Nutrient Source Identification and the BMAP

Dave Tomasko
PBS&J

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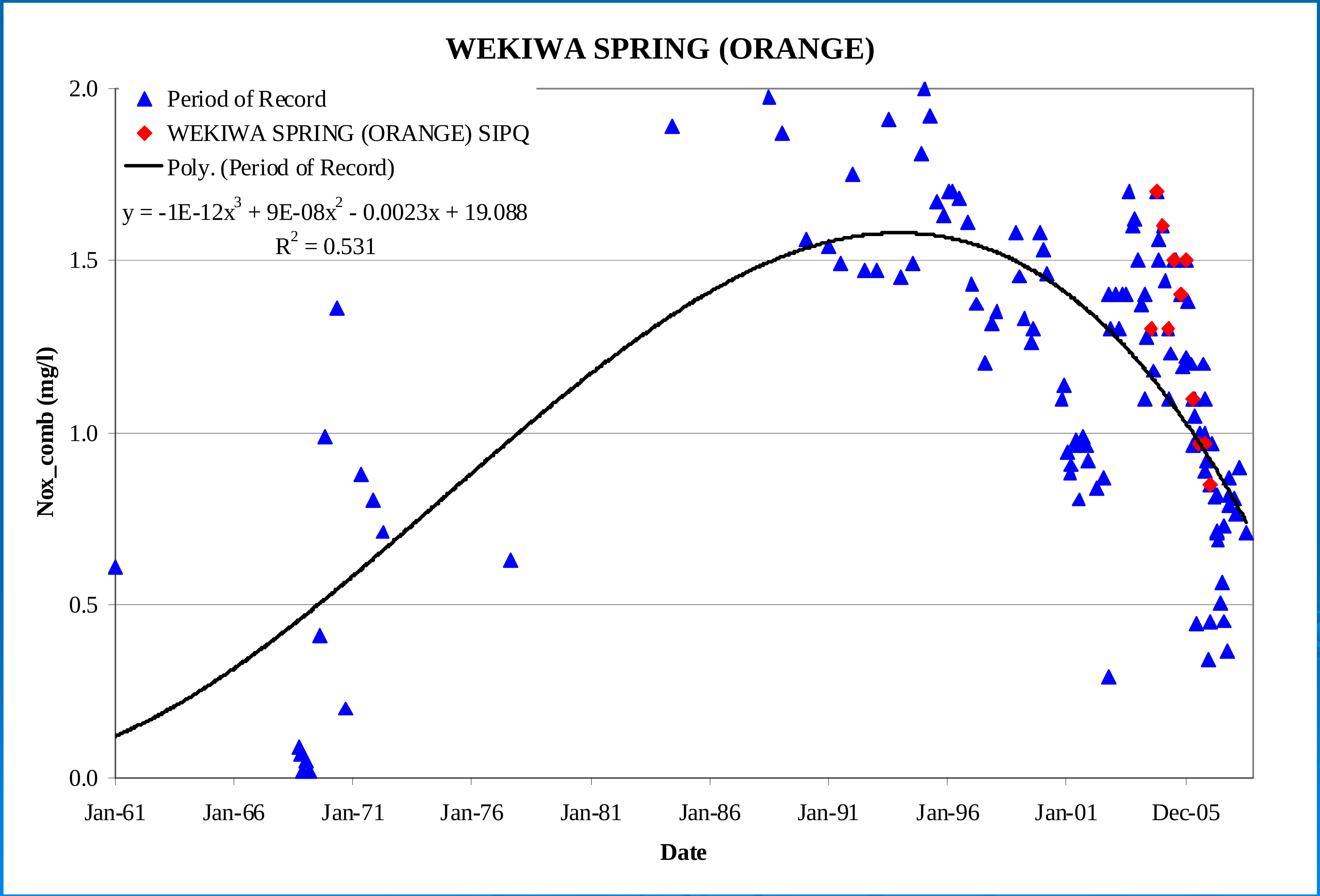
Where does nitrate come from?

- Fertilizer (residential, commercial/golf course, agricultural)
- Domestic wastewater (treatment plants, sewer system leakage, septic systems, reclaimed water)
- Animal waste
- Atmospheric deposition
- Natural areas (e.g. wetlands, natural background in groundwater)

Temporal trends in nitrate

- Does trend in nitrate match trend in land use?
- Watershed has become more urbanized
  - More wastewater to dispose of
  - More stormwater created
  - But practices have improved
- Agriculture has become less dominant
  - Very high fertilizer rates in 1950 and 1960s (up to 500 lbs NOx / acre / yr)
  - Much lower rates since 1970s (ca. 200 lbs / acre / yr)
  - Practices have improved

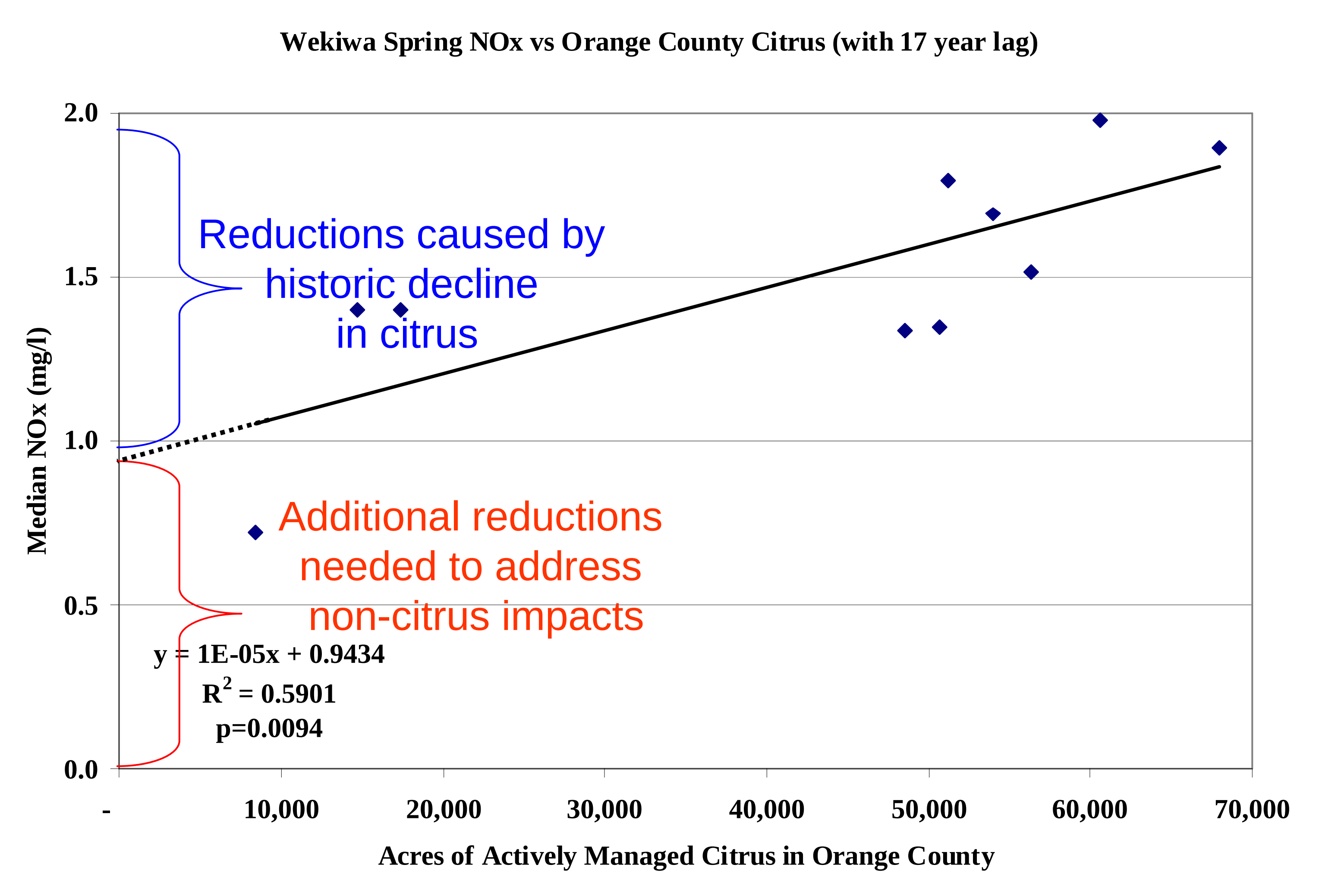
Recent improvements



Why should we care about reasons for nitrate changes?

- Nutrient loading model attempts to determine the impact of various factors (WWTPs, OSDSs, lawn fertilizer, etc.)
- Figuring out loading rates from these sources is dependent upon the total load they have to account for
- If less load discharging at vent, is this the result of reductions from one source only? All sources together?

Reminder from last meeting - Nitrate levels at Wekiwa Spring are positively correlated with acreage of citrus 17 years earlier



Quantification Challenges

- Total load
  - to groundwater ("input")
  - from the springs ("output")
  - to surface waters (direct runoff)
- Relative magnitude of sources (inputs or loads)
- Denitrification rate (transformation of nitrate in groundwater); differs by source

Role of Spring Discharge (TMDL)

Sources	**Nitrate loads (pounds / yr)**	**Percent total load**
Surface runoff from watershed	386,849	43%
Spring contributions	511,433	57 %
TOTAL	898,282	100%

Key Nitrate Source Identification Resources

Wekiva River Basin Nitrate Sourcing Study MACTEC, 2007	Purpose: Provide a preliminary understanding of nitrogen sources and loads in the Wekiva Basin (different nitrogen species for WWTP vs. other sources).	Surface watershed & spring
Revised Estimates of Nitrogen Input and Nitrogen Loading in the Wekiva Study Area DOH, 2008	Purpose: Determine if OSTDS are a significant source of nitrogen relative to other sources.	Surface watershed & spring
Total Maximum Daily Load (Nitrate) DEP, 2008	Purpose: Calculate nitrate restoration targets, percent reductions, and preliminary allocations (wastewater, municipal stormwater, other nonpoint).	Surface watershed (did not identify sources for springs)

Comparison of inputs vs. outputs

Source	Input (%)	Output (%)
Residential fertilizer	42	20
Agricultural fertilizer	26	26
Golf course fertilizer	3	2
Other fertilizer	4	6
Livestock	12	6
Atmospheric	5	2
Domestic WWTP	2	10
OSTDS	6	22

Most significant changes – input vs. loading (output)

- Residential fertilizer application
  - Input of ca. 9 million lbs / yr (42%)
  - Output of ca. 800,000 lbs / yr (20%)
  - Only 9% delivered as output
- OSTDS loads
  - Input of ca. 1.3 million lbs / yr (6%)
  - Output of ca. 880,000 lbs / yr (22%)
  - Only 68% delivered as output

Reason for differences

- Some sources load nitrogen in ways that maximize uptake
  - The intent of fertilizer application is plant uptake
  - Excess application is the problem
- Some sources load nitrogen in ways that short-cut uptake mechanisms
  - Loading nitrogen below a root zone = no plant uptake
  - However, denitrification can still occur
- Not all sources are of equal impact, even if inputs were the same
- Body of evidence as to pathways and uptake rates could be used to differentiate between relative importance of various sources

Comparison of *Load* Calculations: Source Type for Spring Discharge

Source Type	MACTEC (Fig. ES-3)	DOH (Fig. 4.2)	DEP
Residential fertilizer	20%	8%	N/A (spring sources not delineated)
Agricultural fertilizer	26%	24%	
Golf course fertilizer	2%	3%	
Other fertilizer	6%	2%	
Livestock	6%	12%	
Atmospheric	2%	---	
Domestic WWTP	10%	8%	
OSTDS	22%	39%	
Natural Background	6%	4%	

Comparison of *Load* Calculations: Land Use

Land Use	**MACTEC**	**DOH**	**DEP**
Residential	41%	17%	39%
Other Urban	17%	7%	18%
Golf Courses	3%	2%	20.5%
Agriculture	33%	25%	
Background, Open Areas, & Undeveloped Land	6%	16%	22.5%
Other	---	26% OSTDS 7% WWTPs	---
	Surface Watershed & Spring	Spring Discharge	Surface Watershed

Comparison of *Load* Calculations: Subbasin

Rock Spring	81%
Wekiwa Spring	79%
Wekiva River (below Little Wekiva)	68%
Rock Spring Run	63%
Little Wekiva River	59%
Blackwater Creek	52%
Wekiva River (above Little Wekiva)	47%

TMDL Table 5.1

Resolving Discrepancies Between Load Estimates

- Is this necessary?

- Recalculate MACTEC WWTP vs. OSTDS numbers with same nitrogen species

- Investigate assumptions about denitrification effects by source

How does Source ID work fit in?

If you don't know why nitrate levels have gone down recently, you may not know enough to determine how best to address remaining loads.

Ongoing Wekiva Isotope Study

- Nitrogen isotope data from additional locations (watershed and spring vents)
- Oxygen isotope data that can help interpret nitrogen isotope values
- Viruses – human sewage
- Caffeine – human sewage
- Boron – human sewage
- Atrazine – fertilizer use

Expect this work to provide more detailed guidance on nitrate reduction strategies

Field work completed

Expect caffeine/boron/atrazine/nutrient data in late April

Expect isotope & virus results in late May

Where does that leave us?

- Rank-order of loads by source, land use type, or subbasin relatively consistent across studies
- Quantification of relative magnitude more complicated
- Expect that results of dual isotope study will help us determine if quantification of relative magnitude is possible
  - If yes = detailed allocations (source/land use/subbasin)
  - If no = use another metric to evaluate “sufficiency of effort” for implementation based on rank order

Questions?