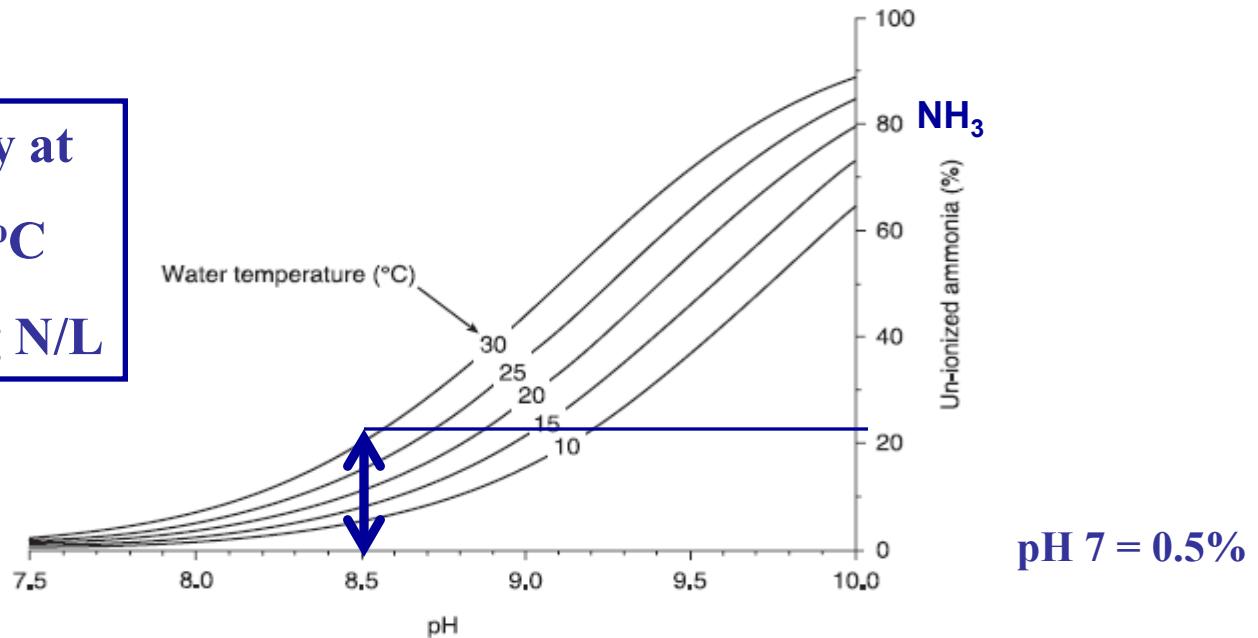
Blue-baby syndrome
(methemoglobinemia)

Ammonia (NH₃) Toxicity – Aquatic Ecosystems

Criterion Duration	2013 Final Criteria TAN at pH = 7 & 20 °C
Acute (1-hr average)	17 mg N/L
Chronic (30-d rolling average)	1.9 mg N/L

TAN = NH₃ + NH₄⁺

**Acute Toxicity at
pH 8.5 & 30 °C
TAN = 0.33 mg N/L**

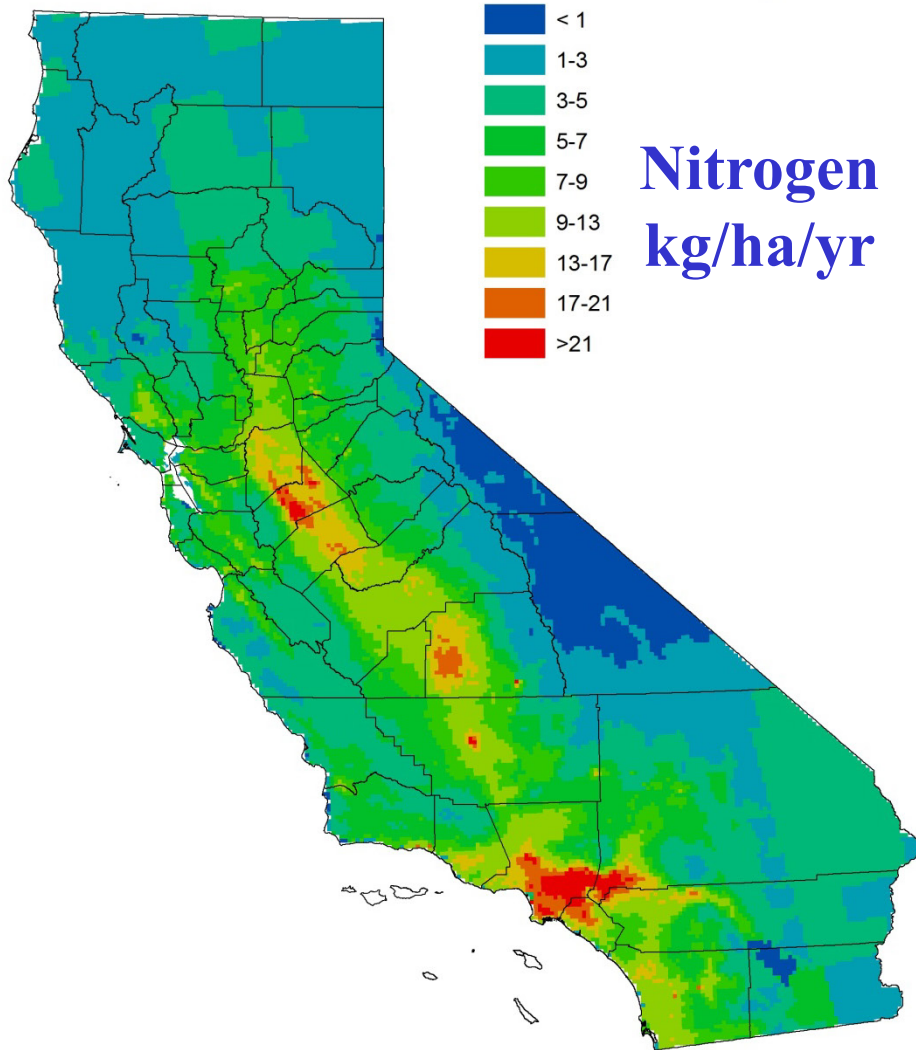




Nutrients (N/P)



$\text{NH}_3/\text{NH}_4/\text{PO}_4$ Runoff

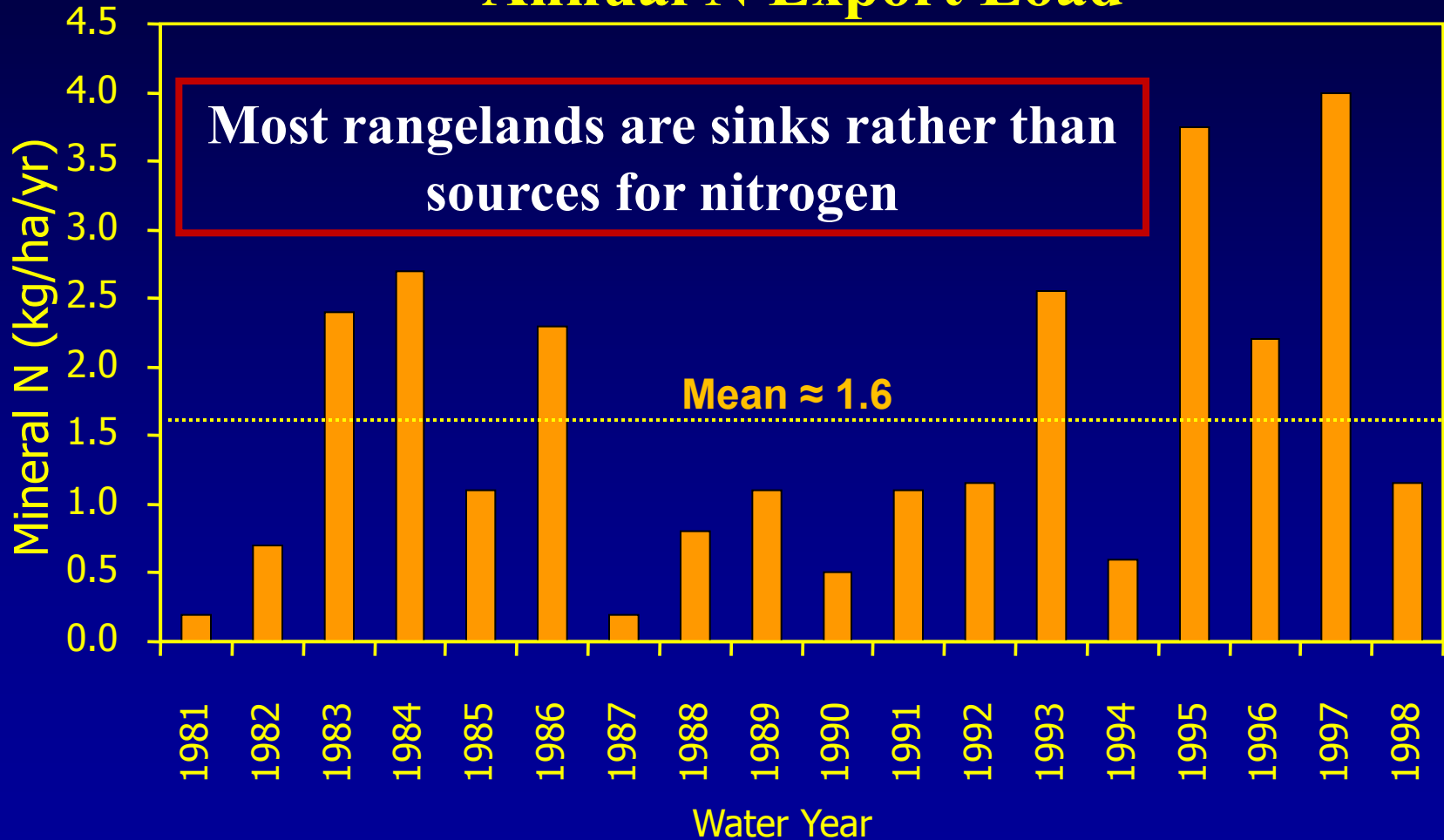


Atmospheric Nitrogen Deposition in California

**Atmospheric N deposition
on California rangelands
is often in the range:
5 – 10 kg/ha/yr**

Sierra Nevada Foothills Watershed

Annual N Export Load



Natural Sources of Nitrogen

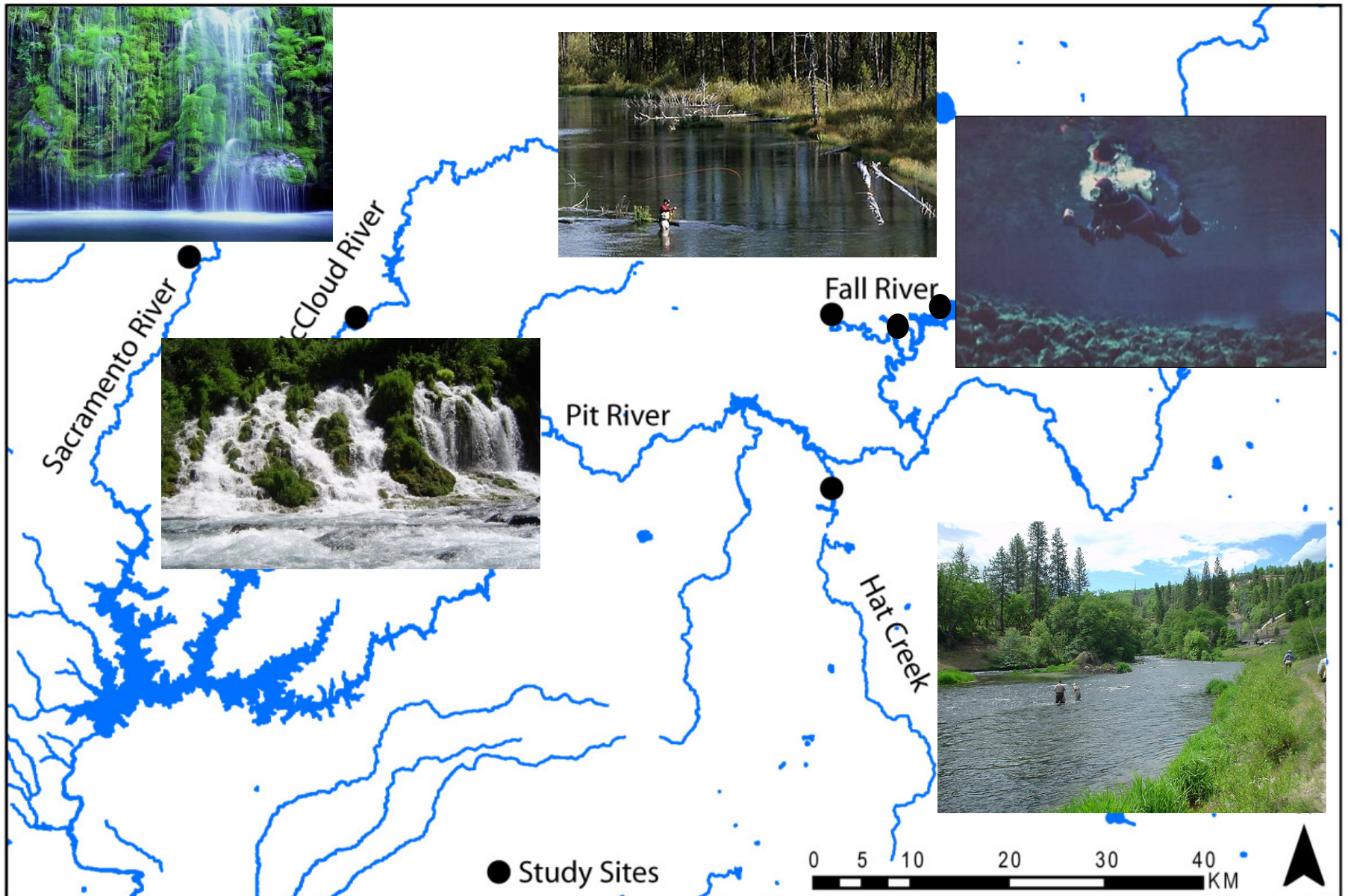
Big Springs Shasta Valley

Spring discharge = 90 cfs

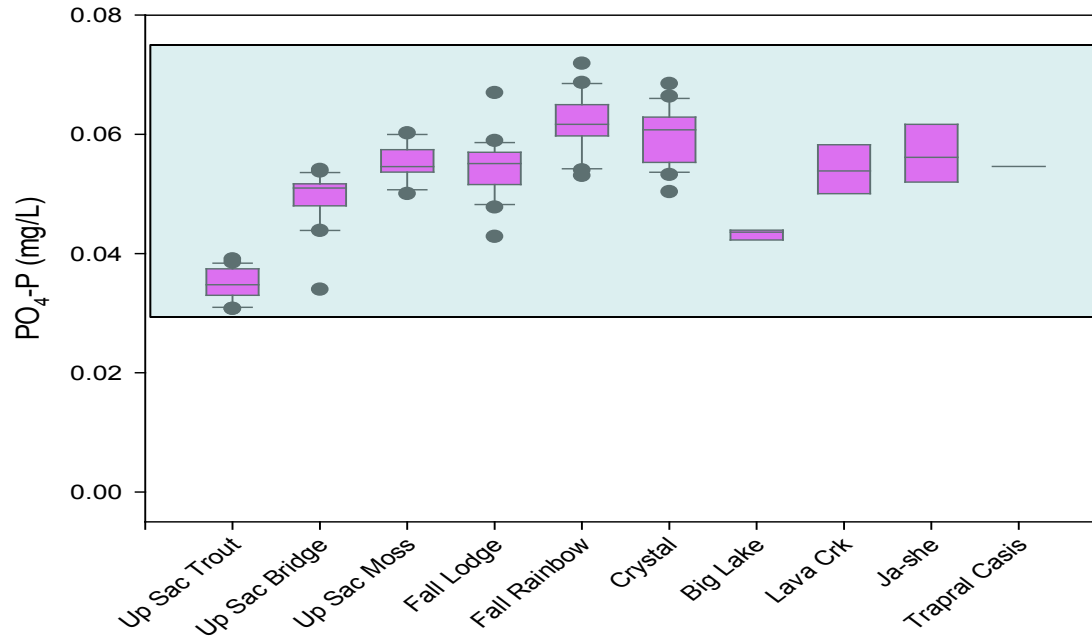
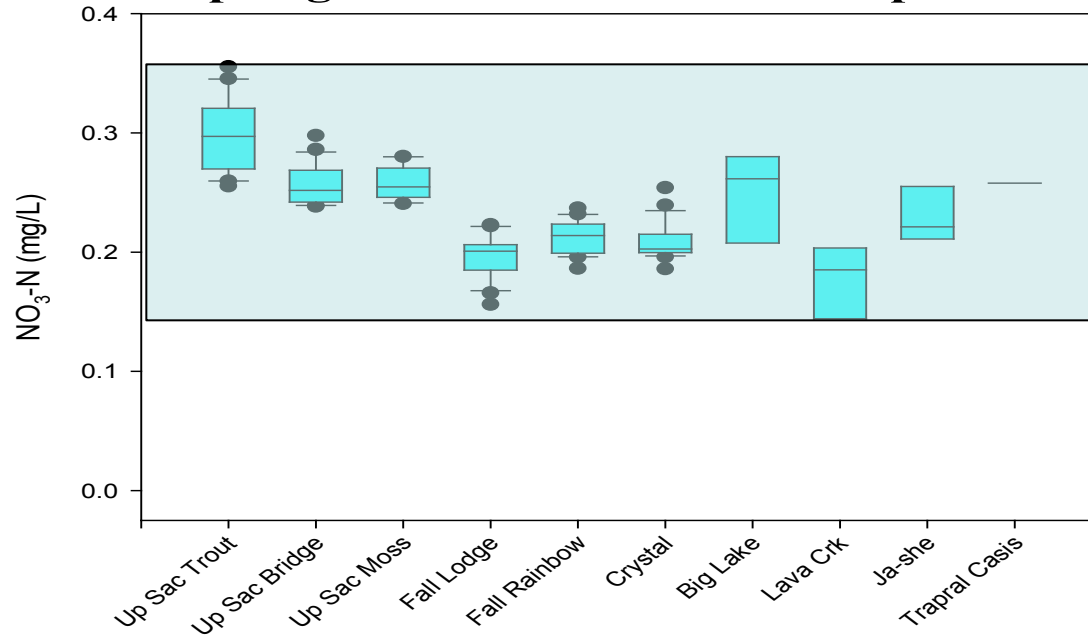
$\text{NO}_3\text{-N} = 0.48 \text{ mg/L}$

$\text{PO}_4\text{-P} = 0.15 \text{ mg/L}$

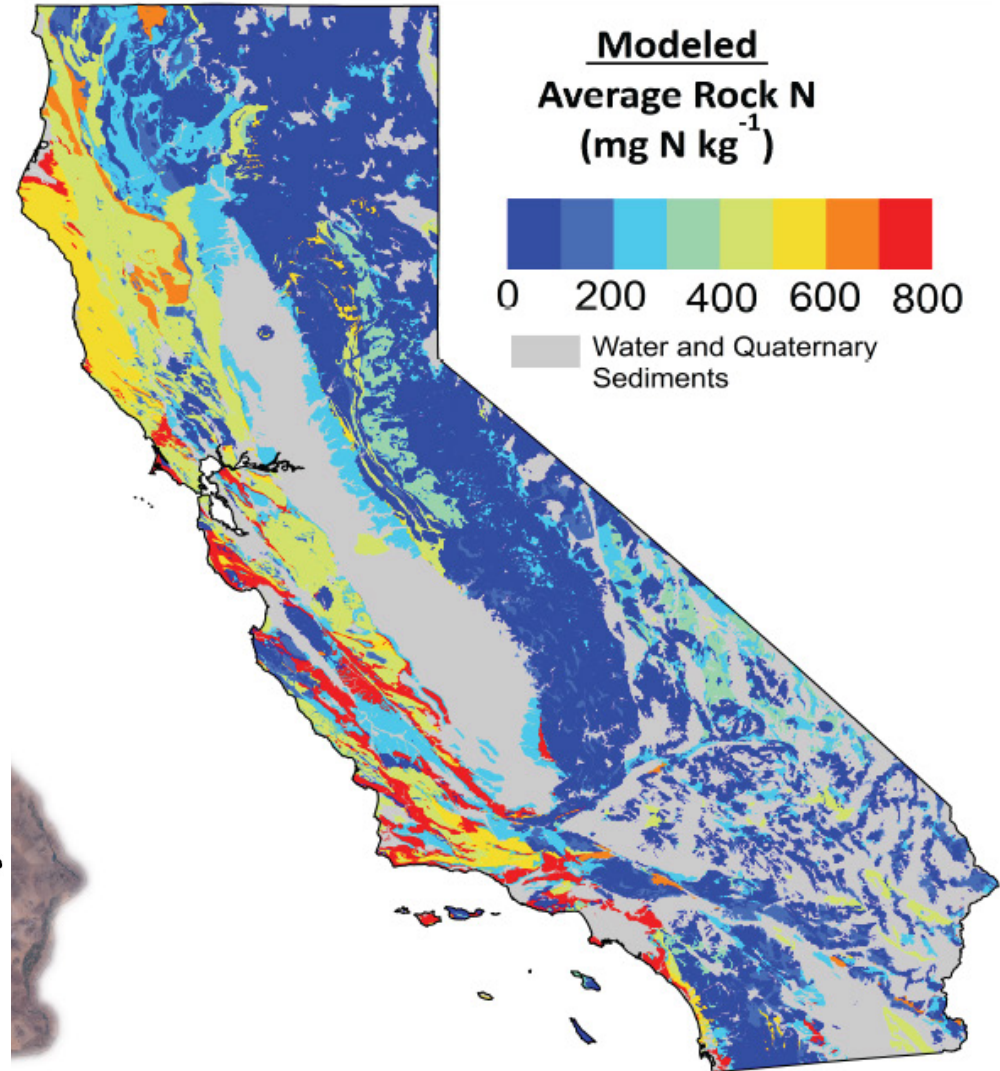
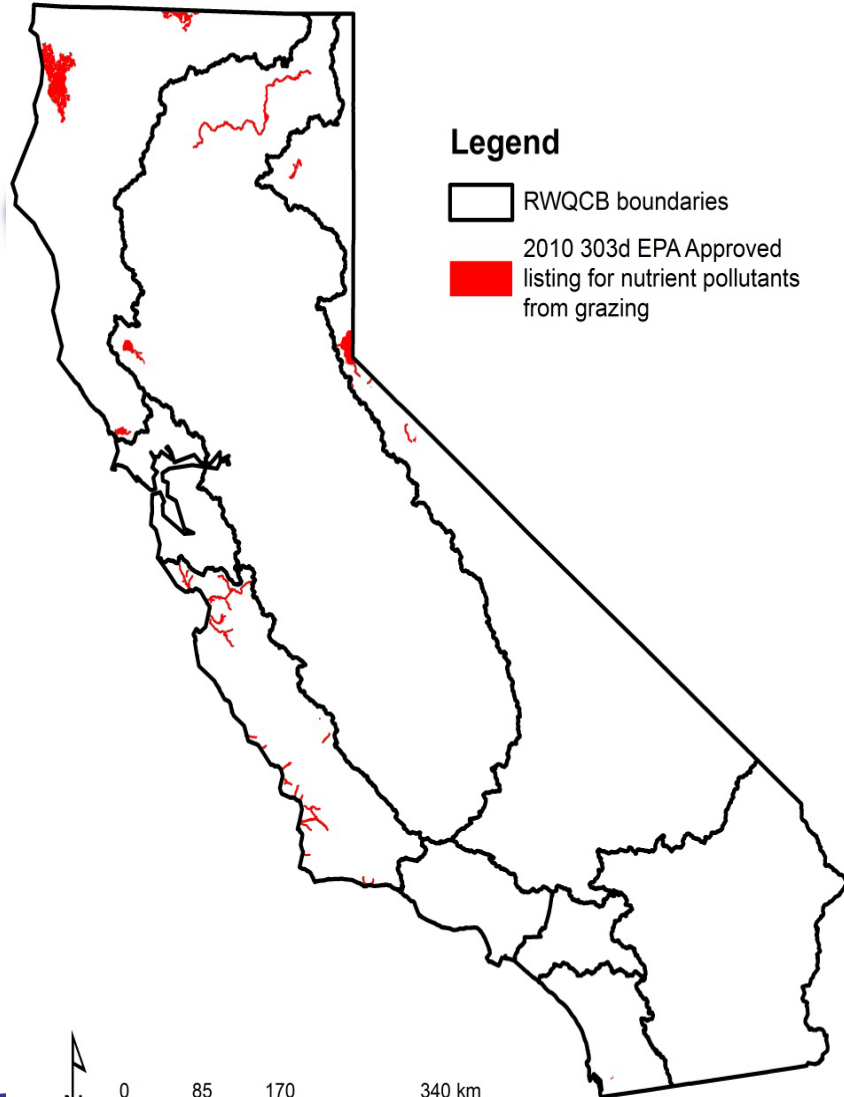
Northern California Volcanic Springs



Spring Water Nitrate and Phosphate



Quantifying Rock N Reservoirs





Ambient Water Quality Criteria Recommendations

Information Supporting the Development
of State and Tribal Nutrient Criteria

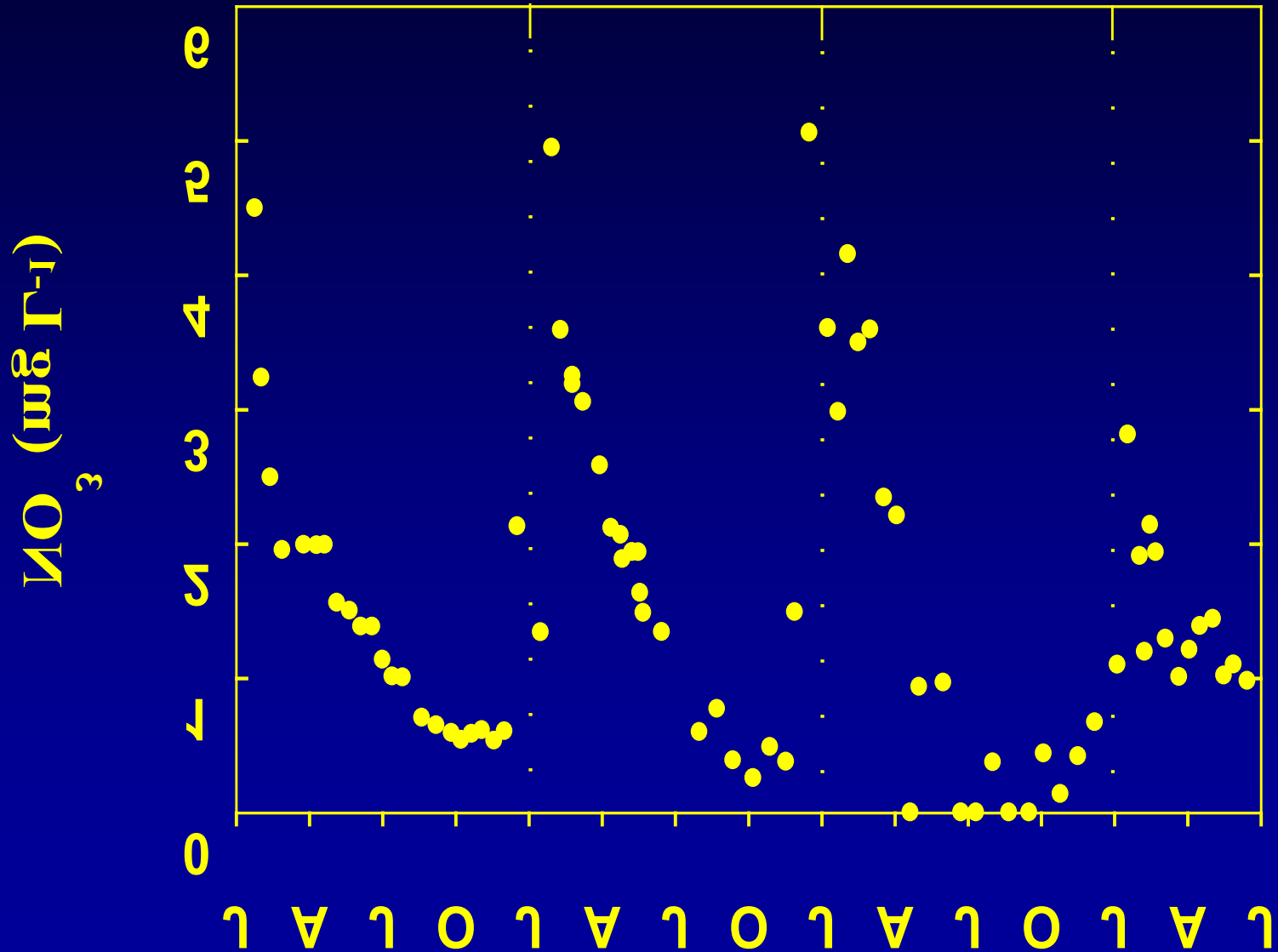
Rivers and Streams in Nutrient Ecoregion II

**Background nutrient levels
are not zero**

Nutrient	Background Level (mg/L)	Eutrophication Concern (mg/L)
TN	0.15 – 0.53	-
NO ₃ -N	0.005 – 0.040 (0.50)	0.30
TP	0.009 – 0.032 (0.15)	0.10
PO ₄ -P	(0.15)	0.05



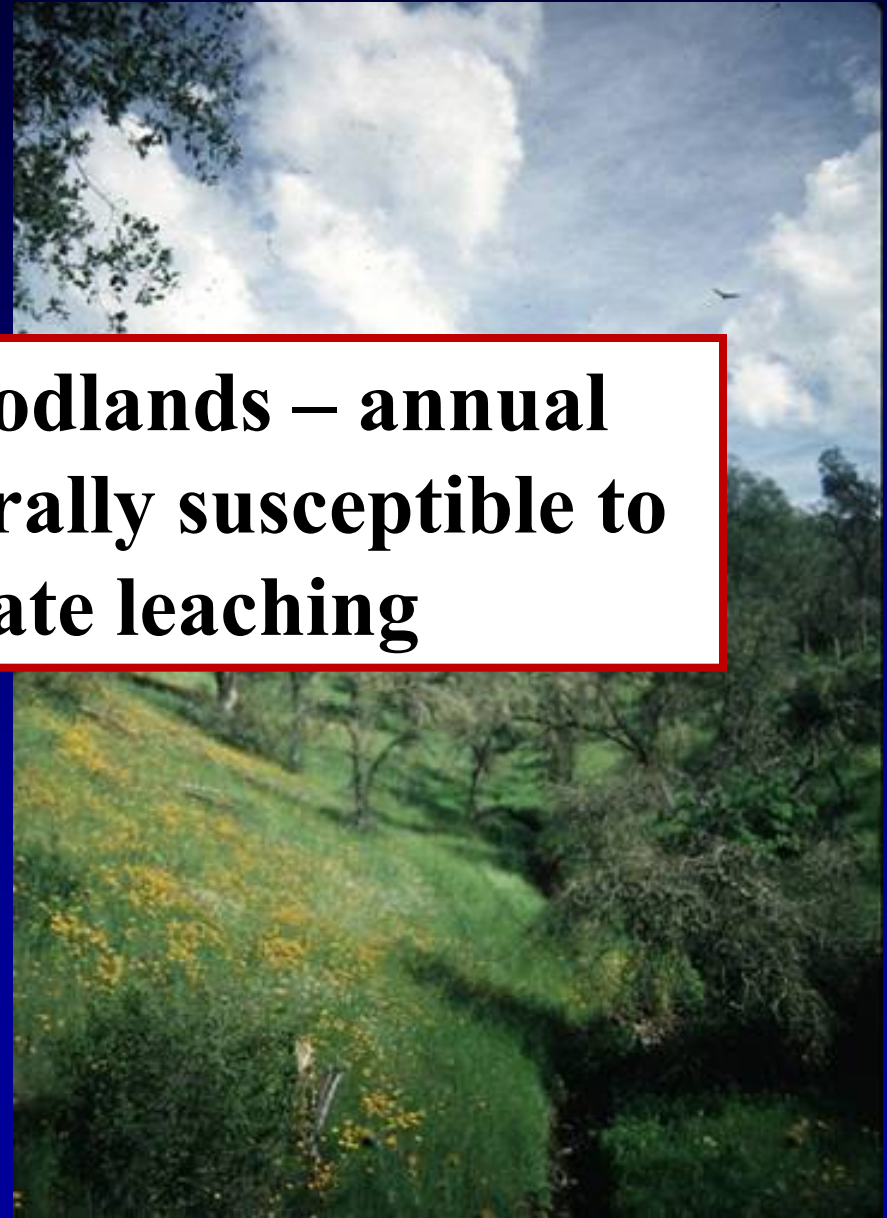
Seasonal Pattern in Streamwater Nitrate in Non-grazed California Oak Woodlands



Low Nutrient Demand

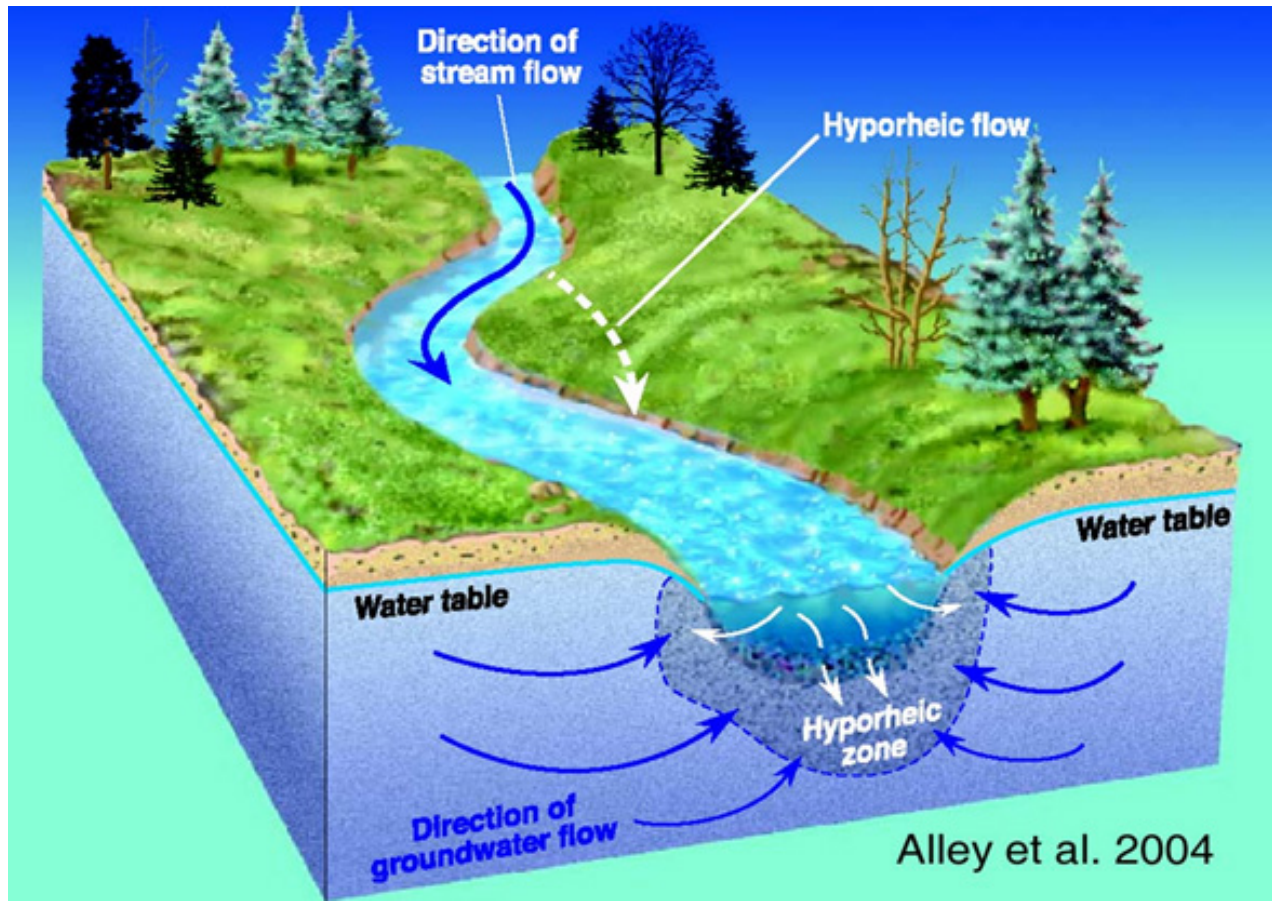
High Nutrient Demand

California oak woodlands – annual grasslands are naturally susceptible to seasonal nitrate leaching



Assimilative Capacity

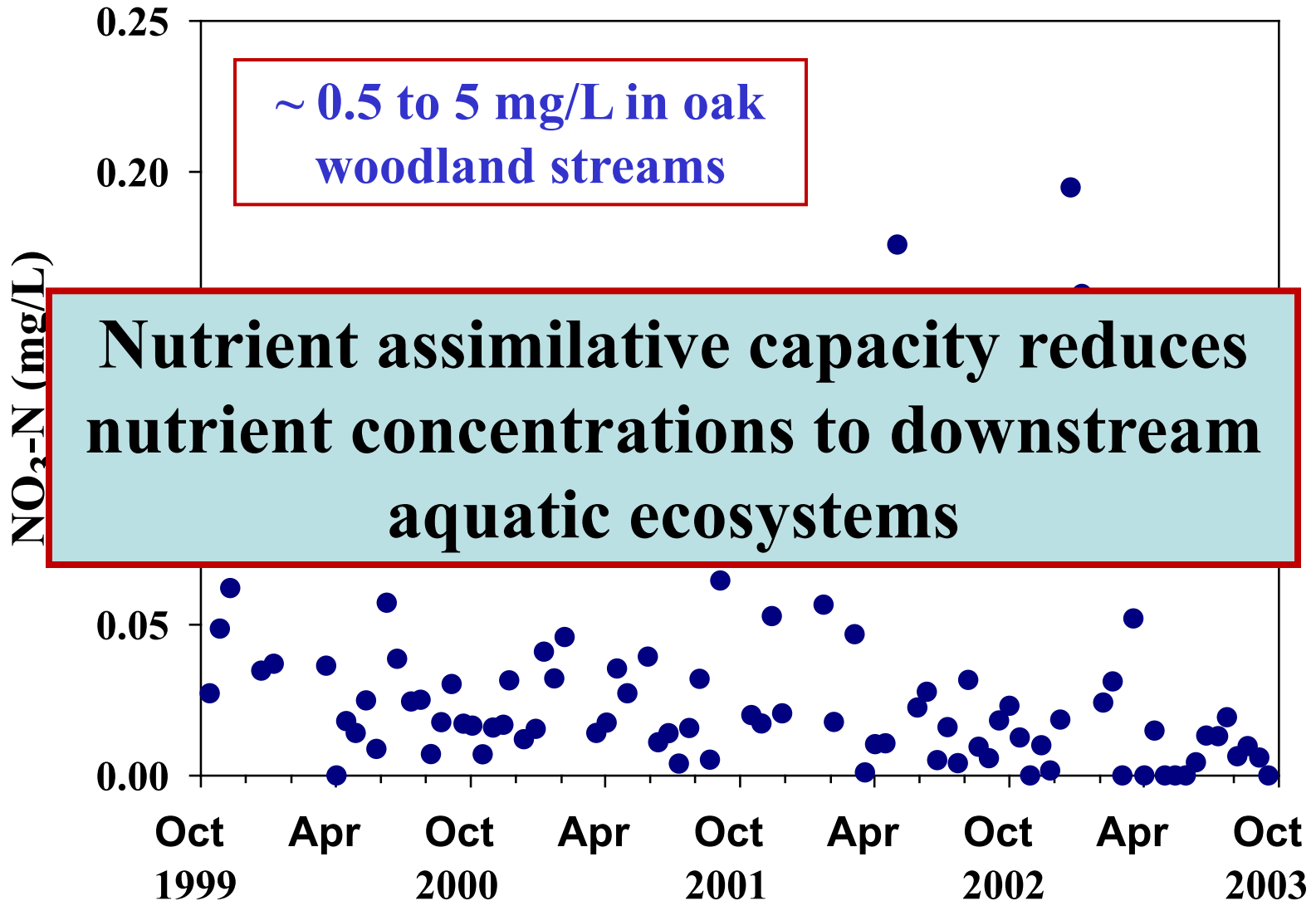
Self-Purification Capacity – removal of pollutants during downstream transport



Assimilative Capacity



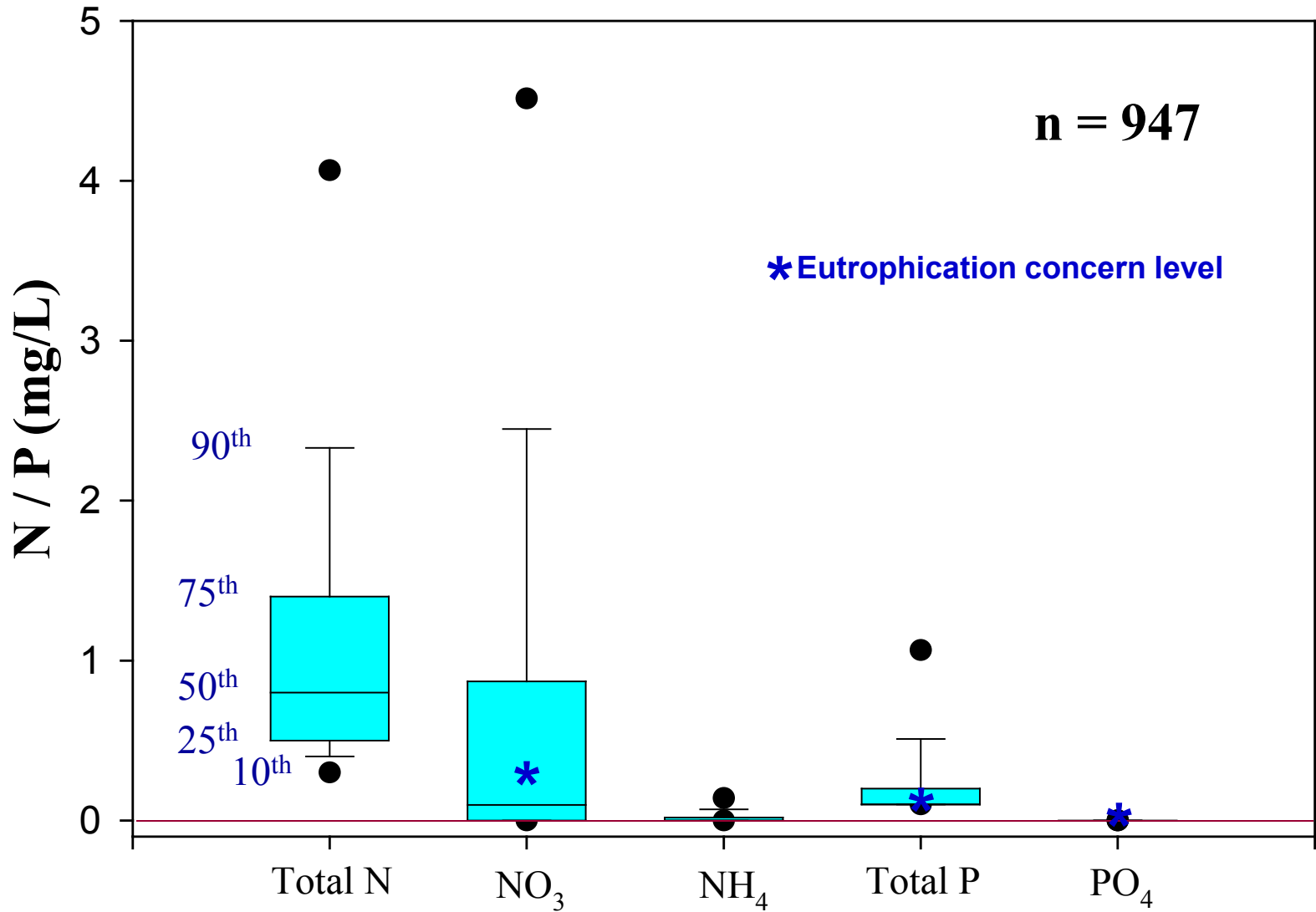
Yuba River - Nitrate





State-wide Survey
24 streams
2000 and 2001 water years

Nutrient Concentrations

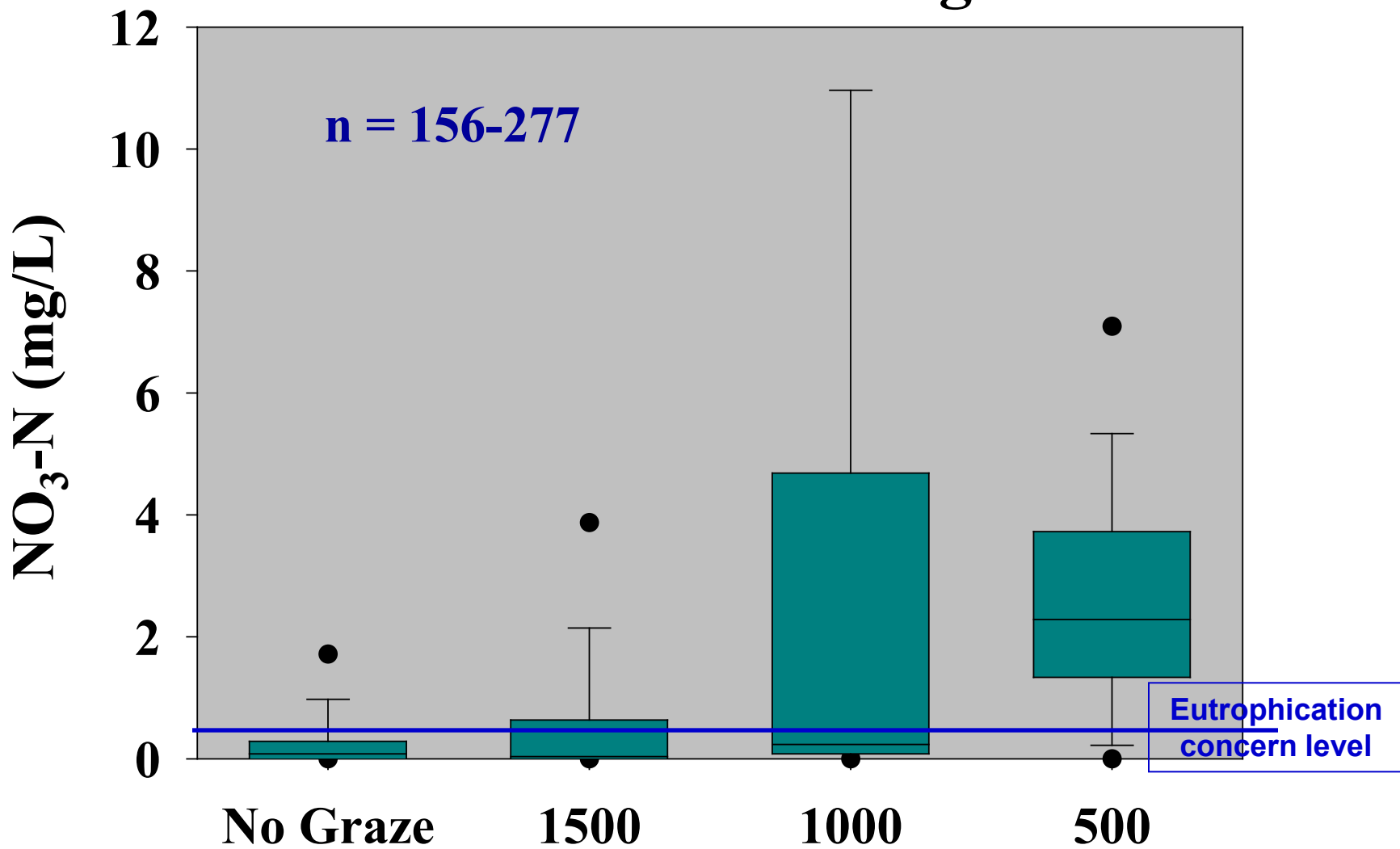


Grazing Treatments

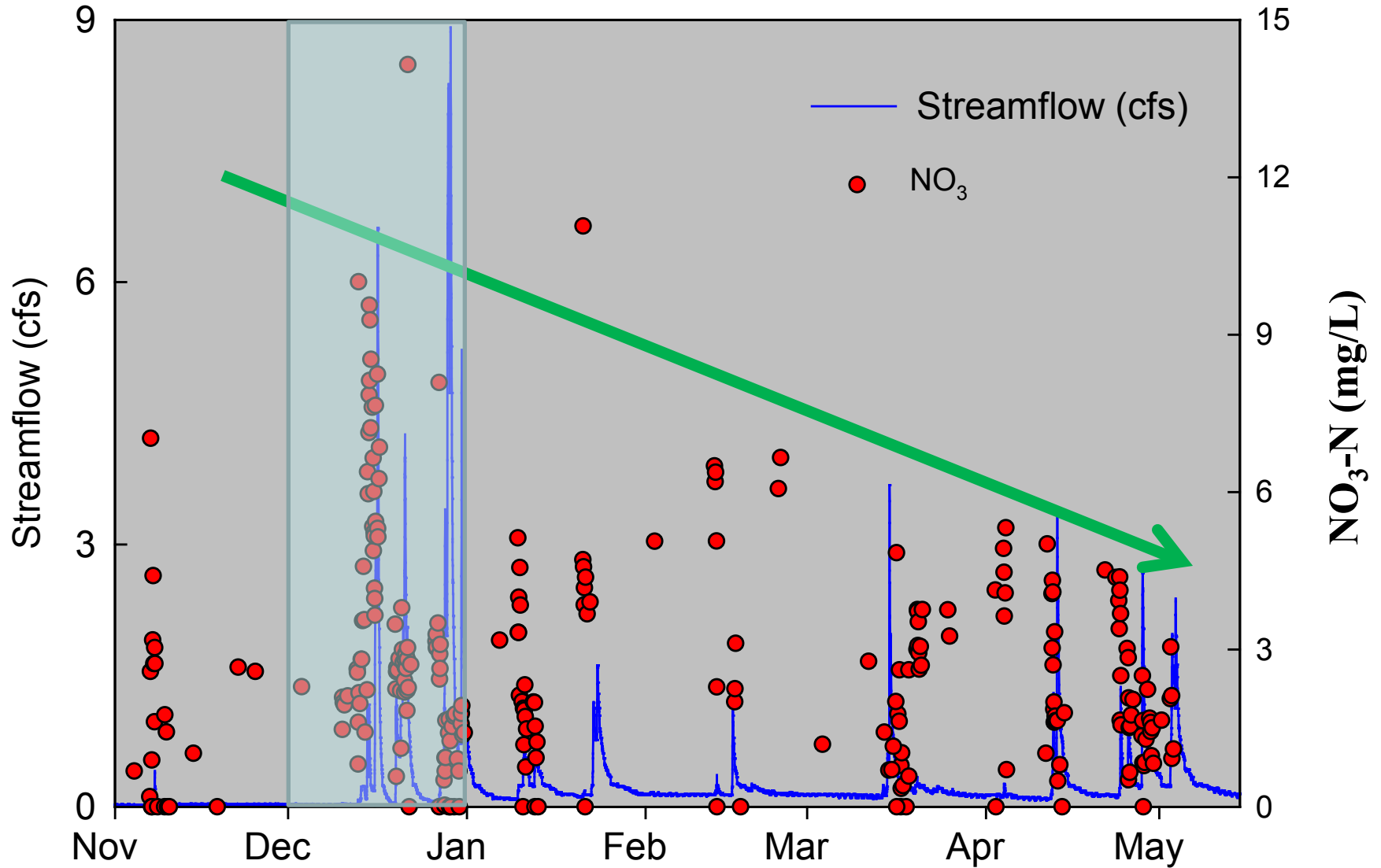
- **No grazing**
- **1500 lb/ac RDM**
- **1000 lb/ac RDM**
- **500 lb/ac RDM**



Nitrate - Grazing

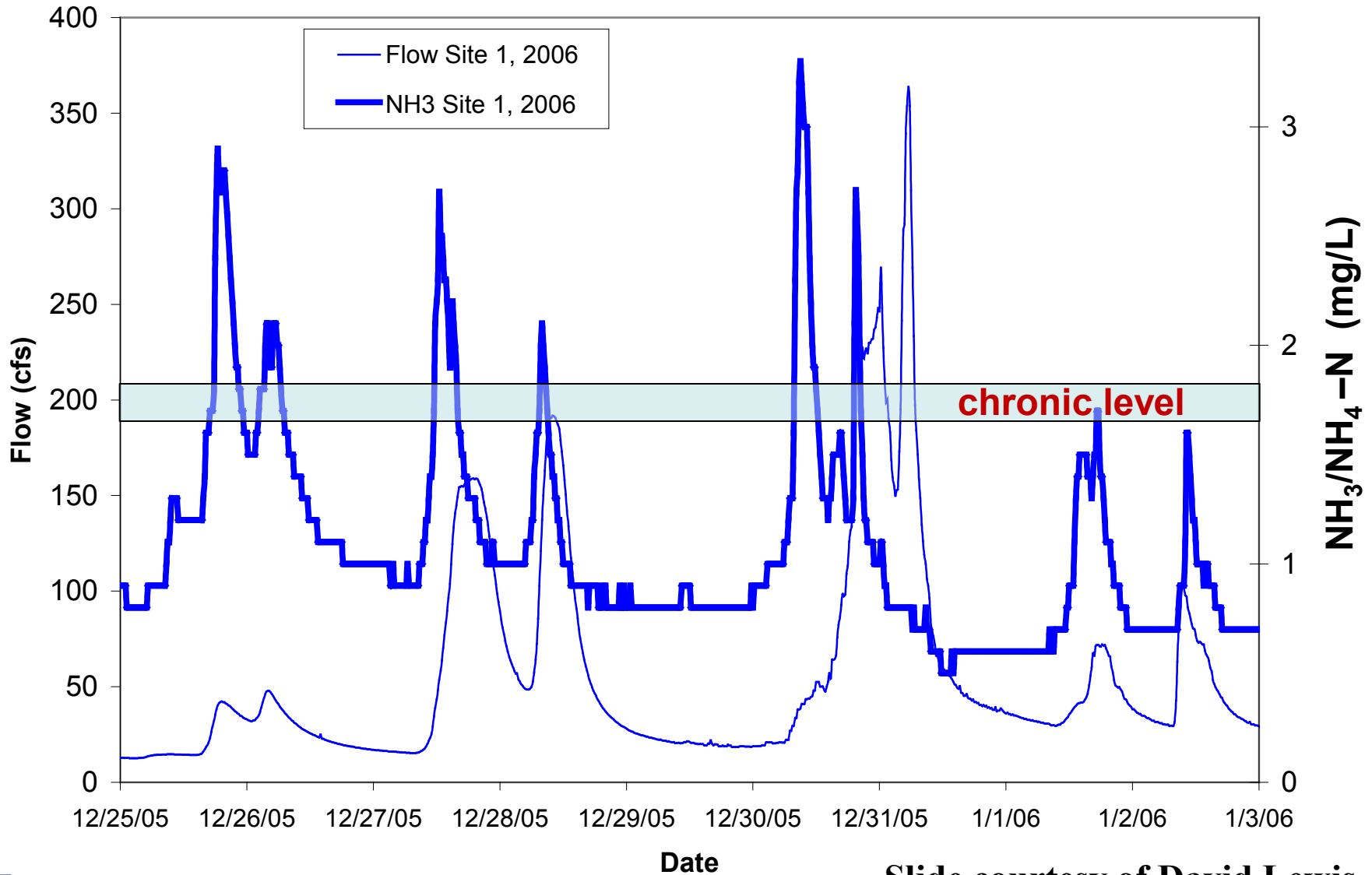


Nitrate - 500 lbs/acre RDM



Coastal Creek Ammonia

Ammonia and Flow for Site 1 during New Years Flood



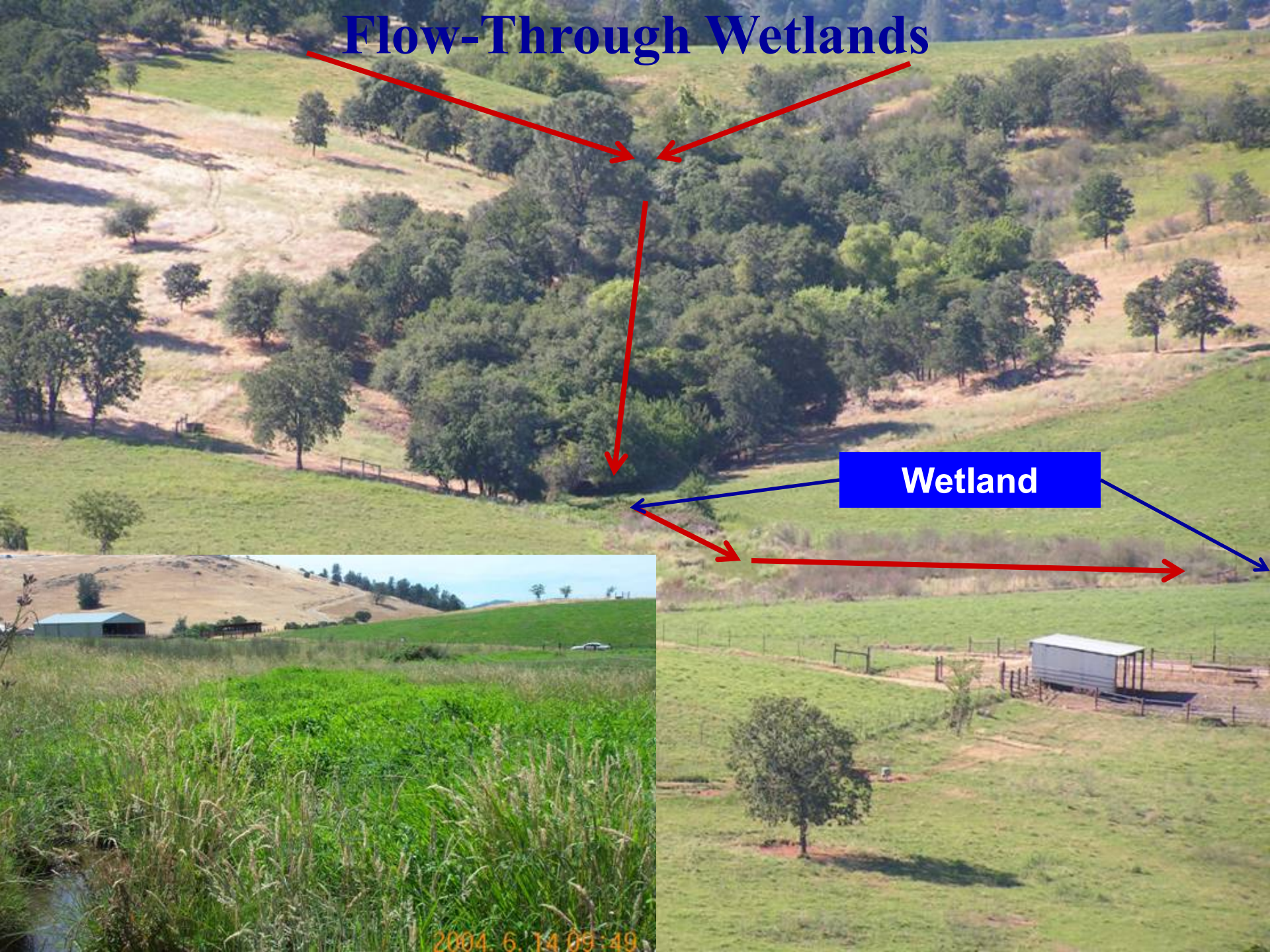


Grazing Management



Buffer/Filter Strip

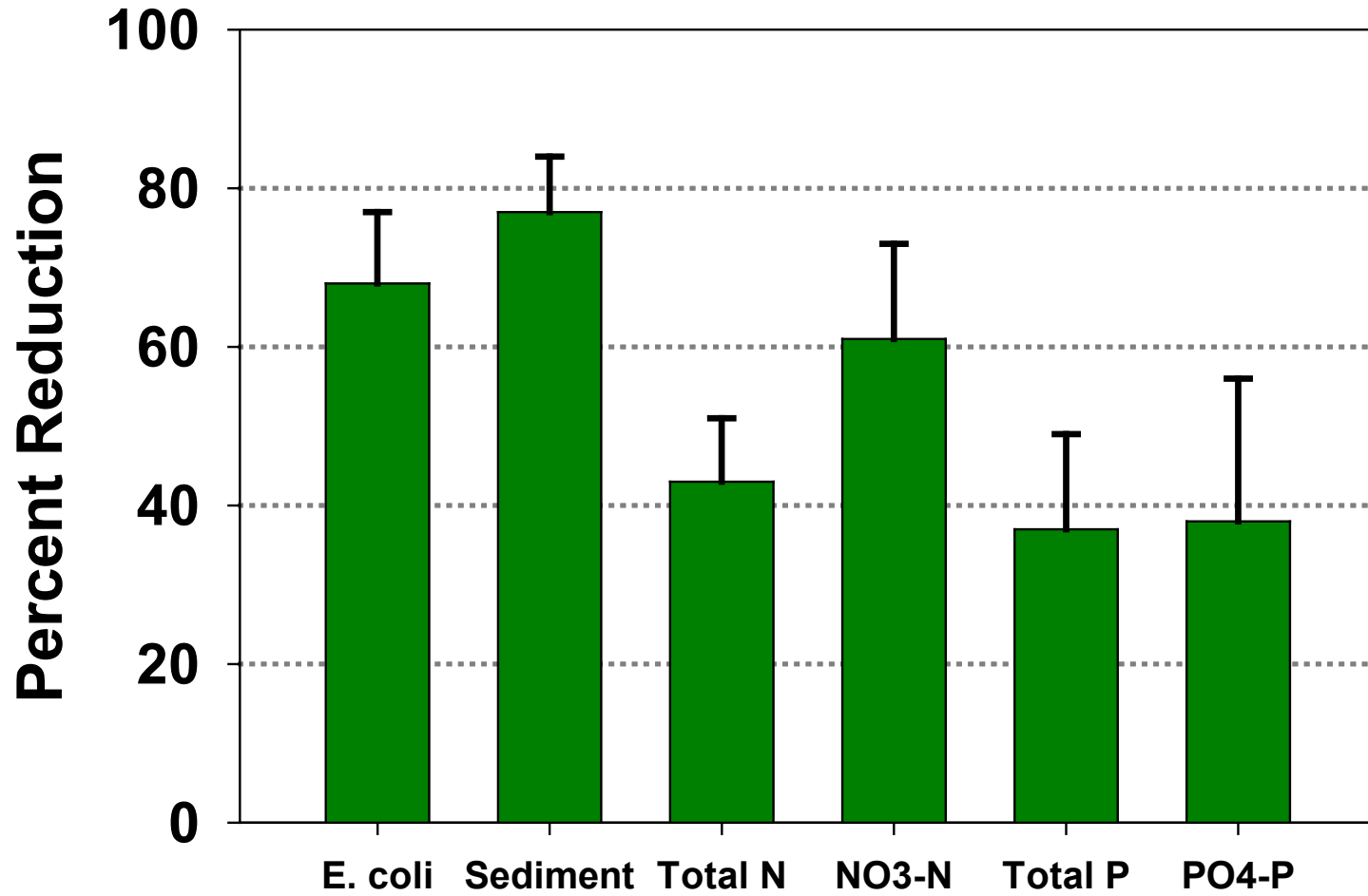
Flow-Through Wetlands



Wetland

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Wetland Treatment of Irrigation Tailwaters



Conclusions

- **Most California rangelands are sinks rather than sources for nutrients**
- **Background nutrient levels are not zero**
- **California oak woodlands – annual grasslands are naturally susceptible to seasonal nitrate leaching**
- **Nutrient assimilative capacity reduces nutrient concentrations to downstream aquatic ecosystems**
- **Rangeland streams rarely exceed nutrient thresholds for eutrophication, except during large storm events**
- **Accurate nutrient monitoring of rangelands is extremely challenging given temporal variability**

Questions?

