EPA
United States
Environmental Protection
Agency

Nitrogen Sources, Management and Impacts on PNW Water Quality

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The views expressed in this presentation are those of the authors and do not necessarily represent the views or policies of the US EPA.

Agency Questions

Connecting source and impacts

- What are the drivers of nutrient-related water quality concerns?
- What is the largest source of nitrogen (N) or phosphorus (P) for water bodies with nutrient-related concerns?
- How can we use nutrient source information to prioritize and manage areas to improve water quality?

Outline

1. EPA's national nutrient input inventory (NNI)
   - Predicting TN in stream water
   - Connecting source and TN condition

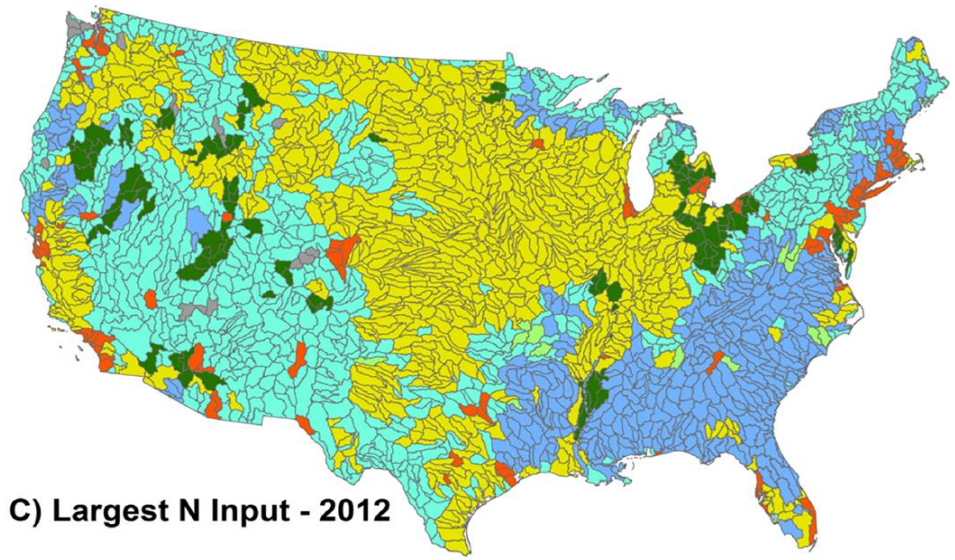
2. Applying N budgets in Region 10
   - Southern Willamette Groundwater Management Area
   - Nooksack

EPA's National Nutrient Inventory

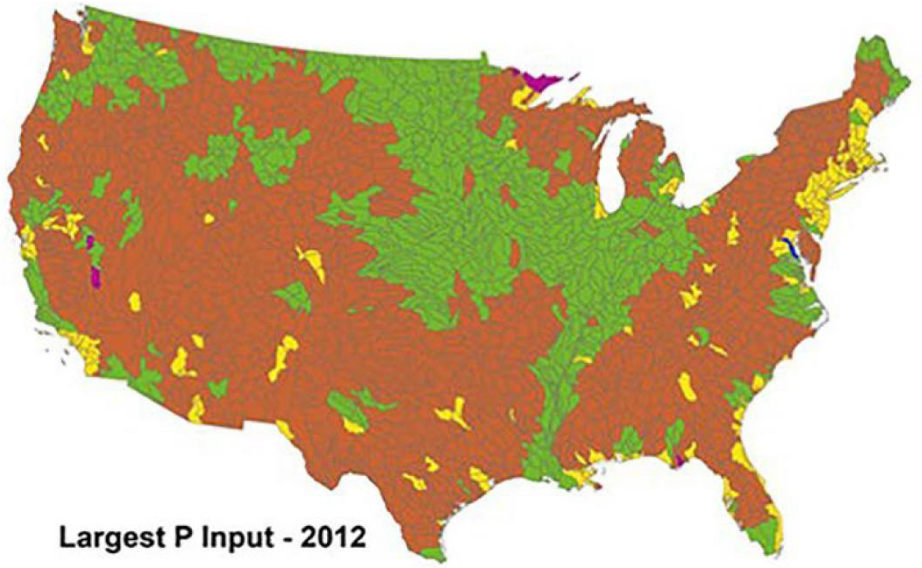
- N and P for 2002, 2007 and 2012
- Largest Anthropogenic Source varies

- Fertilizer is dominant in farmland
- Deposition is largest source in the NE and west
- Human waste near cities

Nitrogen

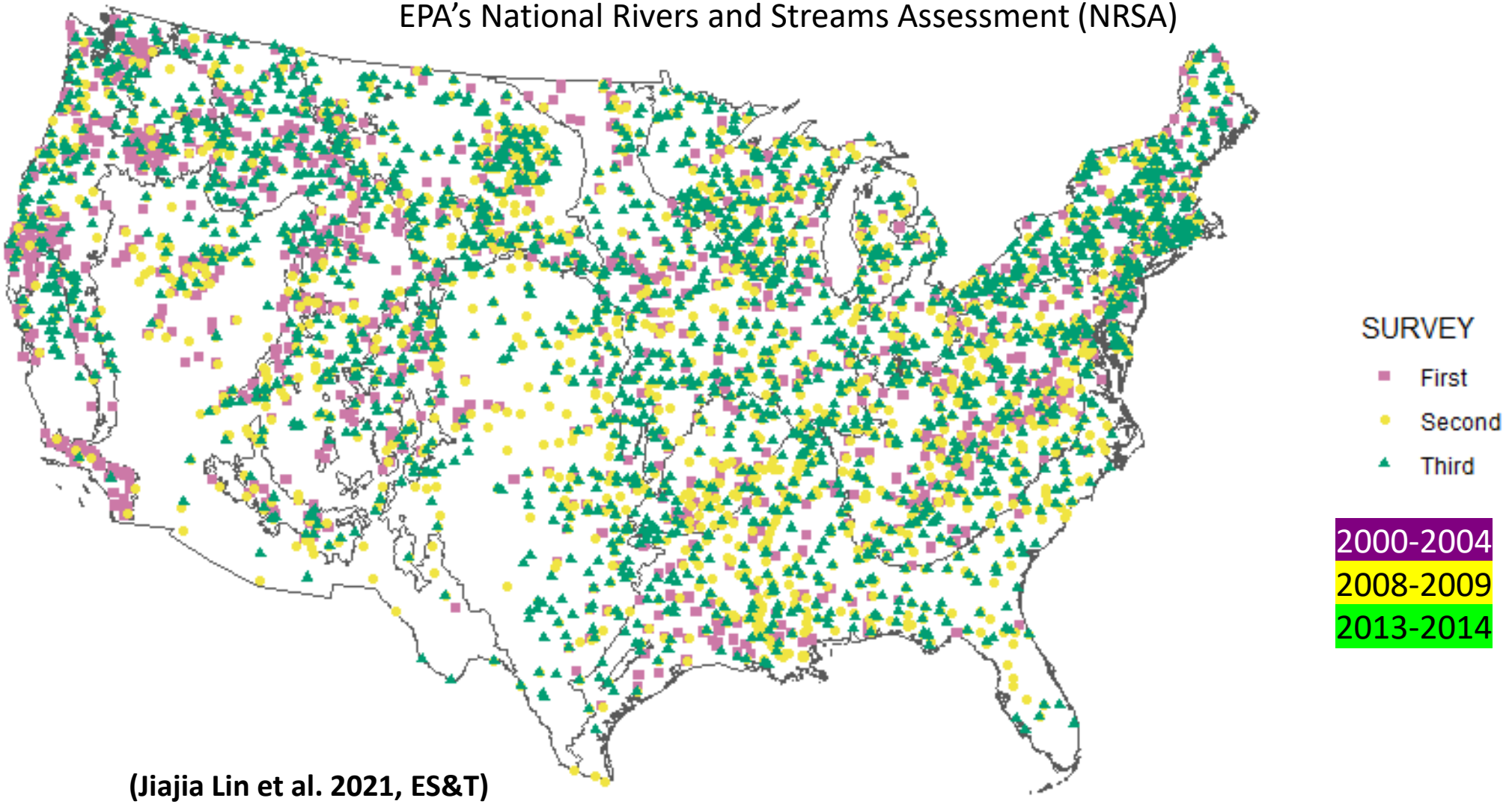


Phosphorus



Connecting the inventory to water quality data

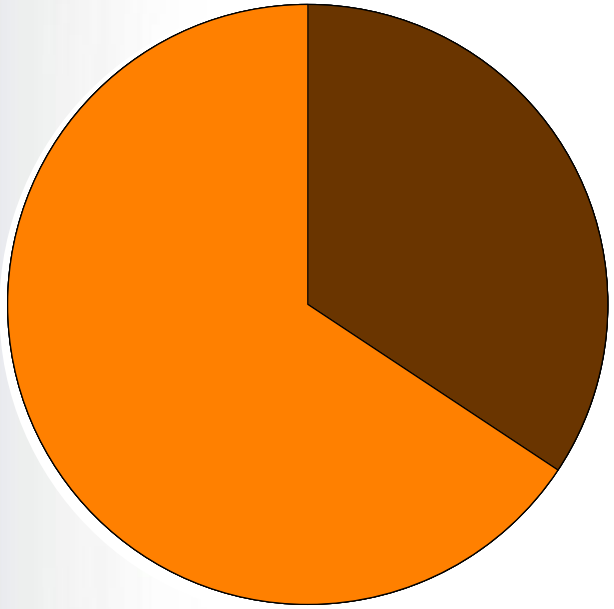
EPA's National Rivers and Streams Assessment (NRSA)

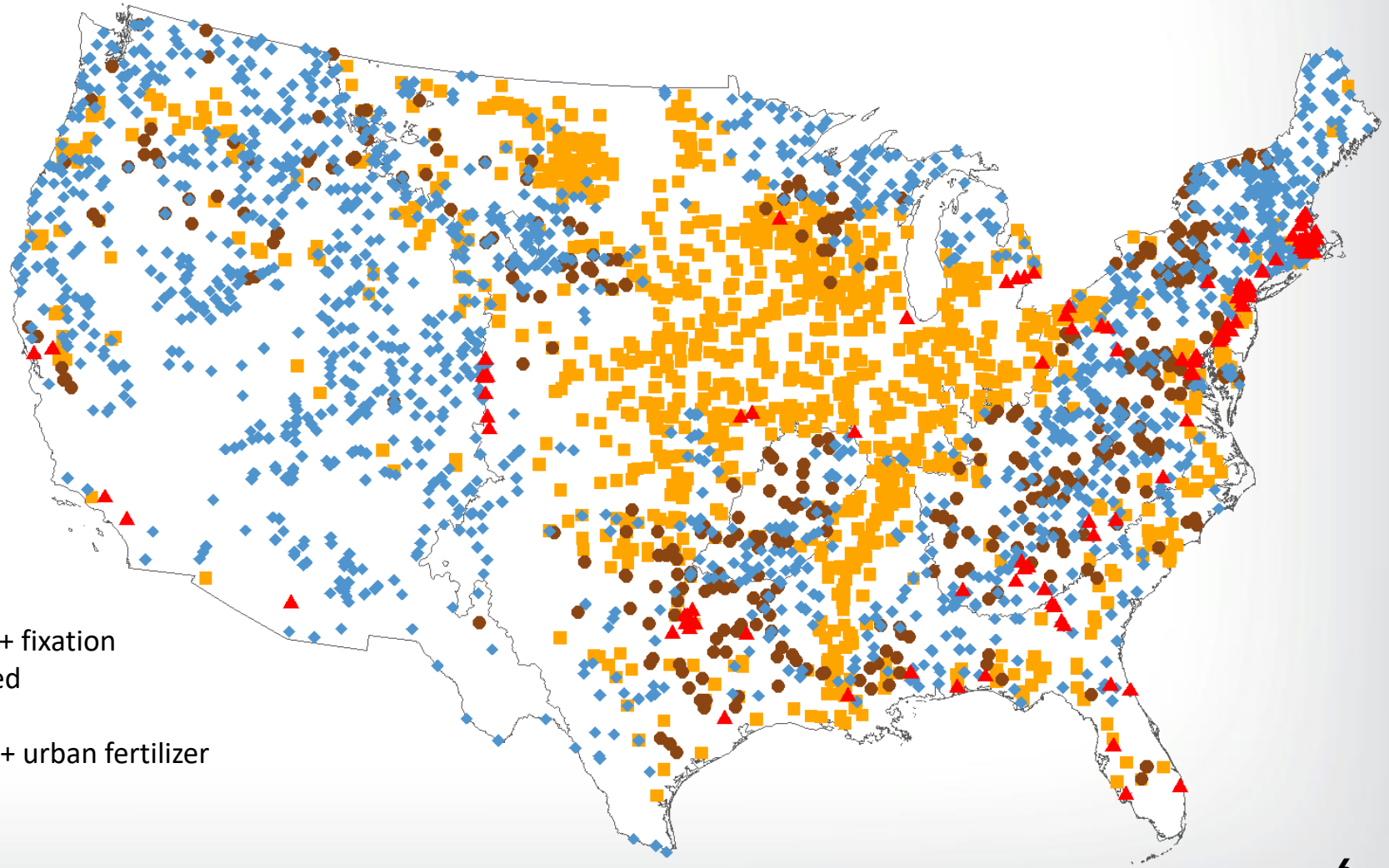


(Jiajia Lin et al. 2021, ES&T)

All NRSA sites categorized by largest N source

Proportion of stream length



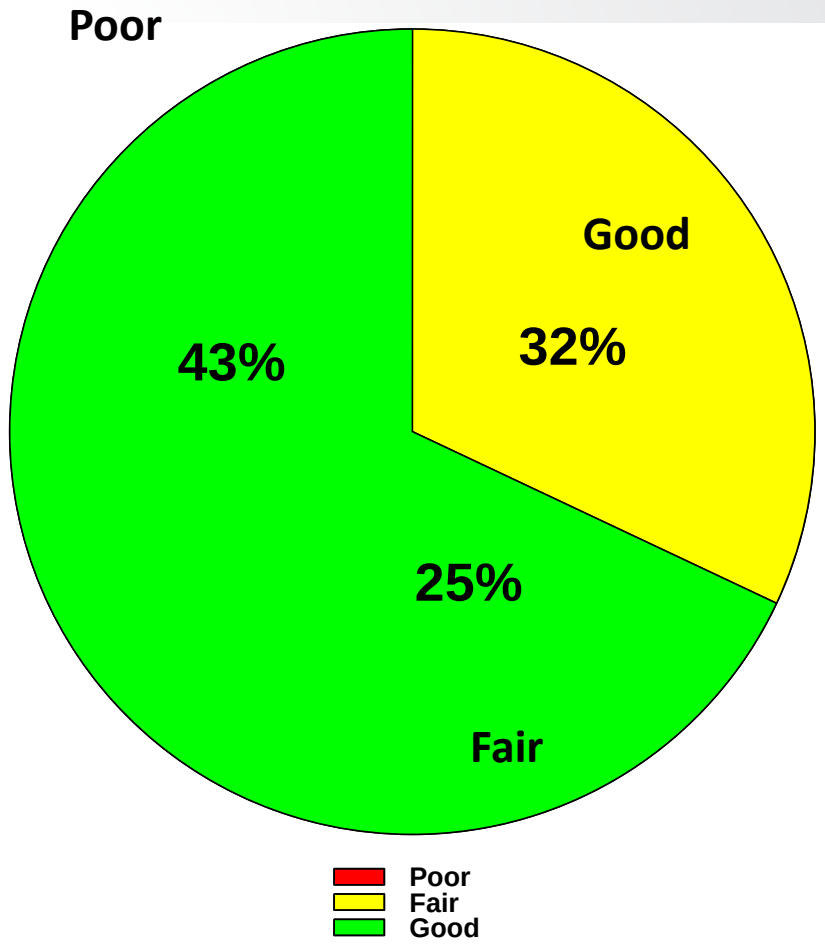


Total Nitrogen condition class

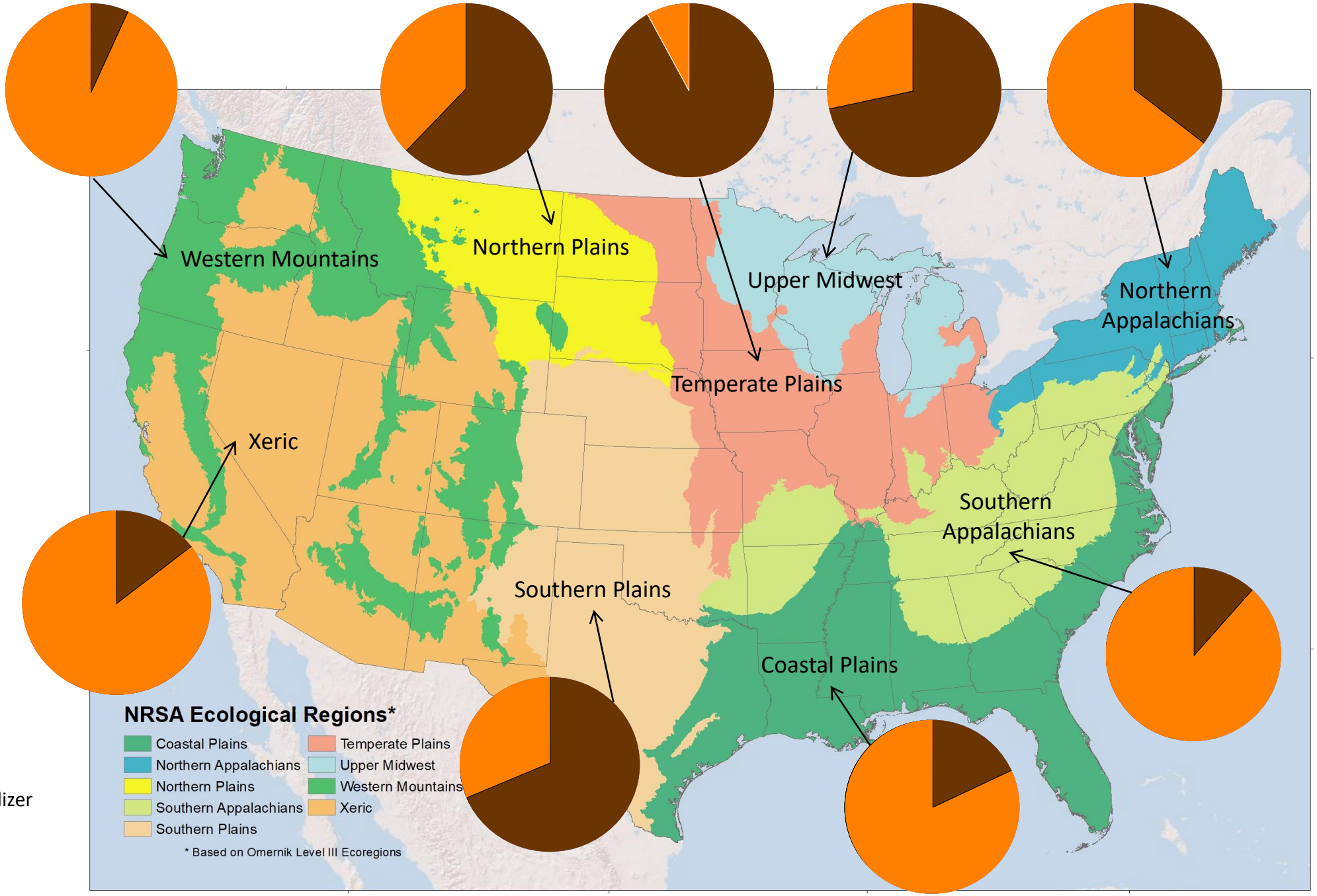
Appendix B

Ecoregion-Specific Benchmarks Used in NRSA 2013–14

Ecoregion	Benthic Macroinvertebrate MMI		Fish MMI		Total Nitrogen (µg/L)		Total Phosphorus (µg/L)	
	Good (≥)	Poor (≤)	Good (≥)	Poor (≤)	Good (≤)	Poor (≥)	Good (≤)	Poor (≥)
CPL	54.9	40.7	57.3	46.8	624	1081	55.9	103.0
NAP	55.0	40.9	57.6	47.1	345	482	17.1	32.6
SAP	45.0	30.8	60.3	49.8	240	456	14.8	24.4
UMW	36.9	22.7	39.8	29.3	583	1024	36.3	49.9
TPL	40.3	26.2	58.0	47.5	700	1274	88.6	143.0
NPL	56.8	42.6	46.3	35.8	575	937	64.0	107.0
SPL	35.5	21.3	50.2	39.7	581	1069	55.8	127.0
WMT	50.1	35.9	75.9	65.4	139	249	17.7	41.0
XER	57.0	42.8	76.8	63.7	285	529	52.0	95.9

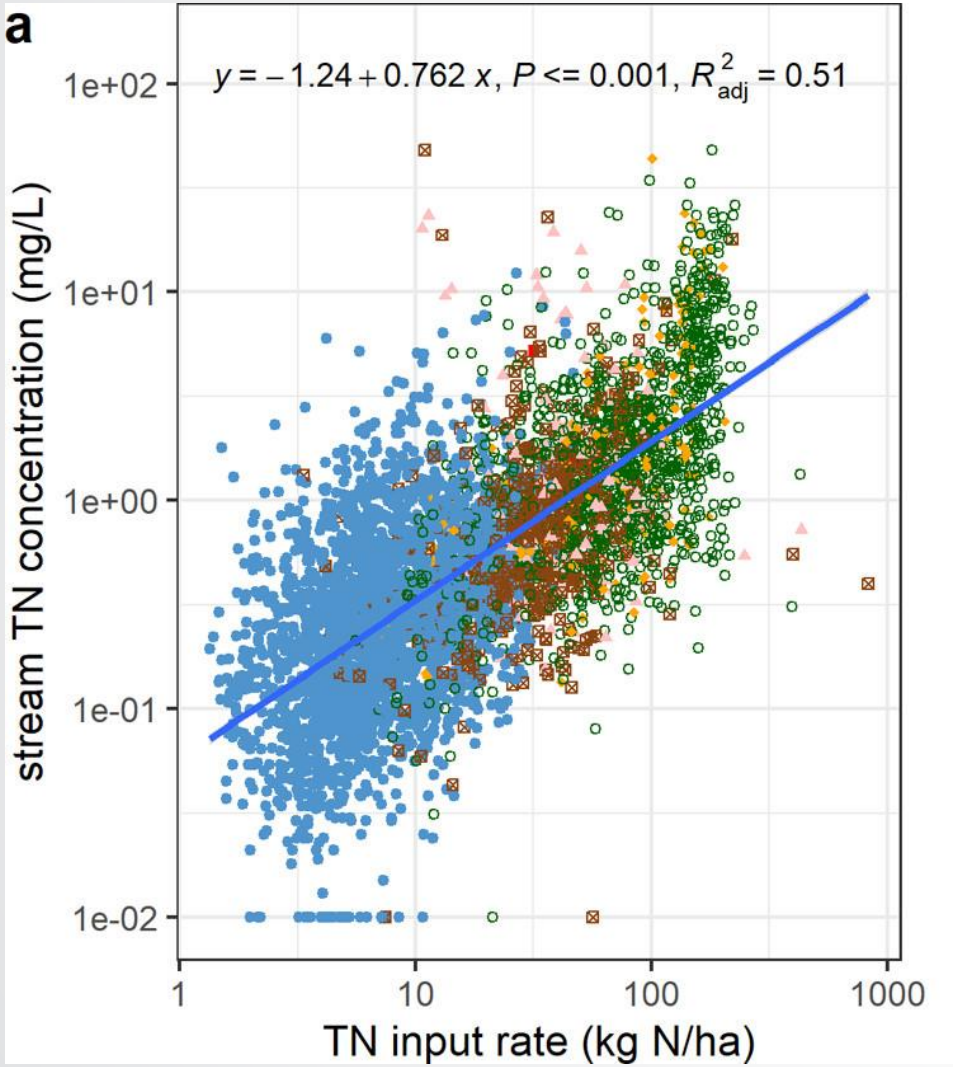


N Sources linked to Poor Condition in River and Stream Length by Ecoregion

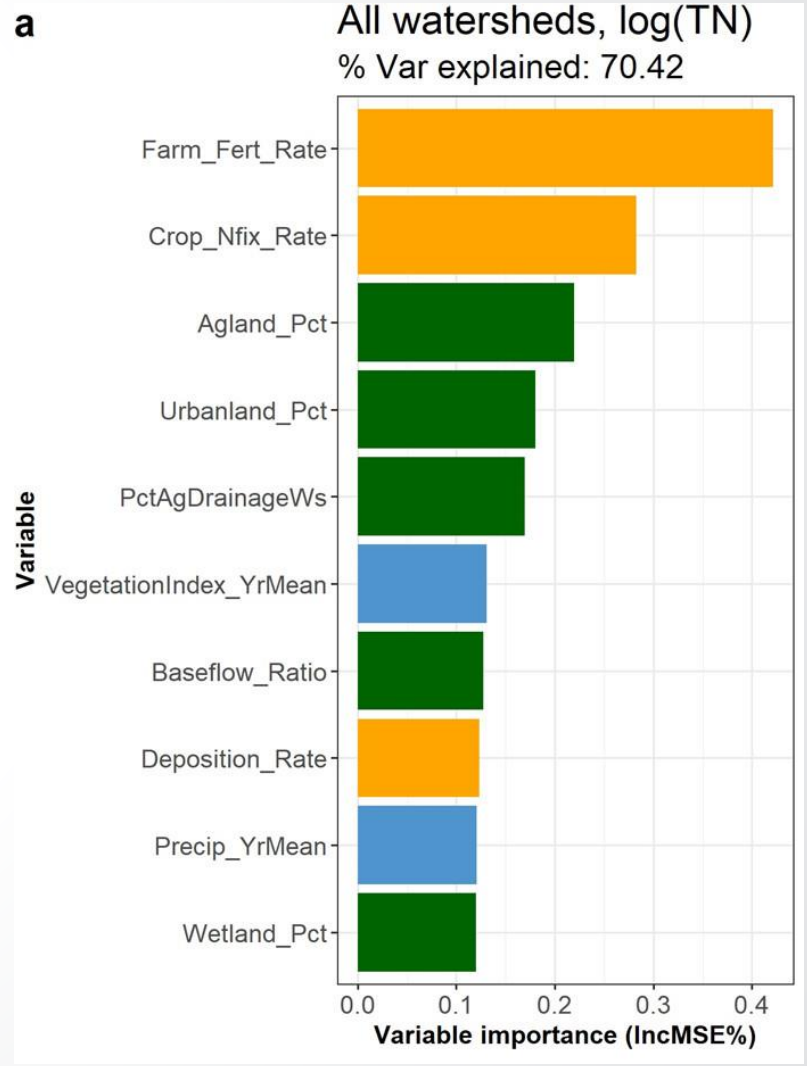


- Crop fertilizer + fixation
- Manure applied
- Deposition
- Human waste + urban fertilizer
- Missing

N inputs drive NRSA stream concentrations



- N inputs alone explain 51% of variation in stream TN
- Land cover type is also important, along with climate, agricultural tile drainage and baseflow ratio
- Predicted 70% of TN variation with this random forest model

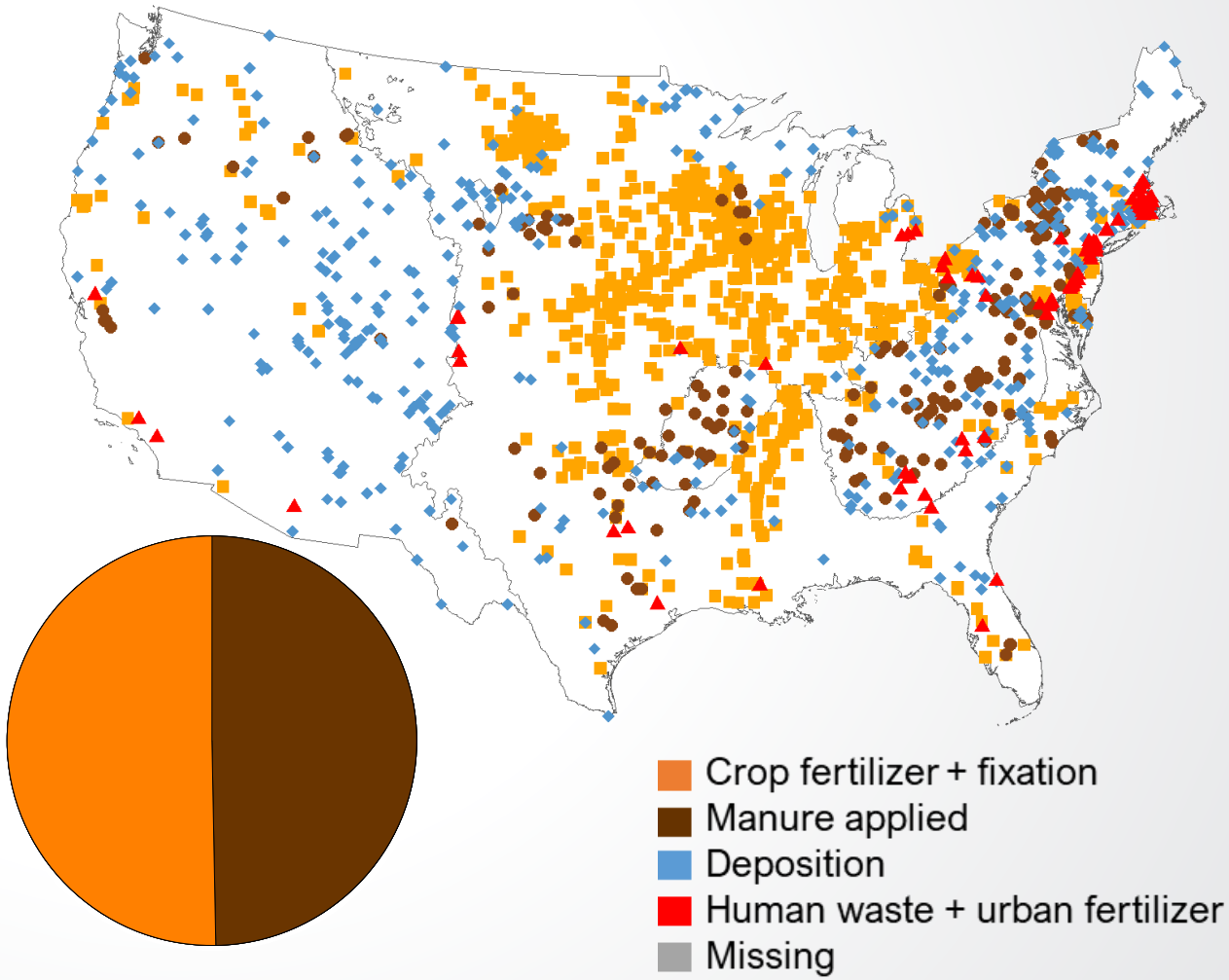


Lin et al. ES&T 2021

NRSA-Inventory Takeaways

- Agricultural non-point source inputs are the major driver for rivers and streams in Poor nutrient condition across the US.
- The largest N source linked to poor condition does differs by region.
- Policies and management to improve condition will differ by region and source.

Largest N source for NRSA sites with Poor nutrient condition



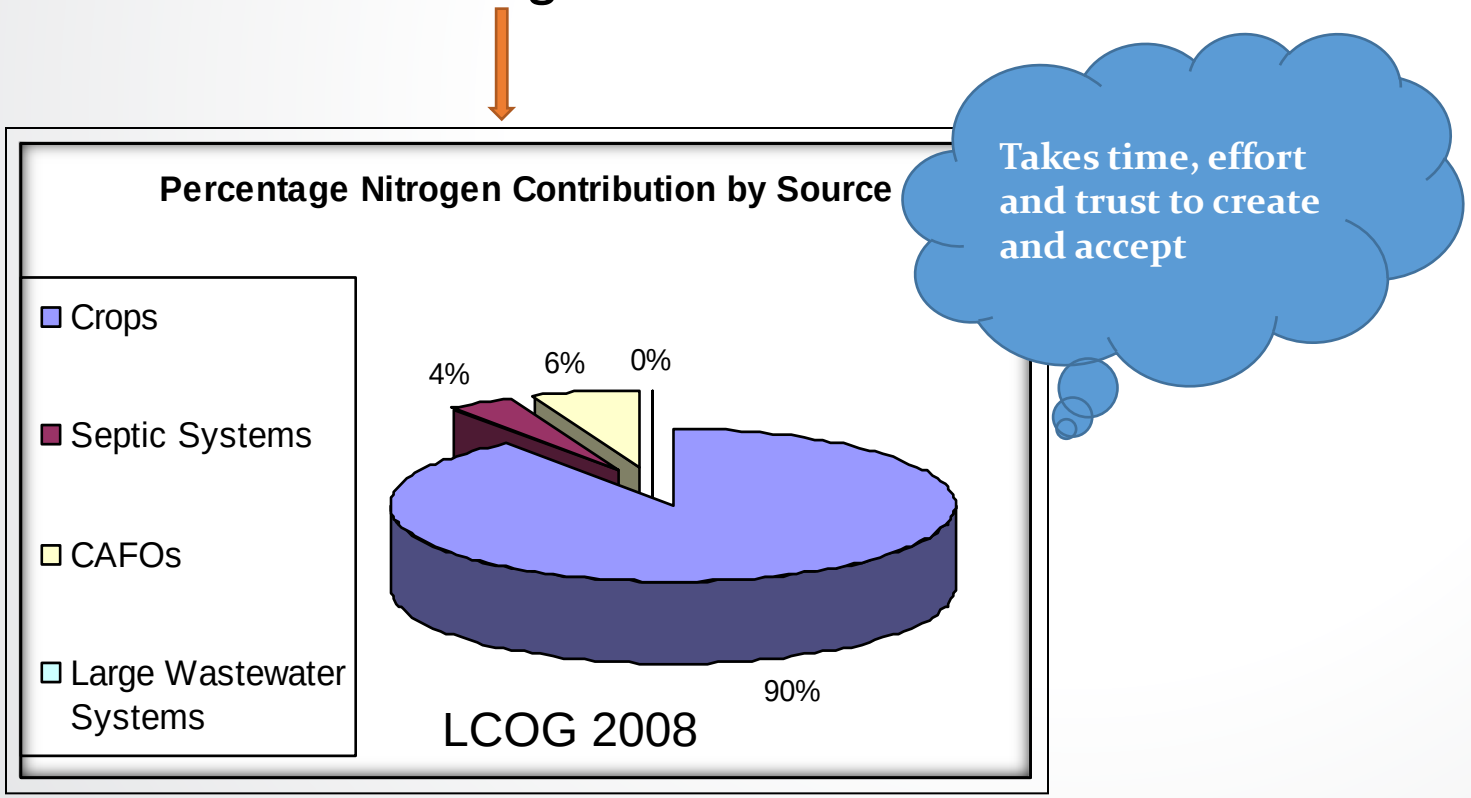
Outline

1. EPA's national nutrient input inventory (NNI)
   - Predicting TN in streamwater
   - Connecting source and poor TN condition

2. System N budgets in Region 10
   - Willamette
   - Groundwater Management Areas
   - Nooksack

Application of N budgets

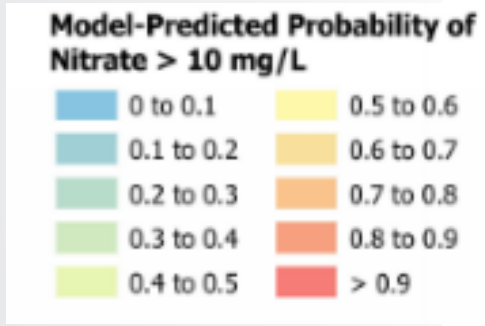
- Puget Sound
- Chesapeake Bay Model
- Gulf Hypoxia Task Force efforts
- Groundwater Management Area

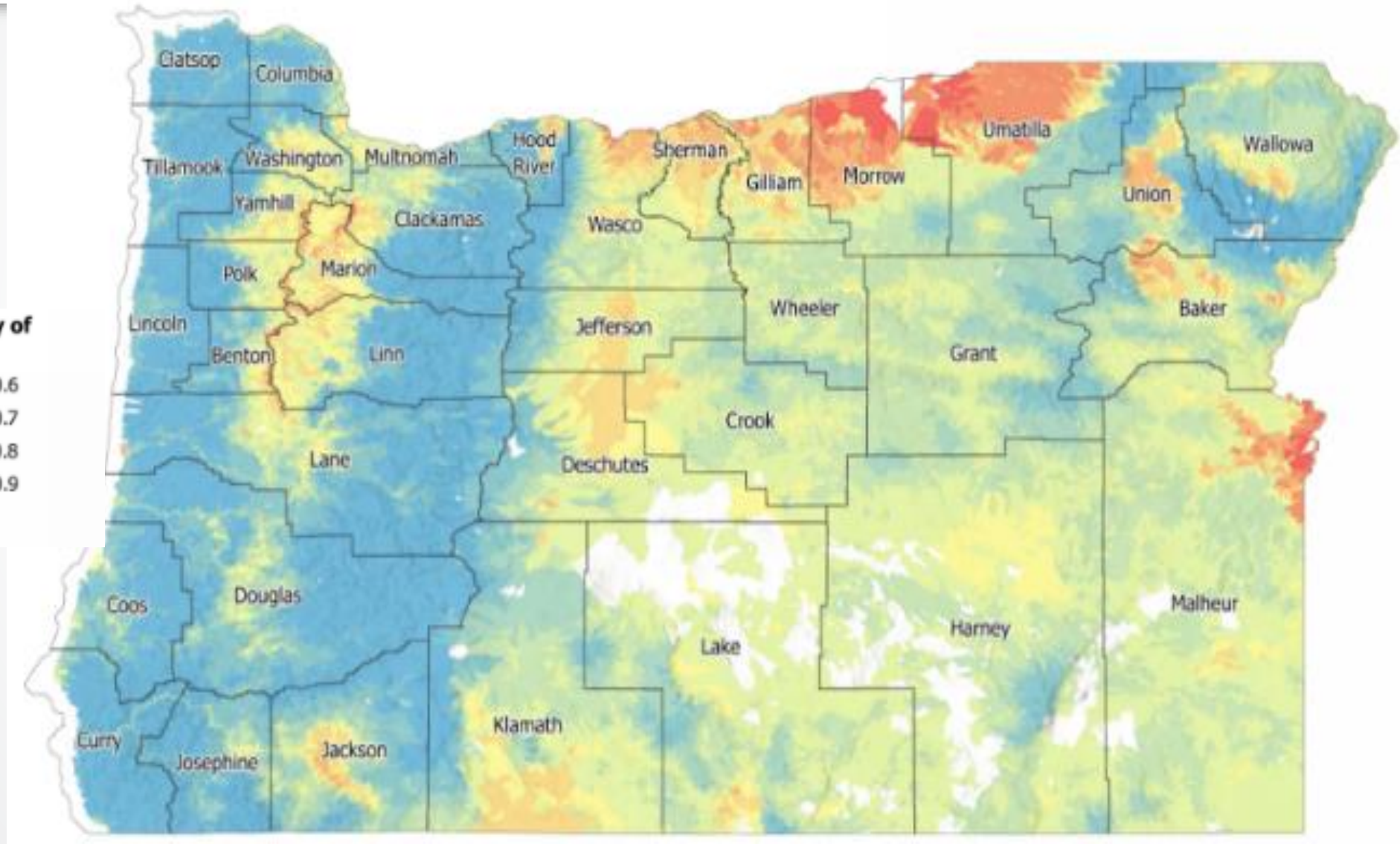


Takes time, effort and trust to create and accept

Southern Willamette Groundwater Management Area

Model-predicted risk of nitrate violations: Oregon



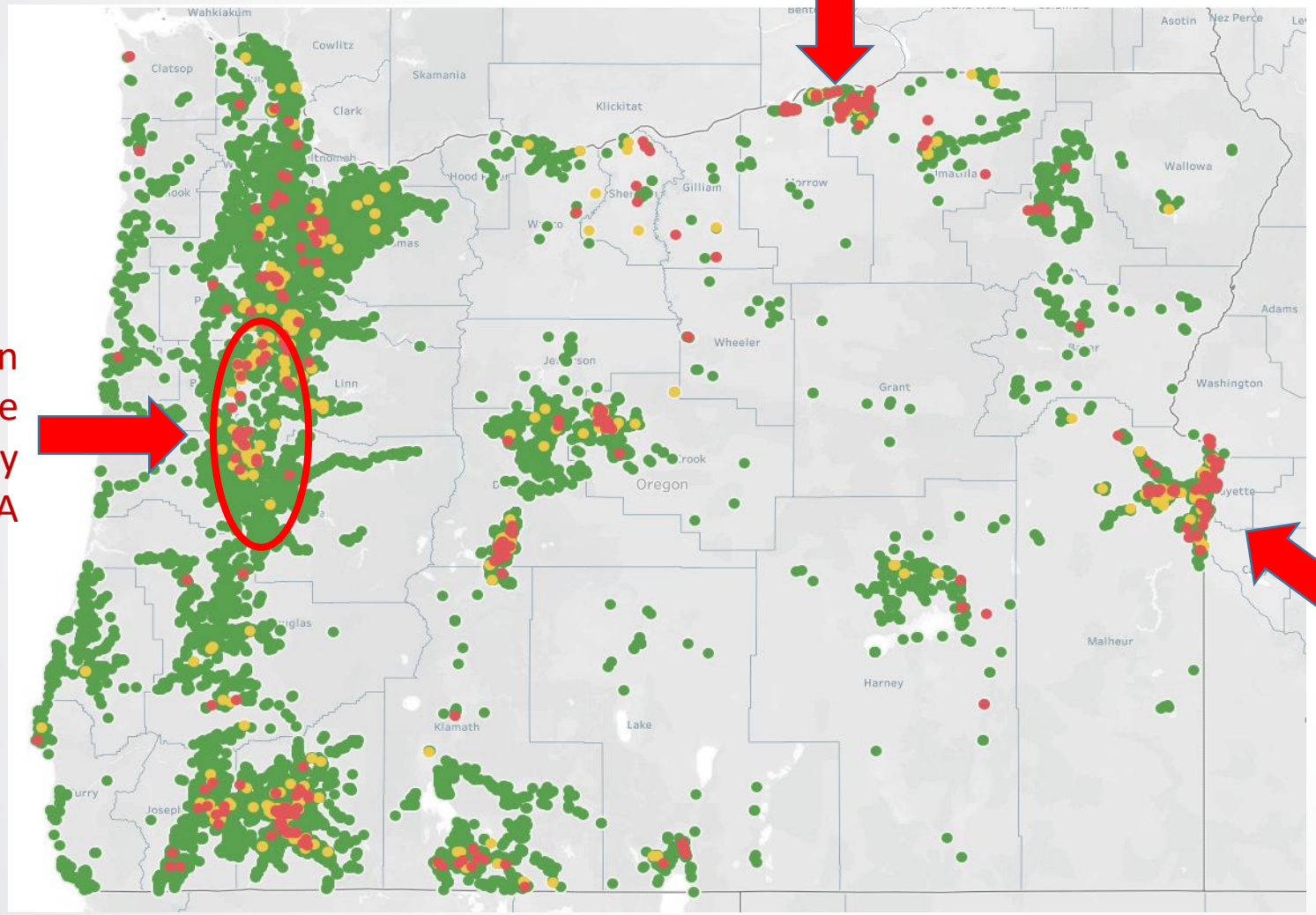


From Pennino et al. 2020 STOTEN

Nitrate in Oregon's Groundwater Management Areas (GWMAs)

Lower Umatilla Basin GWMA

Southern Willamette Valley GWMA



Data from the Real Estate Transaction database for domestic wells (1987-2020, n=30K)

Color Scale

- >10 mg/l Nitrate-N
- 7-10 mg/l Nitrate-N
- <7 mg/l Nitrate-N

Northern Malheur County GWMA

Wenzlick, Compton, Kile et al. In prep.

Management – Local drinking water nitrate

- **Challenge:** High and variable nitrate levels in drinking water wells within the southern Willamette Groundwater Management Area
- Working with local farmers to identify best management practices for nitrogen.

Project Team Members

Oregon Department of Agriculture

DEQ State of Oregon Department of Environmental Quality

WILLAMETTE PARTNERSHIP

LCOG Lane Council of Governments

TiAER Texas Institute for Applied Environmental Research Tarleton State University

Oregon State University Extension Service

Linn Soil & Water Conservation District

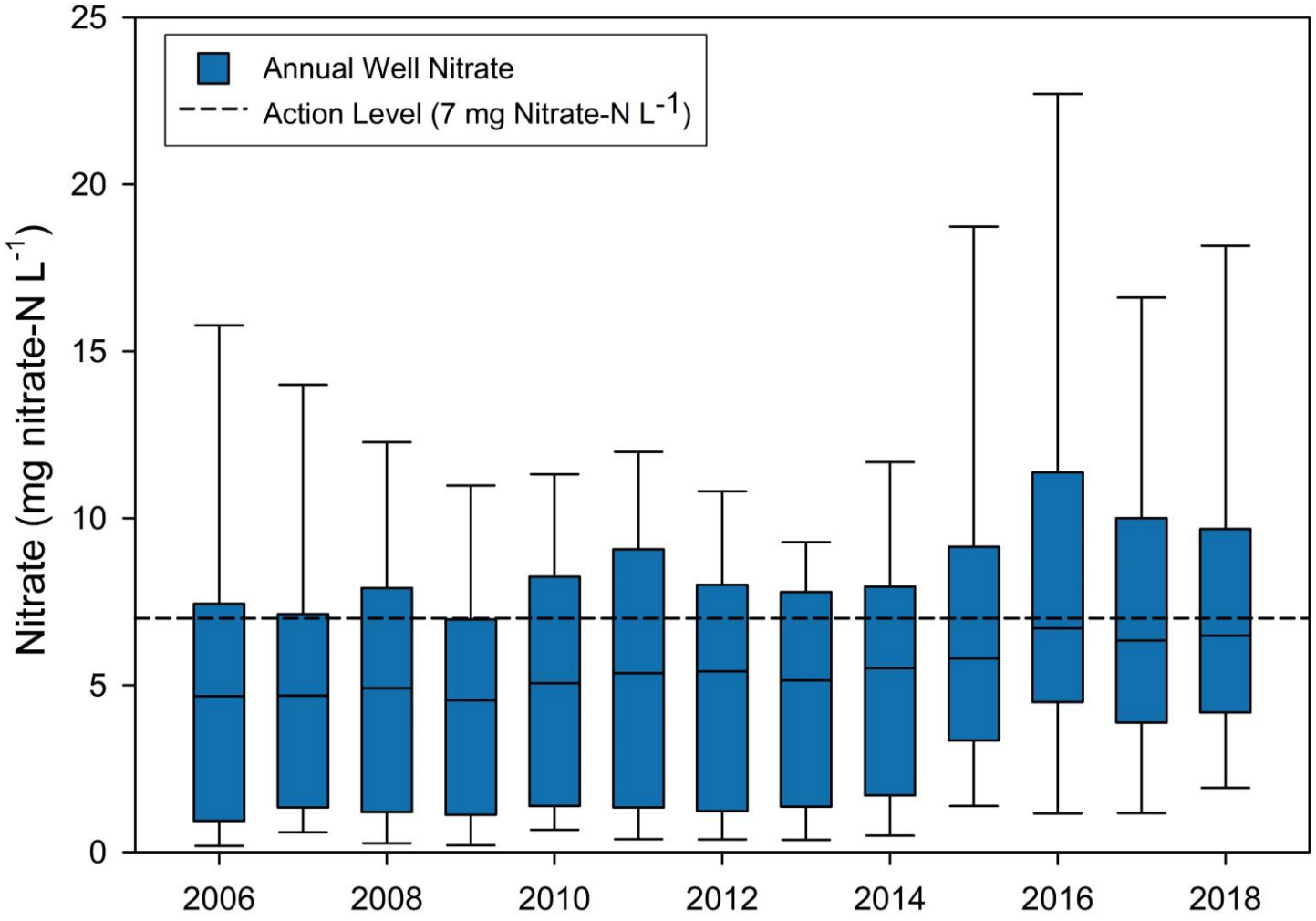
EPA

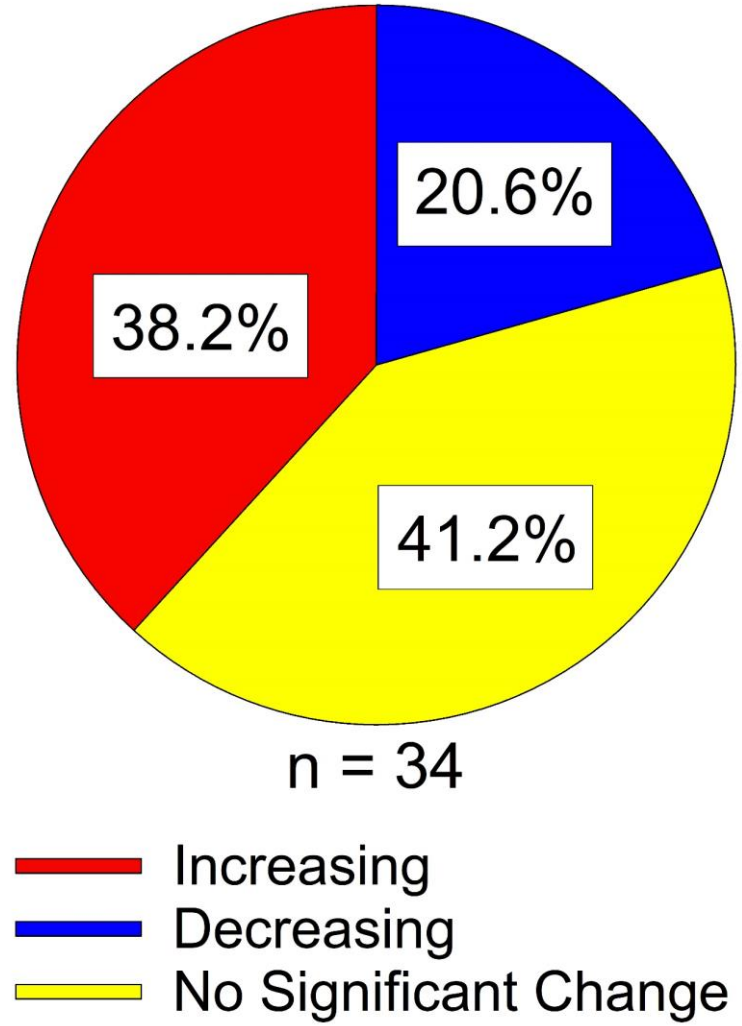
Benton Soil and Water Conservation District

Upper Willamette Soil and Water Conservation District

Increase in GWMA well nitrate

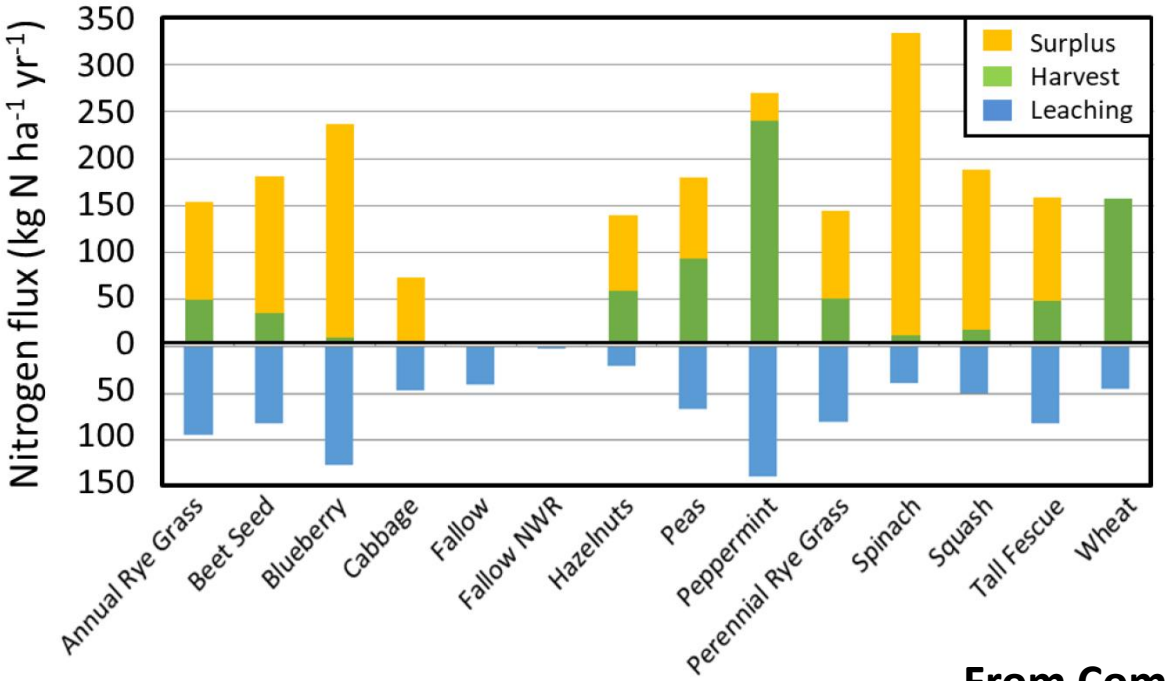
(Piscitelli OSU MS thesis, 2019)



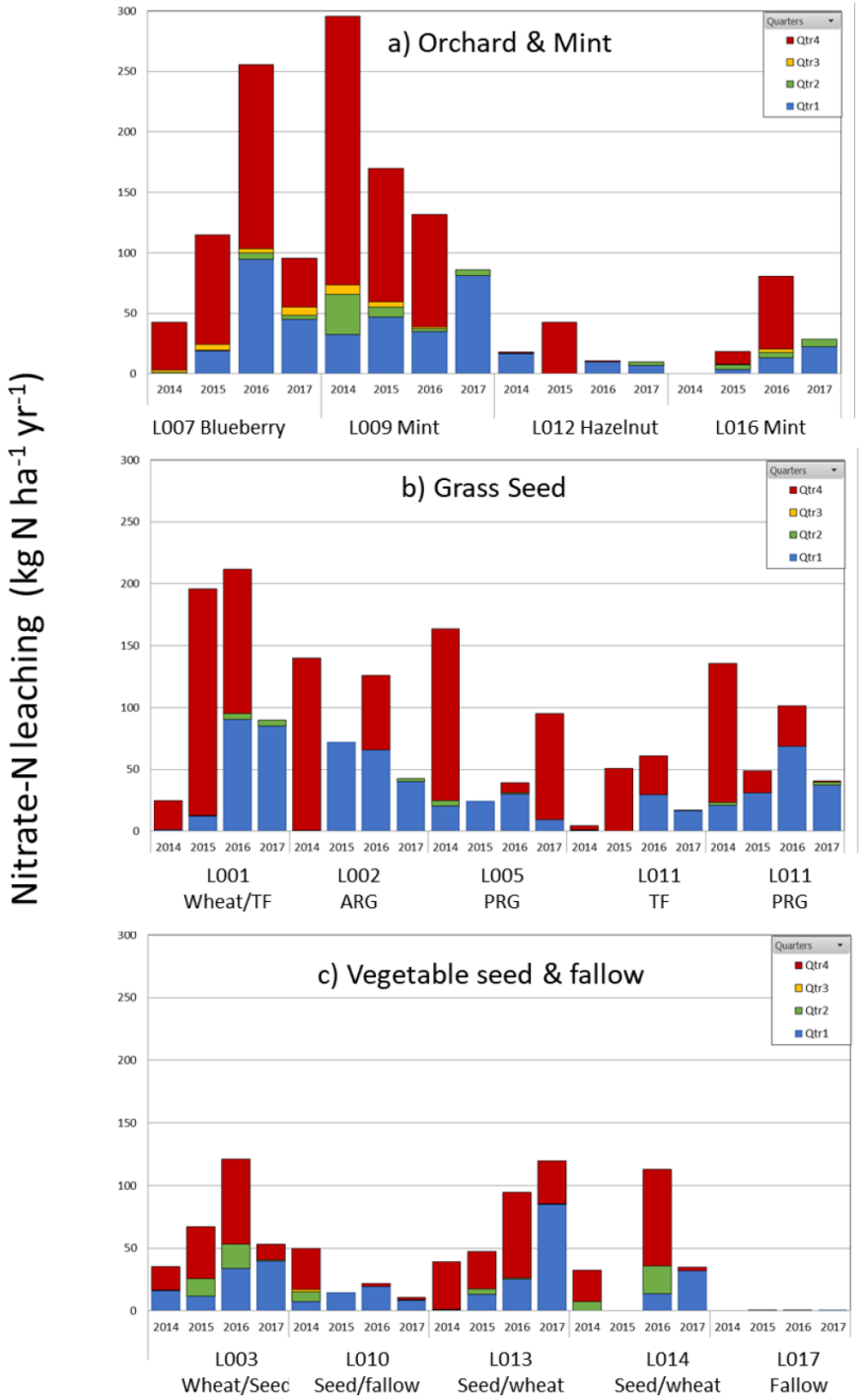


Study findings:

- Lots of variability between crops and fields
- Most leaching happens in fall (red->)
- Some blueberry and mint had high losses
- Grass seed fields were intermediate in leaching and surplus



From Compton et al. 2021



Messages for community

Nitrate leaching losses during fall and winter

- Challenge for nutrient management

Many crops have some N leaching

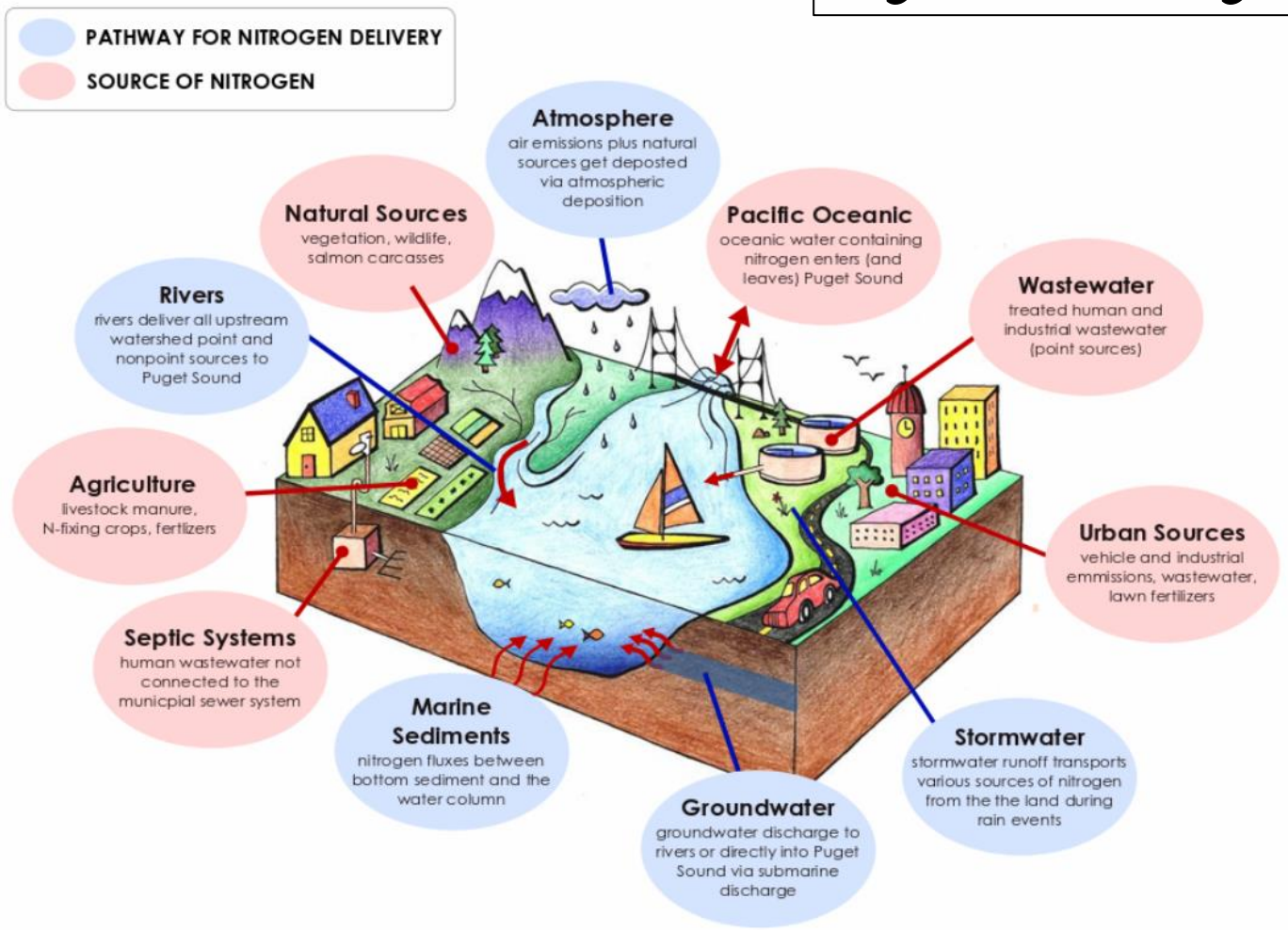
- Variation between crops and years
- Poorly performing crops & bare ground -> high leaching

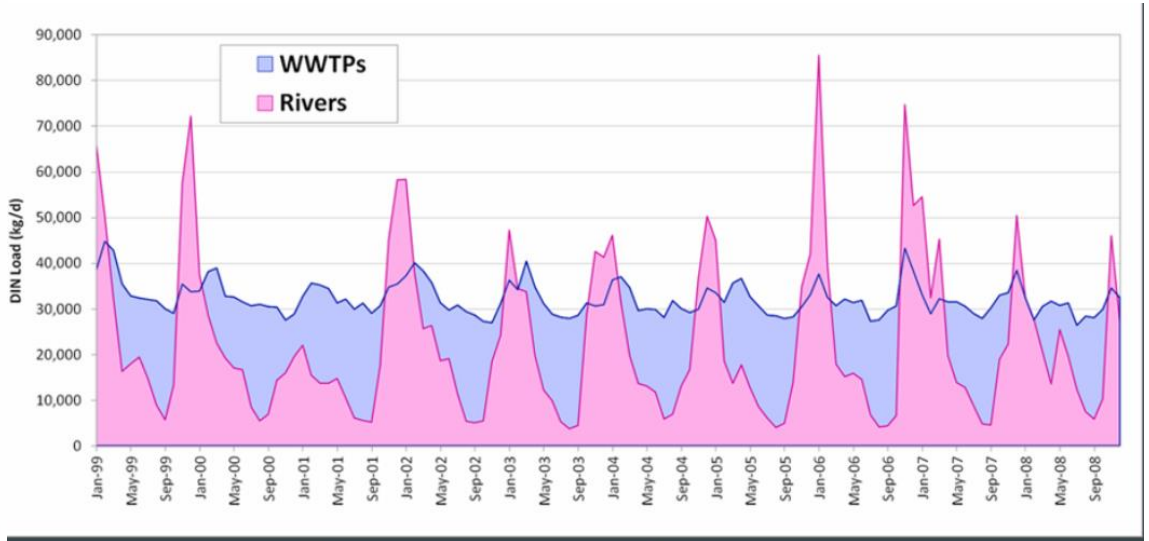
Increase use of cover crops, avoid fall fertilizer, include irrigation water N in balances

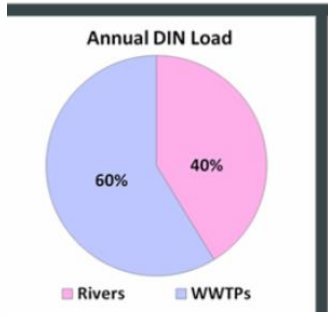
Thank you to farmers and community

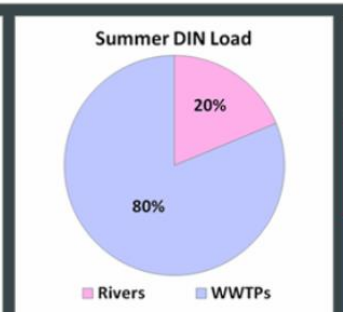
Nutrient inventories track nutrient inputs and outputs across urban, natural, and agricultural sectors

Puget Sound Nitrogen sources









	Annual DIN Load	SUMMER DIN Load
Rivers	22,630 kg/d	6,760 kg/d
WWTPs	32,210 kg/d	29,320 kg/d

Link to WA Ecology's Storymap of N in Puget Sound

Take homes and Next steps

1. EPA's national nutrient input inventory (NNI)
   - Available for HUC8 across the conterminous US
   - Increasing temporal and spatial resolution (HUC12 and raster, 1990s-2019)
   - Apply to water quality questions

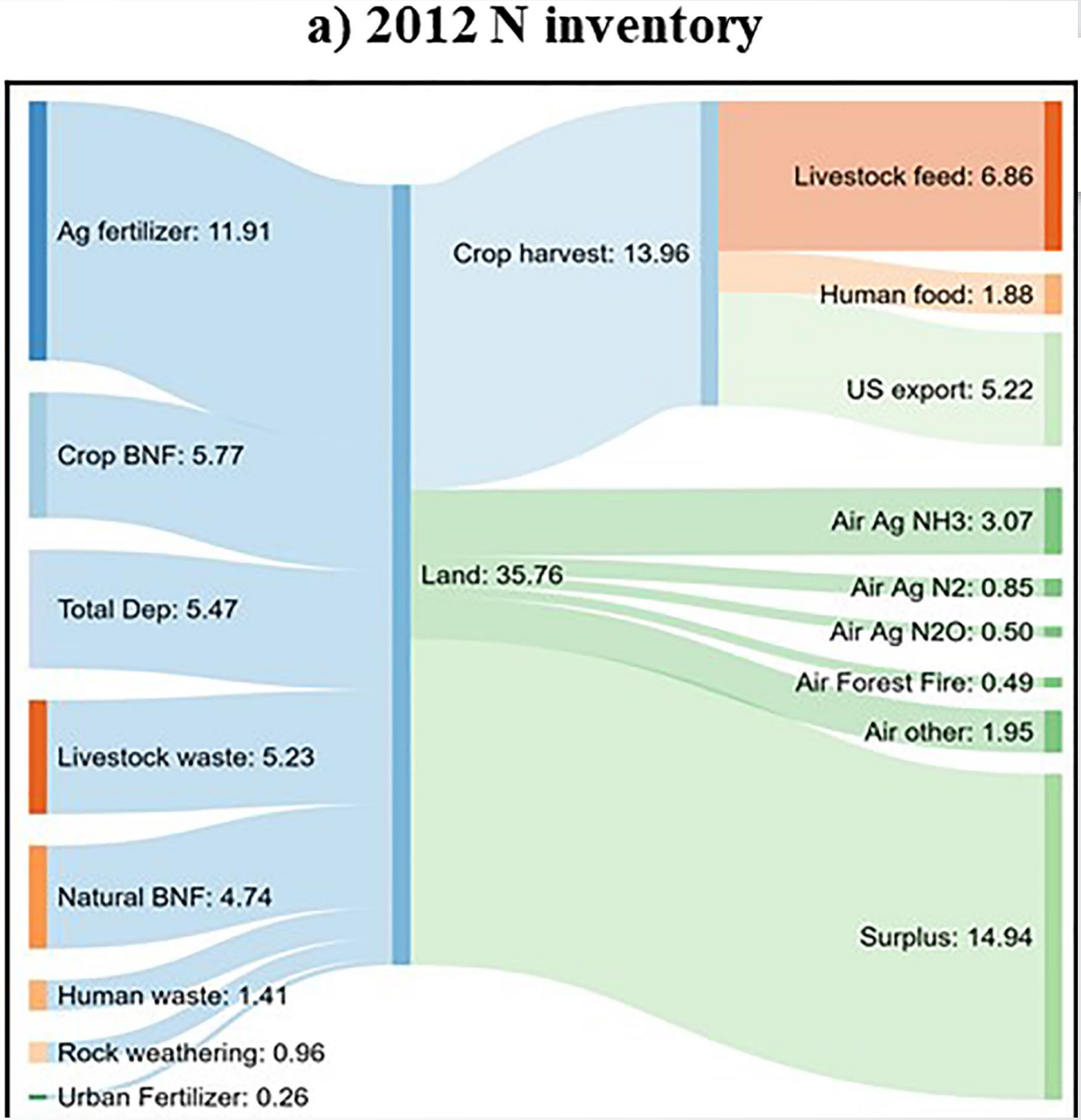
2. System N budgets in Region 10
   - Now that we've identified the scope and drivers of problems ->
   - Prioritize opportunities for on-field, edge-of-field and wetland restoration to reduce nutrient loading and improve condition

3. Post-fire water quality work in Region 10
   - Conducted 1.5 years of stream sampling after Labor Day 2020 fires
   - Monitoring nutrients, carbon, metals

Extra slides

EPA's National Nutrient Inventory (NNI)

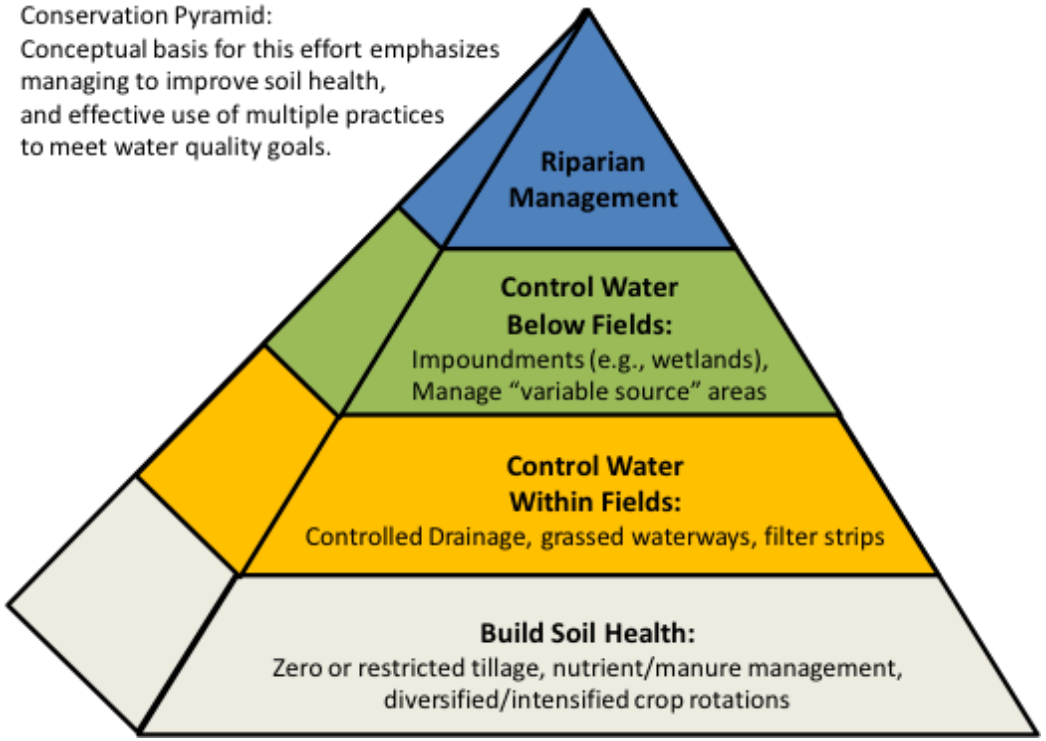
- What is in the NNI?
  - A lot! Lawn fertilizer, crop removal, point source loads, farm fertilizer, human waste, feedlots, atmospheric deposition, emissions….
- What can I use the inventory for?
  - Standardize way to track point and non-point source pollution through time, communicate management relevant metrics to stakeholders, and explain observed patterns in water quality.



Next Steps - Better quantification of on-the-ground practices

1. What is causing the recent increases and decreases in GWMA well nitrate levels (since 2012)?

2. How can we better document landowner nutrient management and conservation practices and connect to water quality?



Tomer et al. 2013 JSWCS
https://acpf4watersheds.org/about-acpf/

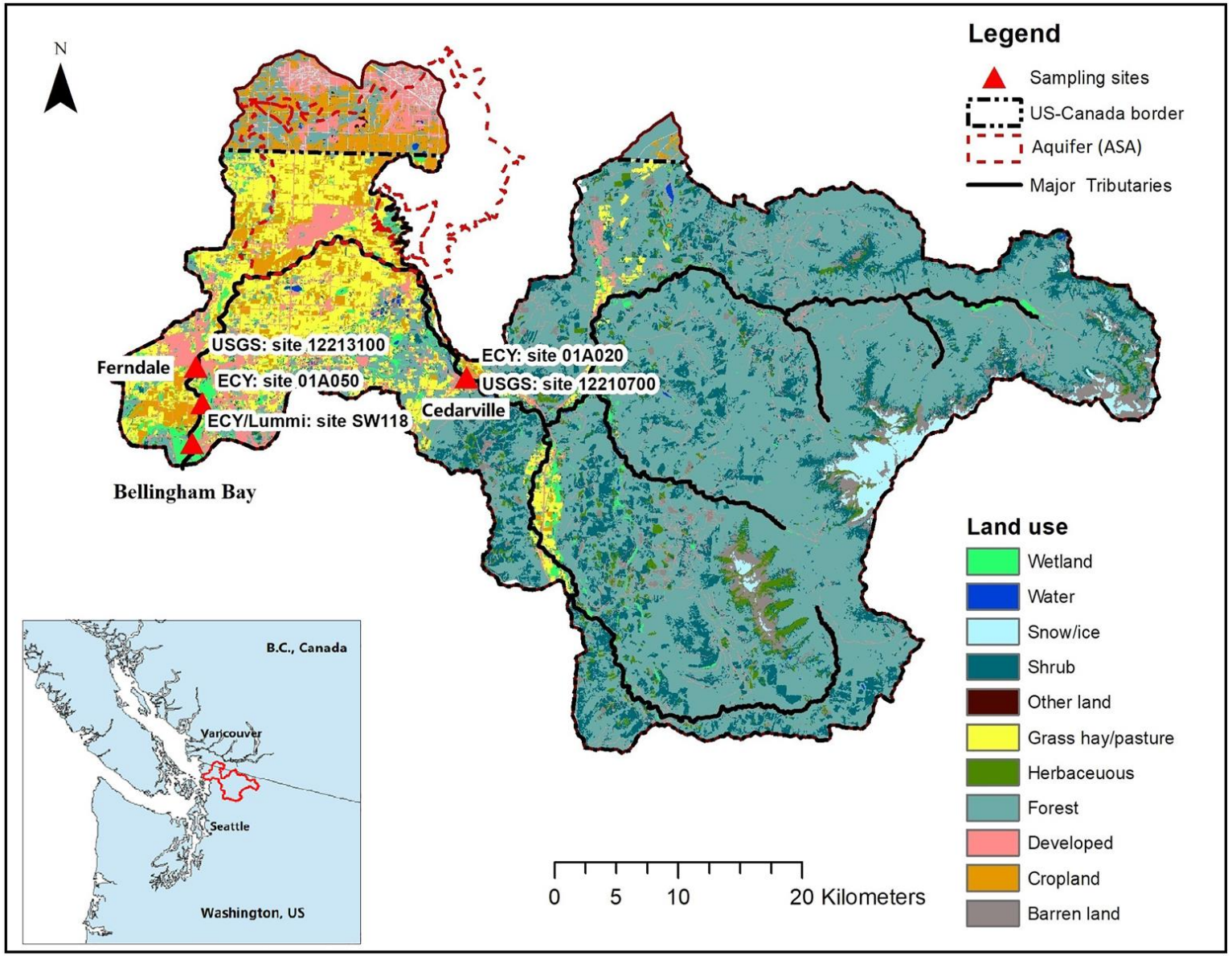
Nooksack-Fraser Transboundary Nitrogen study (NFT-N)

Project Goals

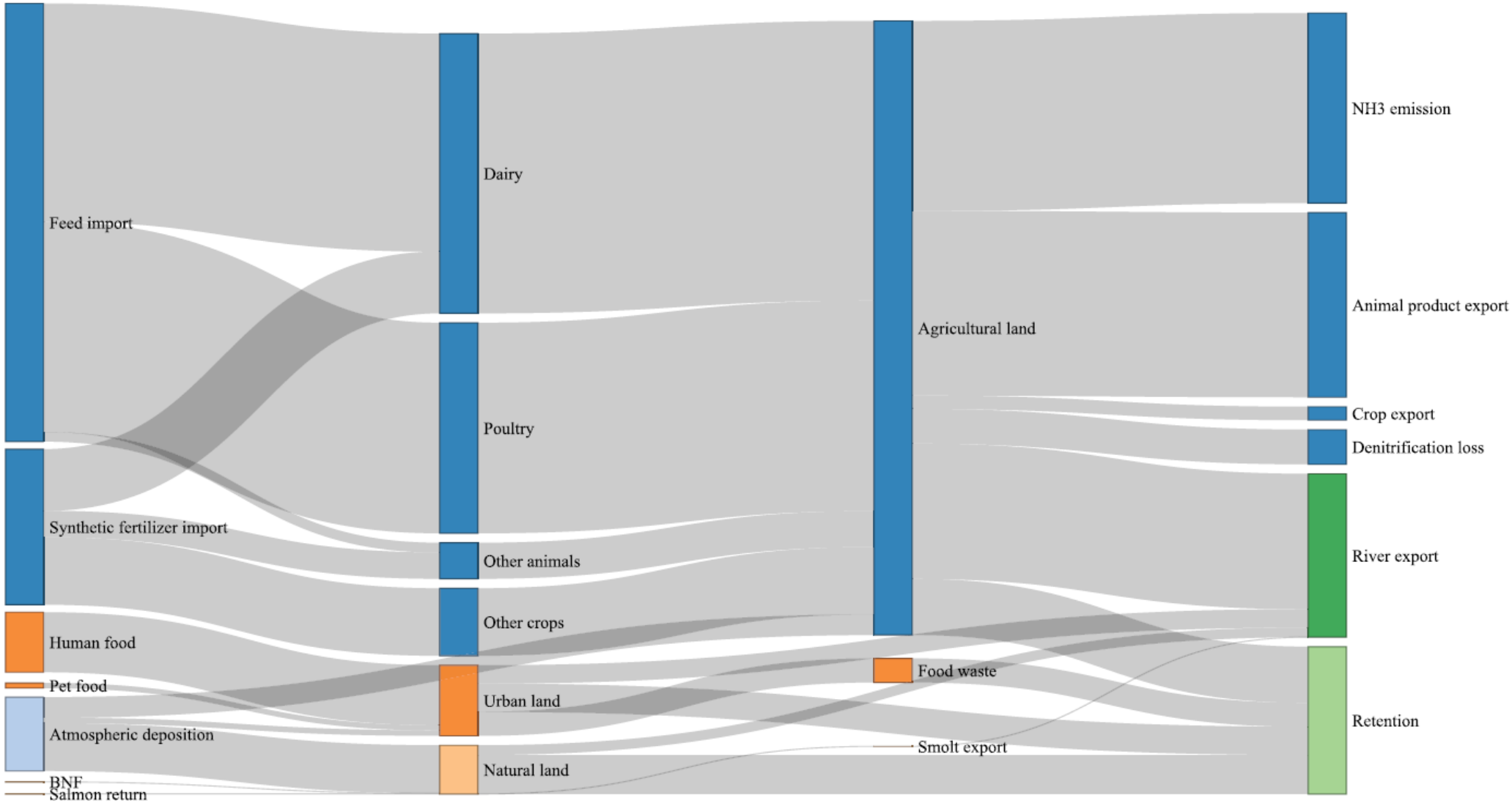
- Develop a nitrogen inventory using local data
- Share and vet data among stakeholders
- Identify and evaluate solutions that can be used by local stakeholders to meet community goals
  - Improve air quality and drinking water quality
  - Balance agriculture, aquaculture and other community interests
  - Economic goals

Nooksack-Fraser Transboundary Watershed

- Lynden, Washington, and Abbotsford, British Columbia
- Cities, farms, dairies, shellfish operations in BC and WA watershed
- Surface water, groundwater, and air quality issues related to nutrients and fecal coliforms



Nooksack Transboundary Watershed N budget



Jiajia Lin, Compton et al. 2020 JGR Biogeosciences