Nutrient Cycling and Water Quality on California Rangelands

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Core Research Team

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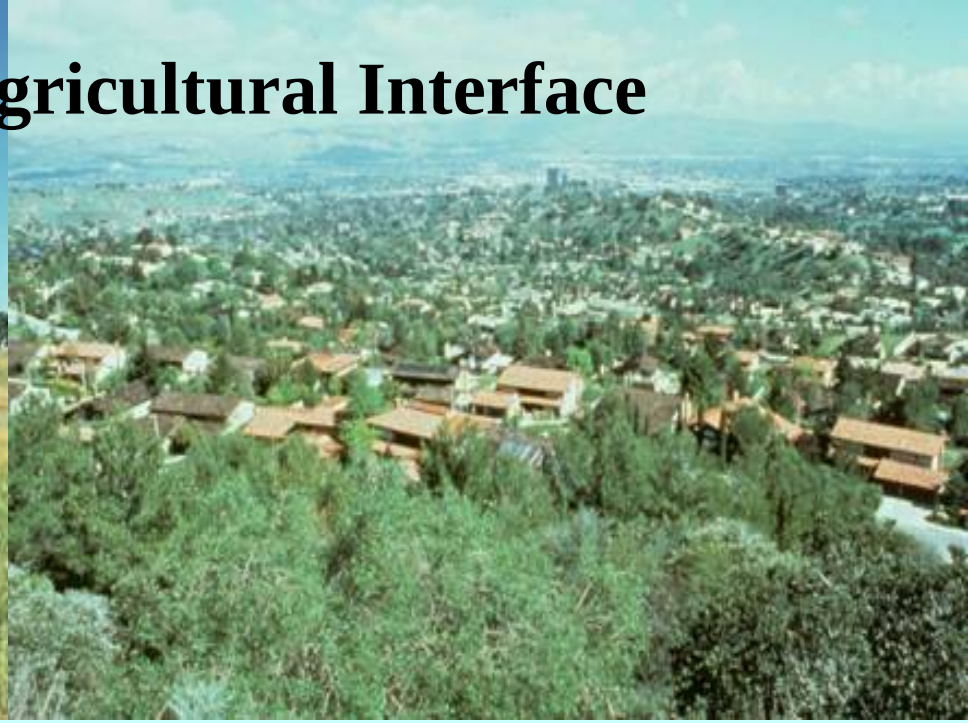
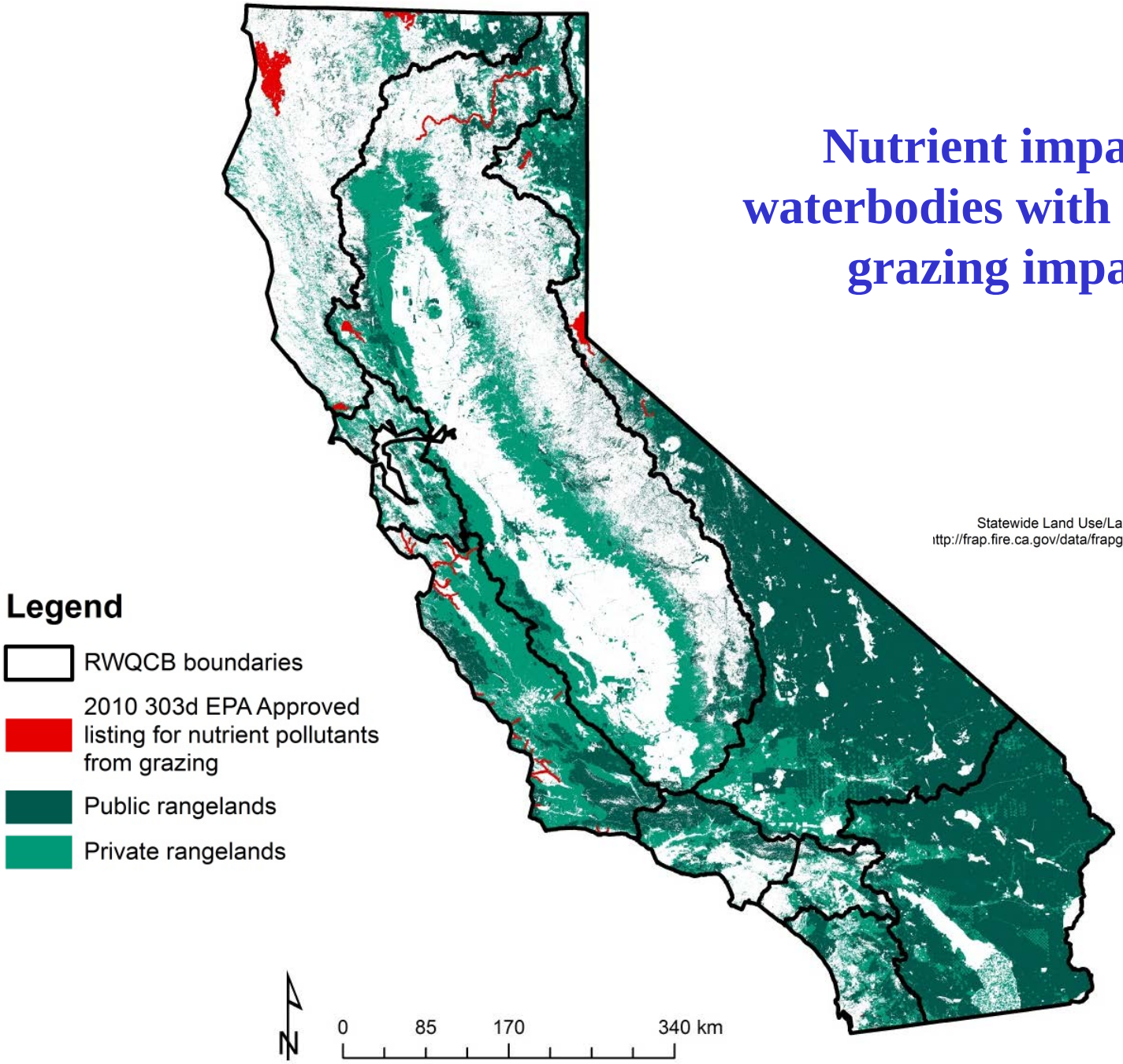
Urban-Wildland-Agricultural Interface



80% of Reservoirs

Nutrient impaired waterbodies with possible grazing impacts



Multi-source data, FRAP and SWRCB
Statewide Land Use/Land Cover Mosaic (2006), Ownership (2009)
ıttp://frap.fire.ca.gov/data/frapgisdata-sw-rangeland-assessment_data.php

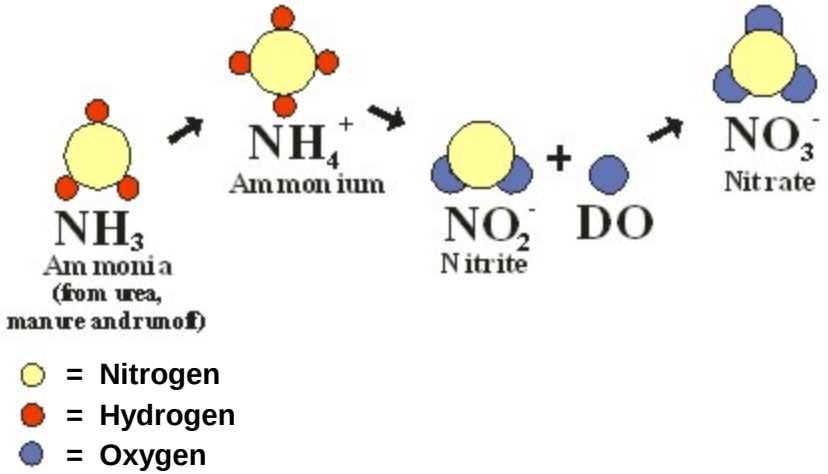
Regional Water Quality Control Board
http://www.waterboards.ca.gov

Nutrient Pollution

Nitrogen

- organic forms
- ammonium (NH_3/NH_4^+)
- nitrate (NO_3^-)

Organic N

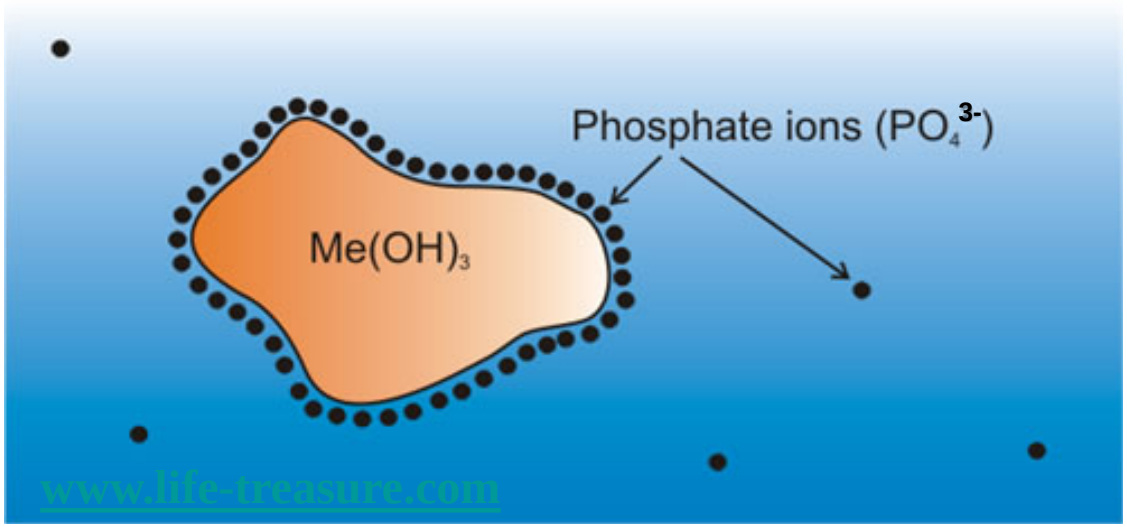


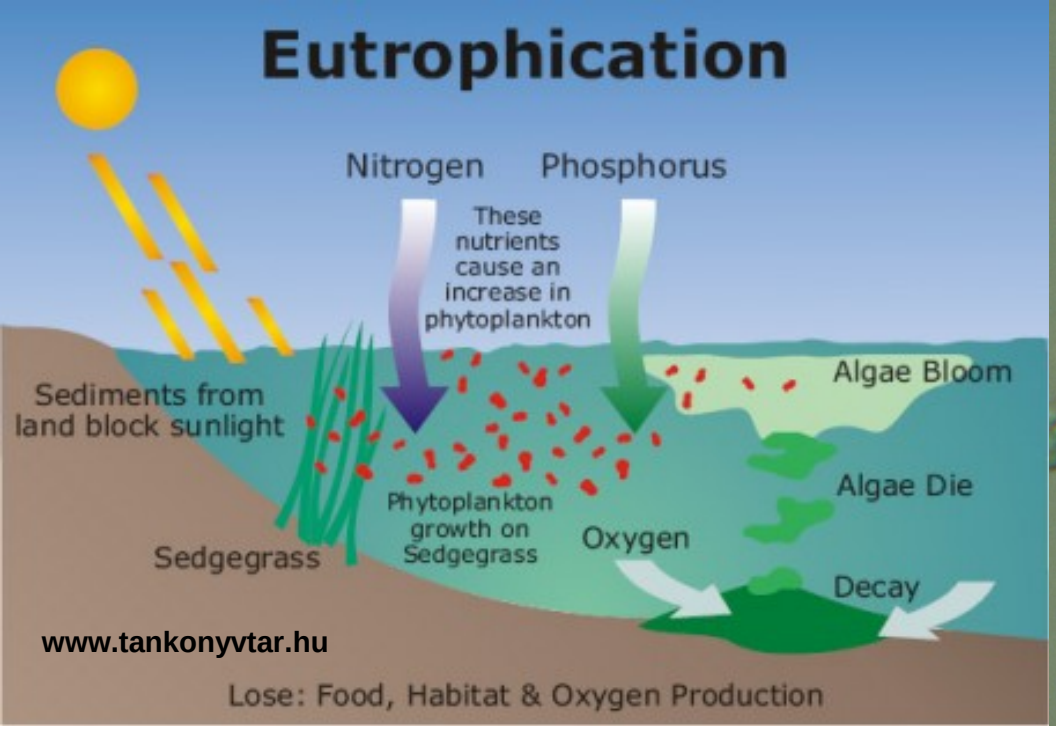
Nutrient Pollution

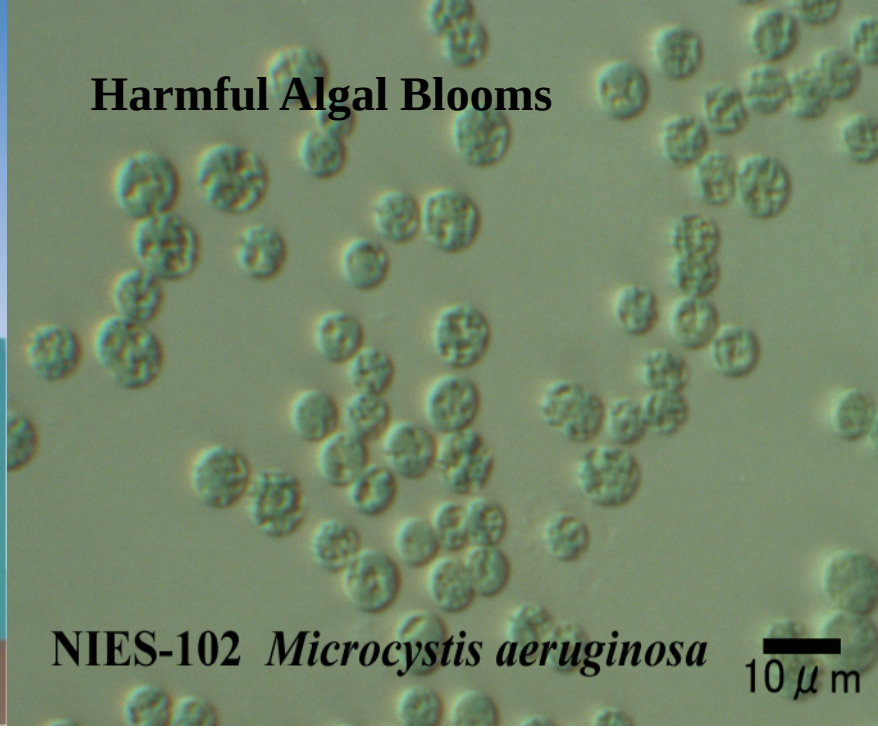
Phosphorus

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

Organic P







Nitrate in drinking water

Water Quality Standard = 10 mg N/L

Blue-baby syndrome

(methemoglobinemia)

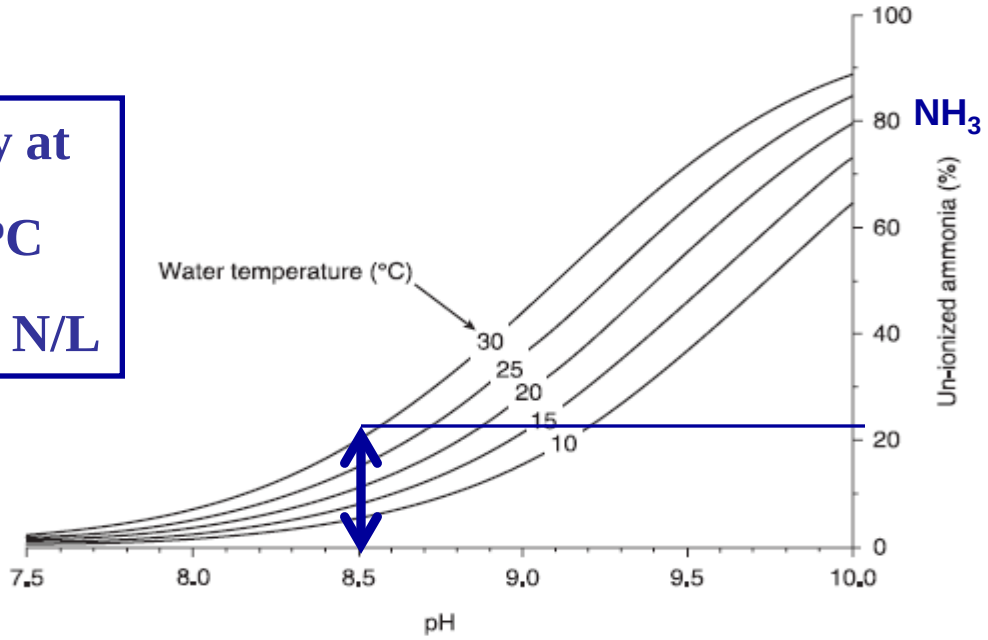
Ammonia (NH_3) Toxicity – Aquatic Ecosystems

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 = NH_3 + NH_4^+	

Acute Toxicity at

pH 8.5 & 30 °C

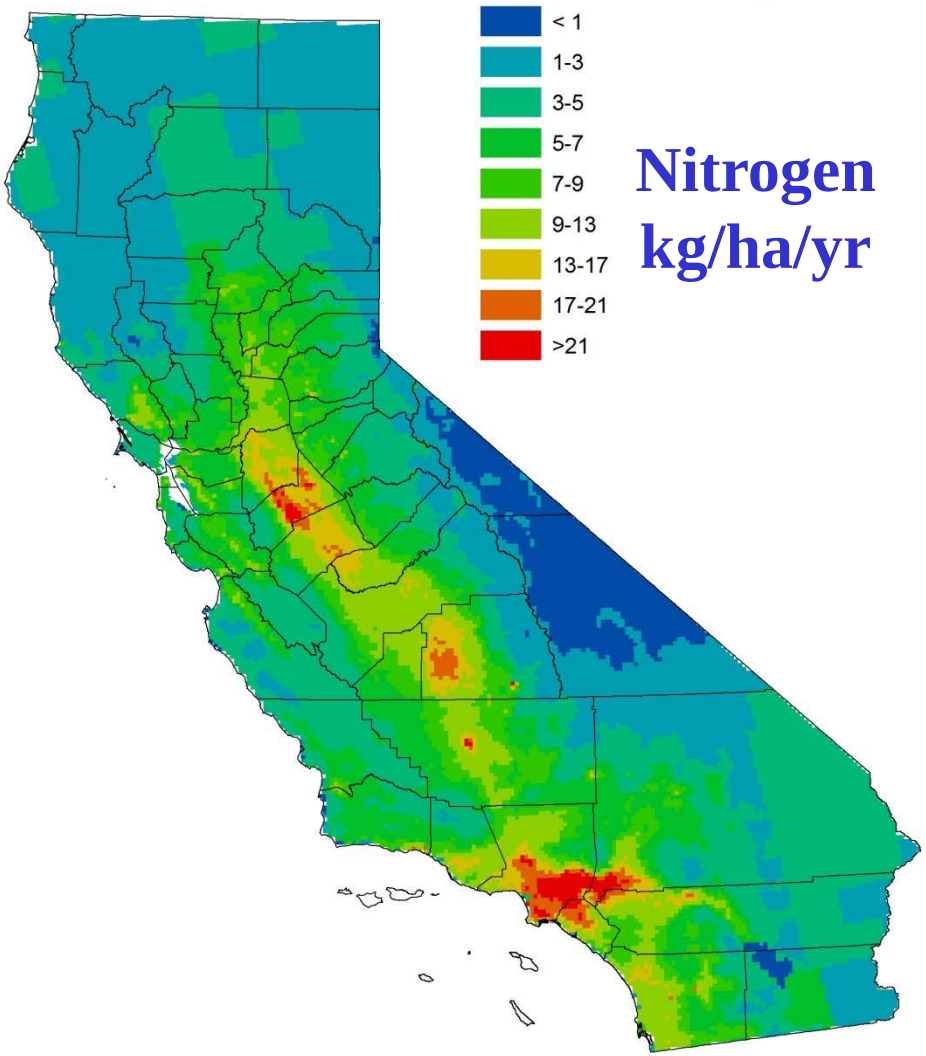
TAN = 0.33 mg N/L



pH 7 = 0.5%

Nutrients (N/P)

$NH_3/NH_4/PO_4$ Runoff



Fenn et al. (2010) J Environ Management. 91:2404–2423

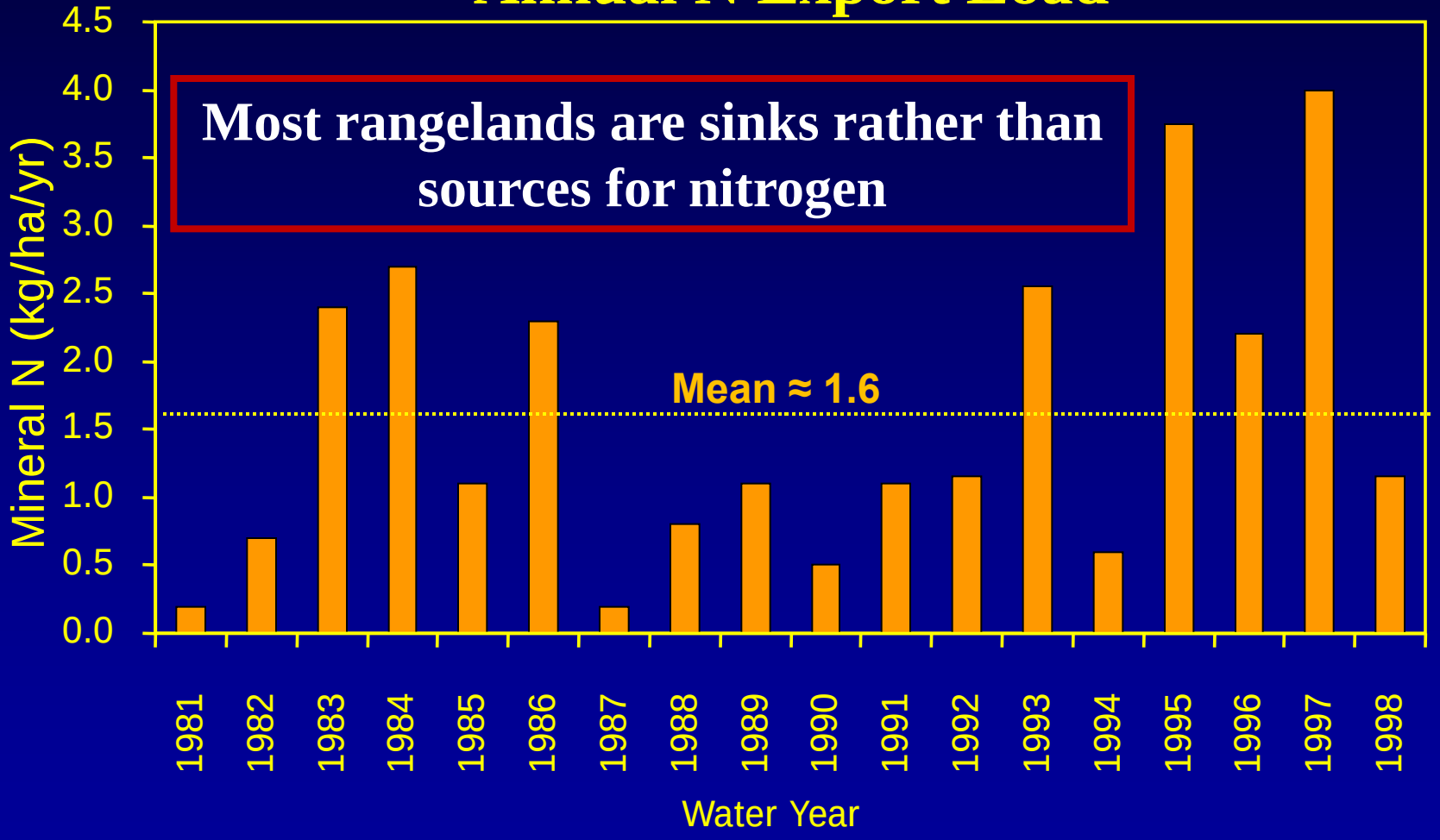
Atmospheric Nitrogen Deposition in California

Atmospheric N deposition on California rangelands is often in the range:

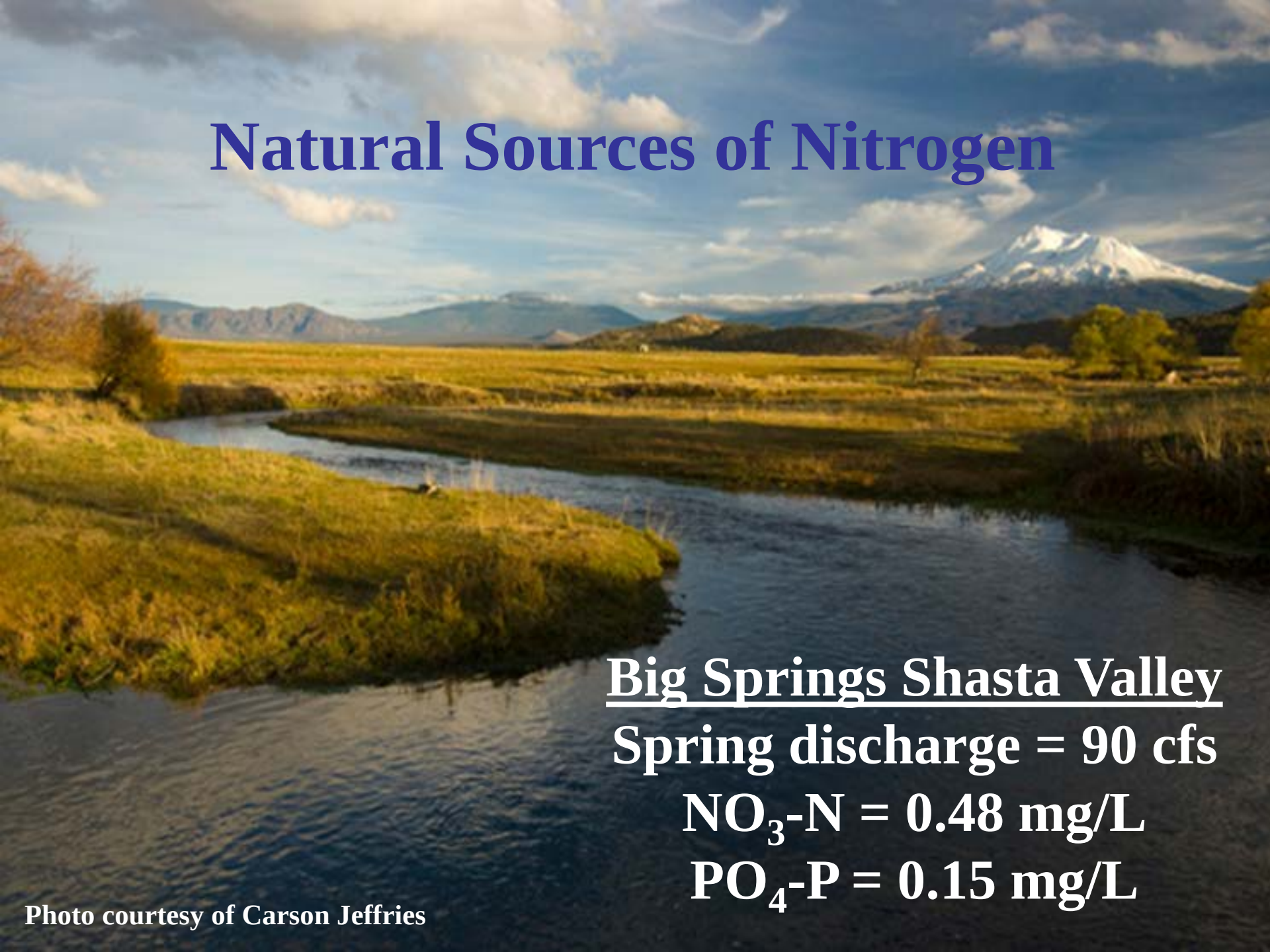
5 – 10 kg/ha/yr

Sierra Nevada Foothills Watershed

Annual N Export Load



Natural Sources of Nitrogen



Big Springs Shasta Valley

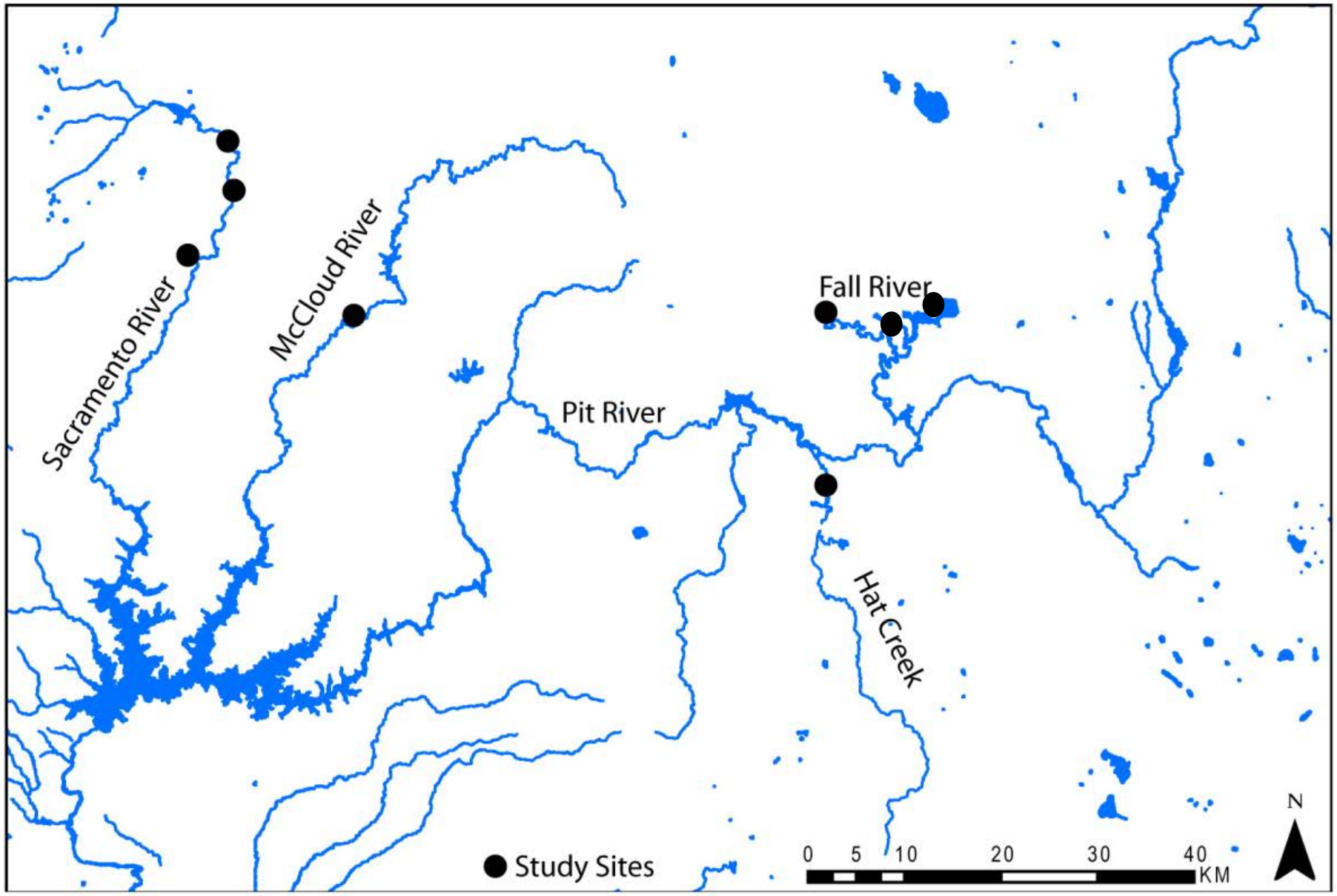
Spring discharge = 90 cfs

NO_3-N = 0.48 mg/L

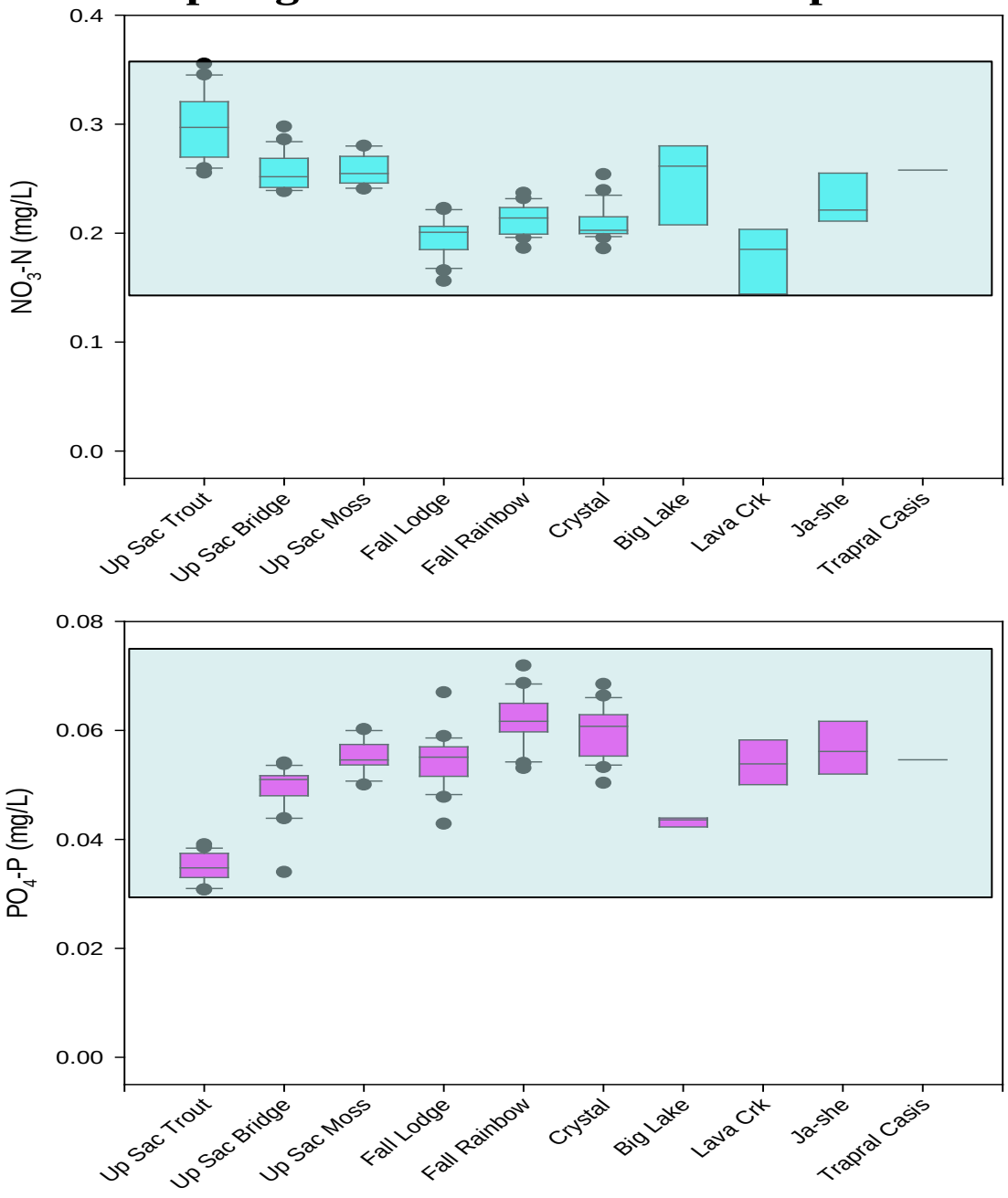
PO_4-P = 0.15 mg/L

Photo courtesy of Carson Jeffries

Northern California Volcanic Springs



Spring Water Nitrate and Phosphate



United States Environmental Protection Agency | Office of Water 4304 | EPA 822-B-00-015 December 2000

EPA

Ambient Water Quality Criteria Recommendations

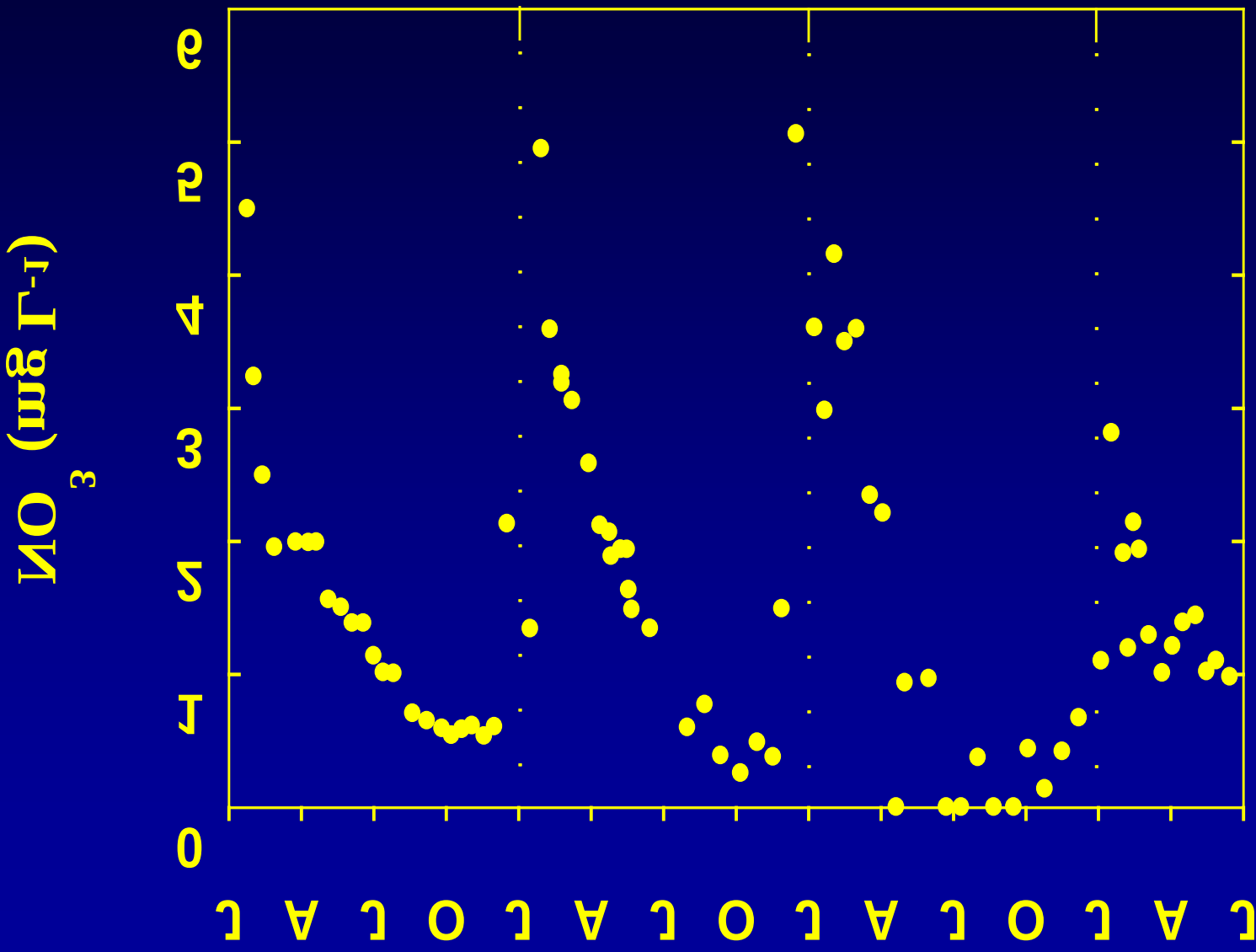
Information Supporting the Development of State and Tribal Nutrient Criteria

Rivers and Streams in Nutrient Ecoregion II

Background nutrient levels are not zero

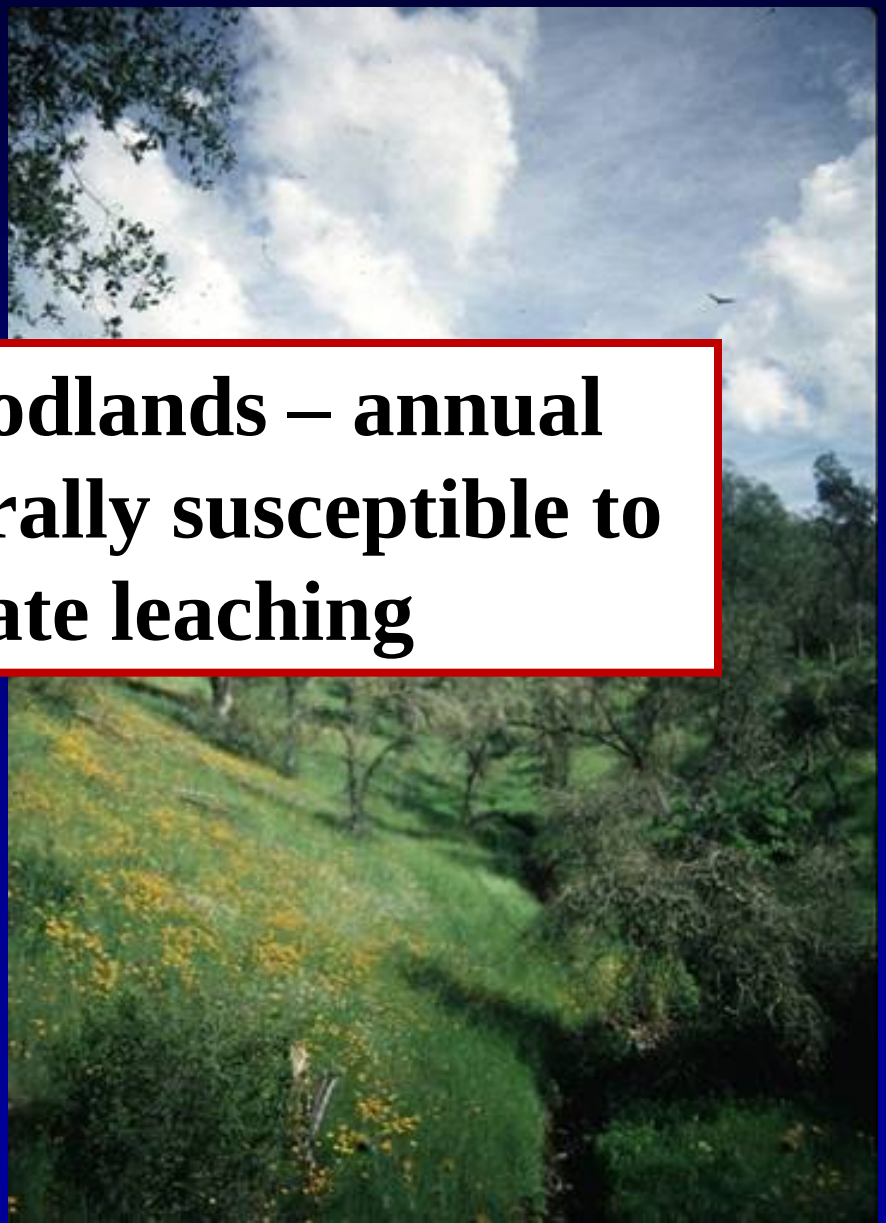
Nutrient	Background Level (mg/L)	Eutrophication Concern (mg/L)
TN	0.15 – 0.53	-
NO_3-N	0.005 – 0.040 (0.50)	0.30
TP	0.009 – 0.032 (0.15)	0.10
PO_4-P	(0.15)	0.05

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



Low Nutrient Demand

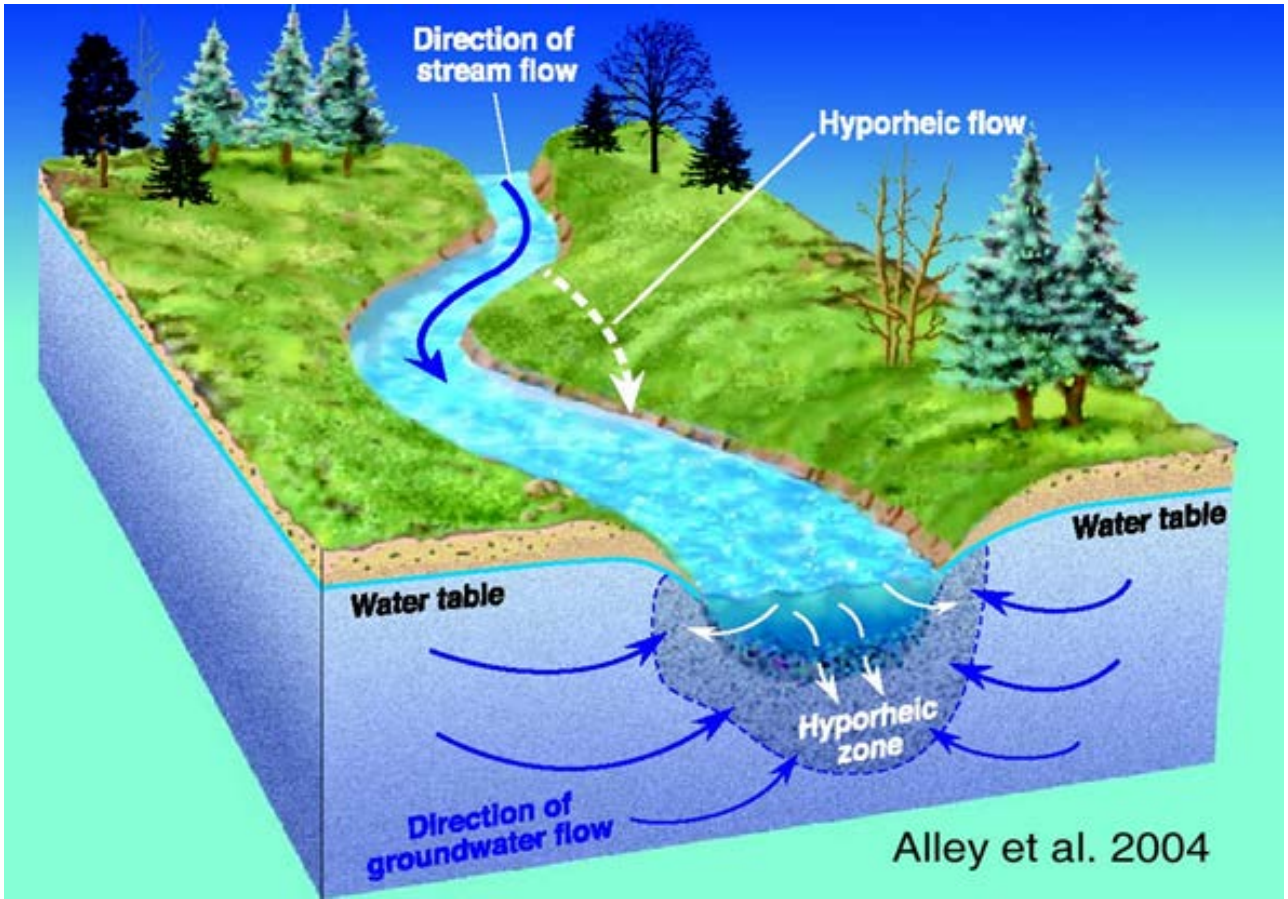
High Nutrient Demand



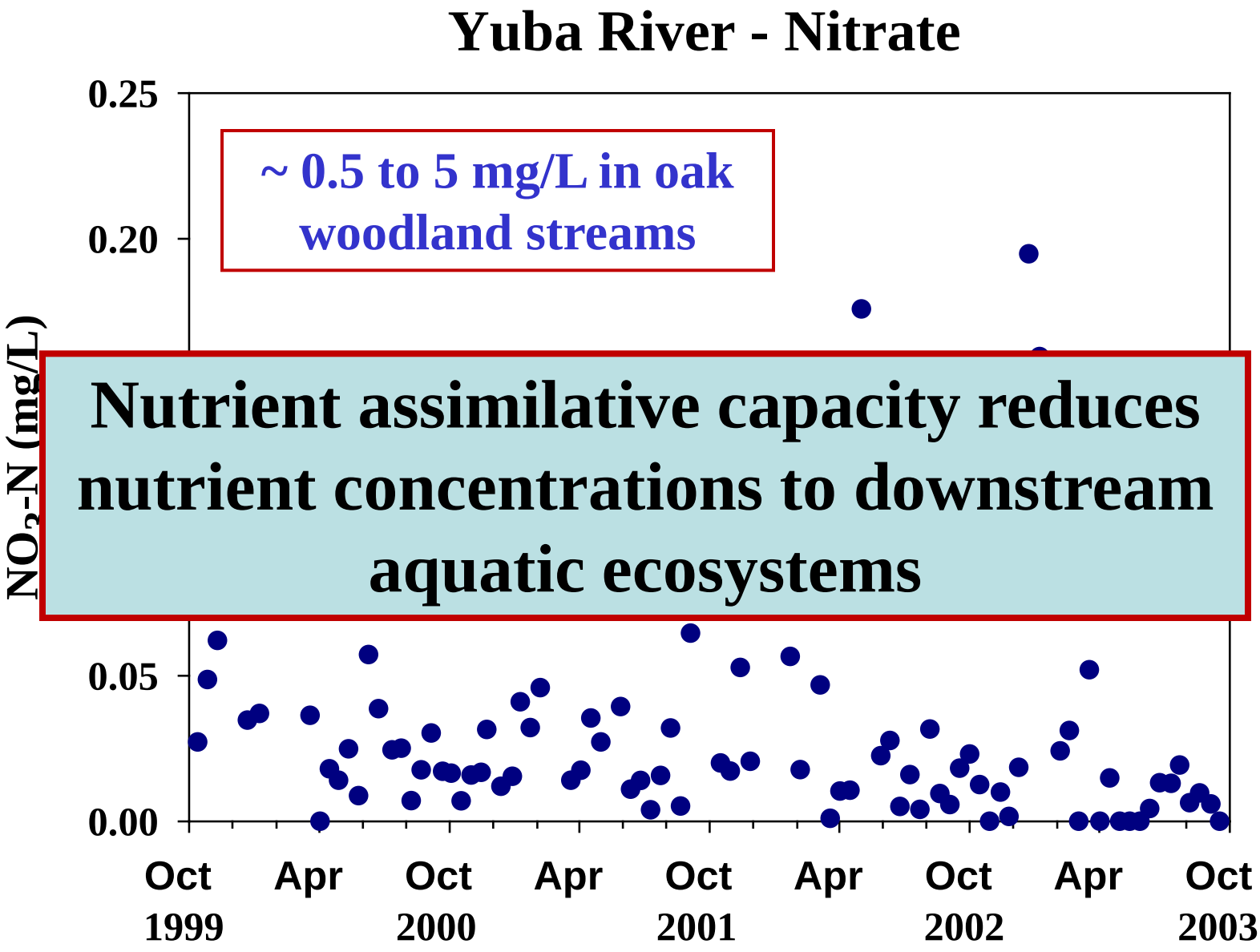
California oak woodlands – annual grasslands are naturally susceptible to seasonal nitrate leaching

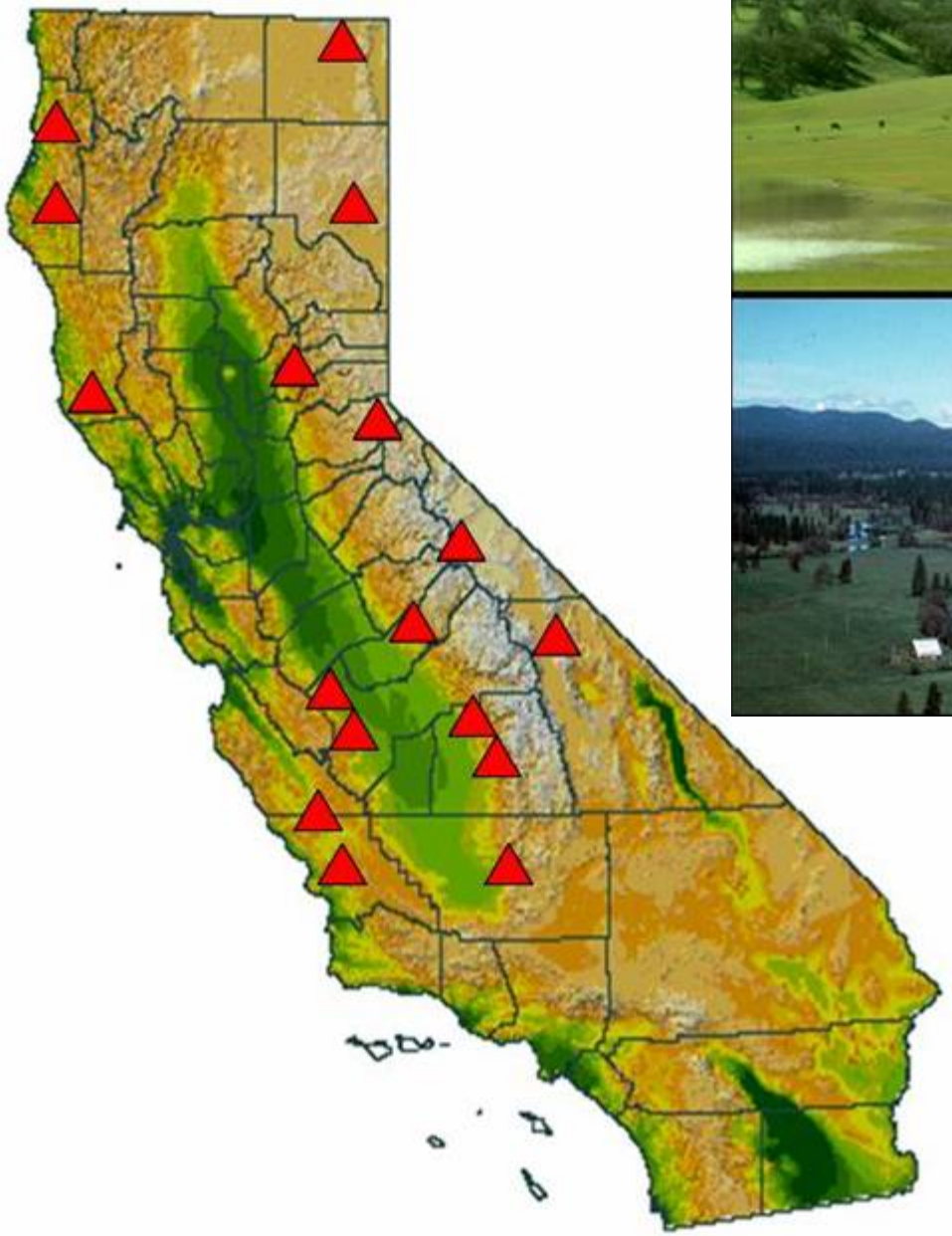
Assimilative Capacity

<u>Self-Purification Capacity</u> – removal of pollutants during downstream transport



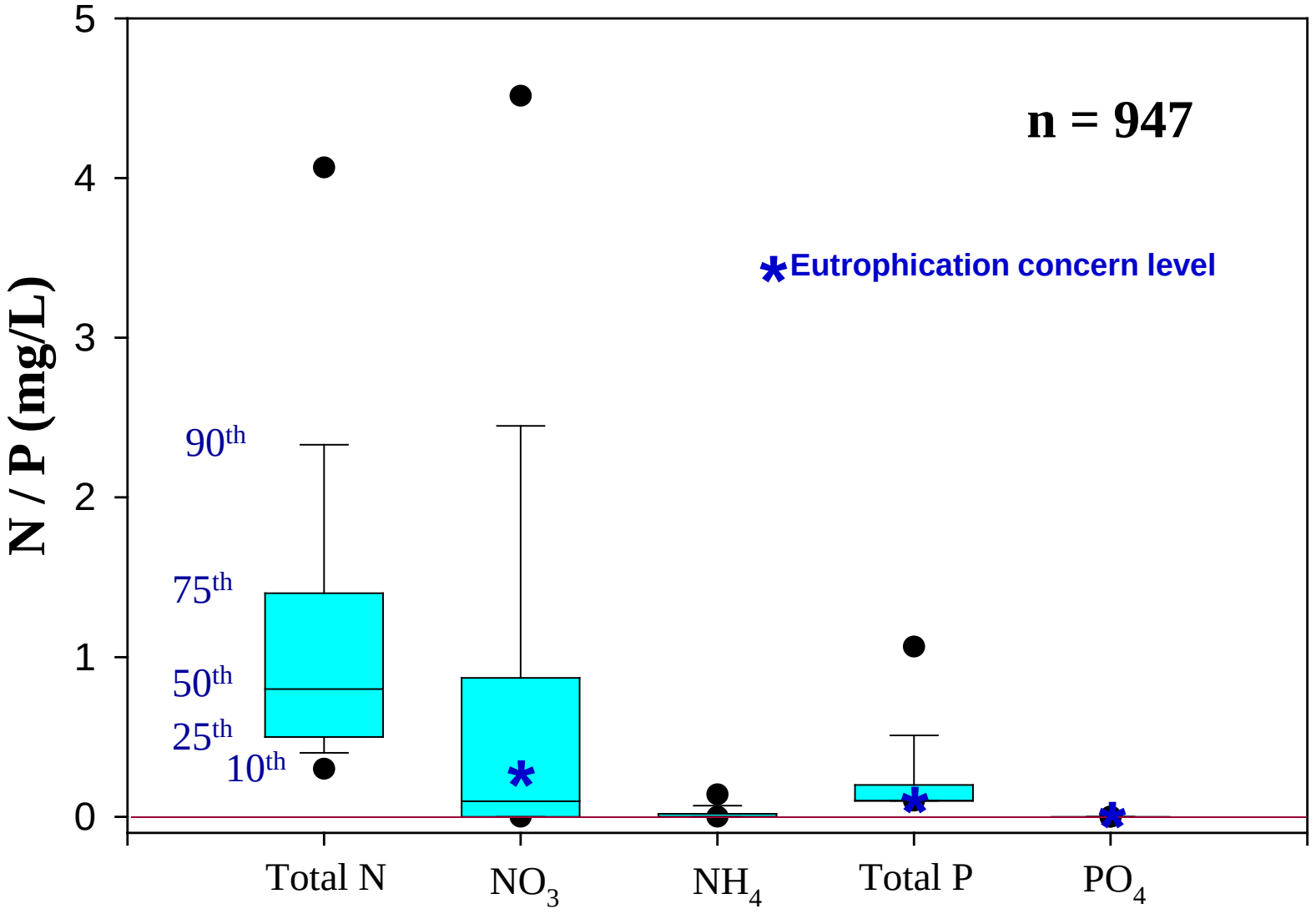
Assimilative Capacity


Yuba River - Nitrate
~ 0.5 to 5 mg/L in oak woodland streams
Nutrient assimilative capacity reduces nutrient concentrations to downstream aquatic ecosystems
NO3-N (mg/L)
0.25
0.20
0.05
0.00
Oct 1999
Apr
Oct 2000
Apr
Oct 2001
Apr
Oct 2002
Apr
Oct 2003



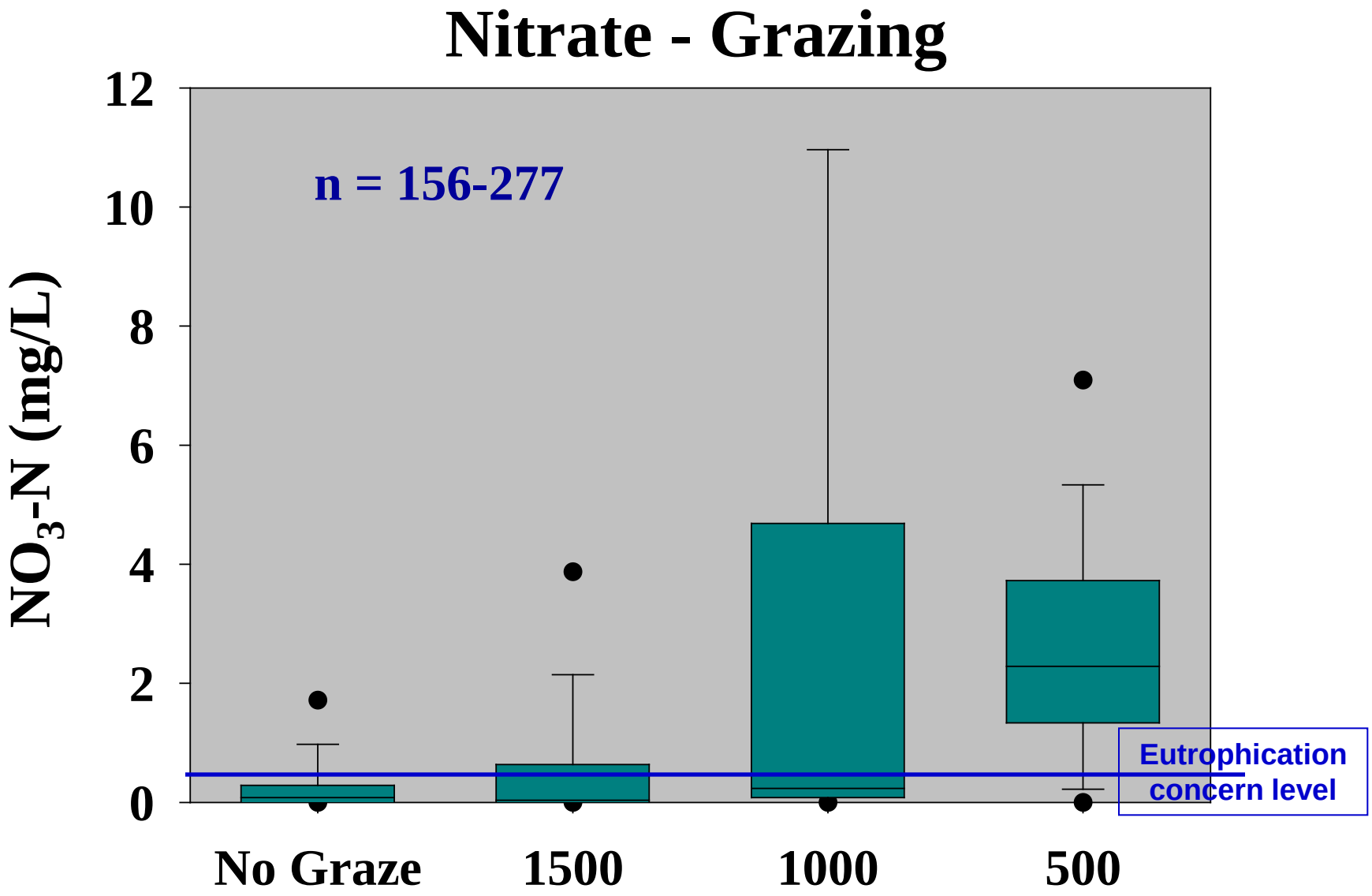
State-wide Survey
24 streams
2000 and 2001 water years

Nutrient Concentrations

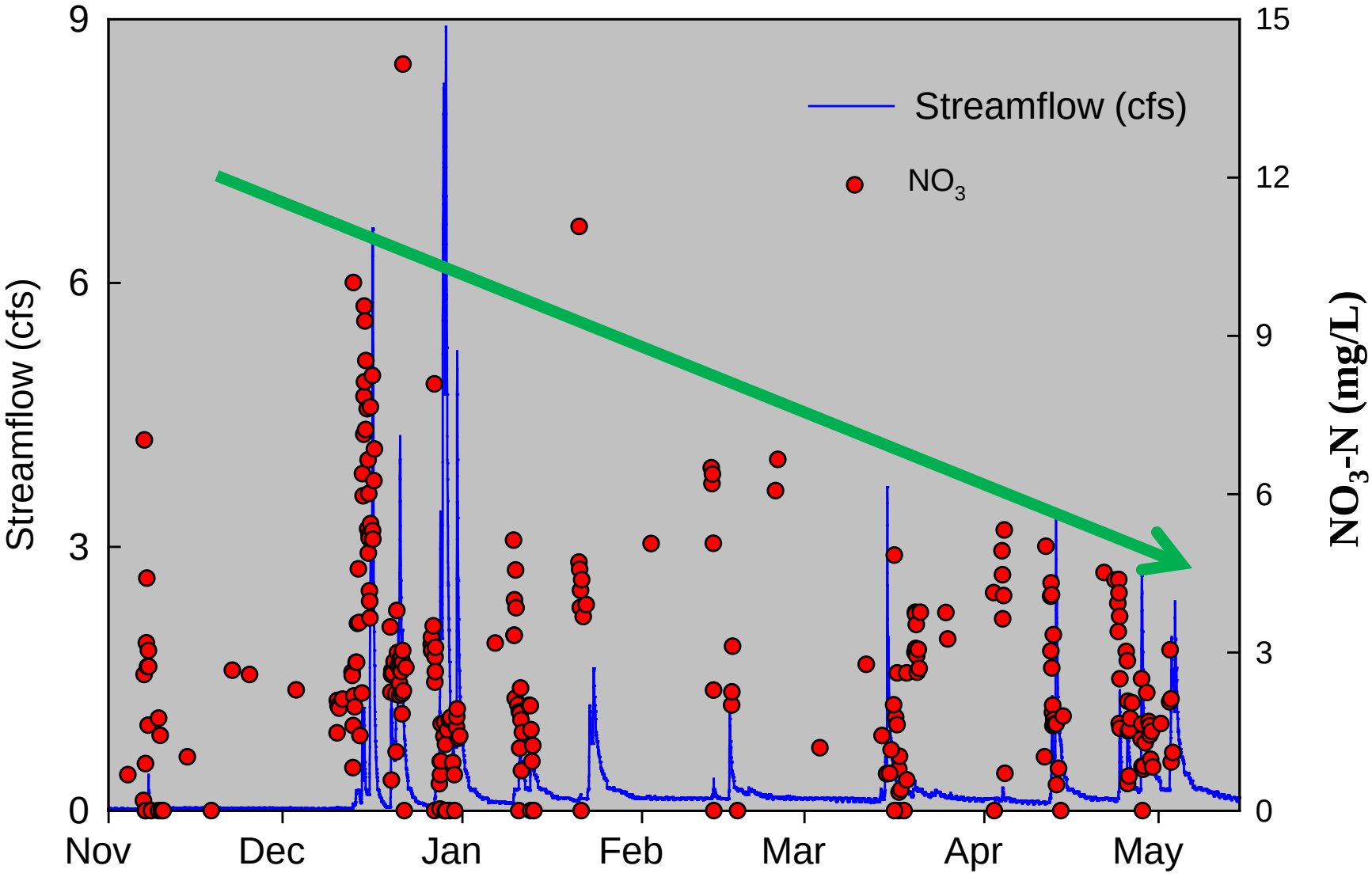


Grazing Treatments

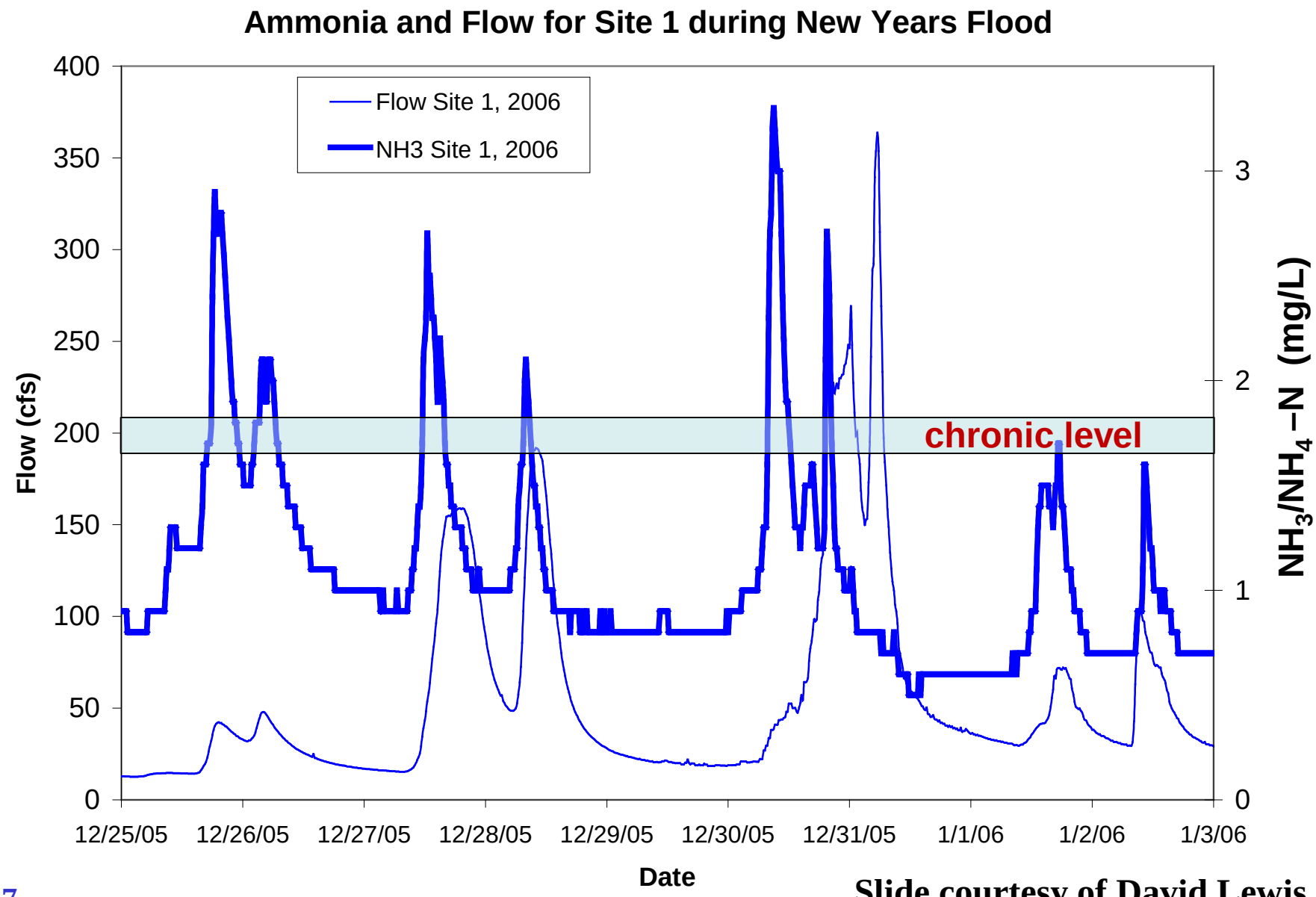
- No grazing
- 1500 lb/ac RDM
- 1000 lb/ac RDM
- 500 lb/ac RDM


Nitrate - Grazing
n = 156-277
NO_3-N (mg/L)
12
10
8
6
4
2
0
No Graze
1500
1000
500
Eutrophication concern level

Nitrate - 500 lbs/acre RDM



Coastal Creek Ammonia

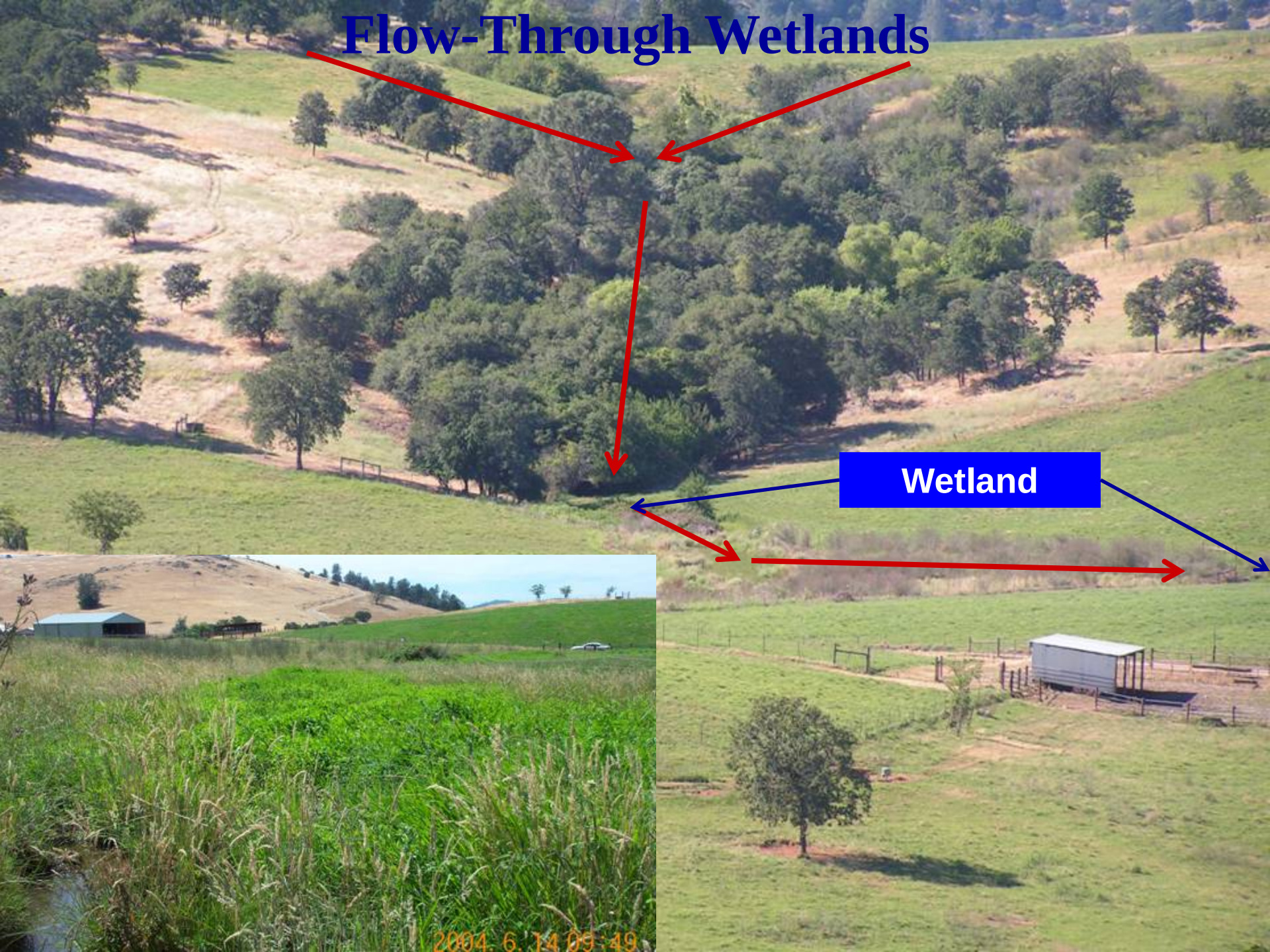


Slide courtesy of David Lewis

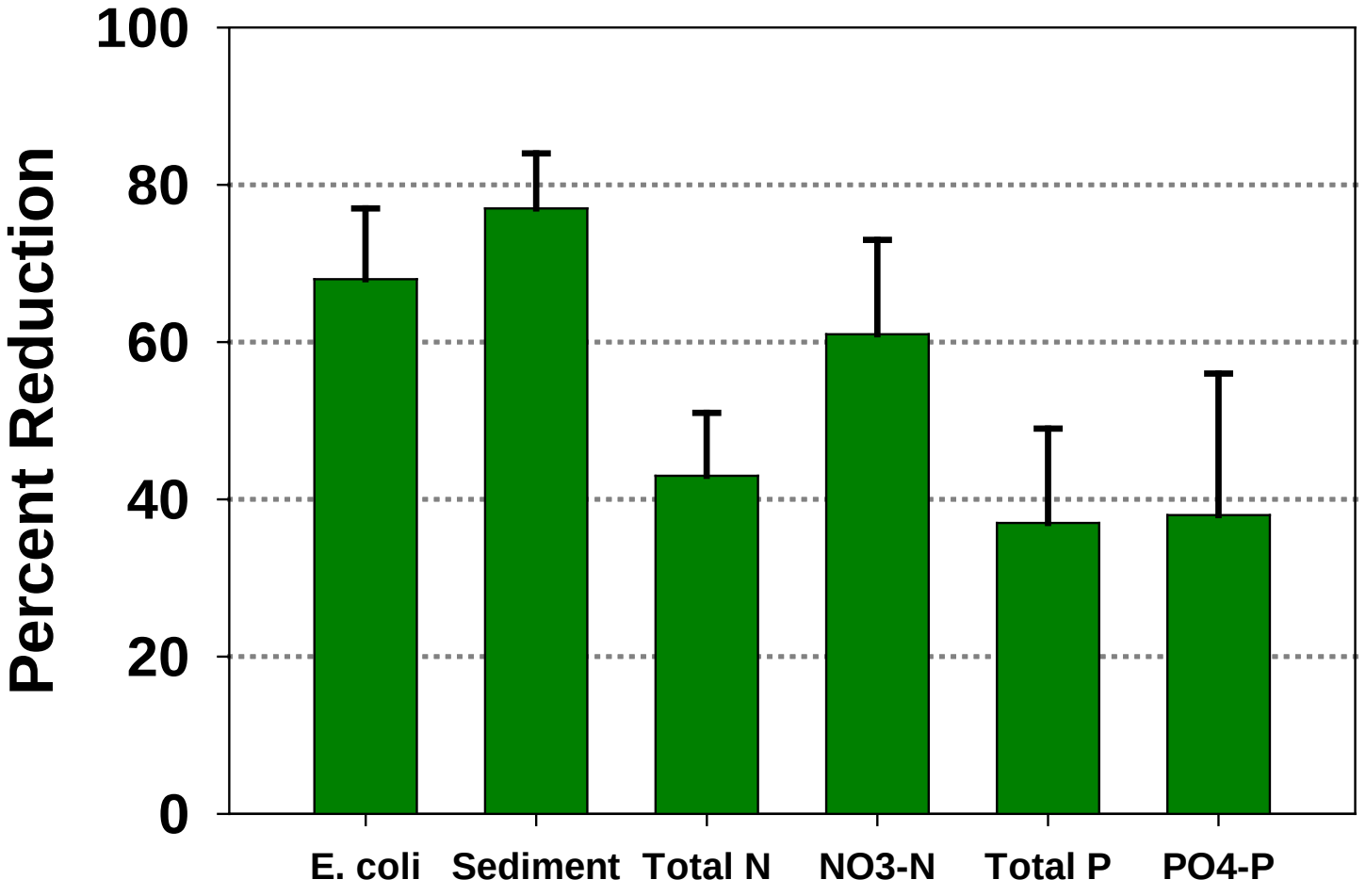
Grazing Management

Buffer/Filter Strip

Flow-Through Wetlands



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