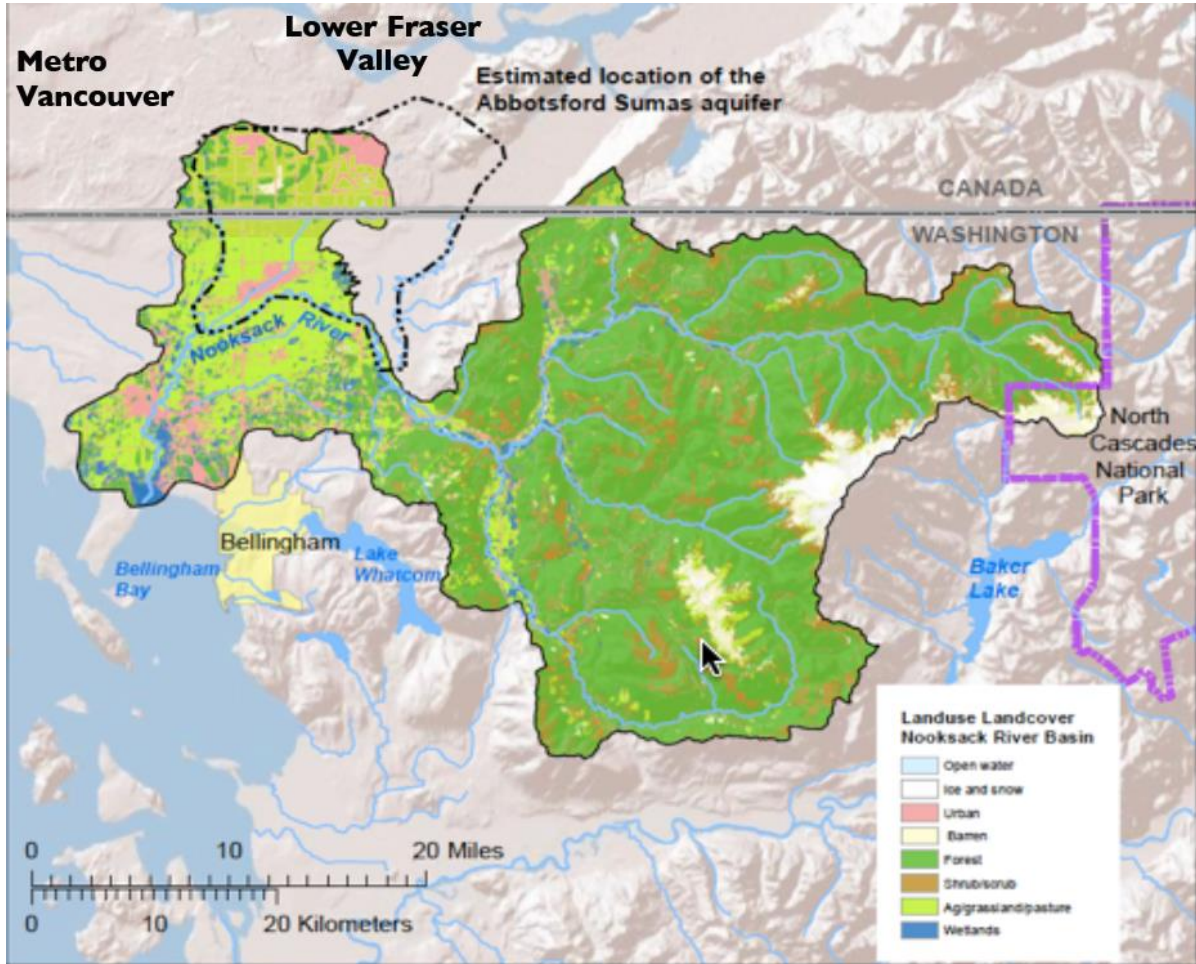


Nitrogen Inventory in the Nooksack-Fraser Transboundary Watershed



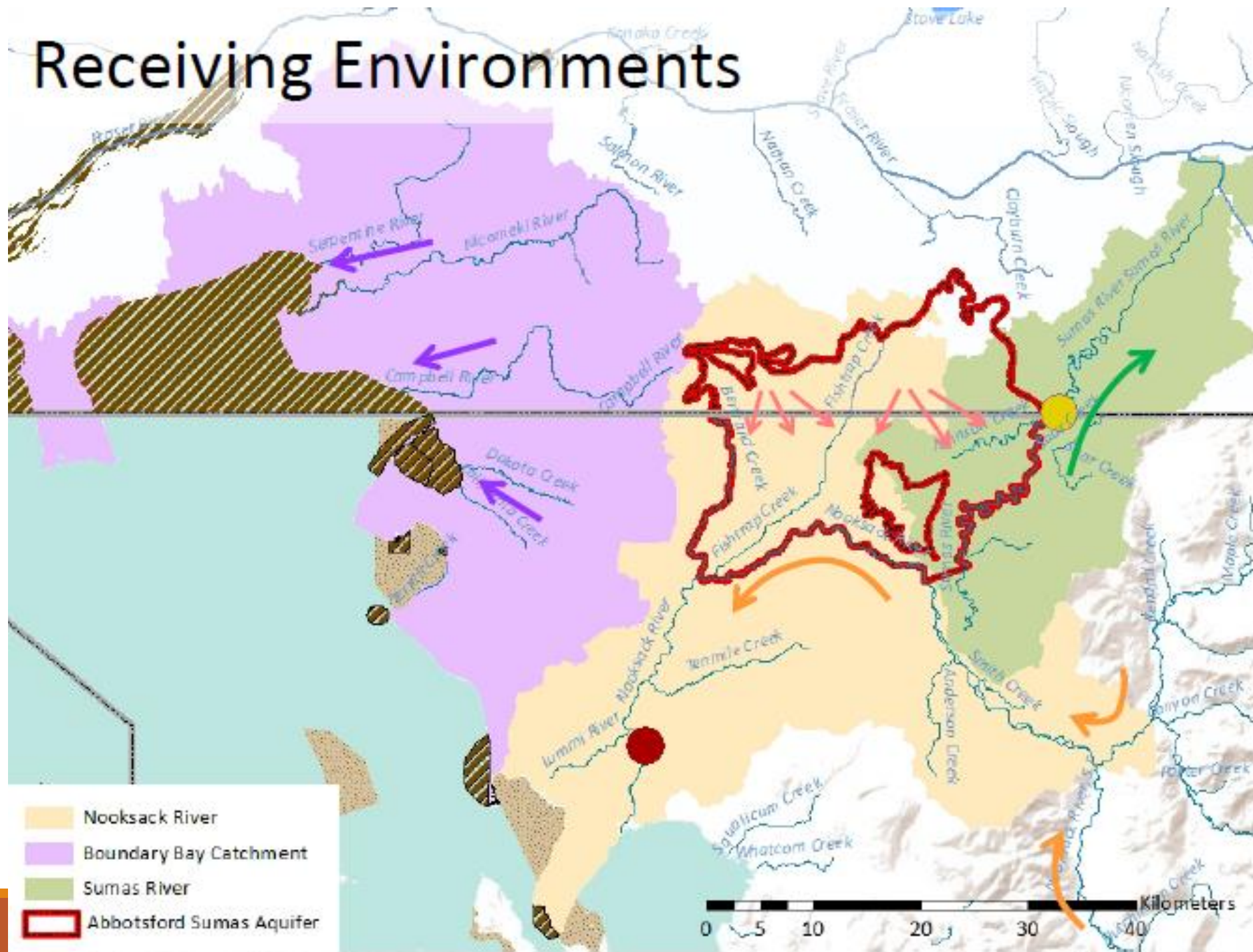
JIAJIA LIN, JANA COMPTON, JILL BARON, CHRIS CLARK, DONNA SCHWEDE, SHABTAI BITTMAN, DAVID HOOPER, BARB CAREY, PETER HOMANN, HANNA WINTER, PETER KIFFNEY, NICHOLE EMBERTSON, HEATHER MACKAY, ROBERT BLACK, GARY BAHR

Nooksack-Fraser Transboundary Watershed



- Cities, farms, dairies, shellfish operations in BC and WA watershed
- Surface water, groundwater, and air quality issues related to nutrients

Receiving Environments



Surface water quality issues

- Nooksack River drains to Bellingham Bay
- Harmful algal blooms
- Biotoxin—shellfish closure
- Hypoxia
- Nutrient enhanced coastal acidification



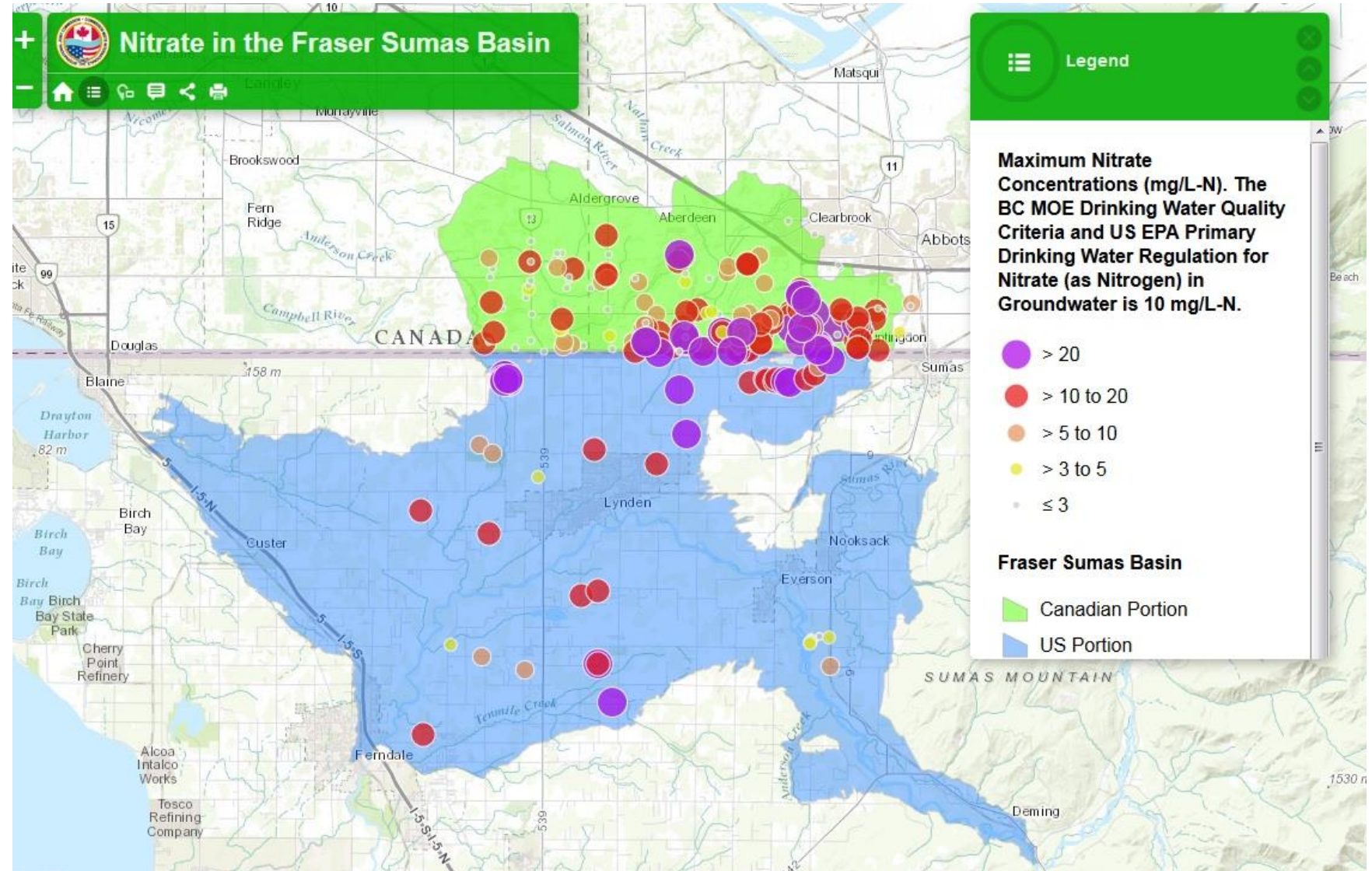
(<http://ecologywa.blogspot.com/2015/07/puget-sound-waters-left-sweltering.html>)



(Photo credit: Encyclopedia of Puget Sound)

Groundwater/drinking water issue

- 44% ≥ 5 mg/L
- 29% ≥ 10 mg/L
- 14% ≥ 20 mg/L
- 73 mg/L max nitrate-N in private well



IJC Cross-Border Characterization

Air quality issues

- Visibility
- Connected airshed
- Requires attention to NO_x , ammonia, SO_2 , organic carbon sources

Vancouver, British Columbia, Canada



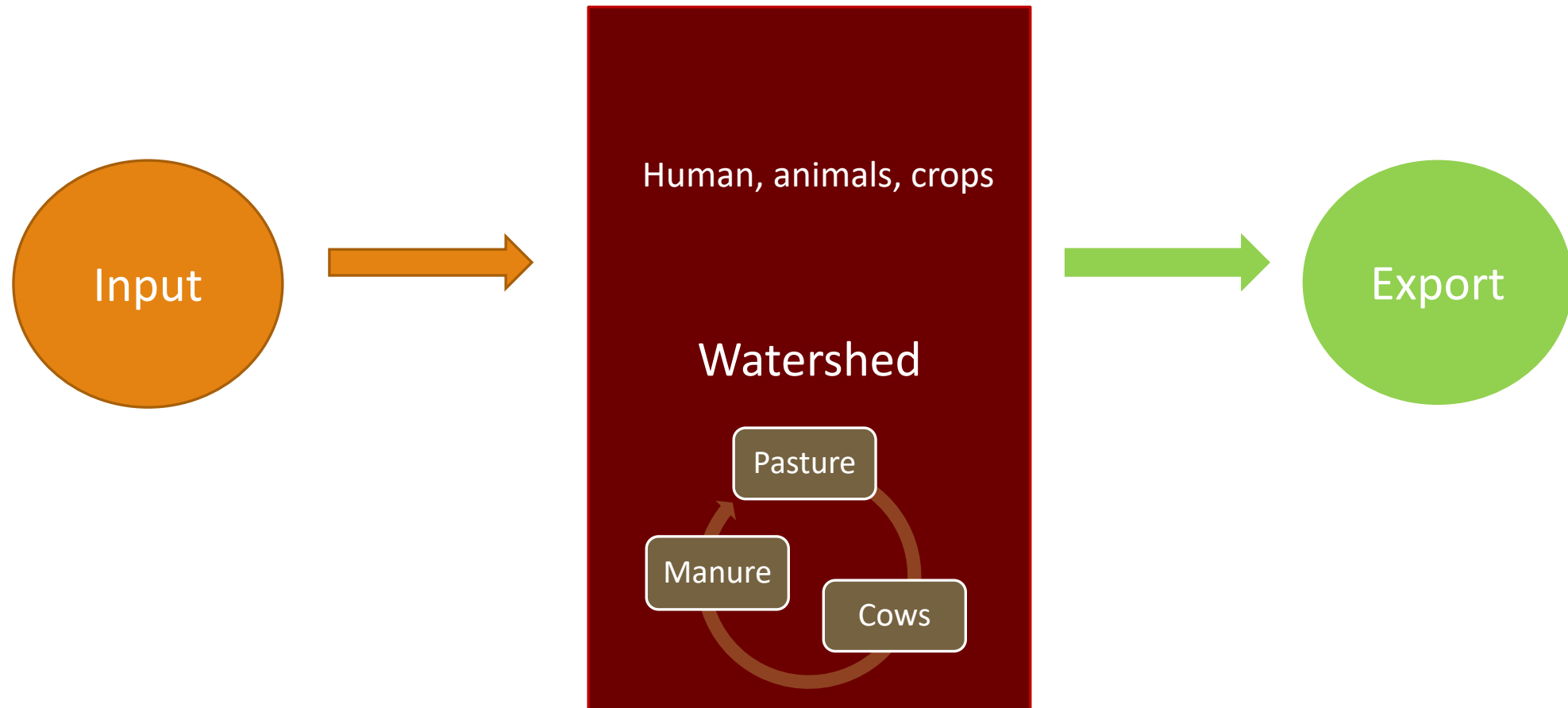
(Photo credit: <http://www.ens-newswire.com/ens/oct2004/2004-10-01-04.html>)

Project Goals

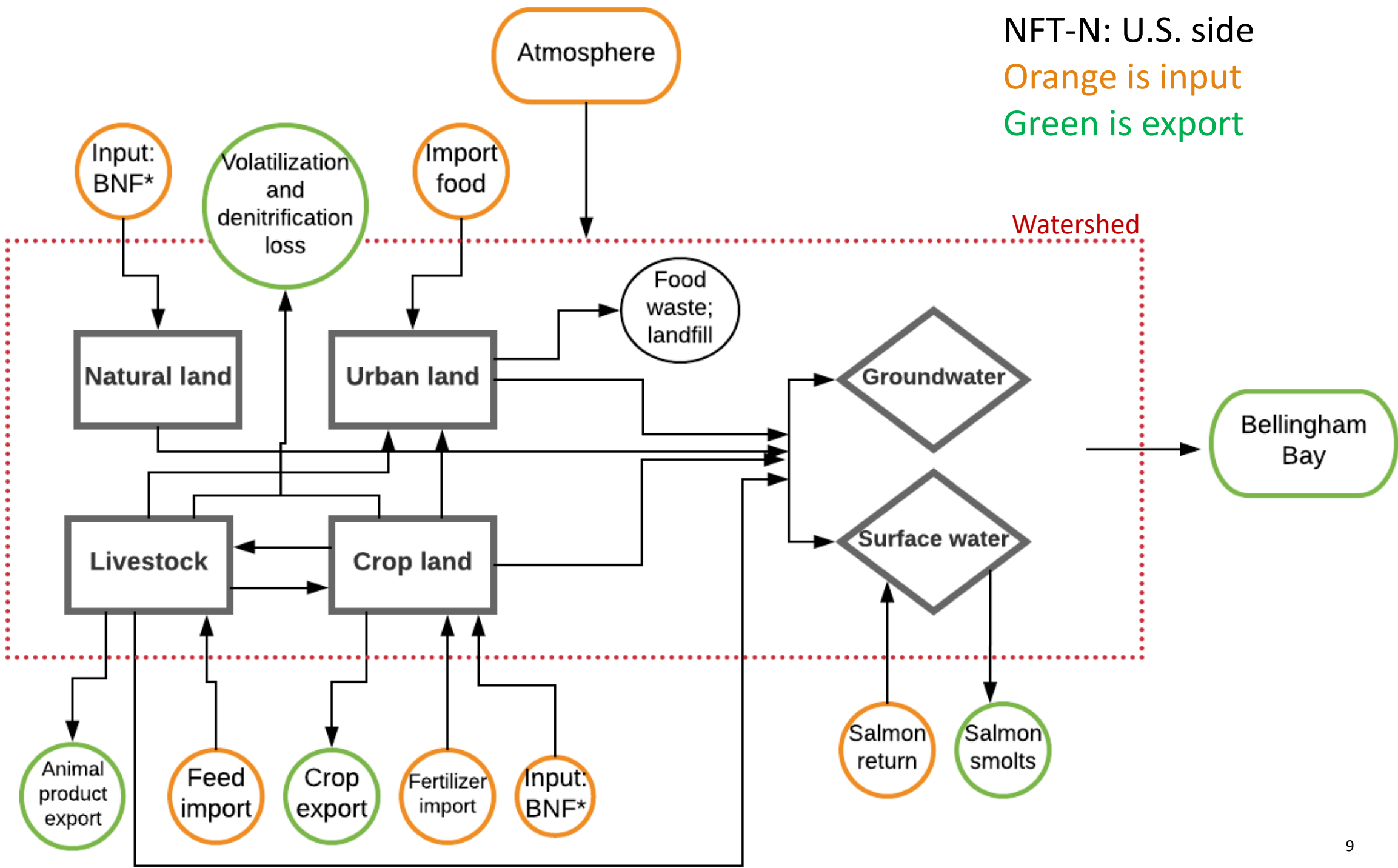
- Nitrogen inventory using local data
- Share among stakeholders
 - Anyone affected by nitrogen in some way is a stakeholder
- Identify/evaluate solutions that can be used by local stakeholders to meet their goals
 - Improve air quality and drinking water quality
 - Economic goals

NFT-N

Nooksack-Fraser Transboundary Nitrogen budget



NFT-N: U.S. side
Orange is input
Green is export

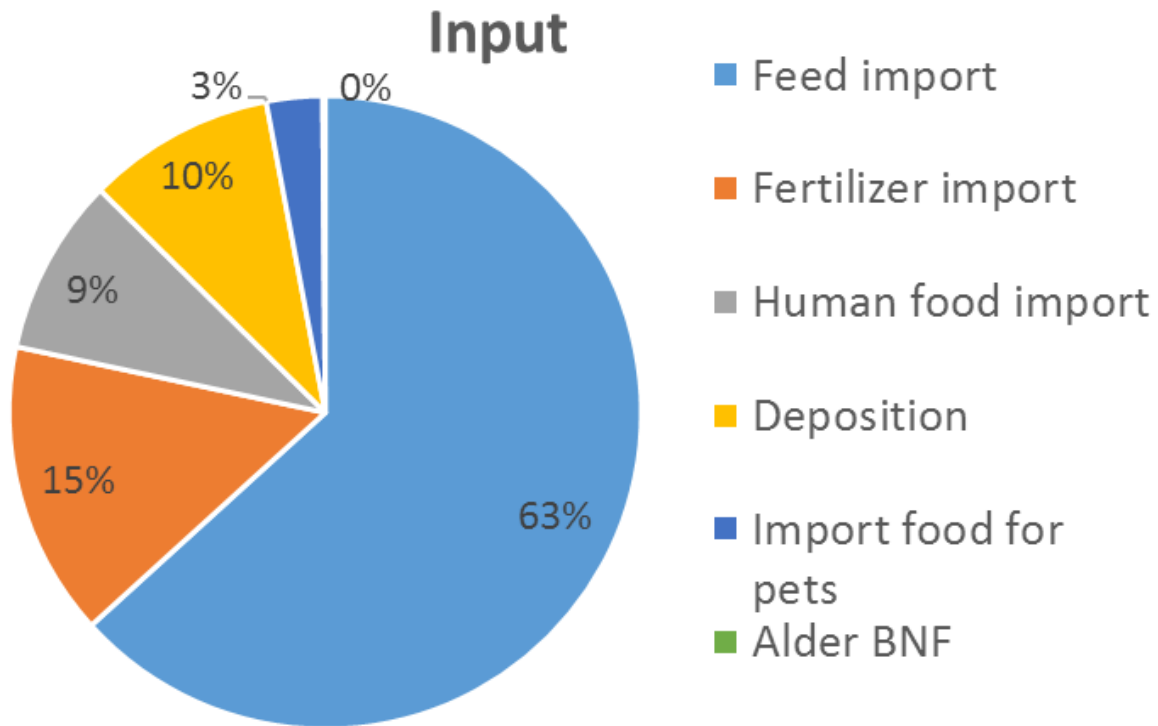


NFT-N: Data sources

- Plus extensive local knowledge
 - WCD

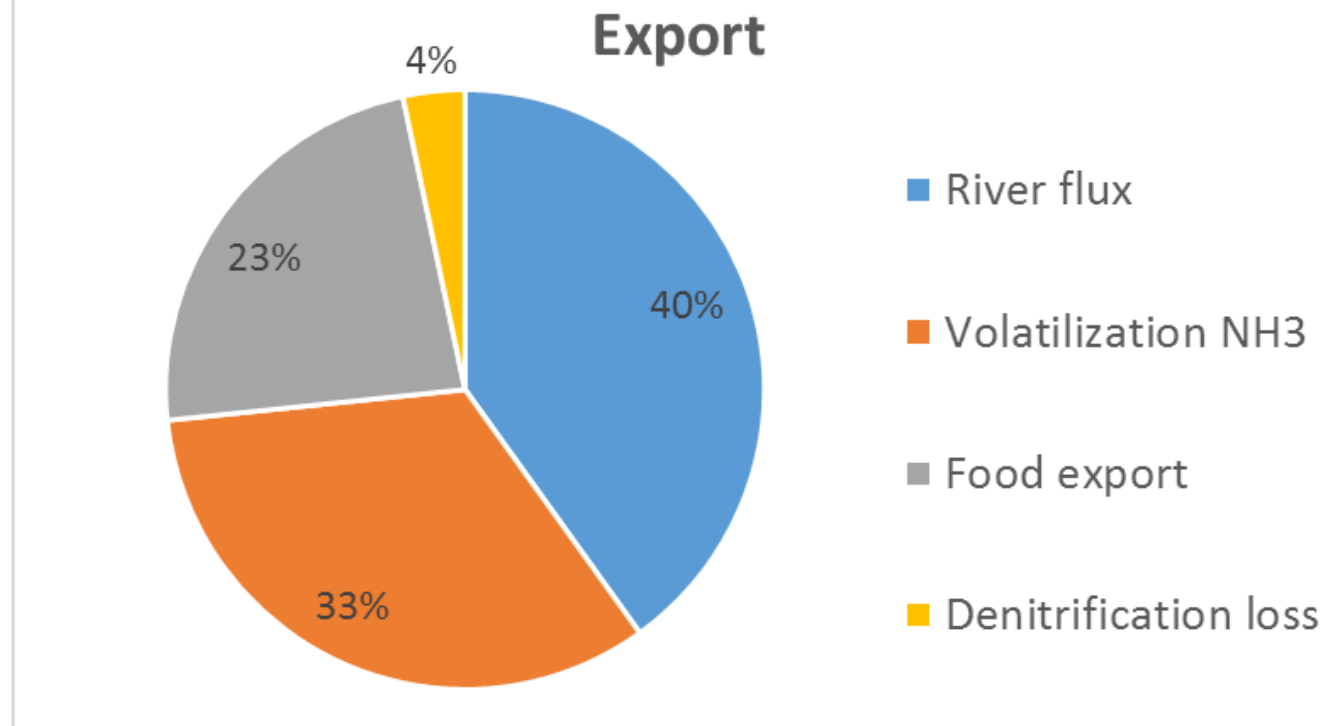
	Component	Parameter	Data source
Input	Atmospheric deposition	Total N deposition	EPA-CMAQ
	Food and feed import	Nutritional requirement	USDA, literature
		Population, human, pets and livestock	USDA census
	Fertilizer import	Crop land	WSDA land use map
		Fertilization rate	Local ag. Expert
	Biological N fixation	Alder density	OSU-LEMMA
		N fixing crop	WSDA land use map
Salmon import	Salmon population and size	NOAA, Lummi Nation	
Export	Food and feed export	Animal population	USDA census
		Animal product and production rate	USDA, WA extension
		N content	USDA Livestock & Meat Domestic Data
		Crop land	WSDA land use map
		Crop N content	USDA nutrient tool
	Smolt export	Smolt population and size	NOAA, Lummi Nation
	Groundwater	Flow and N concentration	USGS, Ecology, ECCC
Surface water	Flow and N concentration	Ecology, USGS, EPA	
Internal	Human waste	Sewage	WTPs
	Animal and food waste	Animal population	USDA, WSDA
		Animal excretion rate	USDA waste characteristics
		Animal product and production rate	USDA, WA extension
	Nutritional requirement	USDA, literature	

Draft N inputs and output proportions, US side



Missing: Canadian inputs, Wildlife, Lawn fertilizer

Total Inputs = 5488 mt N



Missing: Wildlife, groundwater/leaching, non-manure gas losses (?)

Total output = 6114 mt N

River flux includes Canada; 2014 high streamflow year

Early Observations

80% Us imports are feed & fertilizer

Outputs > imports

Little regulation on the Canadian side is

Intriguing

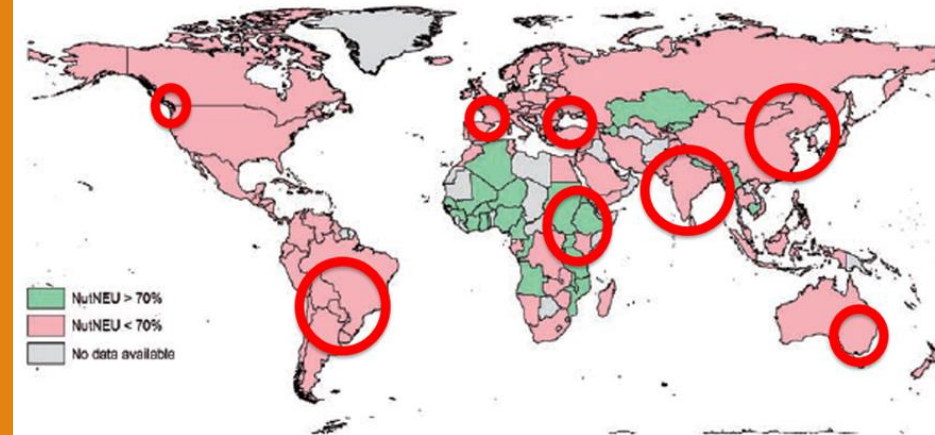
A wide diversity of approaches/BMPs on the USA-side (both carrots and sticks)

Future work

- Refine results
-
- Combine US with Canadian budget
 - Share with local stakeholders to build trust and accuracy
 - Identify implications for management
 - Develop a modeling structure and scenarios of N use in the future using stakeholder input

International Nitrogen Management System (INMS)

- Bring together the science community, the private sector and civil society to synthesize evidence that can support international policy development to improve global nitrogen management.
- Implemented by the UN Environment with funding through the Global Environment Facility (GEF)
- There are over 70 global project partners, conducting eight regional demonstrations



Countries that have a Crop NUE_N below 70% (2008, for details see Appendix).