Presented by Dave Tomasko, PBS&J
at the
Wekiva BMAP Kick-off Meeting
Friday, March 6, 2009
Lake Sylvan Park, Sanford, FL

Evaluation of Knowns & Unknowns

- Balance between solid foundation vs. waiting for “perfect” knowledge

- Topics covered today:
  - Springshed and Planning Area
  - Water quality conditions, TMDL targets, & BMAP management parameters
  - Source identification
  - Present-day unknowns

Springshed and Planning Area

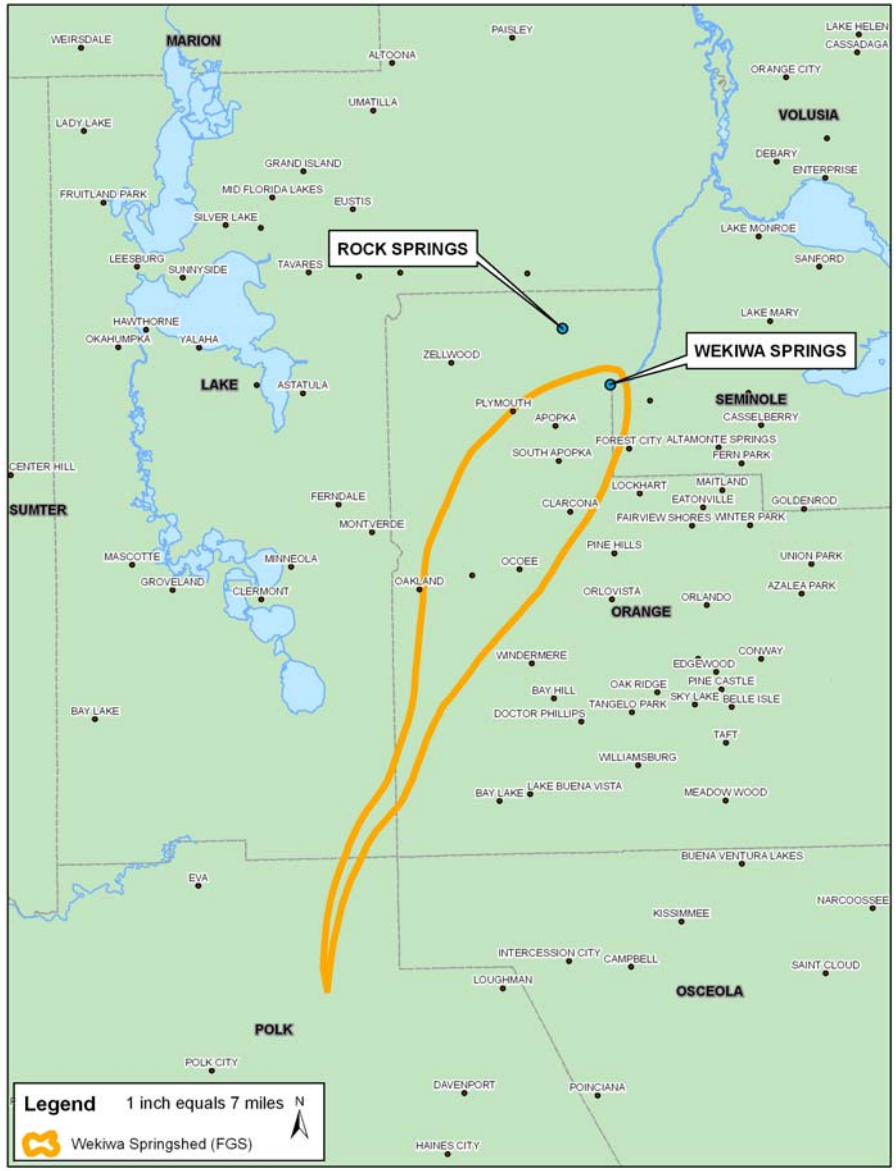
Why do we need to identify a planning area?

What are the key components?

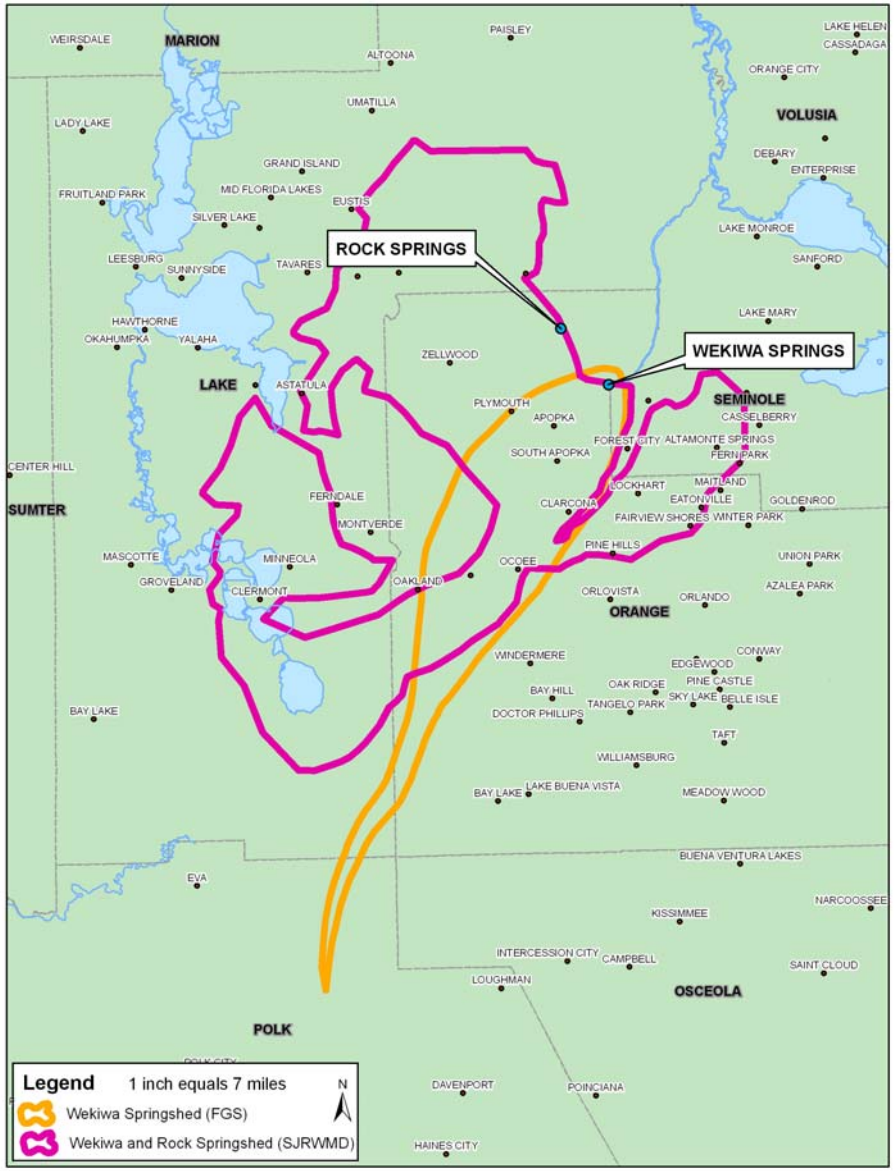
Springshed and Planning Area

- Knowns:
  - Multiple springshed delineations
- Unknowns:
  - Extent to which far reaches of springsheds affect the spring
- Resolution for BMAP:
  - converging lines of evidence

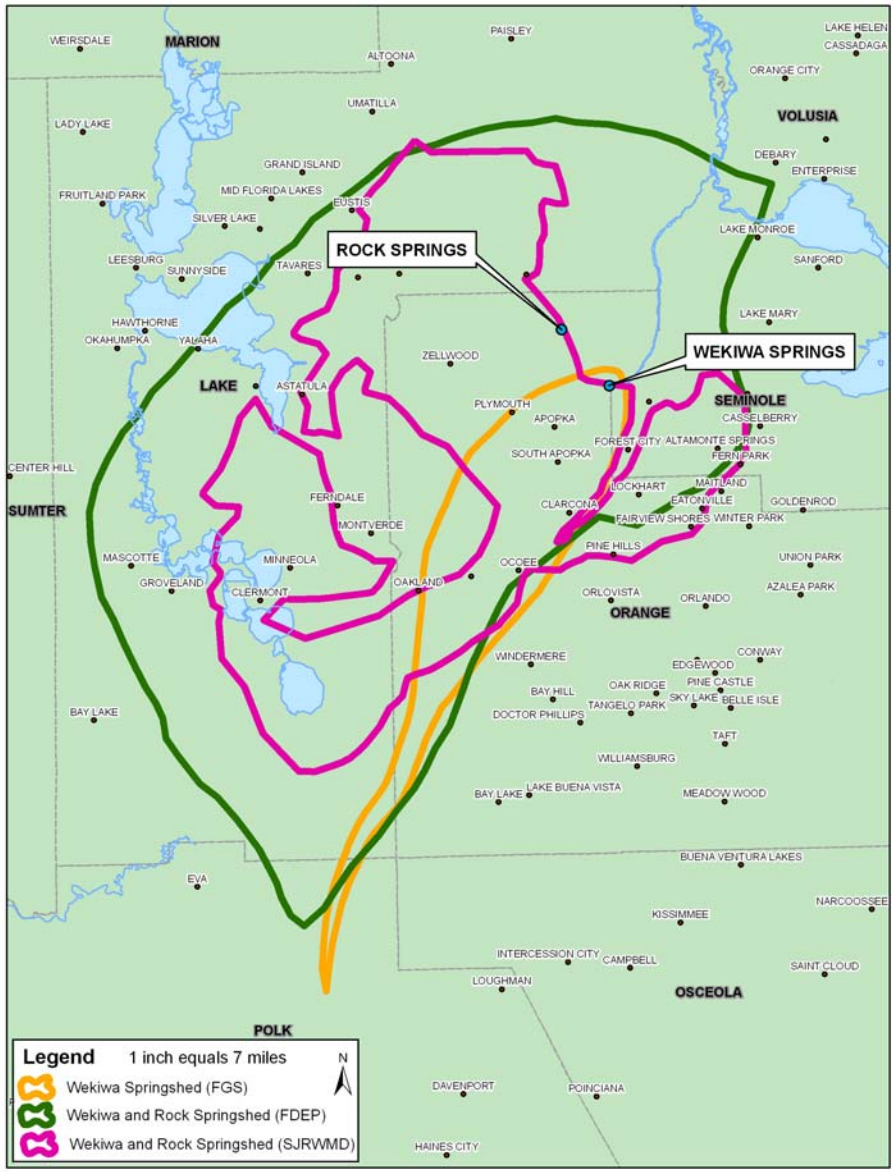
Wekiwa Springshed according to FGS



Compared to the Wekiwa and Rock Springs Run springshed according to SJRWMD

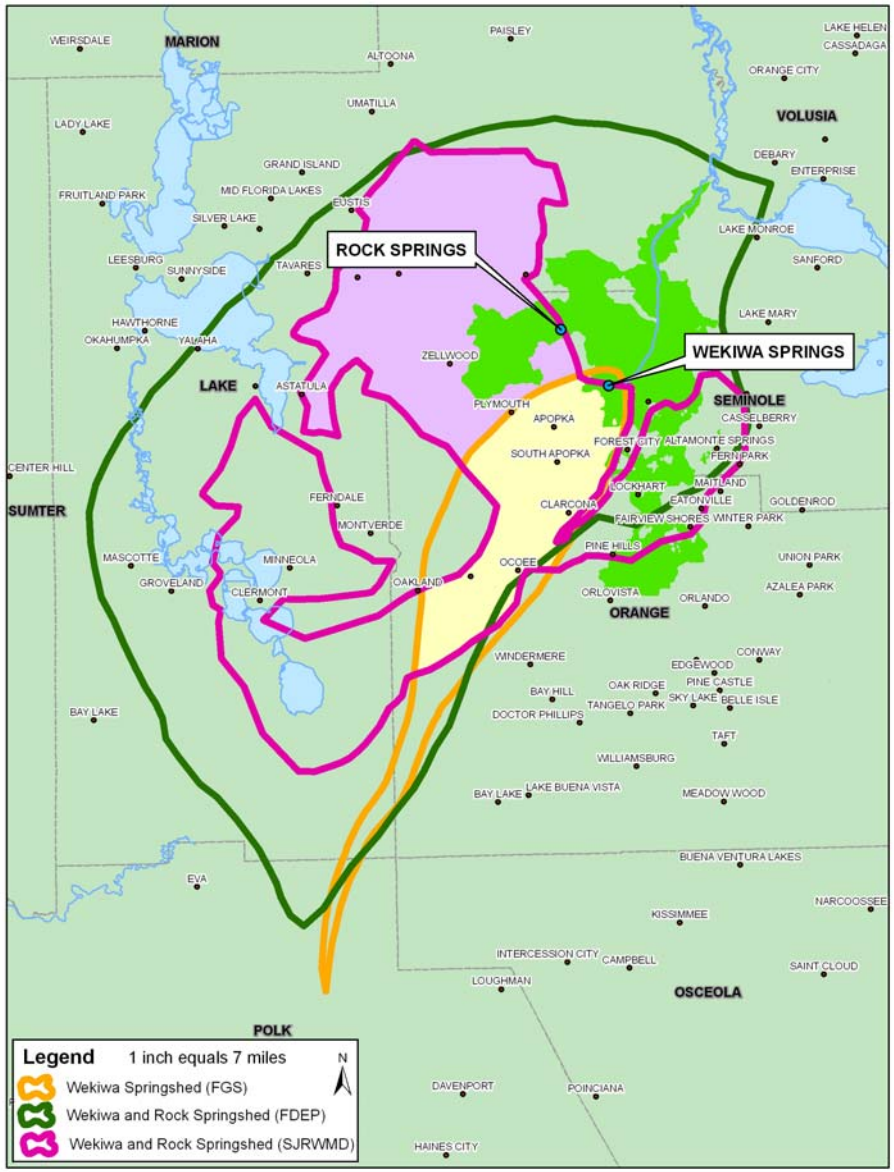


Compared to the Wekiwa and Rock Springs Run Springshed according to FDEP



Multiple springshed delineations, all scientifically valid, but with different results

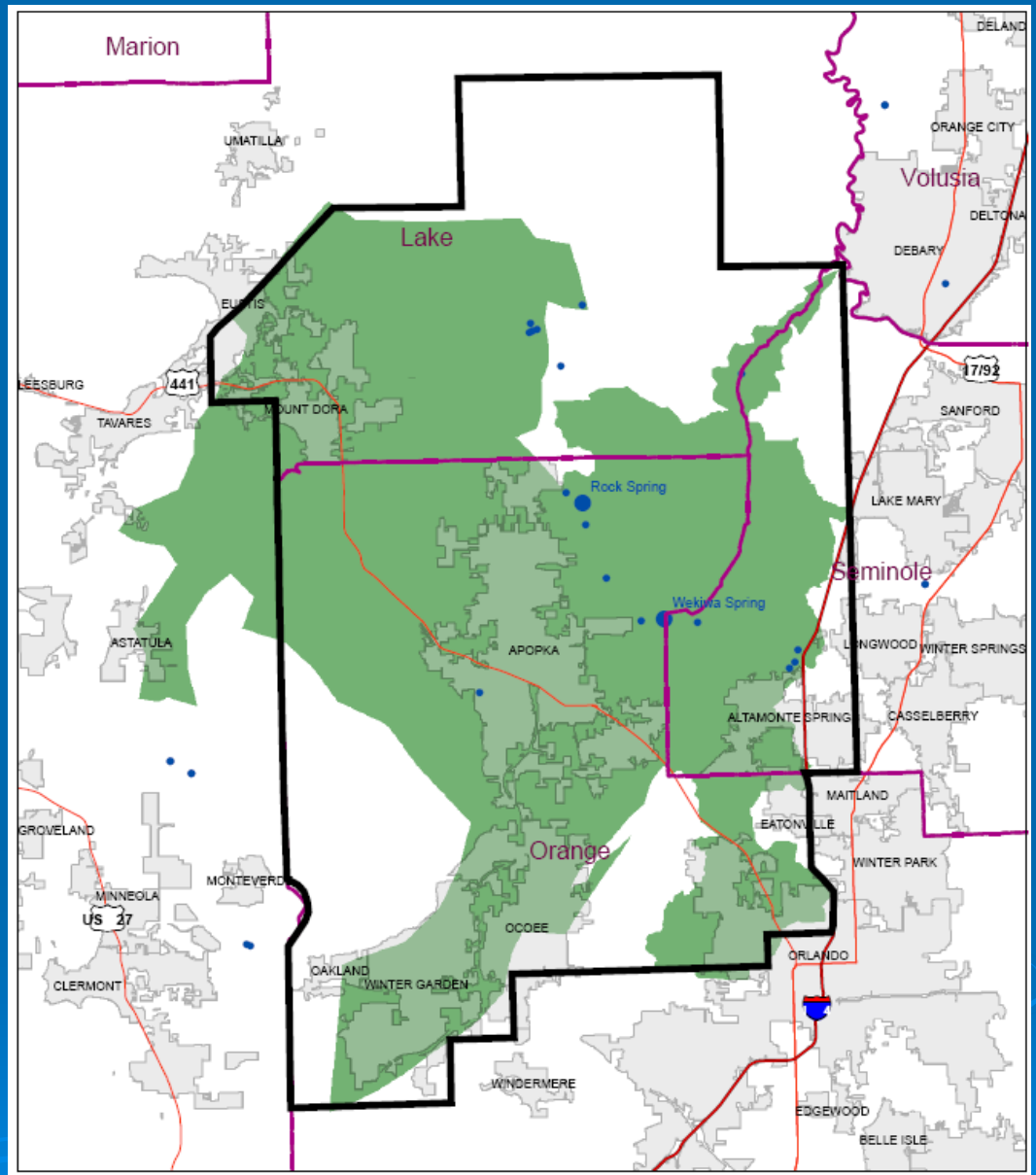
Conservative approach relies on multiple lines of evidence



BMAP Planning Area = immediate springshed + Rock Springs Run / Wekiva River watersheds

Considered Wekiva Study Area and WAVA

Includes the same jurisdictions as the Study Area, except Lake Mary (in Study Area, not in BMAP) and Astatula (in BMAP, not in Study Area)



TMDL Targets and BMAP Management Parameter

Do existing targets make sense?

Do BMAP management parameters make sense?

TMDL Targets & BMAP Management Parameter

- Knowns:
  - Temporal trends
  - Patterns of uptake
  - Nitrate as critical
- Unknowns:
  - Importance of phosphorus
- Resolution for BMAP:
  - No modification of TMDL targets
  - Focus on nitrate
  - Actions probably act on phosphorus as well

Target nitrate and phosphorus values

- do they make sense?

Yes, good science behind them, based on extensive review of literature and local information.

Let's deal with nitrate first….

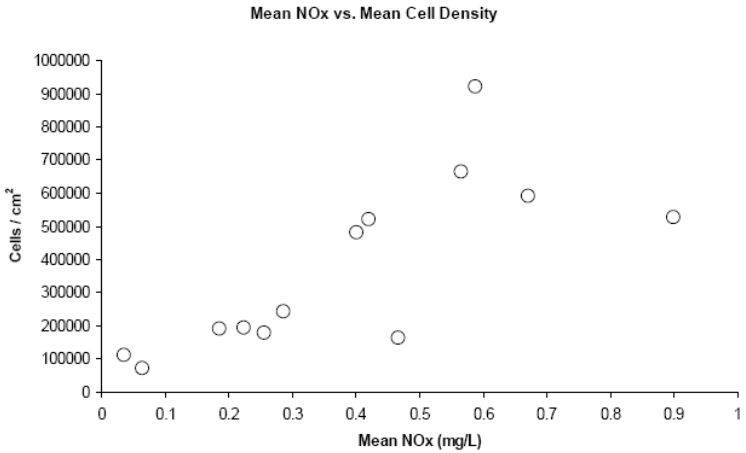


Figure 3.1-A Relationship between mean nitrate concentration and mean periphyton cell density from sampling sites on the Suwannee, Santa Fe, and Withlacoochee Rivers (Mattson et al. 2006).

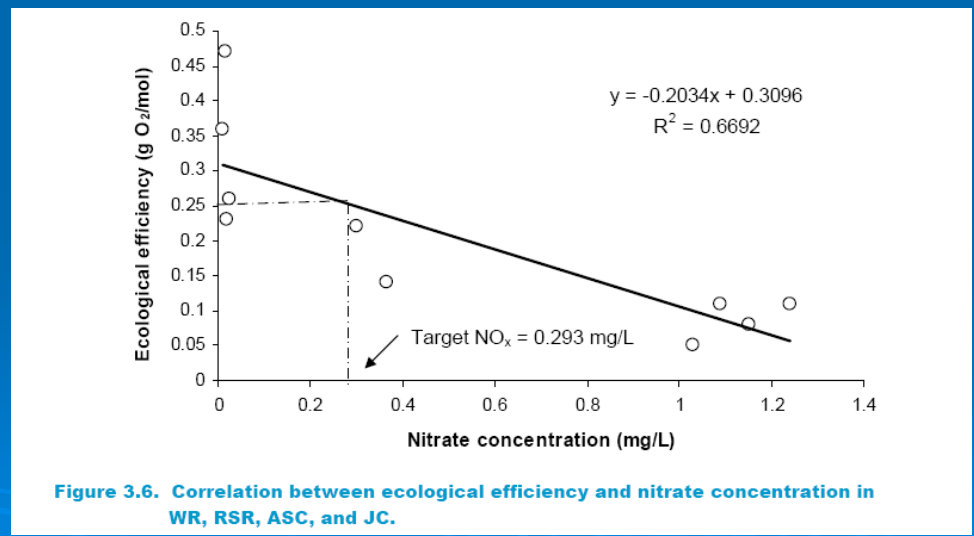


Figure 3.6. Correlation between ecological efficiency and nitrate concentration in WR, RSR, ASC, and JC.

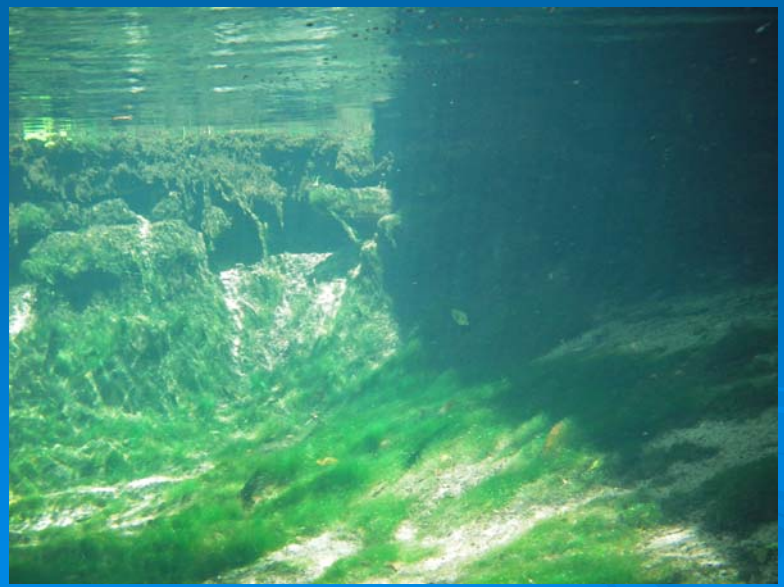
Relevant Findings from Pinowska *et al.* (2007)

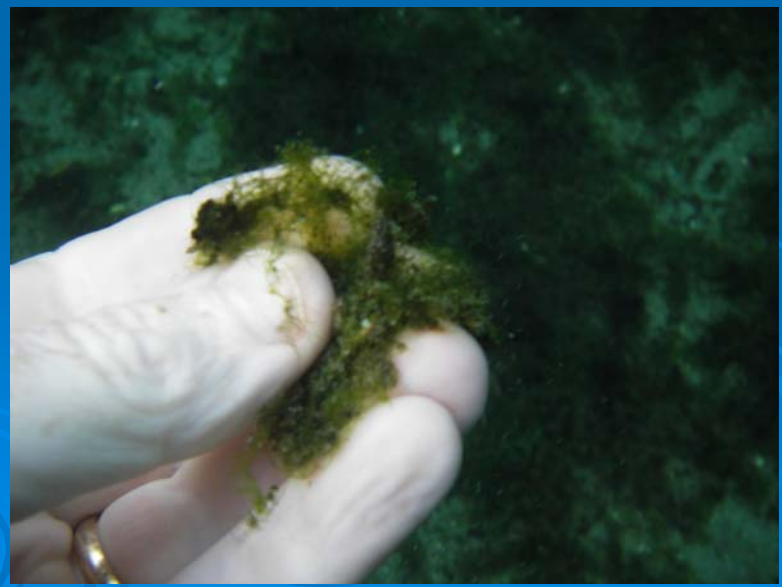
- Data from Rainbow, Weeki Wachee, Wakulla and Silver Rivers
- Substantial increase in nitrate over last 40 to 50 years
- *No concurrent increase in phosphorus*
- Most common algal species was *Lyngbya wollei*
- *Lyngbya* – abundance not related to nitrogen or phosphorus
- *Vaucheria* – abundance related to nitrogen and phosphorus
- The type of algae matters, in terms of susceptibility

Lyngbya
(Cyanophyta)

Vaucheria
(Chrysophyta)

Wekiwa Springs – lots of recreational use, HIGH nutrients, lots of algae (especially *Vaucheria*)

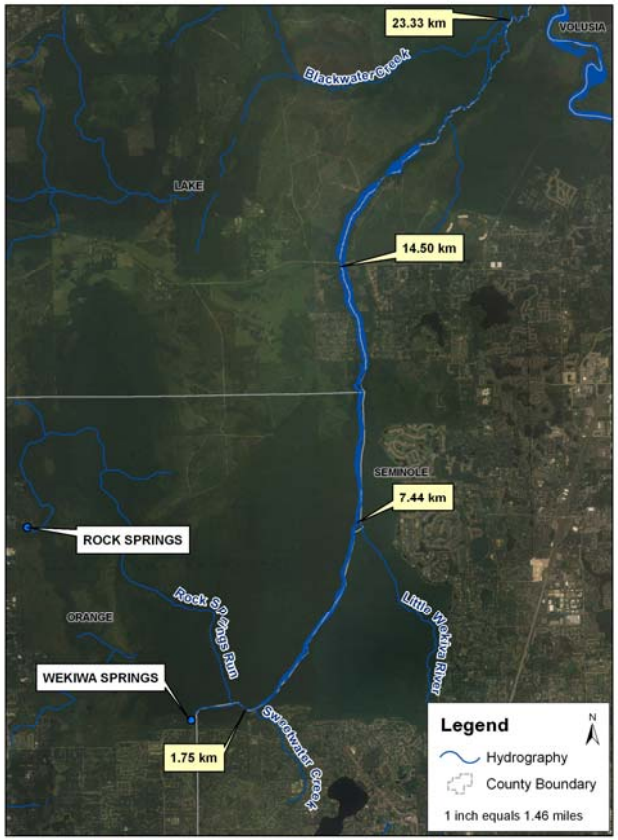


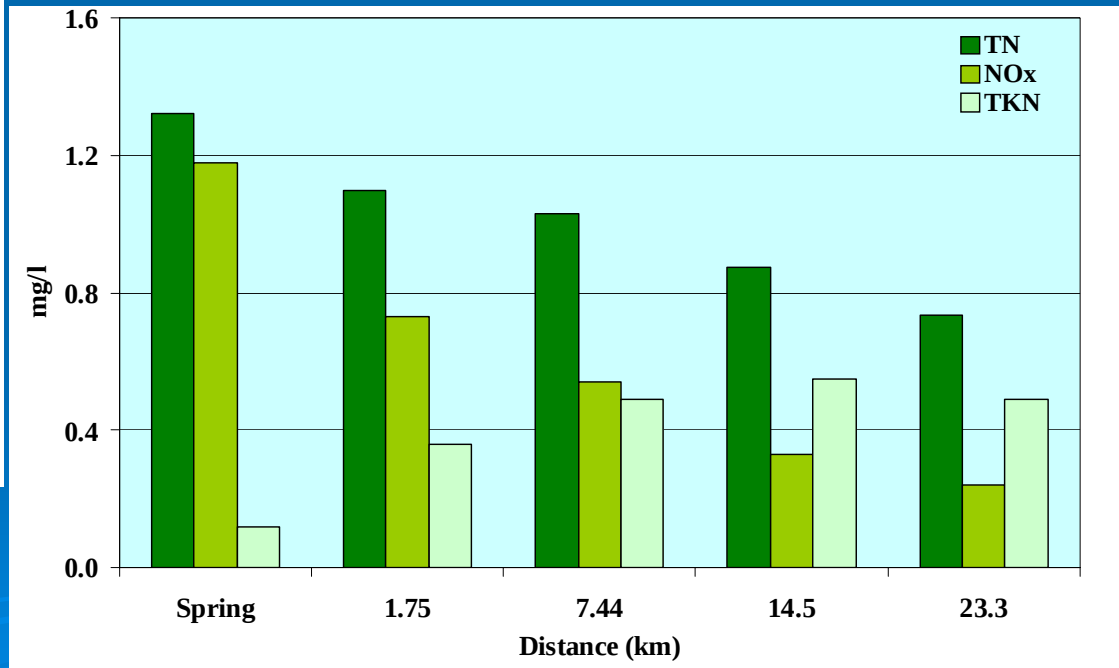


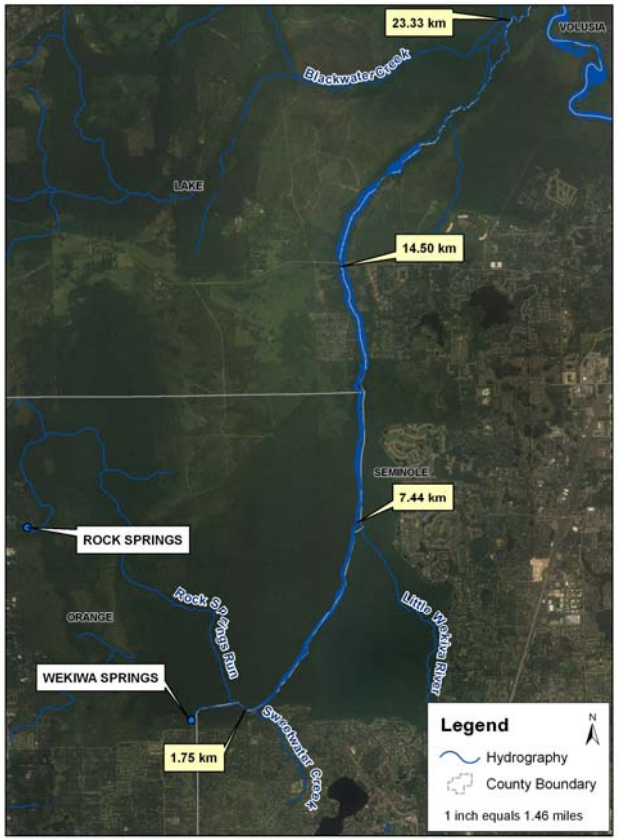
Nutrient processing

- What are the spatial patterns for nitrogen and phosphorus along the spring runs?
  - Nutrients of concern are expected to be “taken up” or assimilated
  - Nutrients that are not a concern might not be assimilated

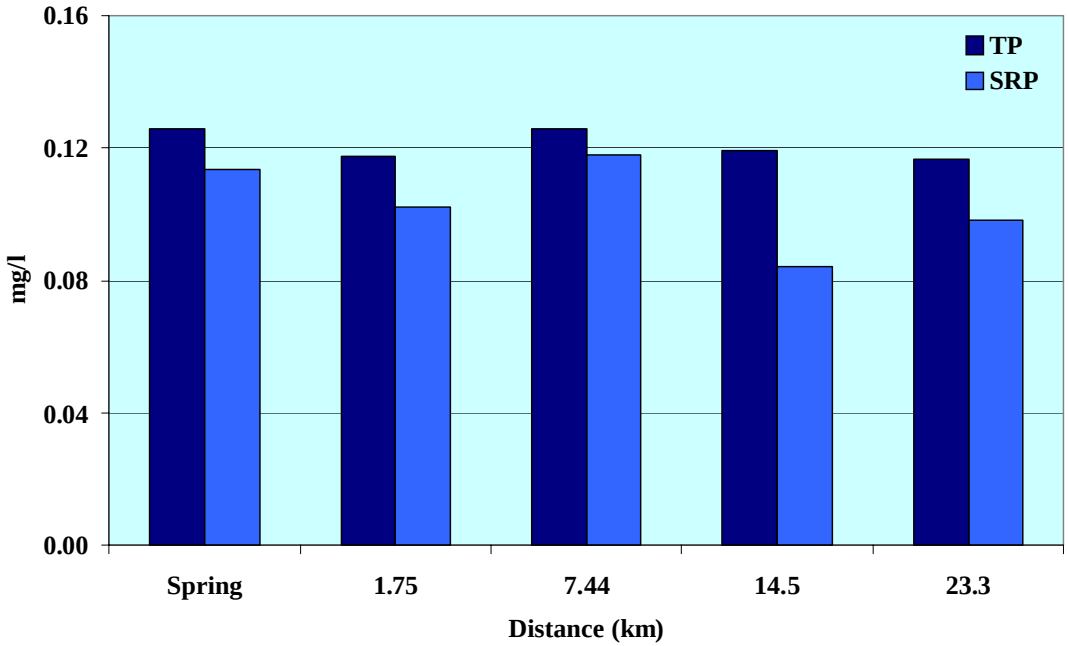
Evidence for uptake and transformation of nitrogen along the Wekiva River



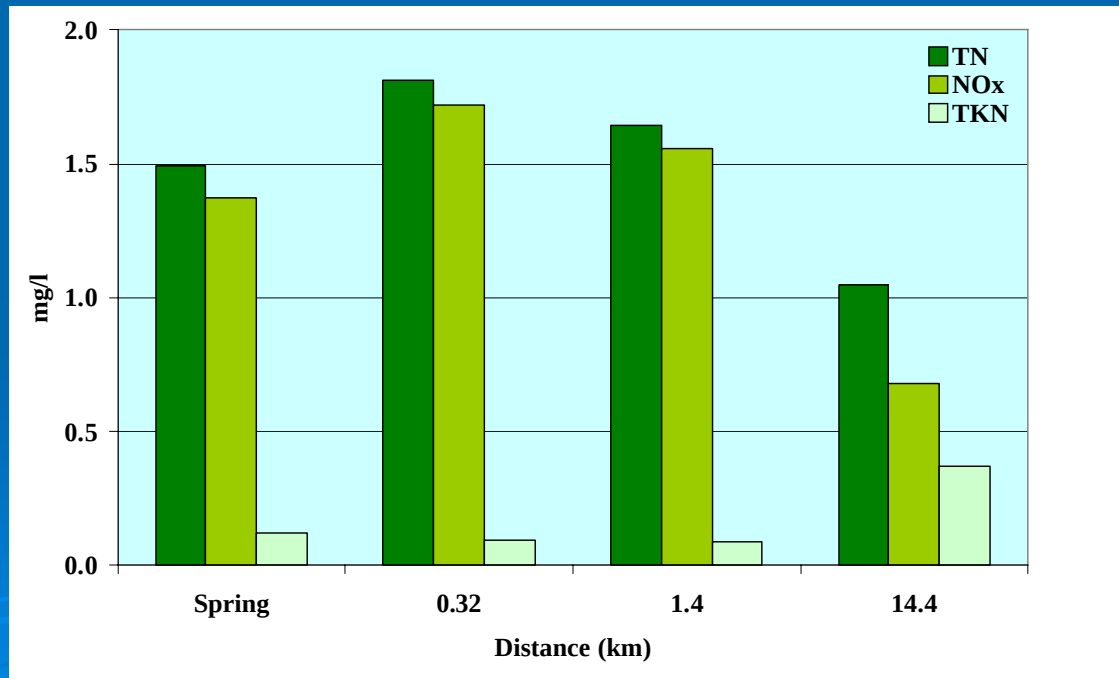




No similar evidence for uptake of phosphorus



Evidence for uptake and transformation of nitrogen in lowest reaches of Rock Springs Run. Data not sufficient to evaluate phosphorus.



Nutrient(s) to be concerned with?

- Nitrogen is clearly assimilated within the Wekiva River (and in lower Rock Springs Run)
- Phosphorus does not appear to be assimilated
- Nitrogen is likely associated with excessive algal growth
- Phosphorus relationship does not appear to be similar
- Primarily, but not exclusively, nitrogen should be addressed

Source Identification

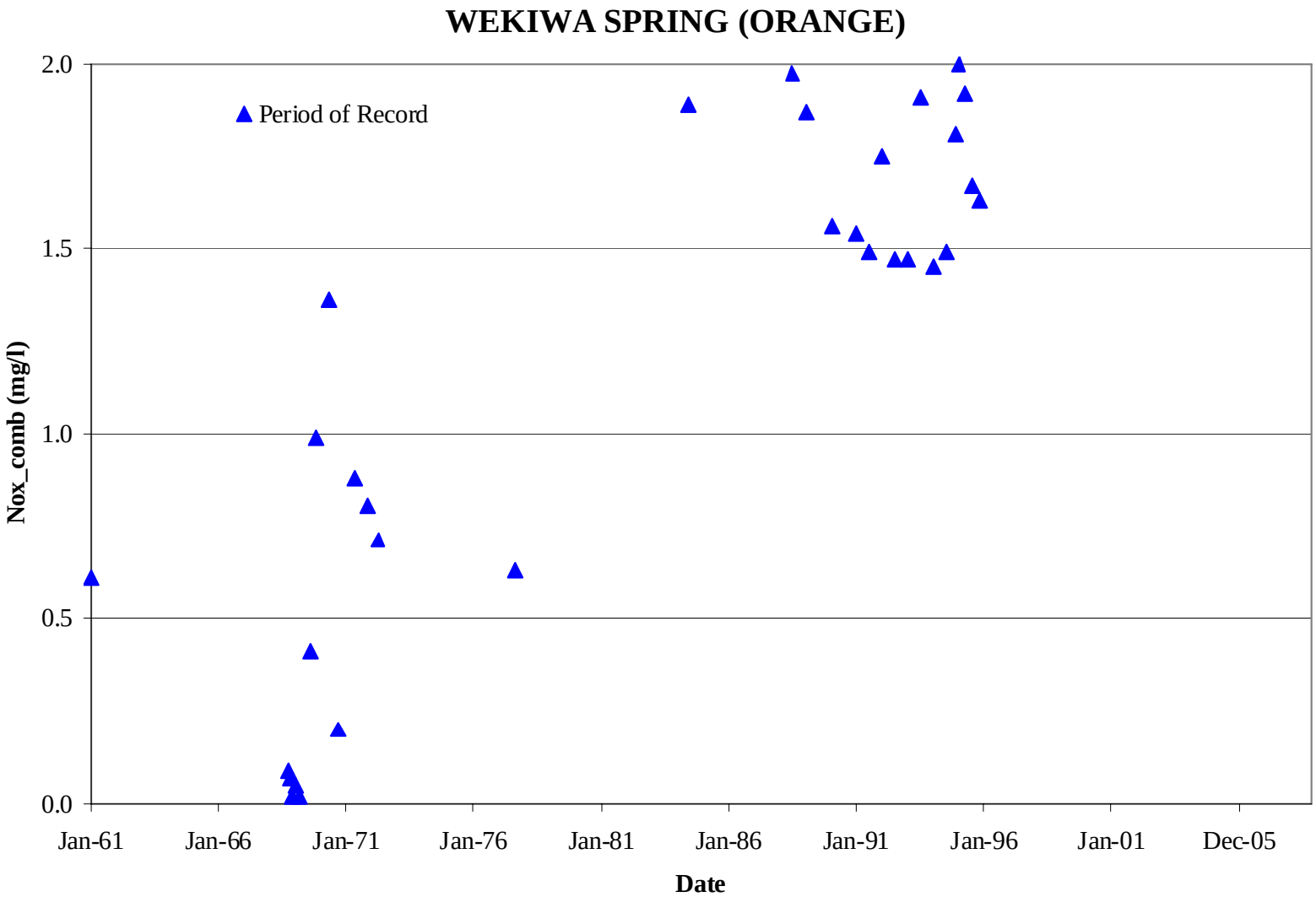
Why do we need to know about sources of nitrate?

What sources are already identified?

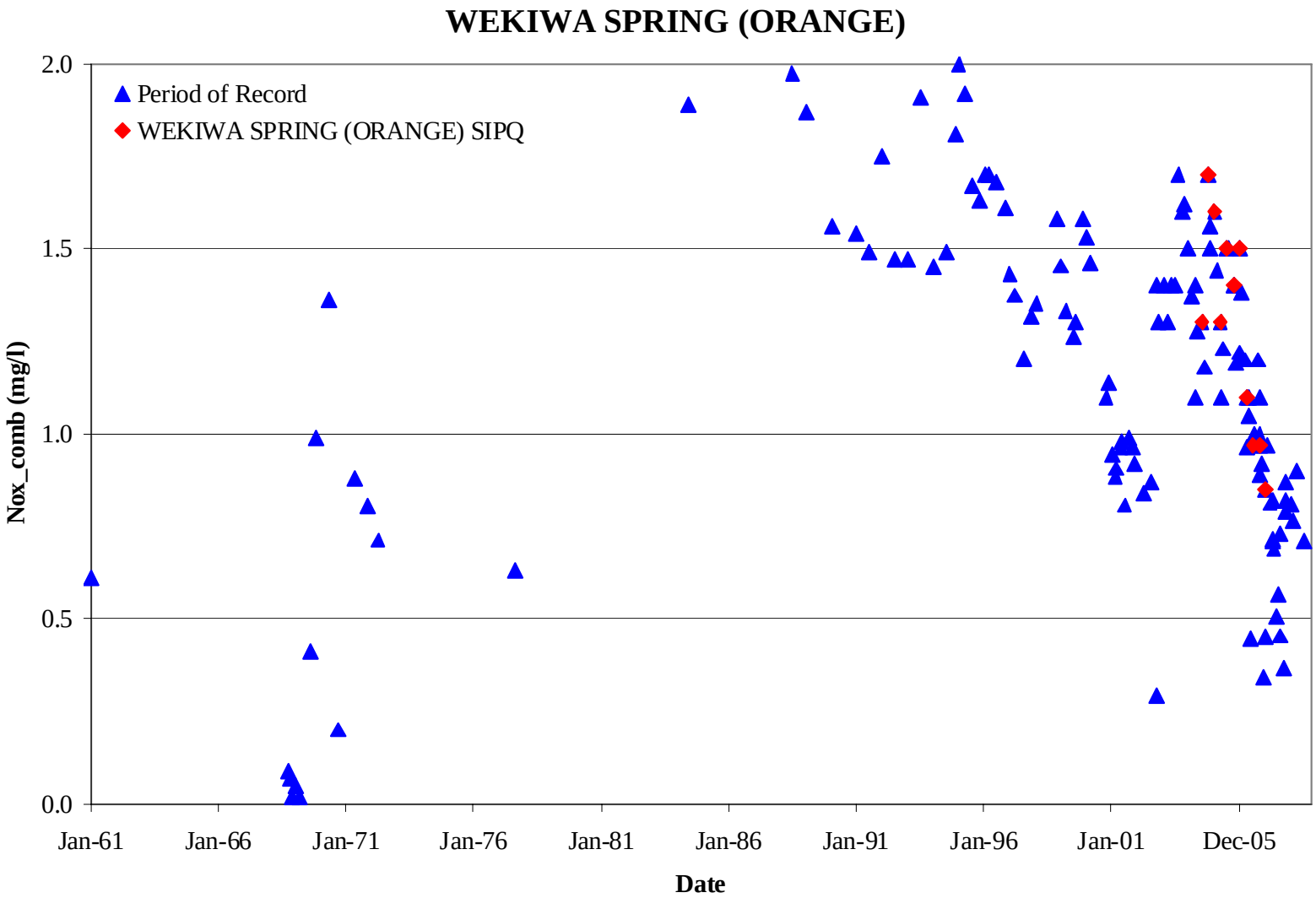
Source Identification

- Knowns:
  - Citrus acreage influences water quality data
  - ~17 year time lag
  - Multiple additional sources
    - Atmospheric deposition
    - WWTPs
    - OSDS
    - Stormwater runoff
    - Fertilizer impacts
- Unknowns:
  - Relative magnitude of sources still under question
  - Existing nitrogen isotope results not entirely clear
- Resolution in the BMAP:
  - Continue to examine sources
  - Conduct nitrogen/oxygen isotope study
  - Act on obvious sources
  - Detailed allocations unlikely

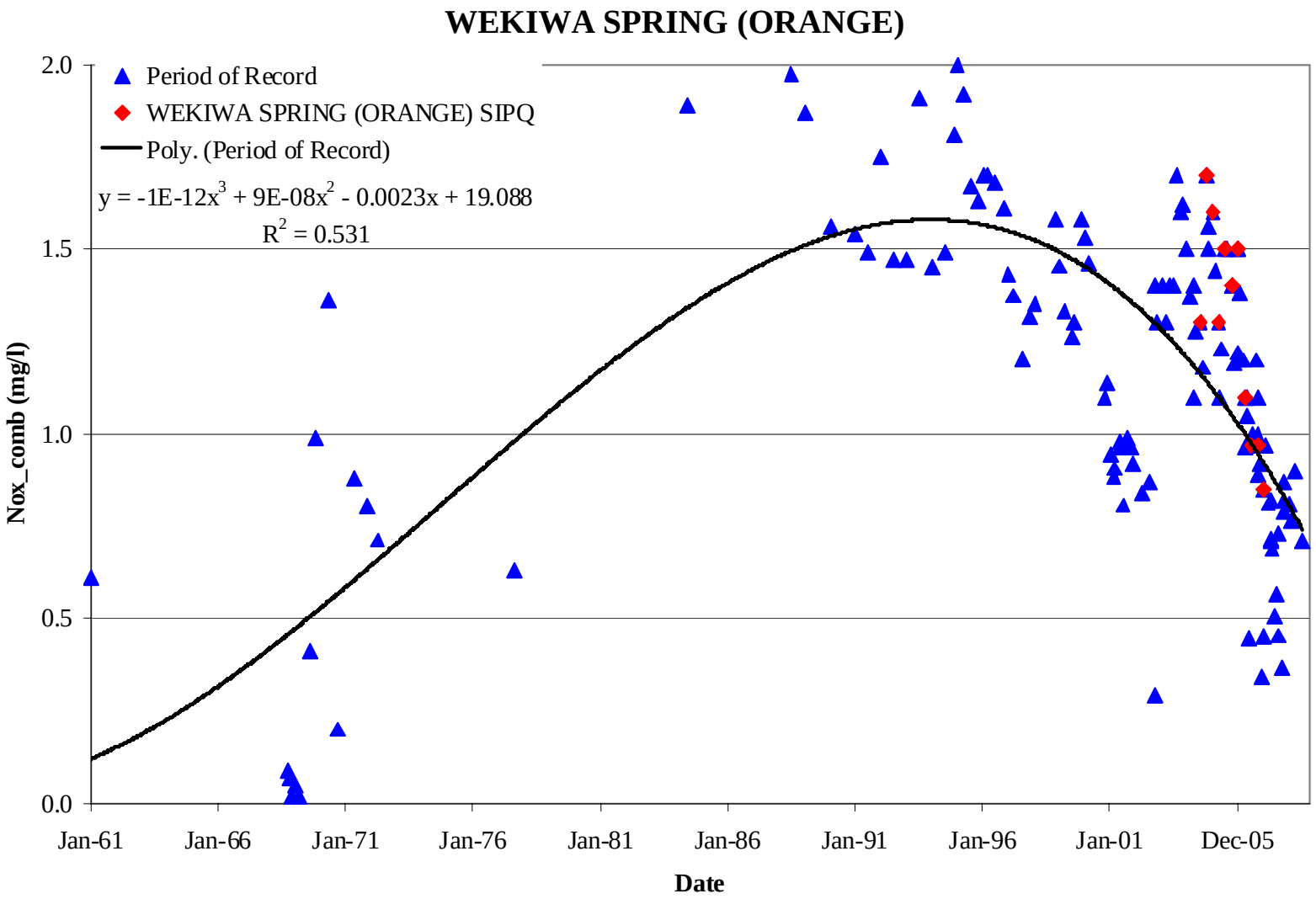
Increasing levels of nitrate



But recent trends are improving



Overall trend?



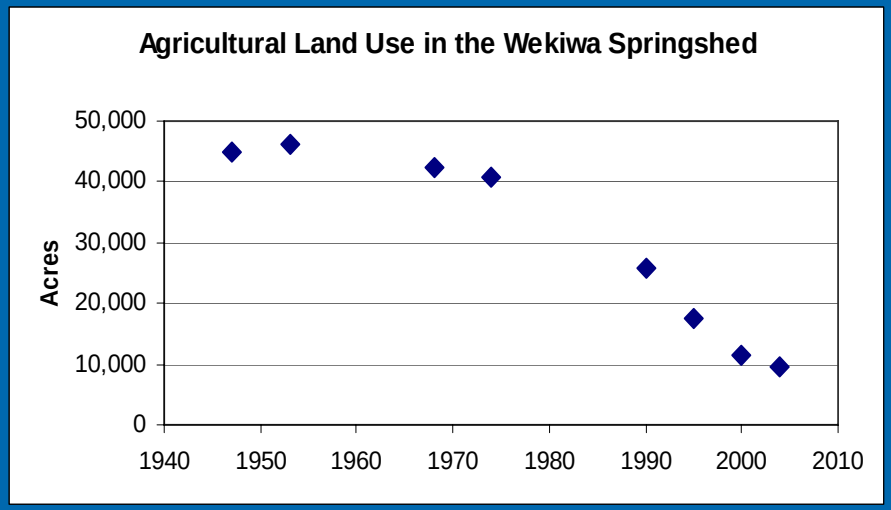
Nitrate trends over time…

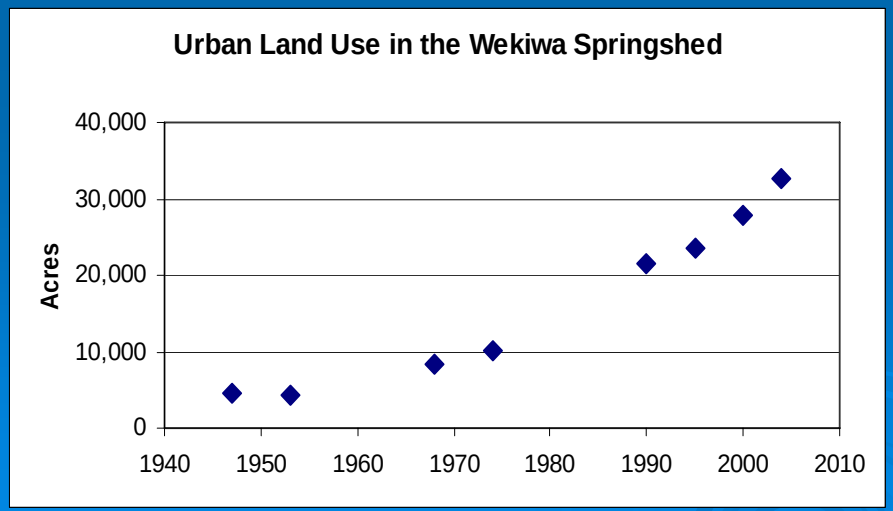
- Low values in 1960s (and probably prior to then)
- Increases to high values in late 1980s to mid 1990s
- Since mid 1990s, declines have occurred
- Levels still higher than target nitrate value from TMDL, however
- How did nitrate go up, then come down?
- Decrease in nitrate over time is more than can be explained by changes in flow over time

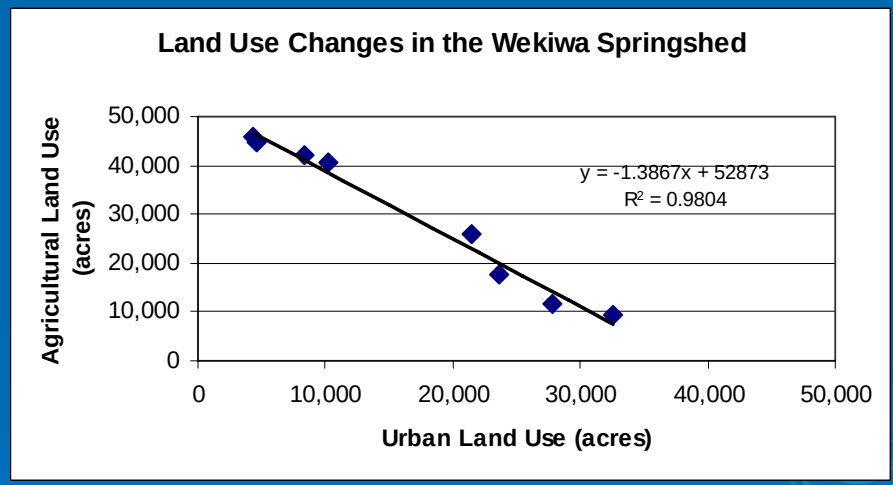
Why should we care about reasons for nitrate changes?

- 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 at vent, then less for one source only? All sources together?
- Complication – time lag between water entering aquifer and leaving via the vent
- How has land use changed over time?

Over time, agricultural land has decreased and urbanization has increased





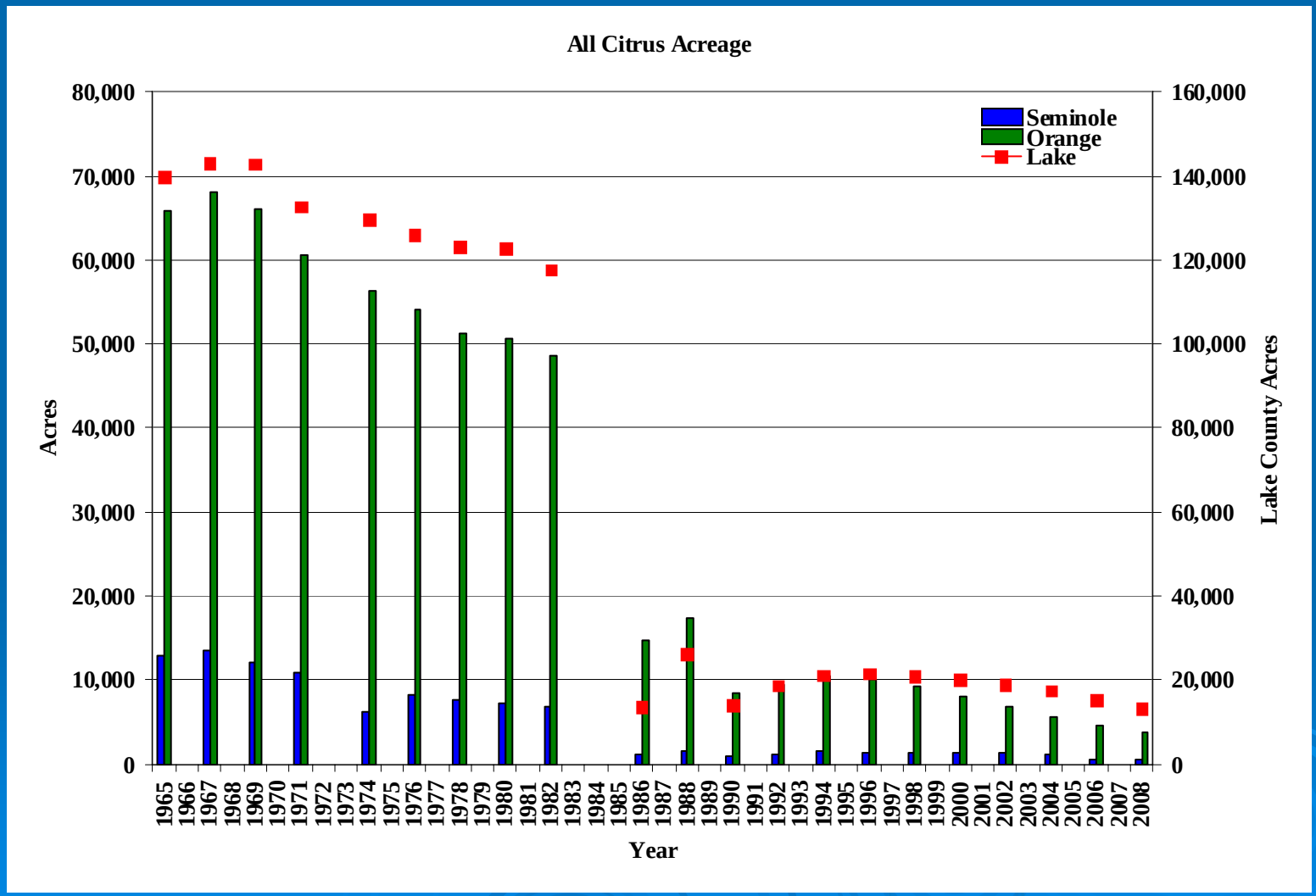


Using FGS-defined springshed

Land use and nitrate

- If agricultural land is decreasing, while urbanization is increasing…
- And nitrate levels increased, and then decreased…
- Which land use is more important?
- Could a prior land use cause a problem, and a newer land use result in the persistence of that problem, perhaps at a diminished rate?

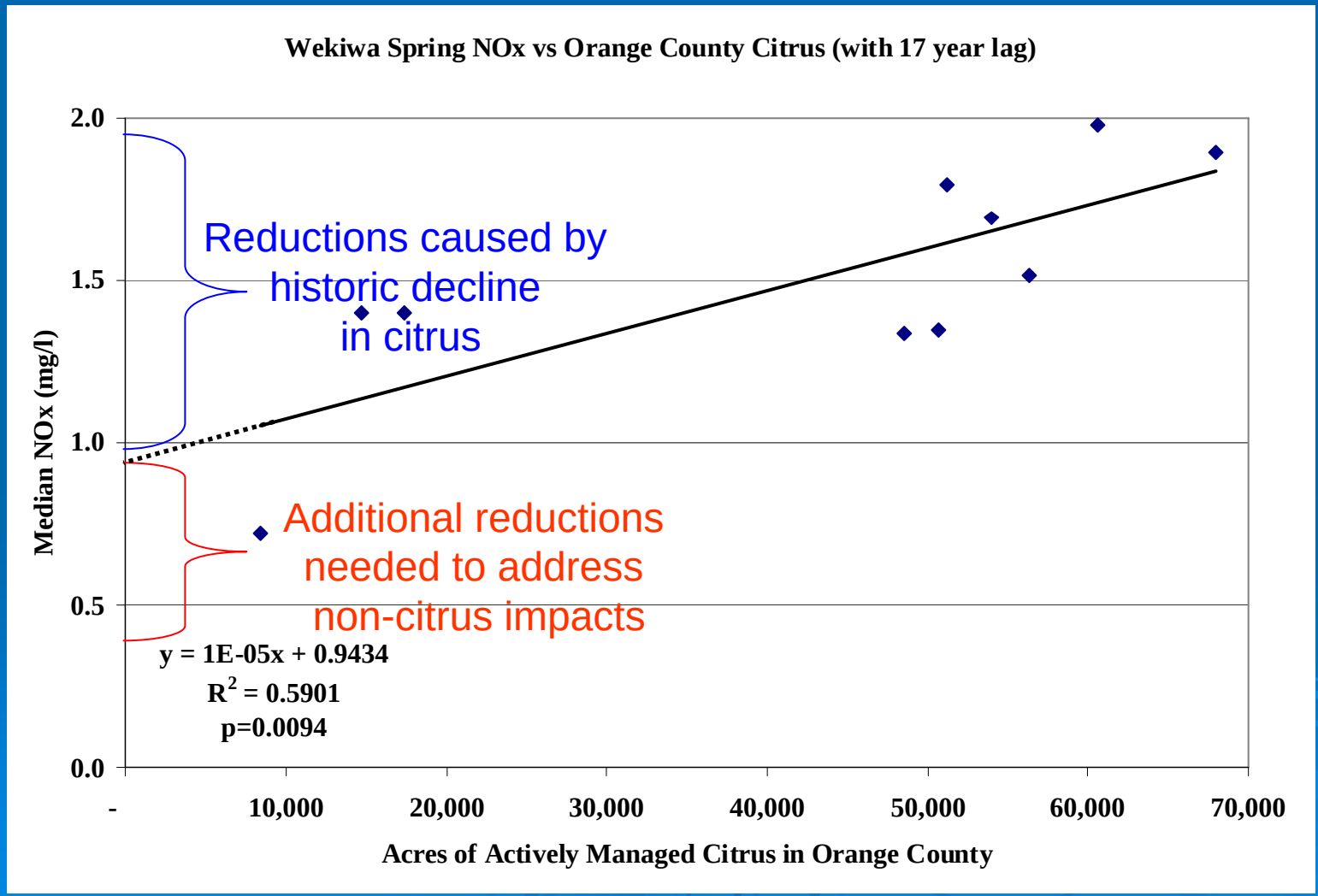
Christmas (12/83) and Super Bowl (1/85) freezes: step-wise decrease on top of prior trend



Source - FDACS

If water quality is related to prior land use…

Nitrate levels at Wekiwa Spring are positively correlated with acreage of citrus 17 years earlier



Relevant Conclusions

- There is about a 17-year delay between watershed activities and observation of effects at the spring
- Thus, citrus may be responsible for the highly elevated nitrate levels back in 1980s and 1990s and the decline in nitrate levels over the past few years
- Recent downward trend in nitrate is unlikely to continue, and **even if citrus were eliminated from the basin, nitrate levels are likely to exceed TMDL target**

Present-day Unknowns

- Definitely relevant
  - Source ID – isotope work
- Probably relevant
  - Physical disturbance
- Other issues?

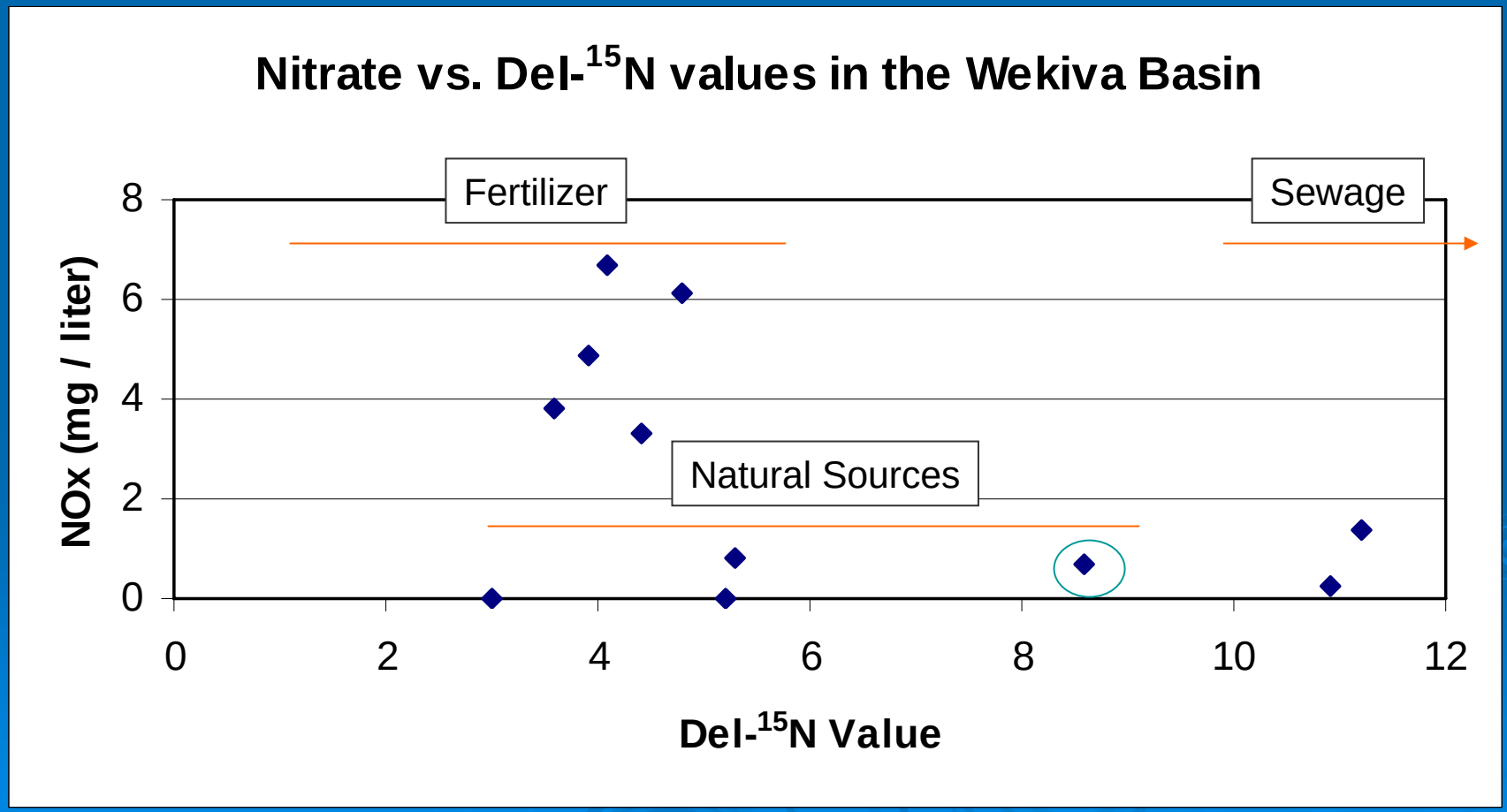
Definitely Relevant – Source ID Work

Nitrogen isotopes

- Two forms of stable isotopes for nitrogen
  - ^{14}N and ^{15}N
- Ratio is called the delta ^{15}N value
- Atmosphere “set at” zero
- Fertilizer typically -1 to + 6 (Toth & Fortich 2002)
- Sewage / manure typically > + 10 (Toth & Fortich 2002)
- Natural sources can vary substantially: + 3 to +9 (Toth & Fortich 2002)

- Examples
  - +1 likely fertilizer
  - + 10 likely sewage
- **What about + 8.6?**
    - Value from Wekiwa Springs (Toth & Fortich 2002)
    - Indicative of OSDS influence?
    - Is it OSDS and fertilizer?
    - Fits in range of “natural” sources

High NOx have low Del-^{15}N.
Low NOx (< 1 mg/l) vary from + 3 to +11.
Fertilizer for highest values, but what is source for Wekiwa?



Data from Toth & Fotich (2002)

Current 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 mid-March (USGS & DEP, coordinated with SJRWMD); expect results by May

Probably relevant – physical disturbance

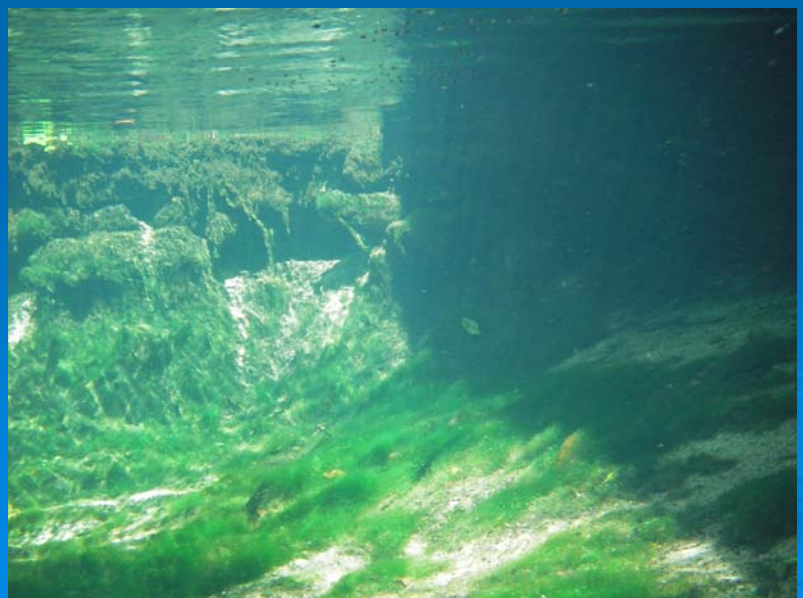
Evidence of Recreational Impacts

Spring	Nitrate levels	Algal levels	Recreation Use
Wekiwa	**High**	**High**	**High**
Juniper	**Low**	**Low**	**Moderate?**
Alexander	**Low**	**High***	**High**
Silver Glen	**Low**	**High**	**High**

* In headwaters region

- Water quality alone may not be enough to attain an "unimpaired" condition, as far as algal coverage
- More holistic approach may be needed

Wekiwa Headsprings: swimming vs. non-swimming areas are substantially different



Concern

- Water quality targets are needed, and are addressed via the TMDL
- But basis for impairment that the public encounters – algal overgrowth – may depend upon activities that address concerns in addition to water quality alone
- Silver Glen Springs Carrying Capacity Study might have relevant findings for Wekiva…

Silver Glen Springs

- Areas with high algal coverage are not also areas with native vegetation
- Swimming causes little impact to bottom vegetation
- But wading causes these areas to be "…devoid of vegetation"
- Replanting (and protection) was able to get 60 to > 300% increase in regrowth of native vegetation
- Perhaps…
  - Native vegetation competes with algae for space and/or light
  - Native vegetation can compete with algae for nutrients
  - Need to act on both water quality and vegetation simultaneously

- "Active, flexible management combined with ecosystem monitoring is needed in order to restore the ecology of Silver Glen while providing a safe, nature-based recreation experience…"

Other issues

- Defining “restoration”
- Integrating source identification efforts with previous studies

Questions?