

Nutrient Loading in Groundwater to Lake Spokane

Spokane Nonpoint Source Workgroup
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Lake Spokane Dissolved Oxygen

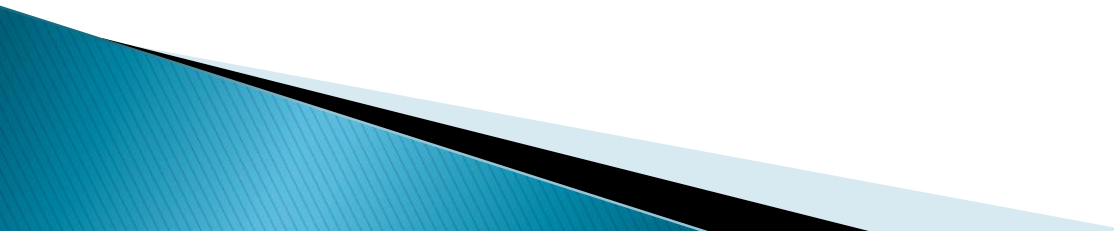
- ▶ Dissolved oxygen level attainment managed through reduction in nutrient loading
- ▶ Algae growing in shorelines surrounding Lake Spokane consumes dissolved oxygen
- ▶ Algal growth fueled by nutrients in the lake
- ▶ Nutrients transported to Lake from human activities
 - Nitrogen from OSS, fertilizers and manure
 - Phosphorus from fertilizers and manure (OSS)



Phosphorus Loading to Lake

- ▶ Sources:
 - Spokane River and Little Spokane River
 - Groundwater
 - Atmospheric Deposition
- ▶ Total phosphorus in groundwater discharging to Lake Spokane about 19 kg/day
- ▶ Orthophosphorus loading 4.5 kg/day
- ▶ Goal:
 - Daily load to entire Spokane River of 259 kg/day
 - Lake Spokane phosphorus concentration of <50 ug/L

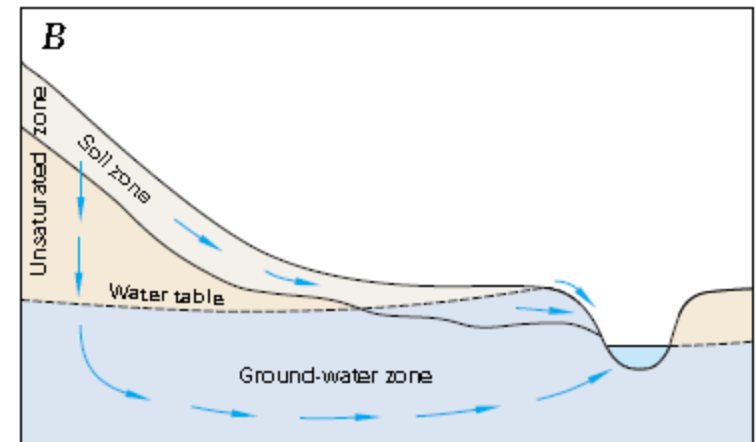
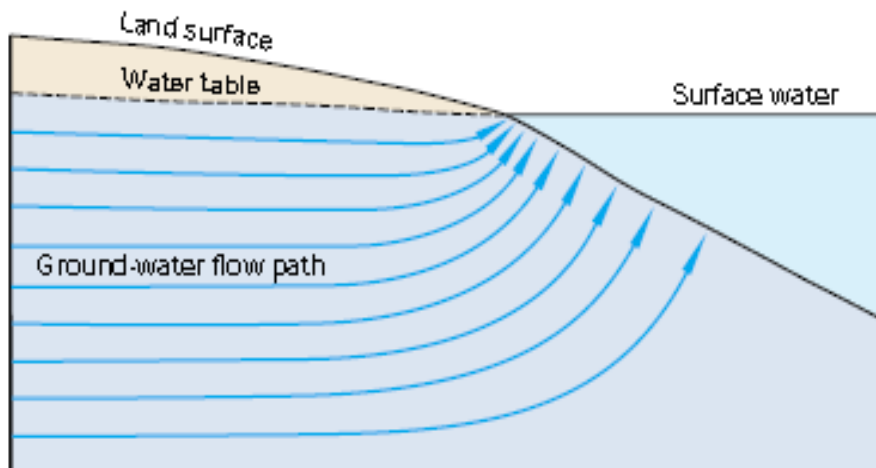
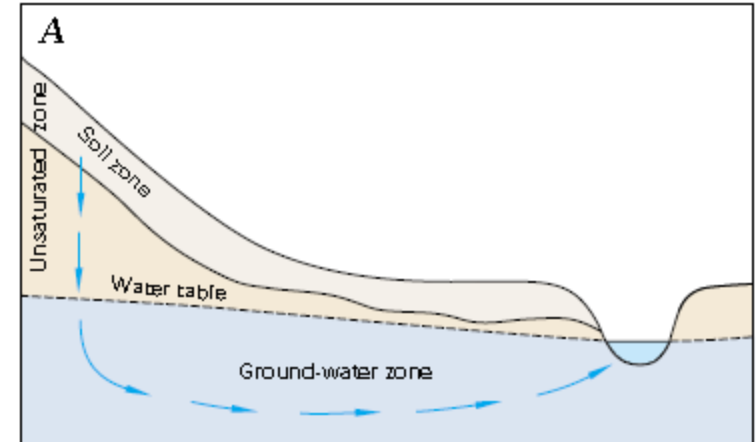
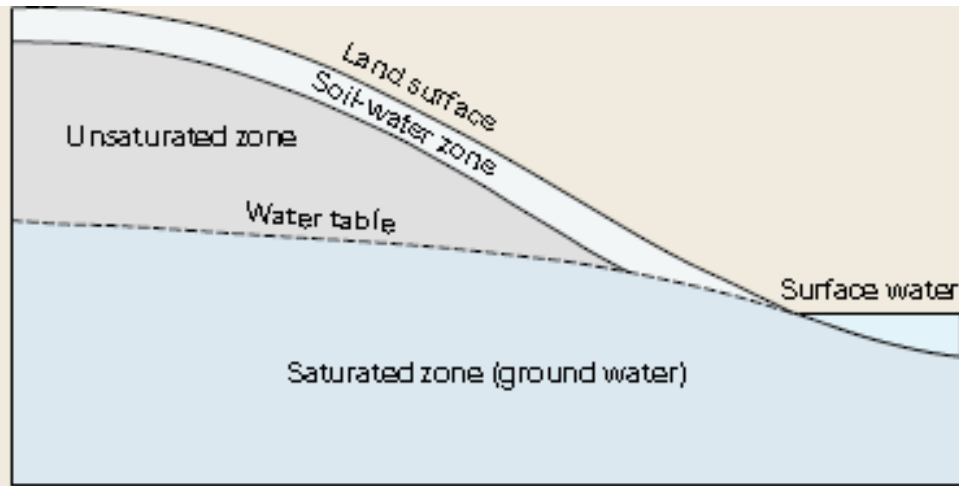
Onsite Septic Systems (OSS) Source

- ▶ 1,380 onsite septic systems (OSS) at Suncrest
 - ▶ 250 OSS along Spokane County side of Lake
 - ▶ Septic systems reduce the rate of phosphorus transport, do not remove phosphorus
 - ▶ Spokane County Shoreline Program instituting enhanced phosphorus removal technologies
 - ▶ Improvement to P removal from Suncrest OSS
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OSS Source Evaluation

- Evaluate shoreline groundwater and algae for evidence of nutrient transport to Lake Spokane
- Measure nutrients in groundwater at:
 - Suncrest area
 - Undeveloped Lake Spokane shoreline
- Measure nitrogen isotopes in vegetation growing along shoreline in Suncrest & undeveloped shoreline areas
- Compare nitrogen isotope ratios at shoreline locations to evaluate septic sources

Groundwater transport of onsite septic system infiltrate



Nutrient isotope source evaluation

- ▶ Nitrogen ^{15}N to ^{14}N isotope ratios indicate nitrogen source
- ▶ Atmospheric ratio ($\delta^{15}\text{N}:\delta^{14}\text{N}$) is constant, at 0 (parts per thousand, denoted as $\delta^{15}\text{N}$)
- ▶ Metabolism fractionates $\delta^{15}\text{N}$; concentrates ^{15}N in the organism in which metabolism occurs
- ▶ $\delta^{15}\text{N}$ ratio increases by 3 for each step up the trophic level (ratio in humans is 6– 10 ppt)
- ▶ $\delta^{15}\text{N}$ ratios further increased by microbial action in septic tanks (10 – 20 ppt)

Nutrient isotope source evaluation

- ▶ Algae (and plants) derive nitrogen from water with animal and plant sources
- ▶ Algae integrates ^{15}N and ^{14}N in the proportions available over time
- ▶ Locations affected by nitrogen from OSS are distinguished by comparing $\delta^{15}\text{N}$ ratios in algae from OSS impacted sources to pristine sites
 - Large numbers of samples required to statistically differentiate ^{15}N variations
 - Eurasian Millefoil, or other plants with roots accessing the littoral zone (shoreline interface) used for ^{15}N ratio analysis

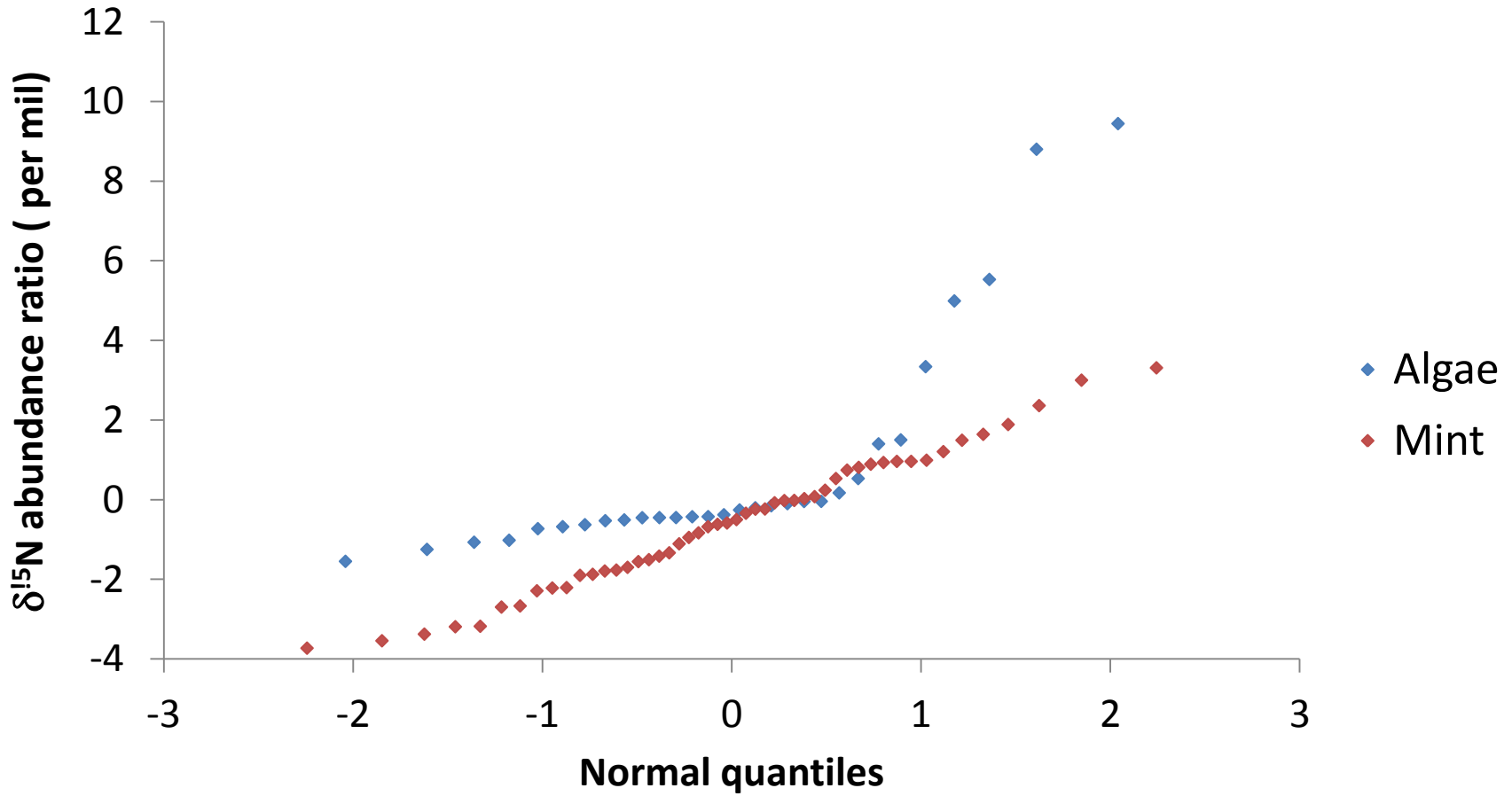
Groundwater characterization

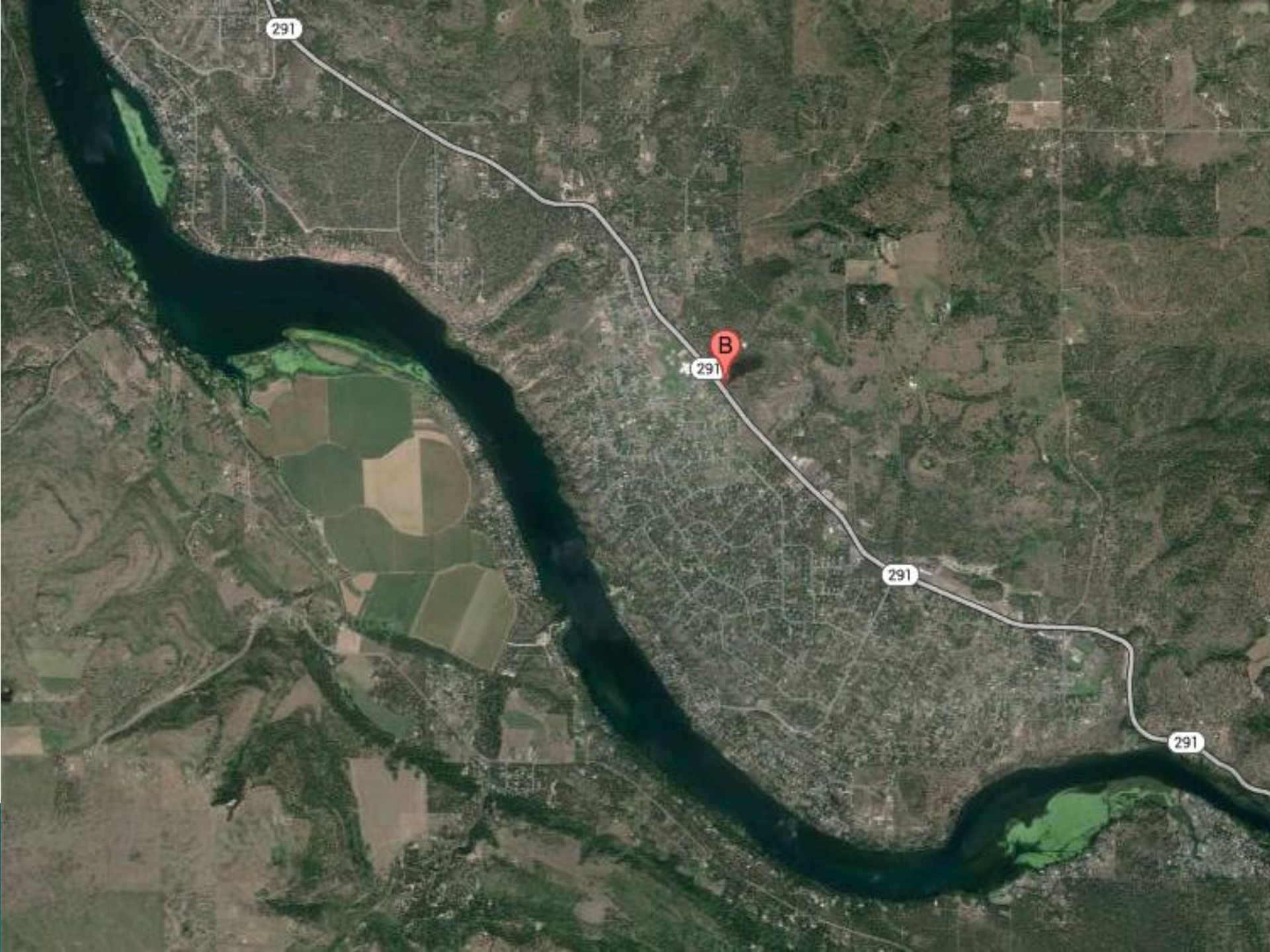
- ▶ Approach for groundwater characterization:
 - Survey range of groundwater P & N content
 - Identify septic influenced groundwater discharge locations using N isotope analyses
 - Assess range of P content in septic influenced gw
 - Calculate P loading using measured conc. (future)
- ▶ Groundwater collected from:
 - Shallow groundwater at shoreline locations around Lake
 - Shallow groundwater in Suncrest area shoreline using hand-installed drive points
 - Wells in upgradient Suncrest area
- ▶ Groundwater analyses:
 - Total phosphorus, ortho-phosphate, nitrate & nitrite, ammonia, dissolved oxygen

Algae $\delta^{15}\text{N}$ Characterization

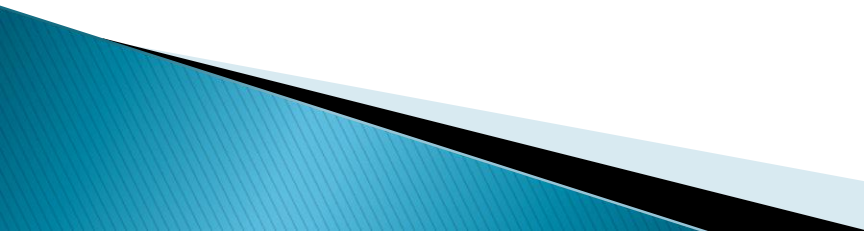
- ▶ Approach for Algae characterization
 - Identify $\delta^{15}\text{N}$ ratios in algae collected around Lake Spokane shorelines
 - Compare Suncrest area $\delta^{15}\text{N}$ to range around Lake
- ▶ Algae samples collected from:
 - Septic impacted shorelines
 - Non-impacted shorelines
 - Eurasian Millefoil
 - Other shoreline plants
- ▶ Algae Analyses: $\delta^{15}\text{N}$ ratio

d¹⁵N analyses results





Analyses and Results

- ▶ Statistical Analyses of $d^{15}N$ ratios in relation to the location sampled (undeveloped v. Suncrest)
 - ▶ $d^{15}N$ ratios differ between locations with septic influenced discharge and non-septic impacted shorelines
 - ▶ Report with mapped impacted areas based on statistical analyses
 - ▶ Recommendations for future study to measure nutrient flux rates in nearshore
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Schedule & Budget

- ▶ \$75,000 cost
 - ▶ USGS matching funds available at ratio of 1:2 (i.e. \$25,000: \$50,000)
 - ▶ Ecology contributing to \$50,000
 - ▶ Other commitments needed to total \$50K
 - ▶ Funds available until June 30, otherwise redirected.
 - ▶ Decision by June 15 to complete agreements
 - ▶ Study duration July 2014 to Dec 2015
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