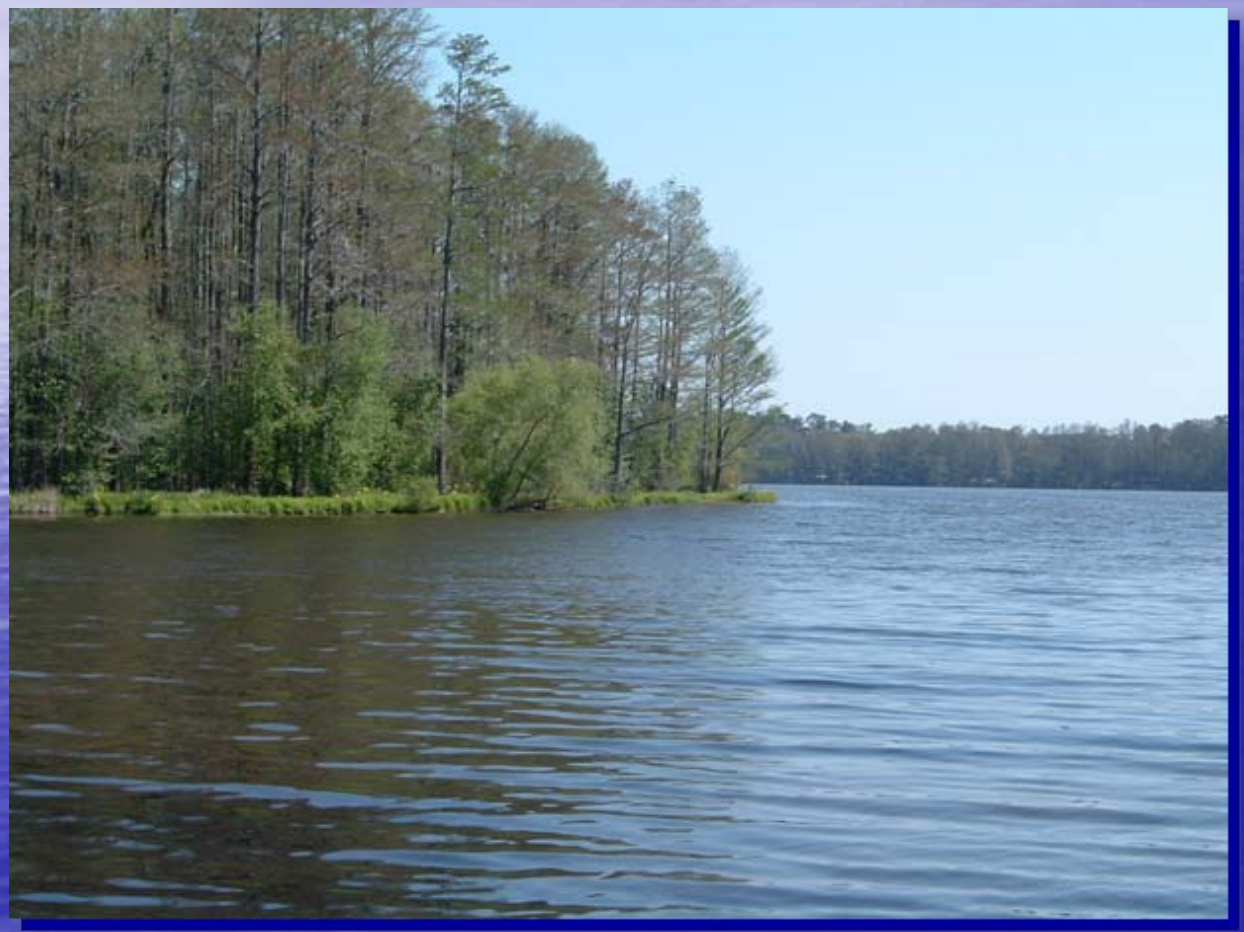
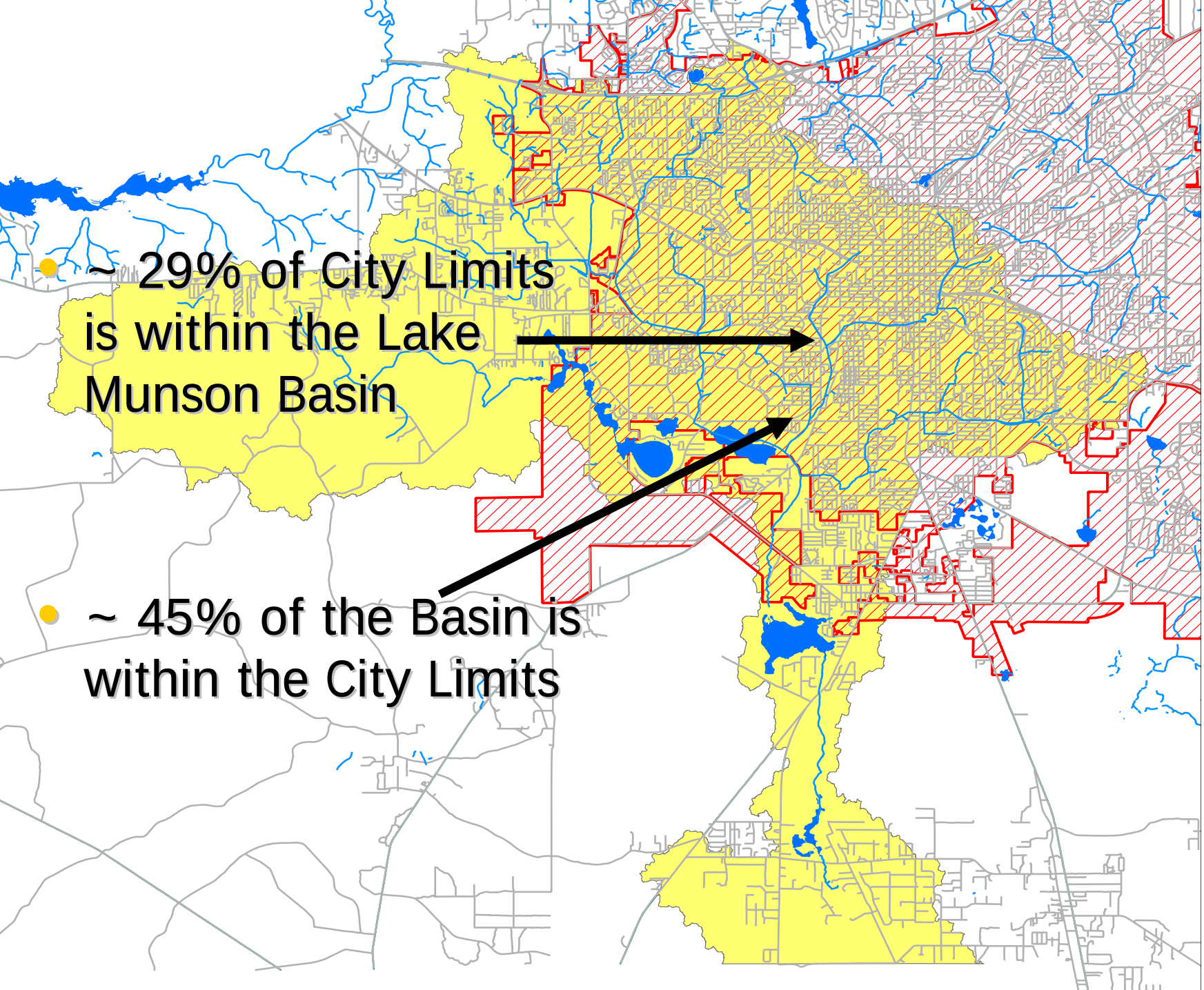
# Lake Munson:
## Past, Present, and Future

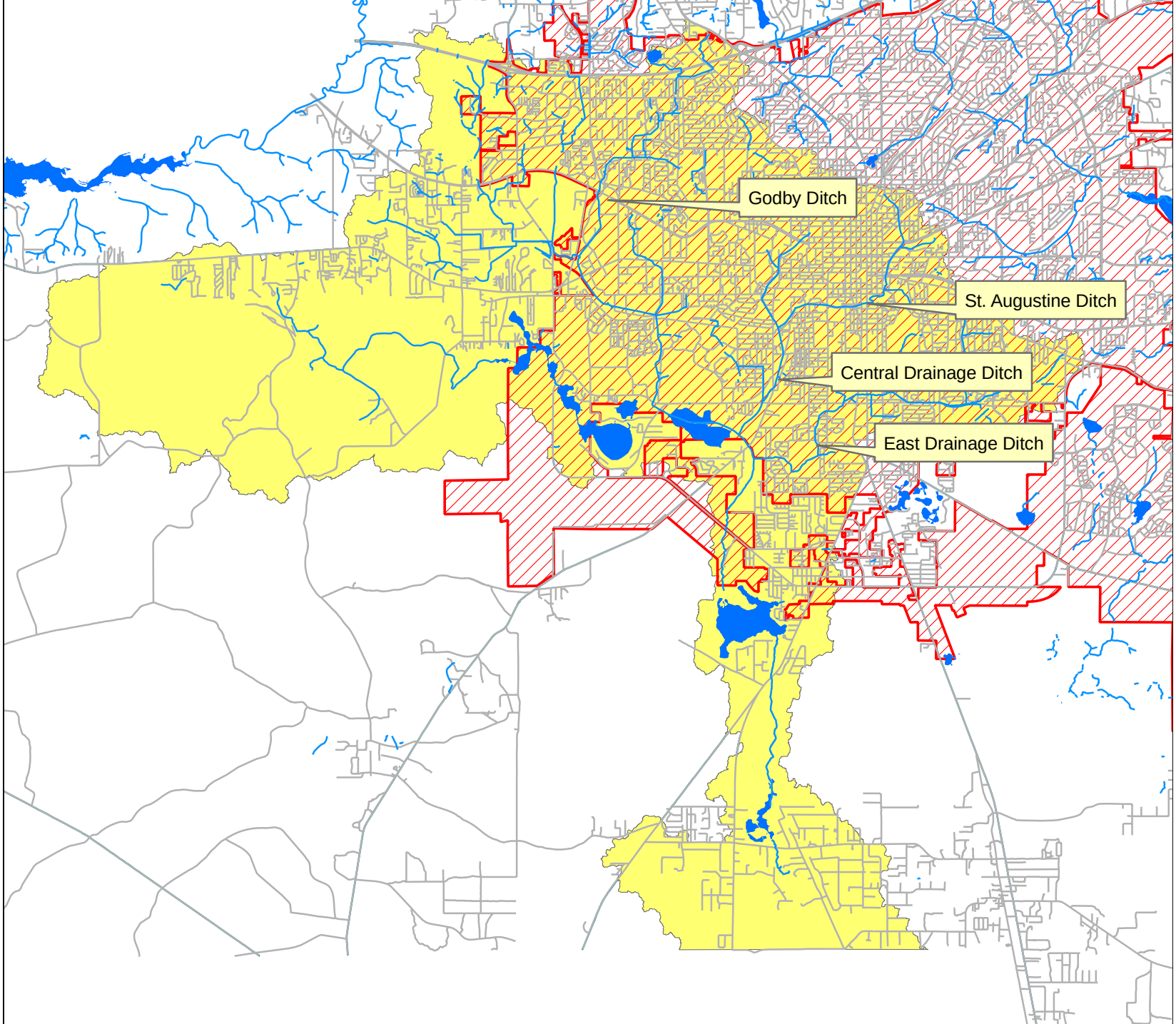


Johnny Richardson,
Water Quality Scientist

# Description

- Shallow, 255 acre, cypress ringed lake that is impounded at the outflow
- Munson Slough is the lake's primary inflow and outflow stream
- 42,529 acres in Lake Munson Basin


~ 29% of City Limits is within the Lake Munson Basin
~ 45% of the Basin is within the City Limits


Godby Ditch
St. Augustine Ditch
Central Drainage Ditch
East Drainage Ditch

# History

- Early 1930's, wastewater was discharged into Lake Munson
- 1954 FL Game and Freshwater Fish Commission indicated that Lake Munson was a good waterfowl hunting area and a "cracker" fishing lake
  - Even then, many people didn't fish the lake because it received effluent from Tallahassee sewage plants and lake esthetics were deteriorating as was evidenced by algal blooms

# History

- 1954 until the early seventies, data on the lake was limited
- Surveys began again 1973
- In 1978-79 wastewater treatment plants contributed at least
  - 66% of BOD,
  - 88% of phosphorus,
  - 91% of nitrogen loads that entered Lake Munson
- 1982 study classified Lake Munson as hypereutrophic and seventh most degraded lake in the state

# History

- Wastewater effluent discharges were eliminated in 1984 and the lake experienced water quality improvements
- The 1986 fish survey indicated an overall 75% decrease in fish biomass from the 1976 survey, despite a 1977 drawdown and supplemental restocking program
- In 1988 Lake Munson was listed as ninth in priority of all water bodies in the NWFWMD Improvement and Management Program and the only water body where restoration was listed as a major activity

# History

- 1992 Diagnostic Feasibility Report for Lake Munson was released
  - Recommended ways to improve the water quality of Lake Munson
    - "In-lake restoration efforts should address the removal of bottom sediments from Lake Munson."
- 1994 Lake Munson Action Plan was released
  - "Without in-lake restoration, water quality will remain poor, even if the quality of stormwater is improved."

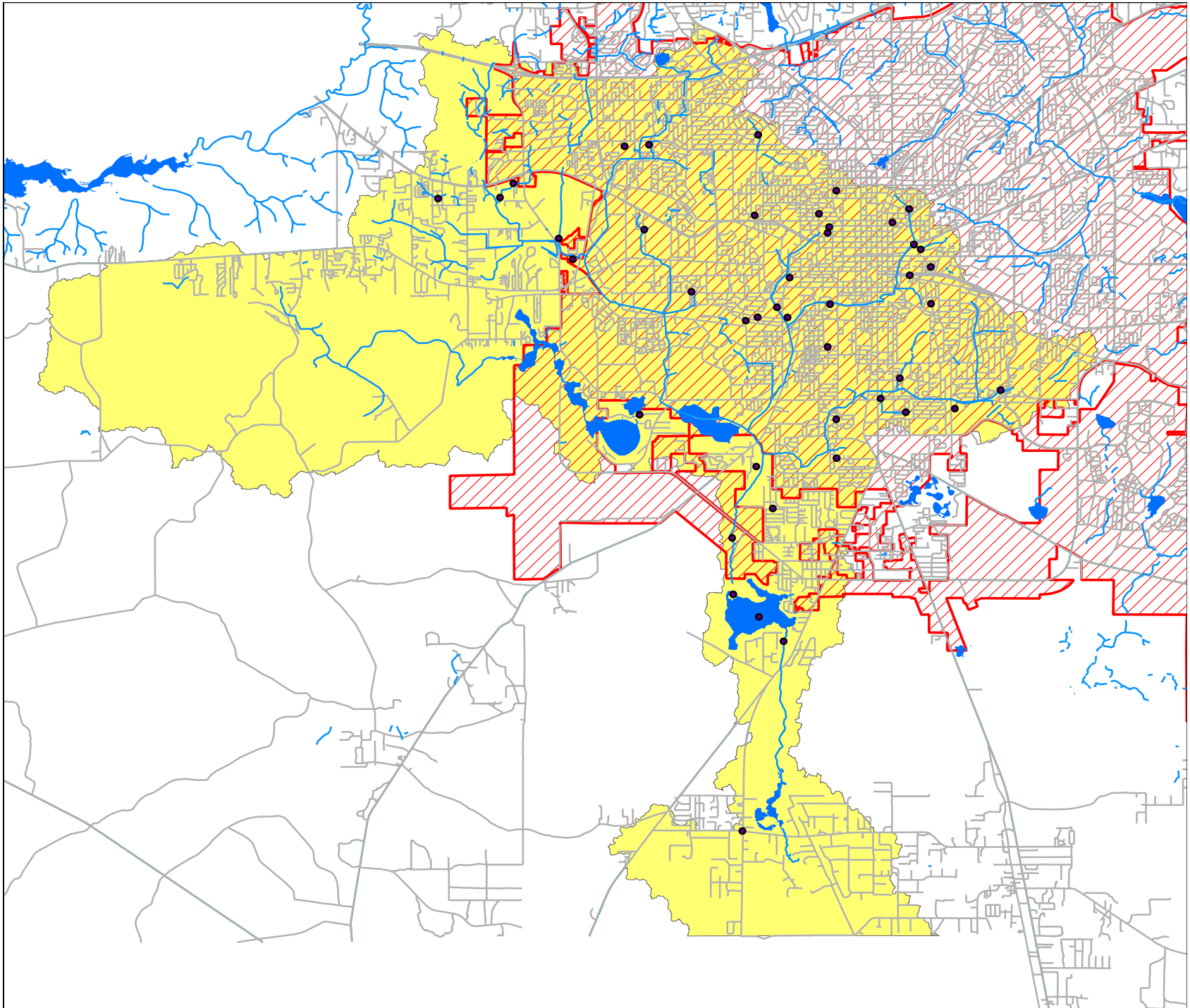
# Finally,

- County has historic and current water quality monitoring program
  - Water and sediment chemistry
  - Biological Surveys

# Overall

- Since the 1930's, the lake's esthetic condition has been quite variable
  - Poor water quality
  - Heavy algal blooms
  - Fish kills
  - Street debris
    - Paper products, cans, bottles, toys, dead animals, and yard trash were scattered throughout the lake's inflow delta and has been around since the 1970's
- But, over time there has been a gradual improvement in water quality

# Lake Munson Basin Projects



# Lake Henrietta Construction/Munson Slough Restoration

- Twenty five acre wet detention treatment facility with dual trash traps was constructed to slow runoff, reduce sediments and trash before water enters the restored wetlands and stabilized channel north of Lake Munson
- Slough improvements increase the width of the channel, which slows the water flow, allowing the slough banks to remain natural
- Flow was restored to the adjacent wetlands via three low-level weirs for additional flood storage and nutrient removal

- Most importantly, nothing changed (regarding the project) to increase the amount of stormwater coming into the slough, so there is no physical way the project increased flow to Lake Munson

# During Construction

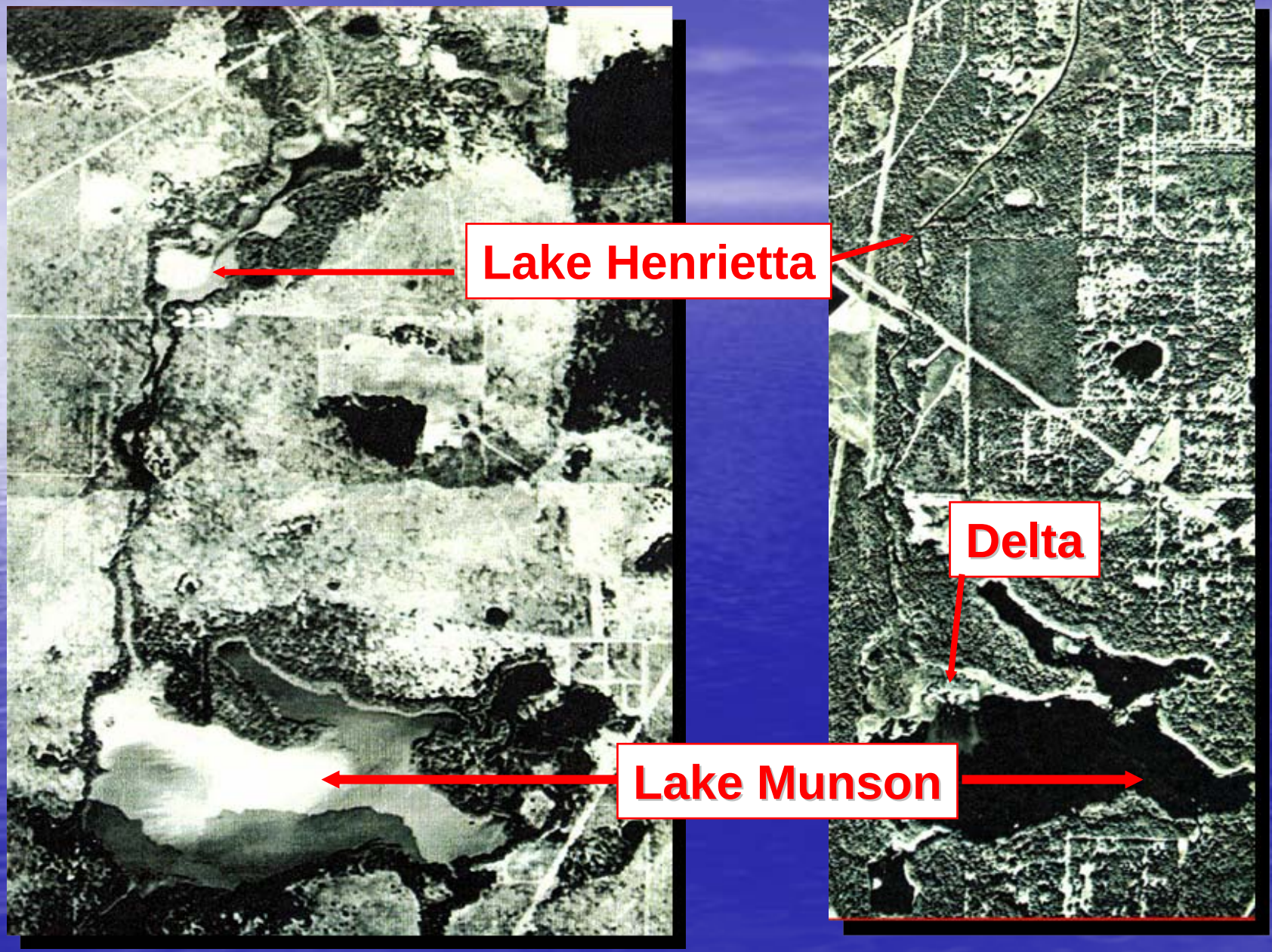
- Thirty acre sediment and trash delta was removed from the northwest inflow
- Twenty four tons of debris was removed from the lake and vicinity during September 2000 Lake Munson cleanup day; contractor removed an additional eight tons during the course of the construction project

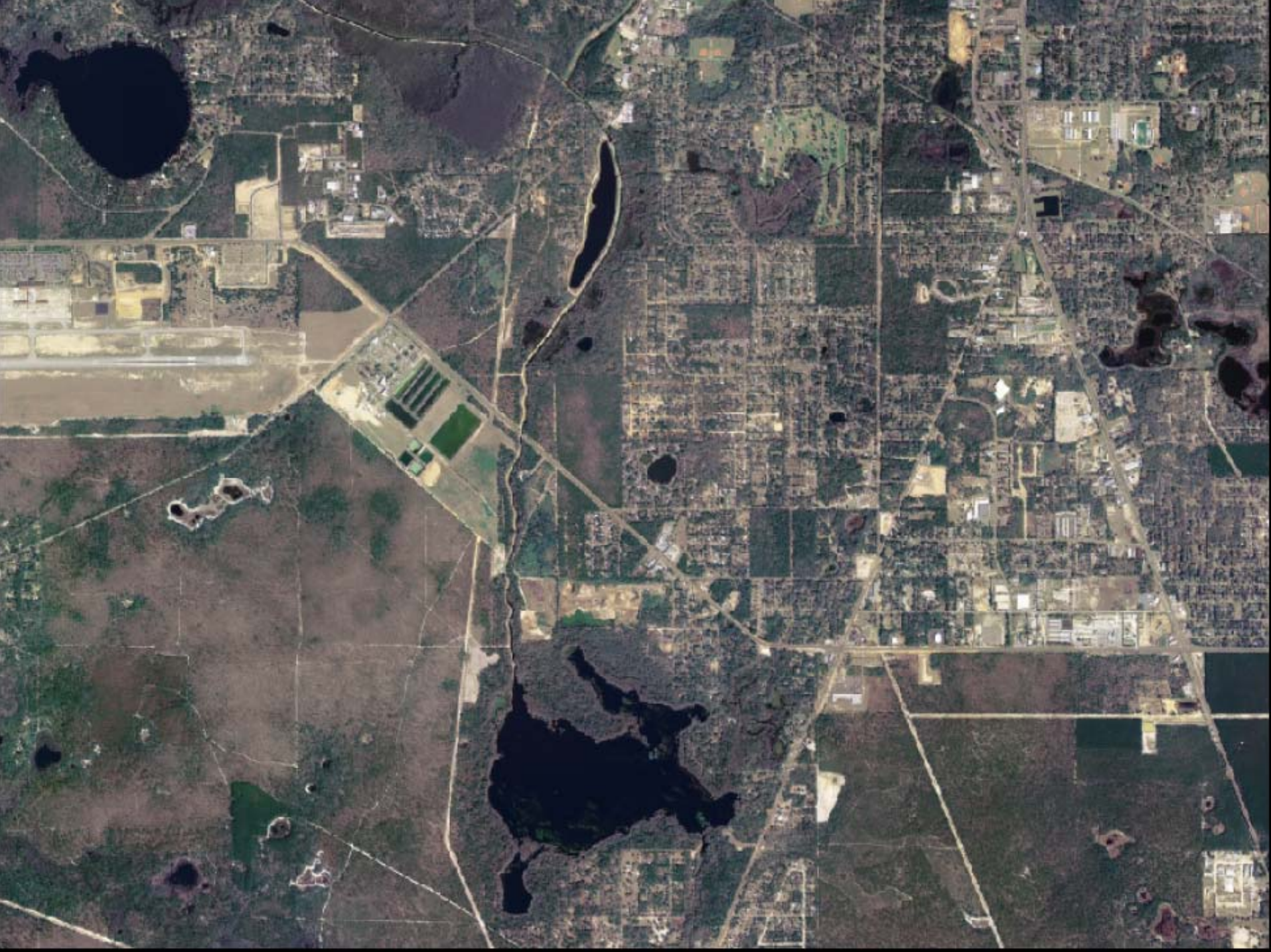
# After Construction

- During normal maintenance of Lake Henrietta
  - Sediment Removed
    - May 2003 - 382 cubic yards
    - August 2004 - 300 cubic yards
    - April 2006 - 408 cubic yards
- Average dump truck holds nine cubic yards

1955

1990





# Gum Swamp Restoration – Completed 1999

- Gum Swamp Restoration – Complete 1999
  - Wetland area was restored between Capital Circle NW, US 90 West and SR 20
  - Attenuates flood conditions and improves stormwater quality from northwestern areas of the Lake Munson Basin.
  - Significant tree mortality was determined to result from extended high water levels; current operation incorporates seasonal fluctuation (reduction in managed water level during fall/winter)

# Other Projects

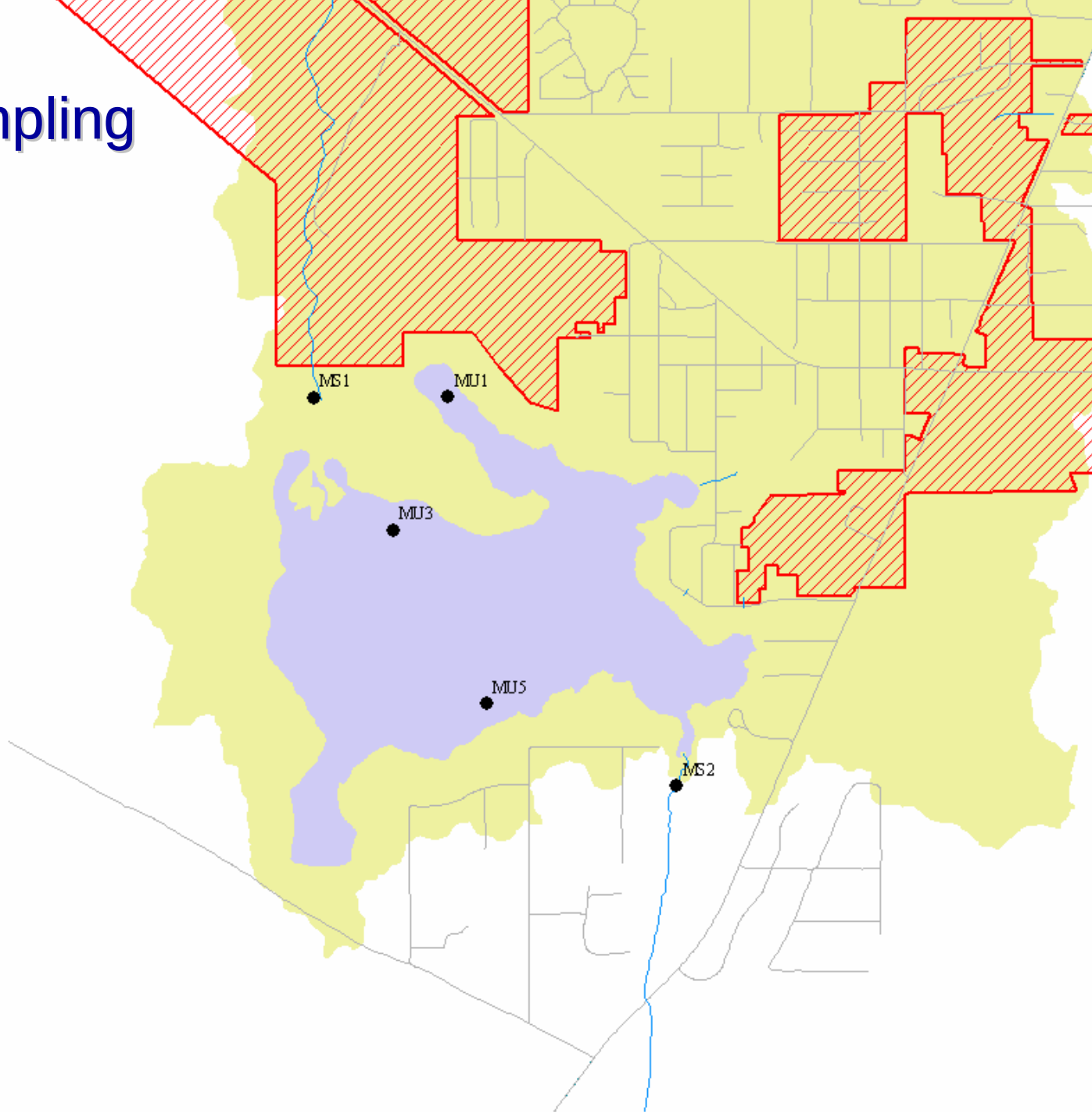
- Lake Munson dam renovation – in development
  - The 1968 structure requires modification to address access, operation and maintenance deficiencies.
    - No planned action will affect lake level.
- Orange Avenue – Complete 2006
  - Reconstruction of Orange Avenue included a wet detention treatment facility and floodplain storage constructed at the intersection of Meridian and Orange Avenue. Trash capture was incorporated on the East Drainage Ditch east of Jim Lee Road.

# Other Projects

- Gum Creek Watershed Management Program - In Construction
  - Capital Circle NW joint project with FDOT to construct wet detention facility at the intersection of US 90 West and Capital Circle. The contributing basin is fully treated to state stormwater standard.
- City of Tallahassee
  - The Frenchtown, Jim Lee and FSU facilities are complete. A trash rack was installed on the East Drainage Ditch east of Jake Gaither Golf Course and on the Central Drainage Ditch west of Lake Bradford Road.
- Blueprint 2000
  - Capital Cascade Trail improvements to the St. Augustine Branch and Central Drainage Ditch are currently in design.

# So, what's happening in Lake Munson?

- Selected Sampling Stations



# Trophic State Index (TSI)

- Trophic state relates to biological productivity of a lake
- Uses total nitrogen, total phosphorus and chlorophyll a
- Numerical scale from 0 to 100
- The higher the score, the higher the productivity

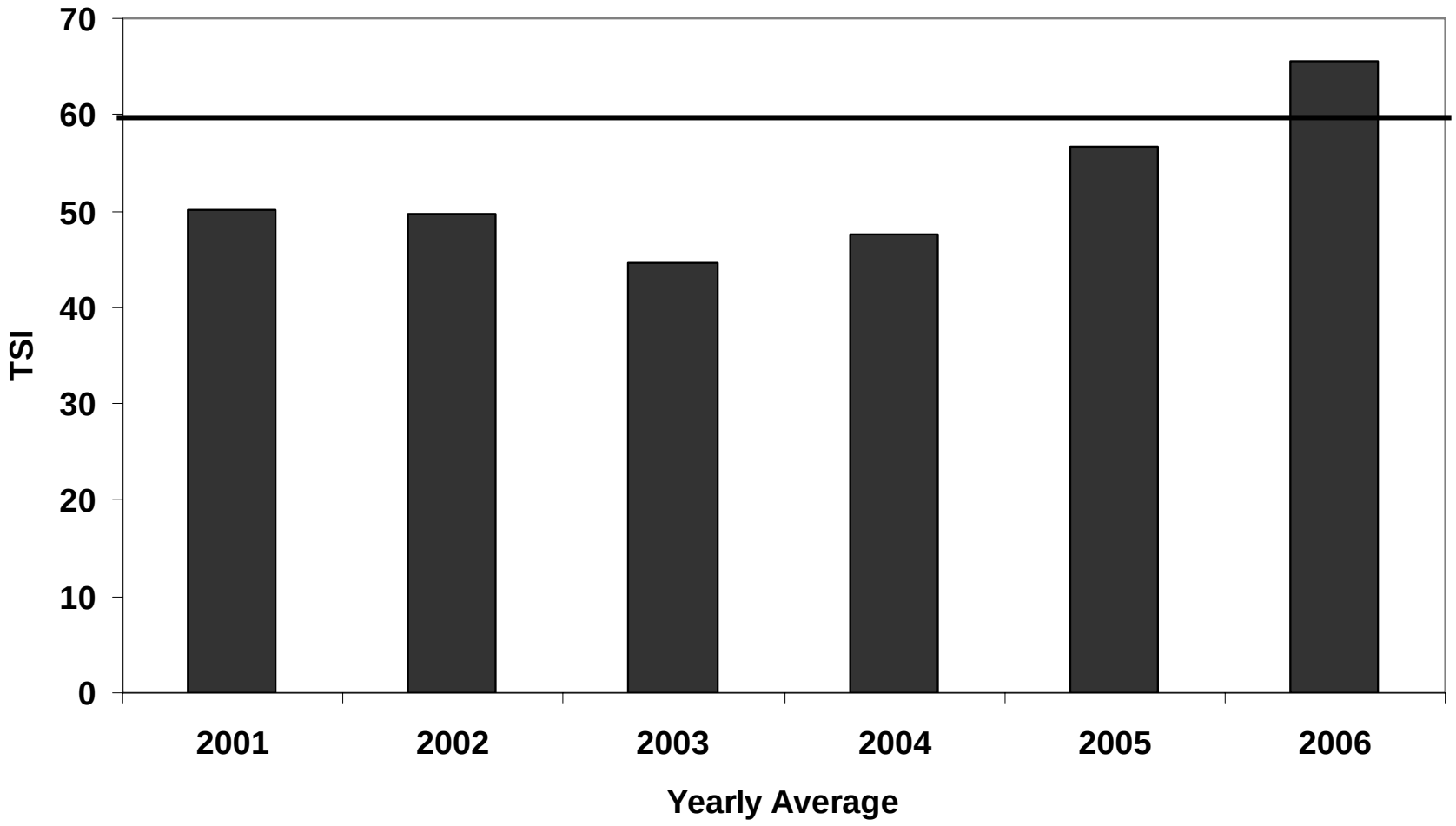
# TSI

- The threshold for possible impairment is as follows:
  - For lakes with a mean color greater than 40 PCU, the annual mean TSI for the lake exceeds 60, unless paleolimnological information indicates the lake was naturally greater than 60
  - For lakes with a mean color less than or equal to 40 PCU, the annual mean TSI for the lake exceeds 40 unless paleolimnological information indicates the lake was naturally greater than 40
- Lake Munson mean color is 65 PCU so a TSI of 60 would be the threshold for possible impairment

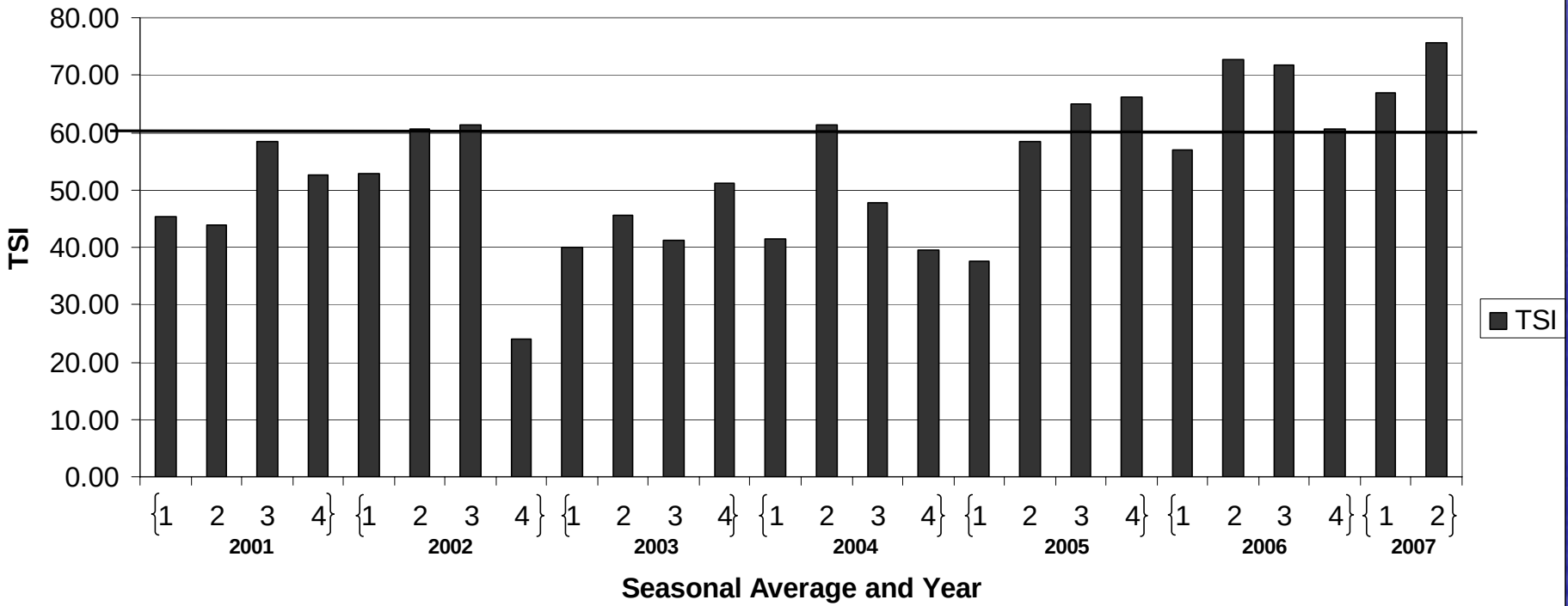
# FDEP Interpretation

- 0-59 good and fully able to support designated use
- 60-69 fair and partially supports designated use
- 70-100 poor and does not support designated use

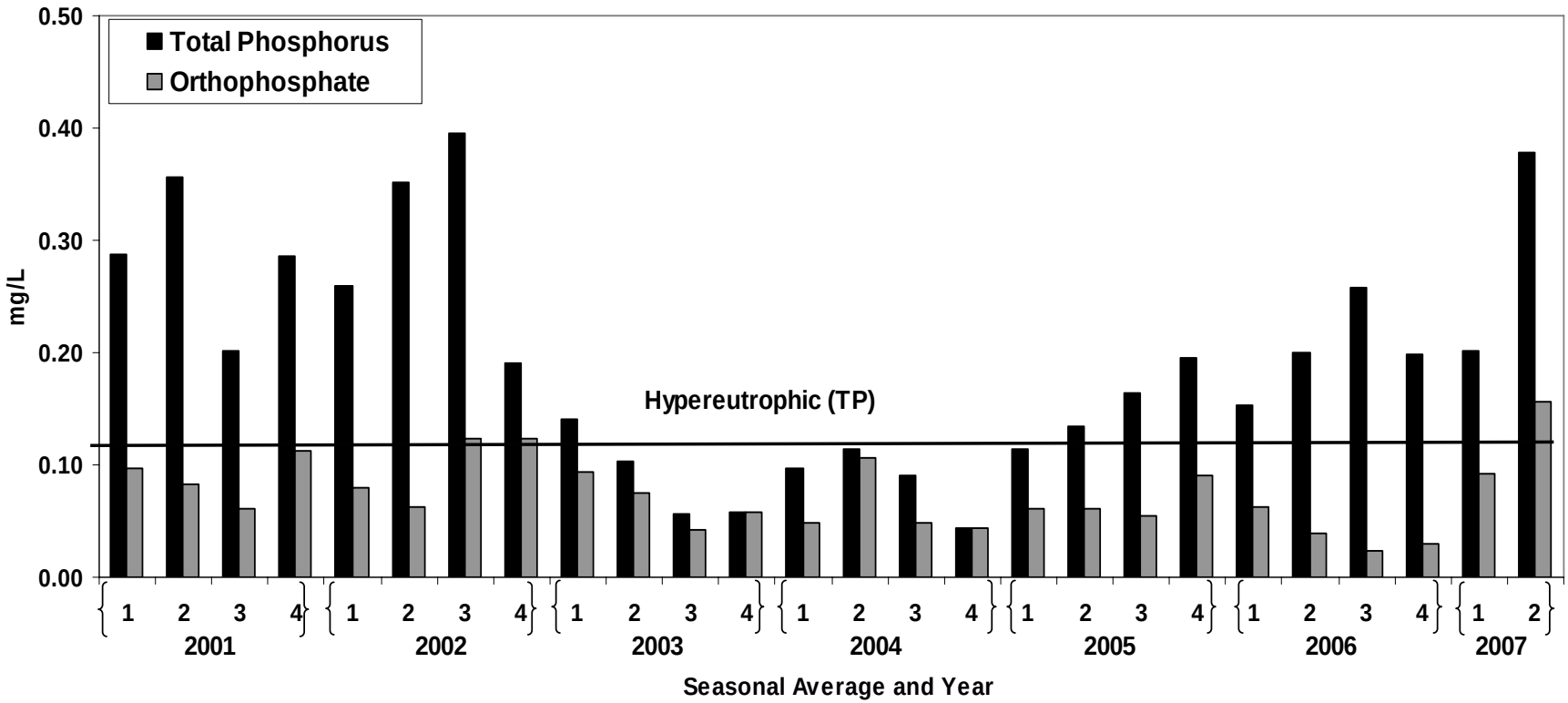
# Trophic State Index



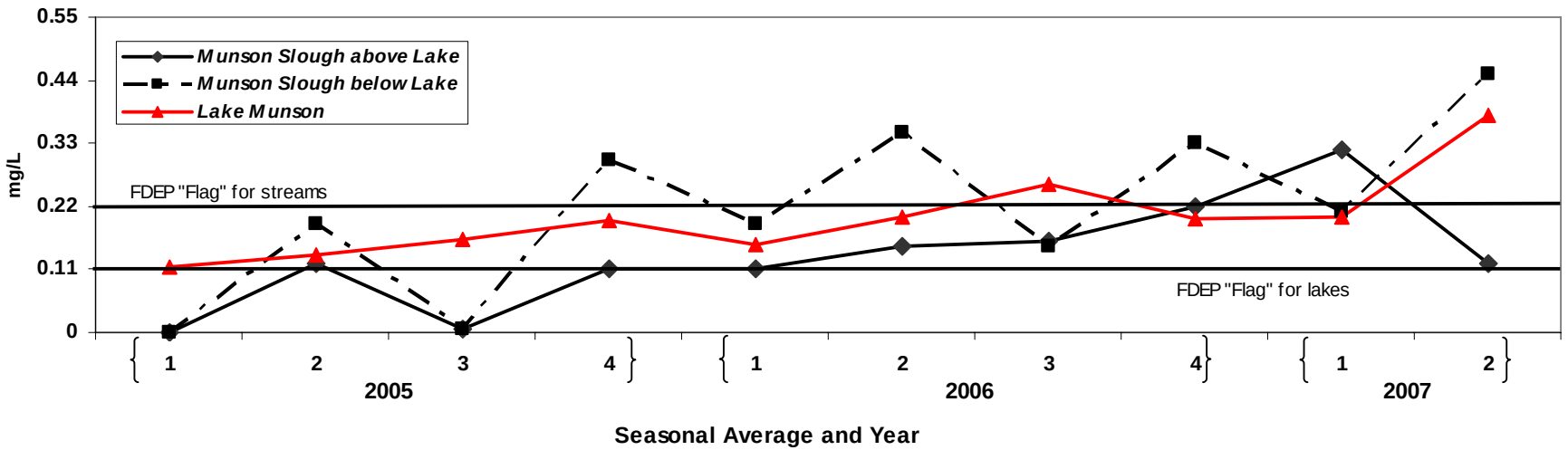
# Trophic State Index



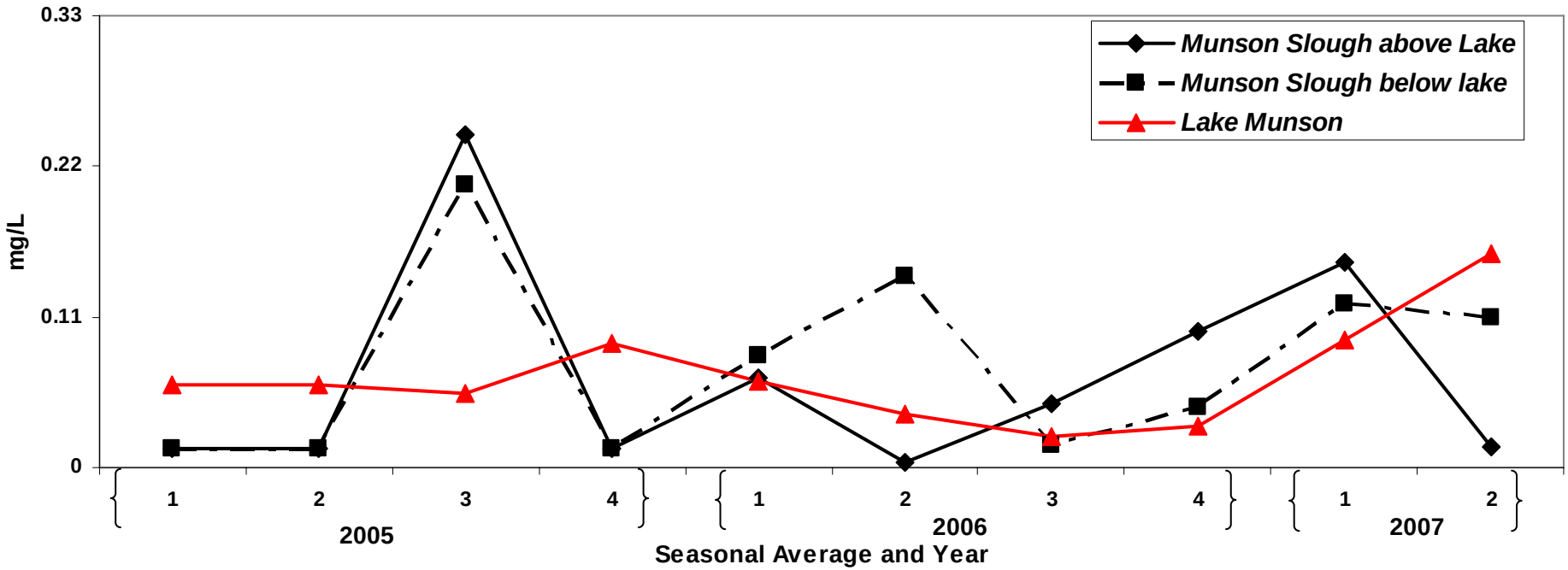
# Phosphorus


Total Phosphorus
Orthophosphate
0.50
0.40
0.30
0.20
0.10
0.00
mg/L
Hypereutrophic (TP)
1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2
2001
2002
2003
2004
2005
2006
2007
Seasonal Average and Year

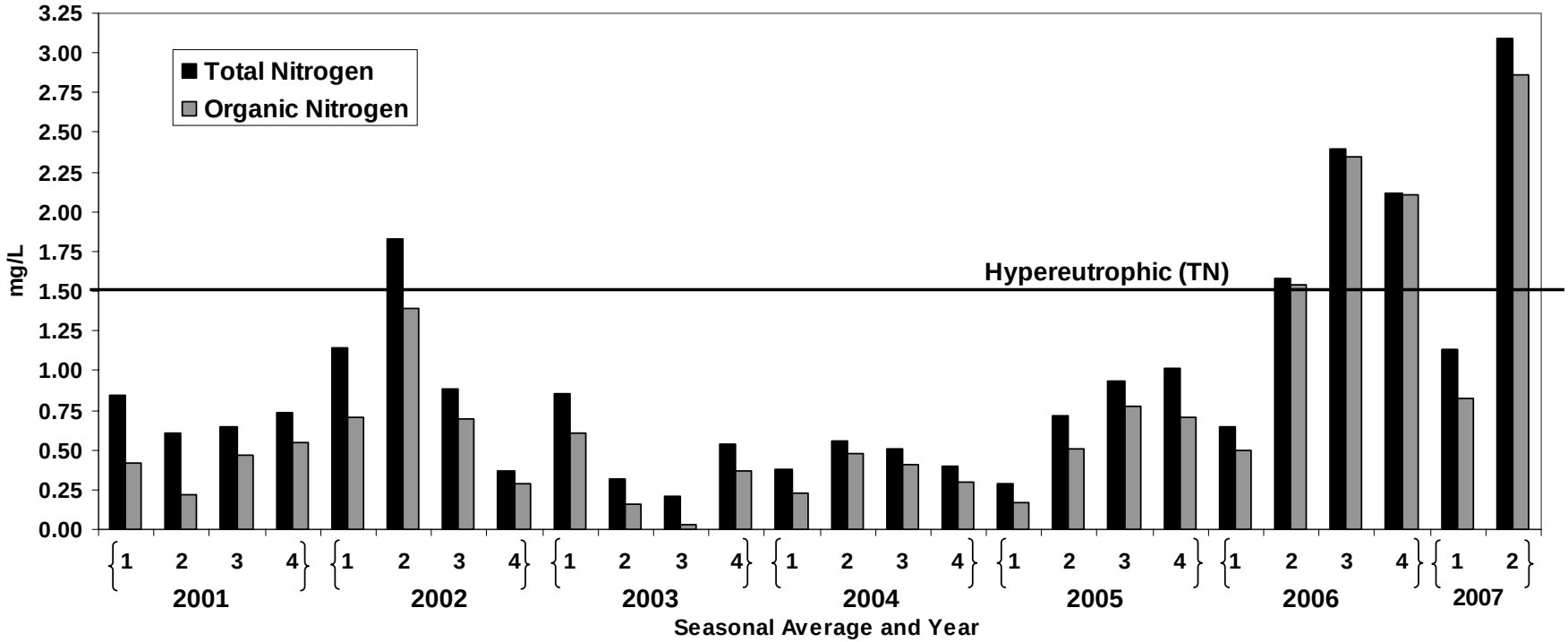
# Total Phosphorus



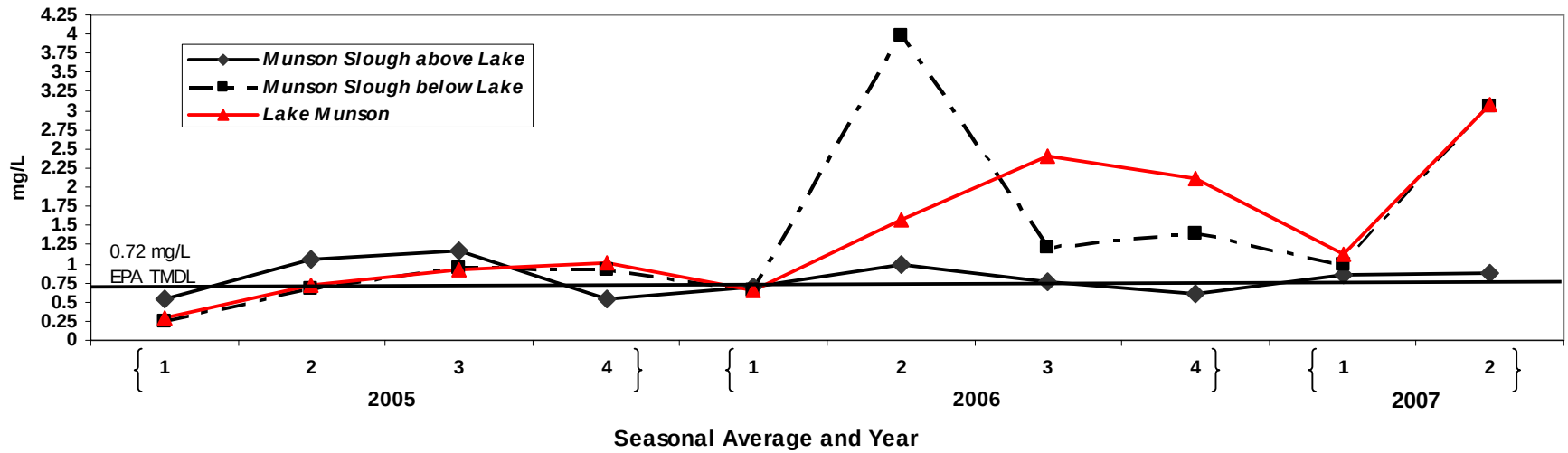
# Orthophosphate



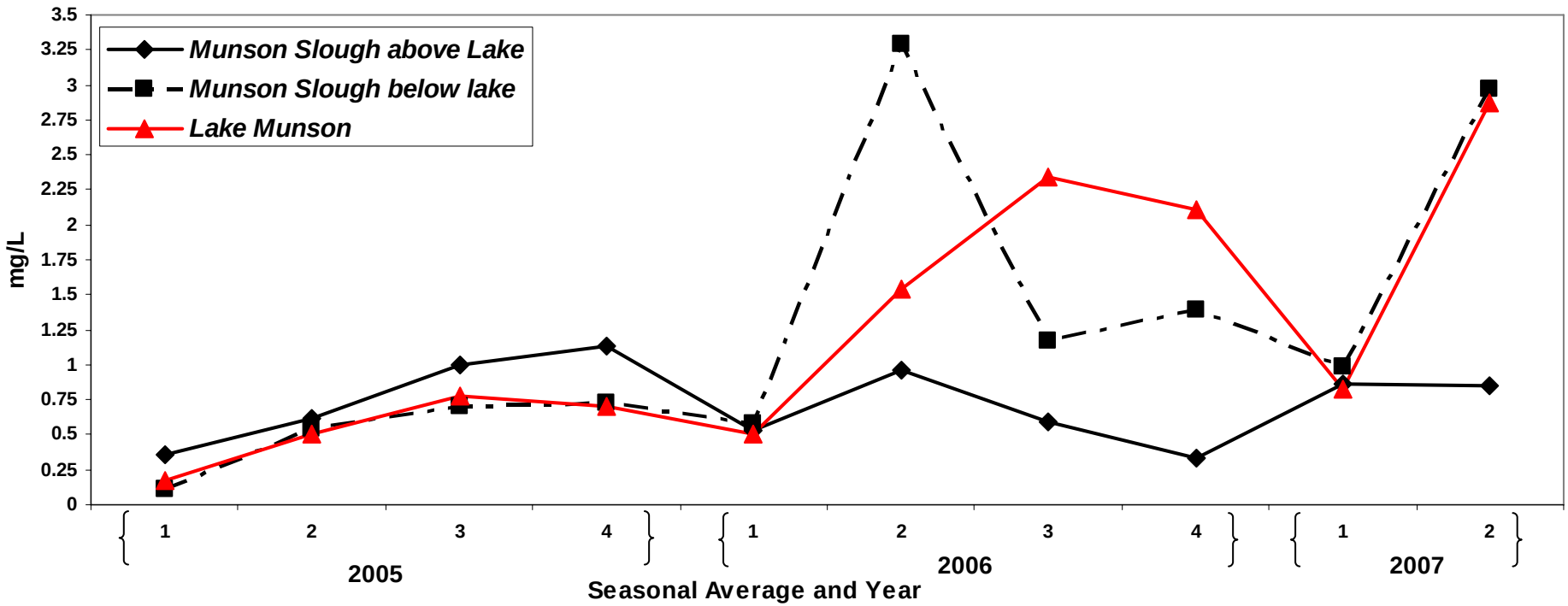
# Nitrogen


Total Nitrogen
Organic Nitrogen
Hypereutrophic (TN)
mg/L
3.25
3.00
2.75
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
1 2 3 4
2001
1 2 3 4
2002
1 2 3 4
2003
1 2 3 4
2004
1 2 3 4
2005
1 2 3 4
2006
1 2
2007
Seasonal Average and Year

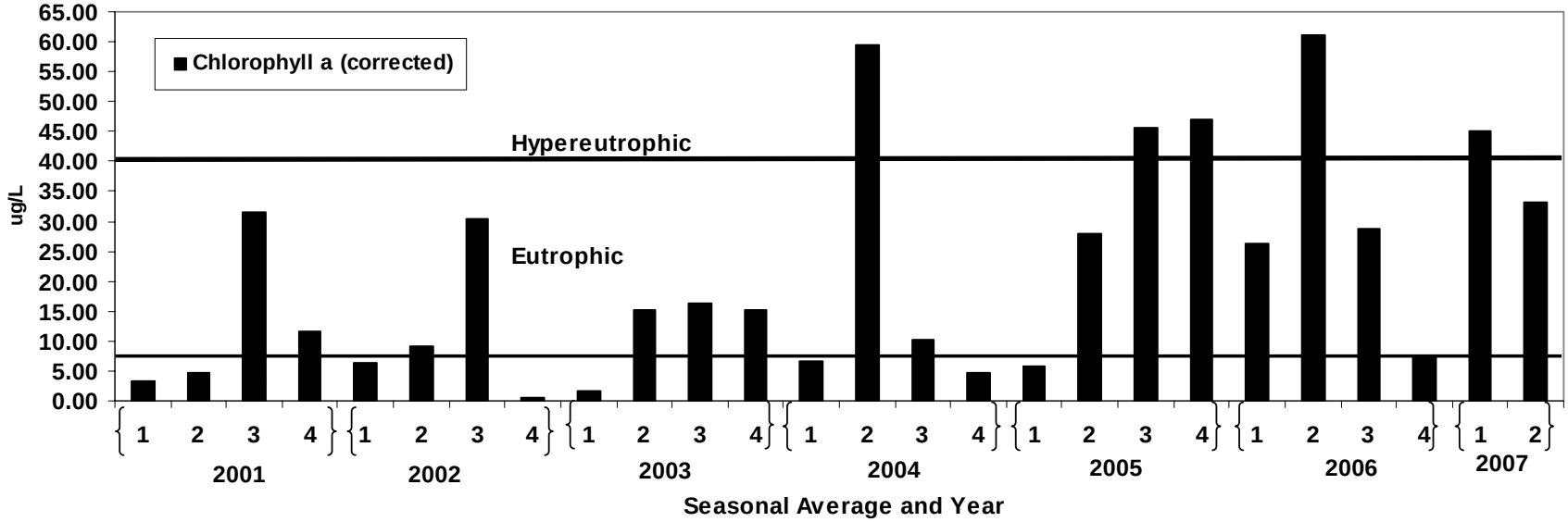
# Total Nitrogen



# Organic Nitrogen



# Lake Munson Chlorophyll a



# So what's happening in Lake Munson?

- There has been a shift from a vascular plant community to an algal community


2000

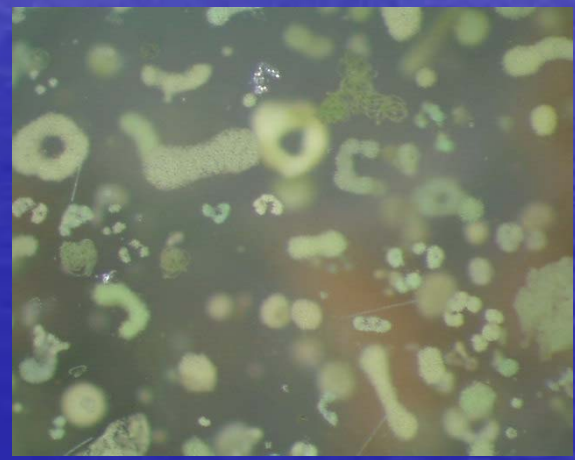

2007

# Algal Blooms

- An algal bloom is an overabundance of algae
  - Can block sunlight preventing light from reaching submersed plants
  - Can cause fish kills.  In FL, this is most likely to occur after several days of hot weather with overcast skies or after a heavy rain.

# Algal blooms cont.

- During the Lake Munson blooms the dominant species was
  - *Microcystis aeruginosa*
    - blue-green algae (cyanobacteria) that grows naturally in many surface waters. In most bodies of fresh water and most weather conditions it does not pose a hazard to wildlife or human beings.



- But . . . .

# *Microcystis aeruginosa*

- can produce natural toxins (called microcystins)
- microcystin toxins are produced and contained inside the *Microcystis* cells, and are released to the water when the cells die and disintegrate.
- Also, since the cells are very small, they can be ingested along with the water

# Effects of microcystin

- primary toxic effect of microcystins is on the liver.
- At very high doses, death of liver cells and destruction of blood vessels in the liver can result in serious injury and possibly death.

# Effects cont.

- Though less is known about the long-term effects of microcystin toxins, animal studies have shown these toxins can cause chronic liver damage and may promote the formation of liver tumors. These effects are more likely to occur if exposure is frequent over a long period of time.

# Other Effects

- Toxic effects to zooplankton, fish, other wildlife etc.
  - Can accumulate in fish organs (liver)
- Can possibly inhibit vascular plant growth

# Guidelines

- World Health Organization provisional guideline for drinking water standards is 1 µg/L
- Greenwater Labs reported 26.0 µg/L in Munson (10/5/06)
- But, keep in mind that the lake itself is not used for drinking water

# What is the best way to minimize health risks from blue-green algae?

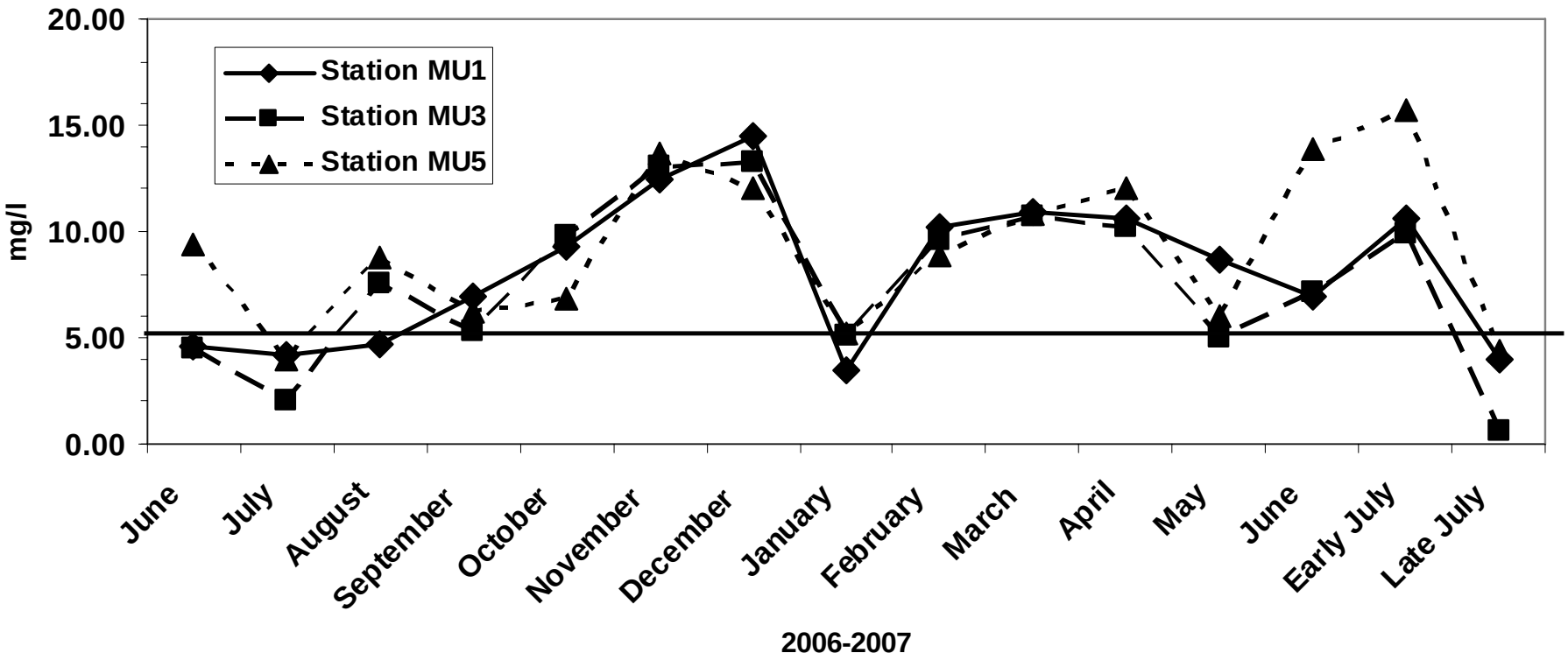
- Avoid body contact with blue-green algal blooms. This includes swimming, wading, water-skiing
- Don’t allow children or pets to play in or drink scummy water
- Do not water/jet ski over algae mats
- Do not use scummy water for cleaning or irrigation
- If you come into contact with a blue-green algae bloom wash thoroughly

# Algal blooms contribute to fish kills

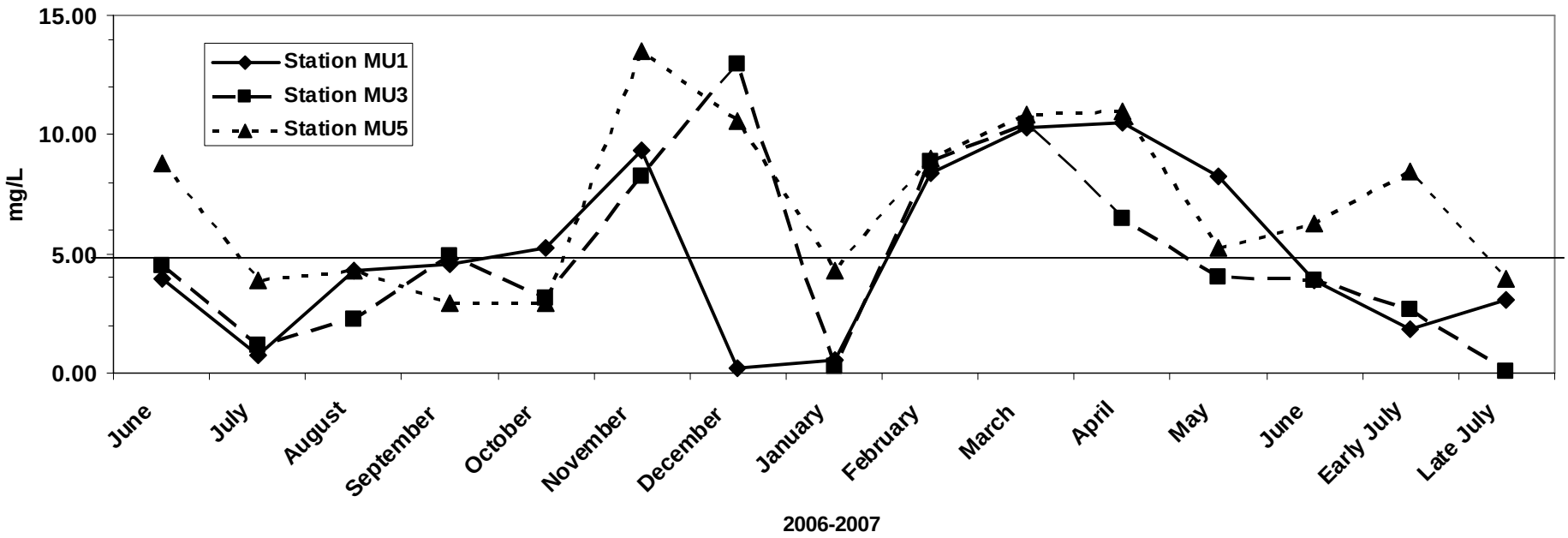
Fish Kill reported 11/28/06

- How does algal blooms kill fish?
  - Dissolved oxygen levels
    - Too high or too low

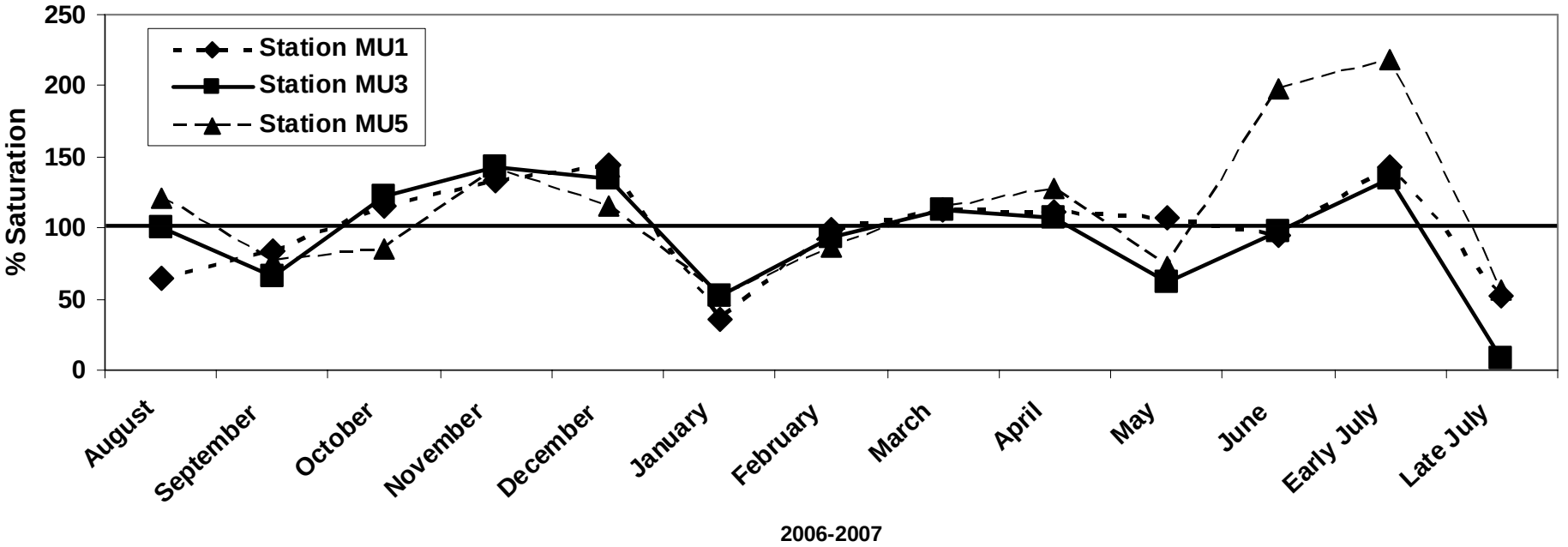
# Dissolved Oxygen (Surface)



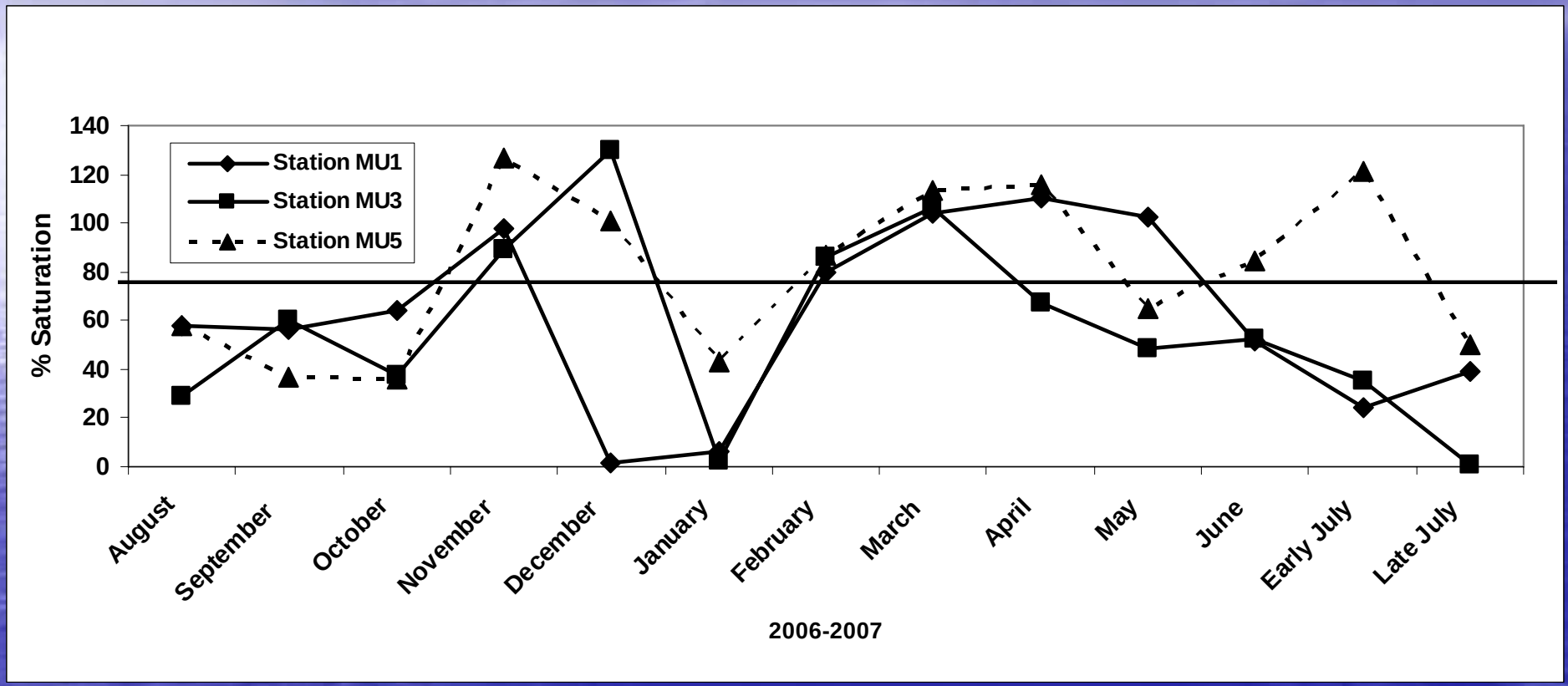
# Bottom


15.00
10.00
5.00
0.00
mg/L
Station MU1
Station MU3
Station MU5
June
July
August
September
October
November
December
January
February
March
April
May
June
Early July
Late July
2006-2007

# DO % Saturation (Surface)



# Bottom


140
120
100
80
60
40
20
0
% Saturation
Station MU1
Station MU3
Station MU5
August
September
October
November
December
January
February
March
April
May
June
Early July
Late July
2006-2007

# Algal toxins?

- While toxins produced by toxin producing algae have the potential to kill fish there are few cases that have been definitively linked to toxins

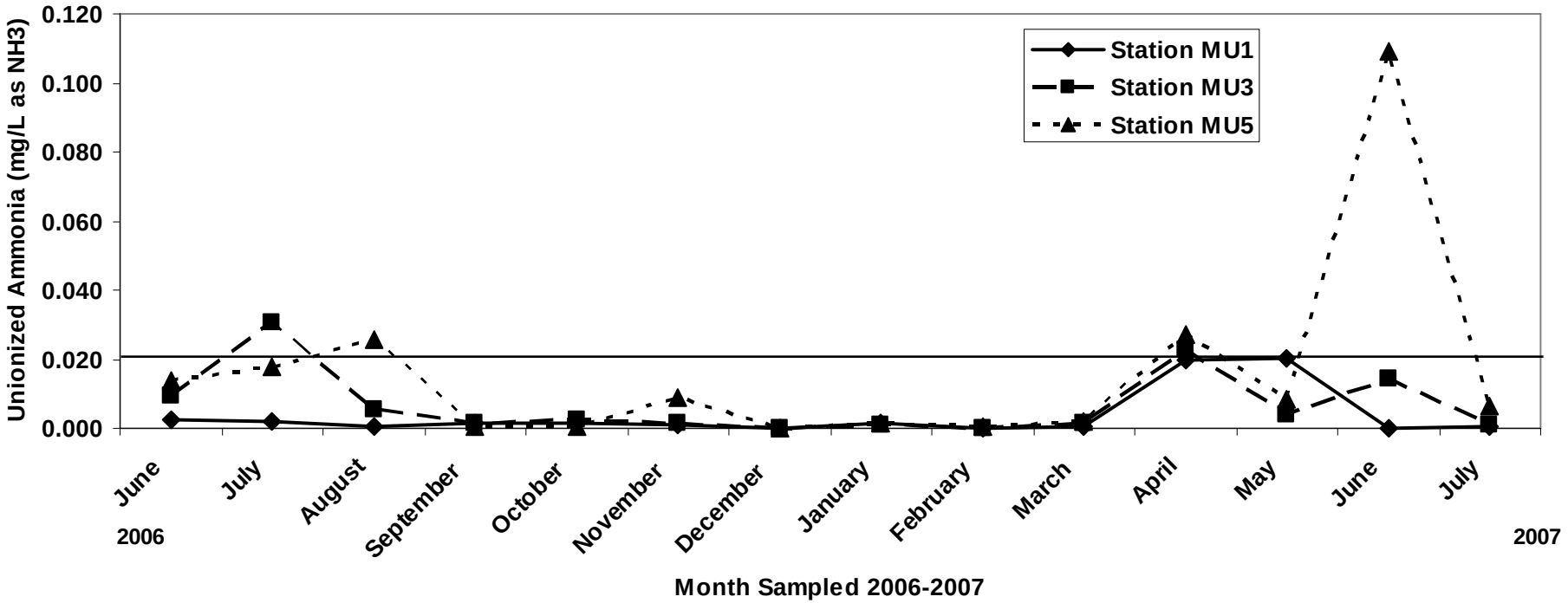
# Water Chemistry Changes

- Algal blooms causes pH to increase during daylight hours and decrease at night
  - Contributes to unionized ammonia toxicity

# Unionized ammonia

- Form of ammonia that is toxic to fish
- Water temperature and pH will affect which form of ammonia is predominant at any given time in an aquatic system
- FDEP limit is less than or equal to 0.02 mg/L as $NH_3$

# Unionized Ammonia Levels



# Finally,

- Drought followed by,
- Too much rain in a short period of time
  - Heavy rains tend to wash large amounts of organic material into lakes streams, etc.
  - Bacterial decompose the new material using oxygen much faster than normal
  - Can also cause water turnover

# But . . .

- These fish came out of Lake Munson

# So,

- The lake has gone from a vascular plant community to an algal community
- Fish Kill
- Upstream nutrients are lower than in lake nutrients
- Why has this happened? And how do we fix it?

# One suspect

Channeled Apple Snail

- ***Pomacea canaliculata*** **complex**

# *Pomacea canaliculata*

- Family Ampullariidae (= Pilidae)
  - Complex of five species (confirmed *insularum* in Leon County)
- shells globular, as much as 5 inches long (much larger than native *Pomacea*)
- brown, greenish, or yellowish in color, sometimes with longitudinal stripes
- introduced into FL from S. America as early as 1978; spread to many parts of the world
- serious agricultural pest of rice, taro, and other crops
- adaptable: tolerant of dessication, low DO, some salinity (to 8 ppt), eutrophication, etc.

# Potential environmental impacts

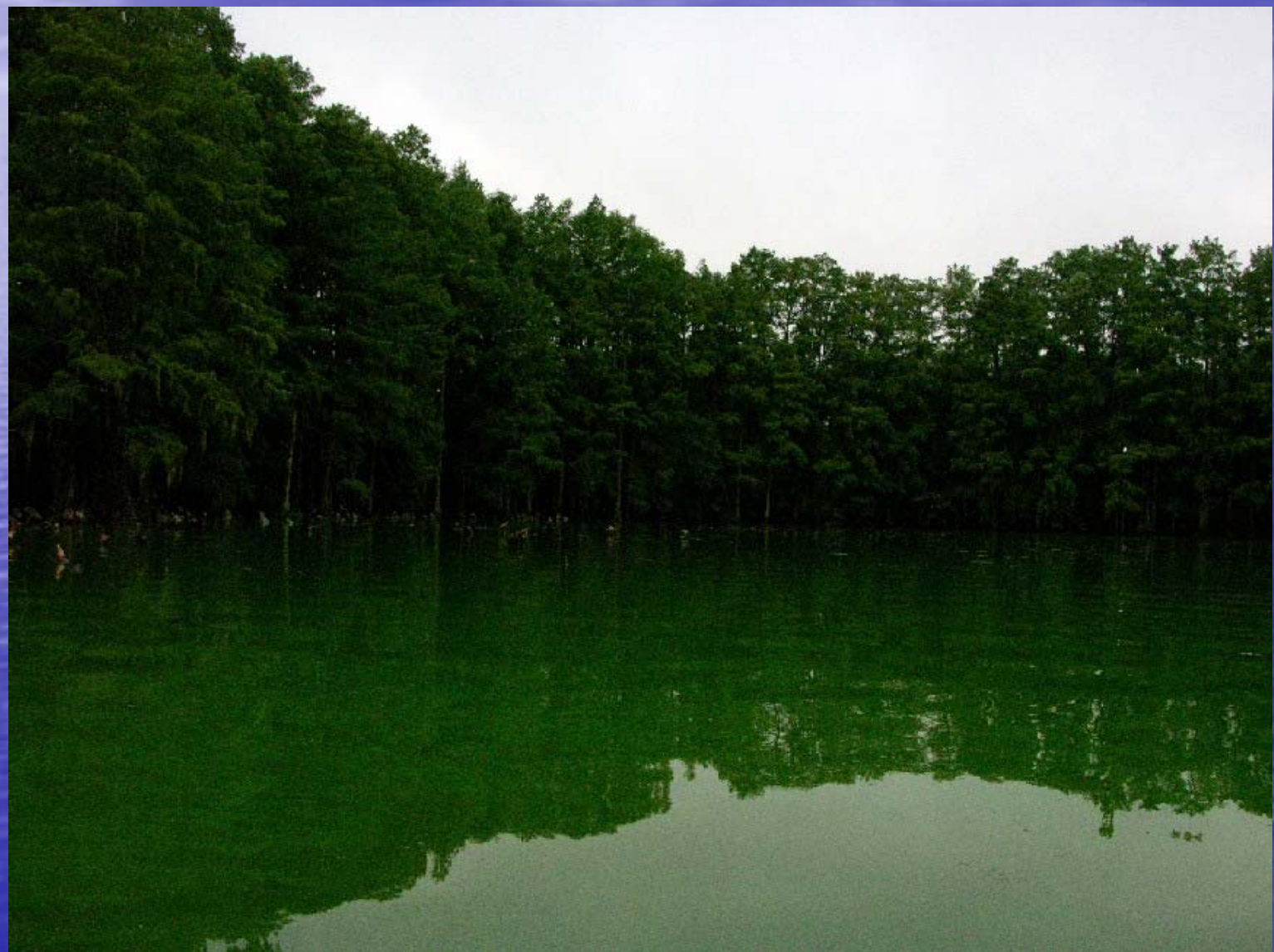
- reduction in macrophyte diversity
- habitat loss → reduced overall biodiversity
- outcompeting native species
- potential water quality deterioration
  - ✓ extensive macrophyte grazing
  - ✓ nutrient uptake by phytoplankton
  - ✓ proliferation of phytoplankton
  - ✓ oxygen sags
  - ✓ fish and invertebrate kills

# June 2006

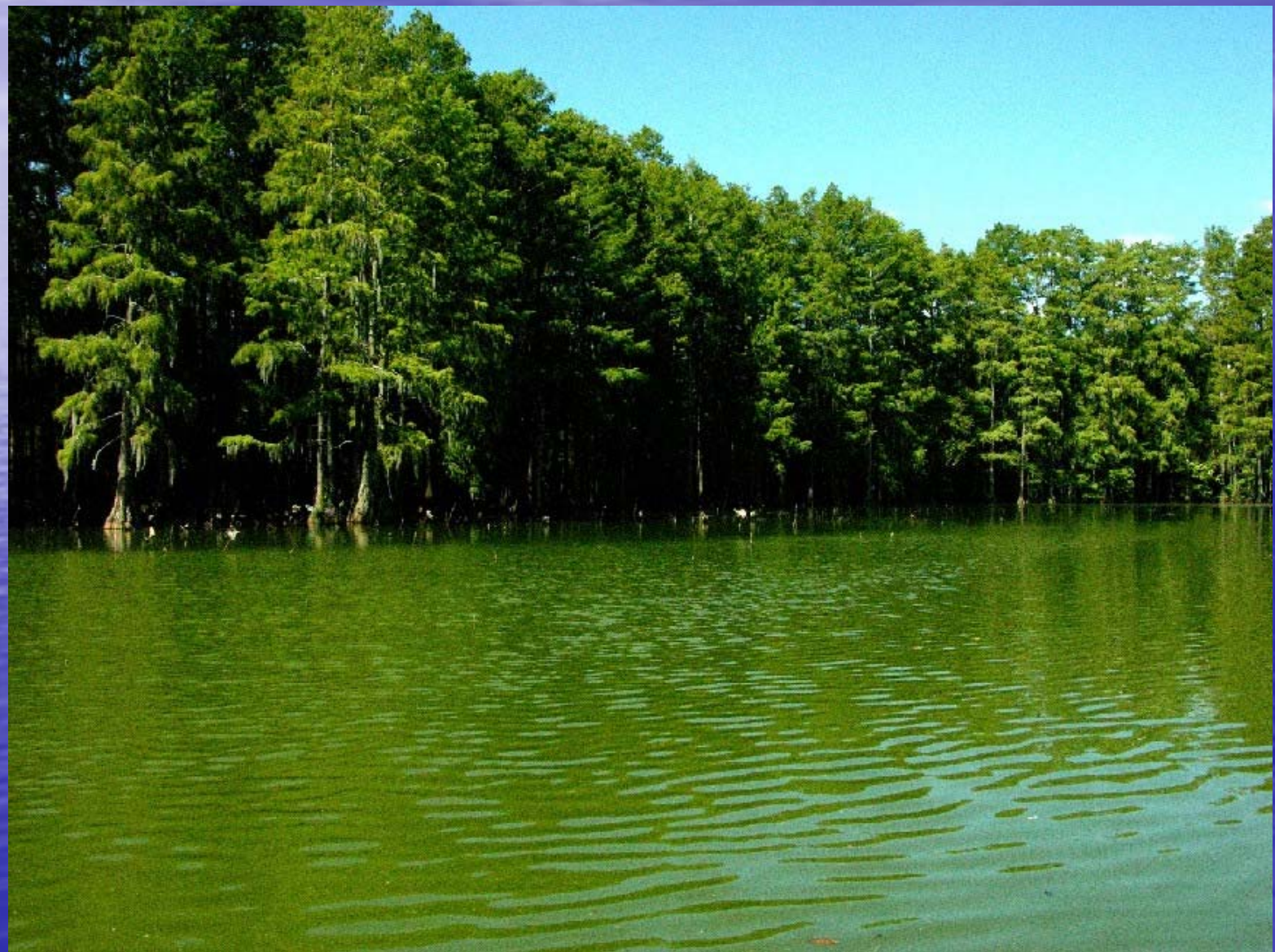
# July 2006

# August 2006

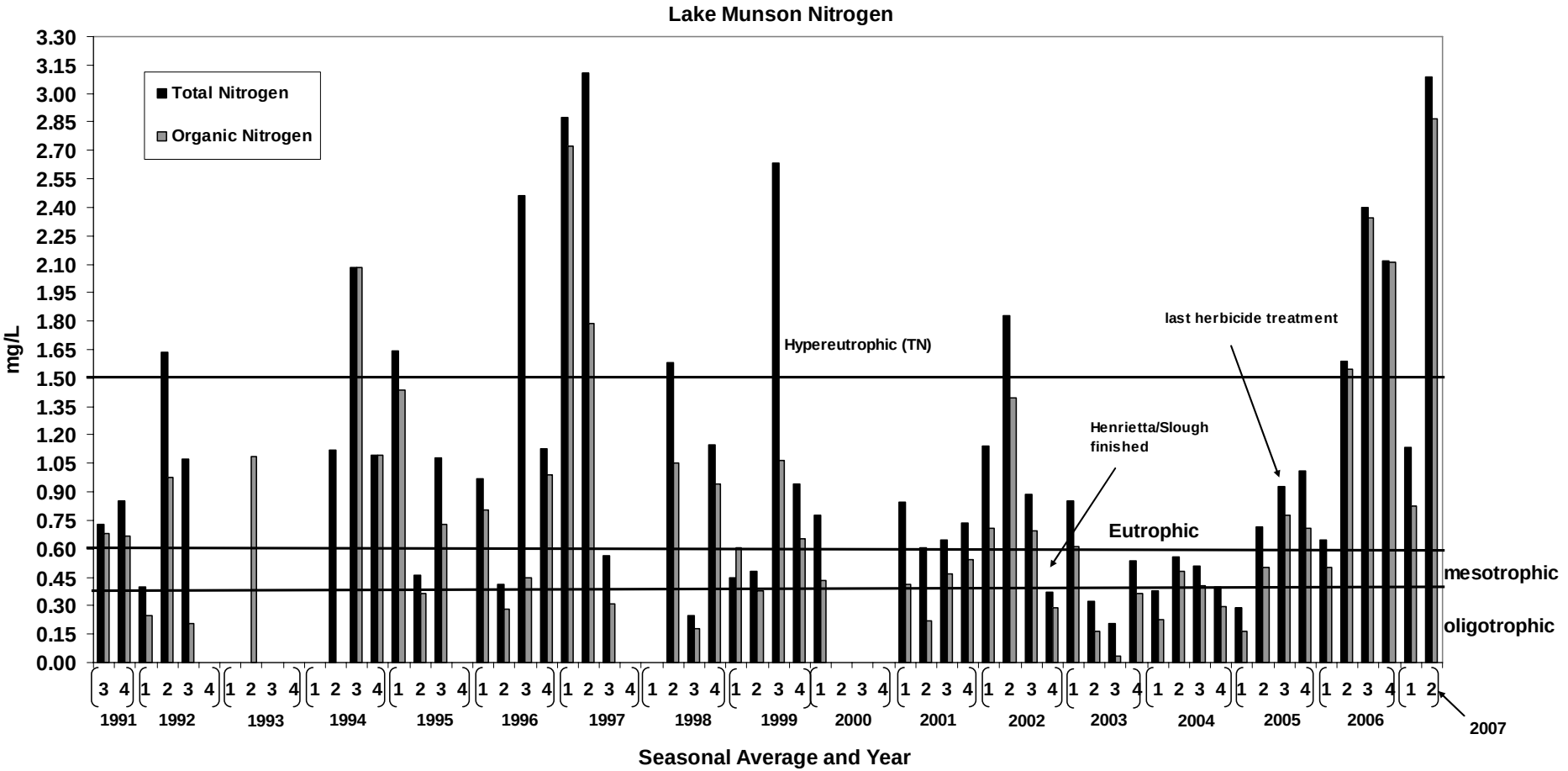
# September 2006



# October 2006



# Lake Munson over time



# Channeled apple snail facts

1. Can you eat them?

- Yes, **BUT**, they are an intermediate host for *Angiostrongylus cantonensis*, or rat lung worm, a nematode which can cause eosinophilic meningitis, a serious and occasionally fatal illness. Symptoms include severe headache, stiff neck, various paresthesias (prickly tingling or numbness in skin), potential facial paralysis, and, rarely, death.
- Have not been found in Channeled Apple Snails located in FL
- One infection recorded in U.S. (Louisiana)

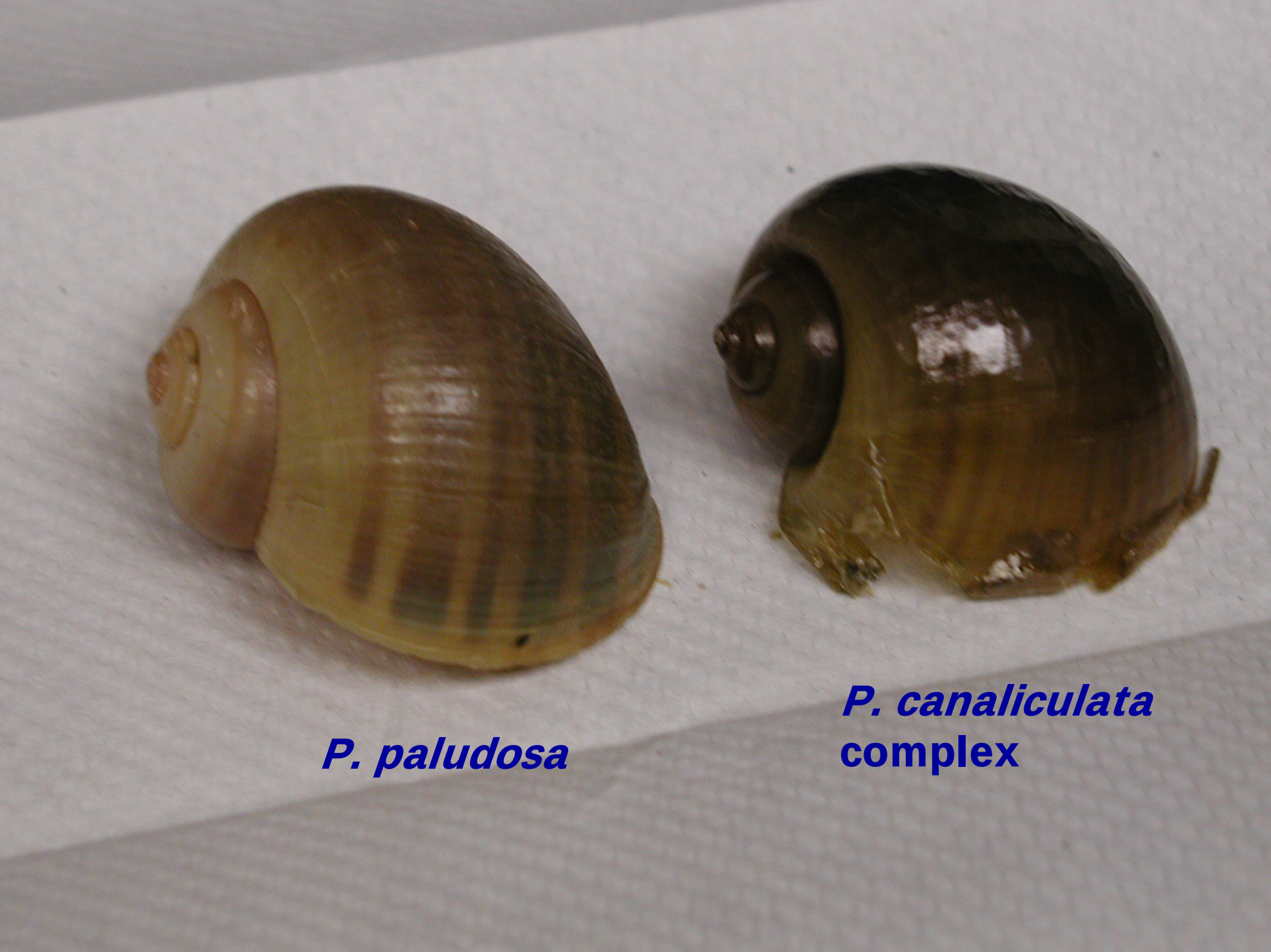
# Channeled apple snail facts

2. How can you tell the difference between channeled and native apple snails?

- channeled apple snails are bigger

# Channeled apple snails are BIGGER

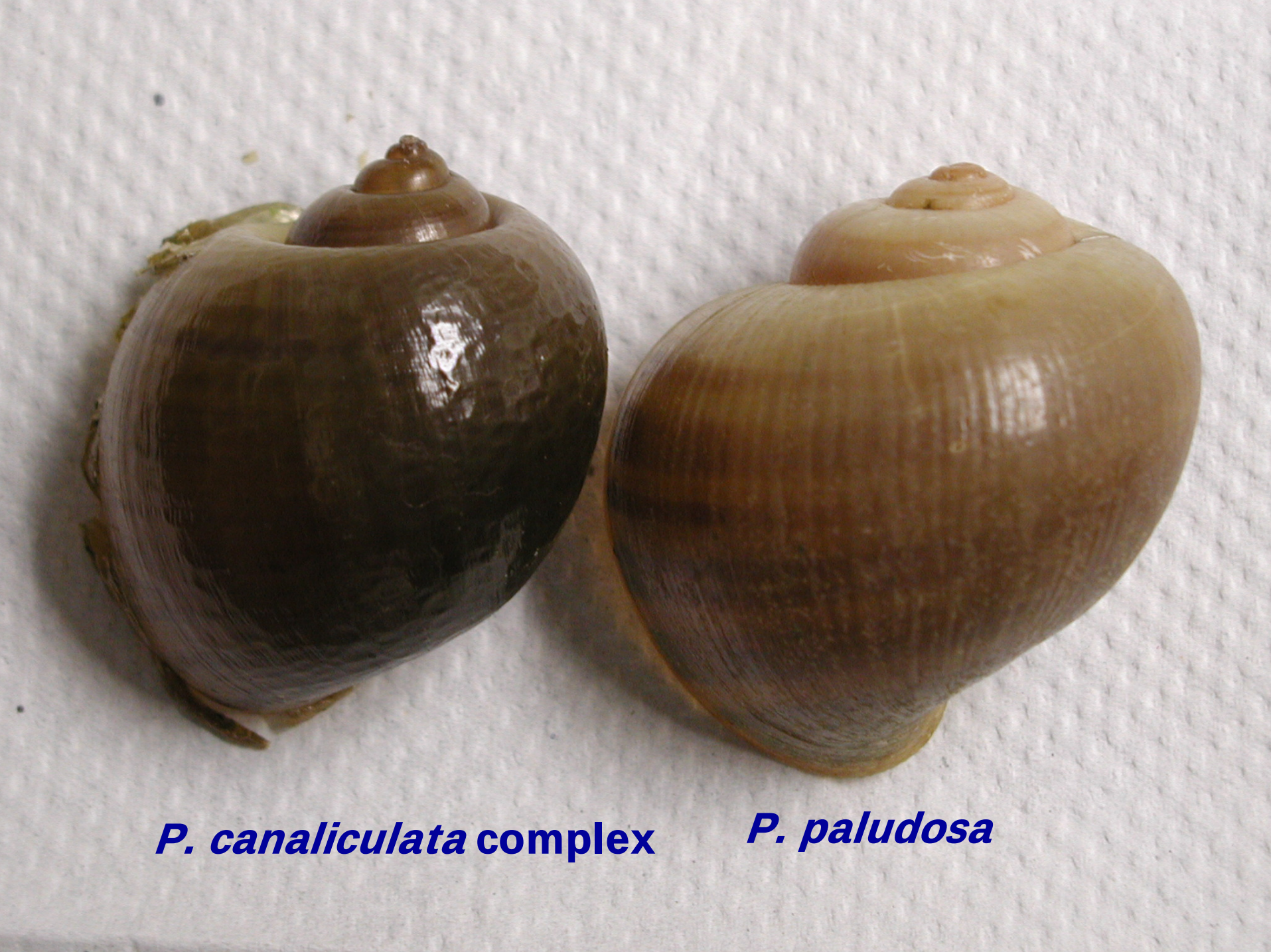
but....


P. paludosa
P. canaliculata
complex

# Channeled apple snail FAQs

3. How can you tell the difference between channeled and native apple snails?

- channeled apple snails are bigger
- channeled apple snails have a groove (channel) between the whorls


*P. canaliculata* complex
*P. paludosa*

# Channeled apple snail FAQs

3. How can you tell the difference between channeled and native apple snails?

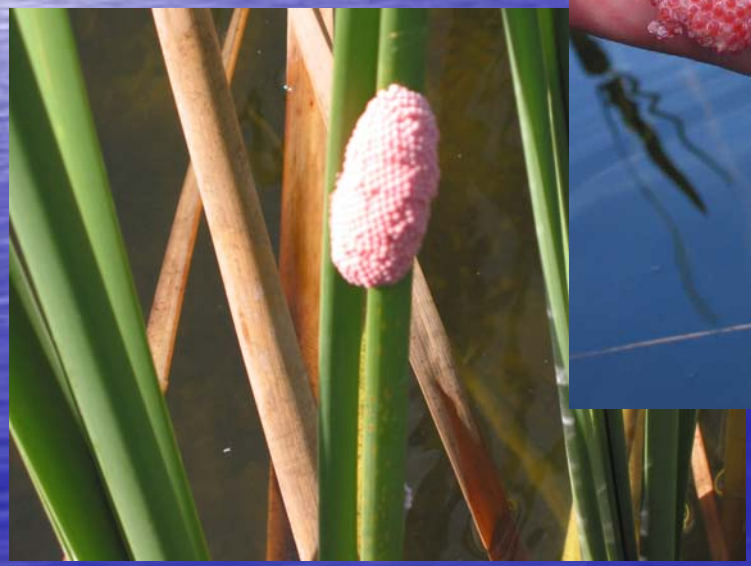
- channeled apple snails are bigger
- channeled apple snails have a groove (channel) between the whorls
- their eggs are very different

# Their eggs are different

- Channeled apple snail eggs very small, numerous, bright pink

- Native apple snail eggs larger, fewer, and white or light pink

***Pomacea canaliculata*** **complex eggs ↓**



***Pomacea paludosa*** **↑ eggs**

# Channeled apple snail FAQs

4. How can we get rid of them?

-- We probably can't. --

- **molluscicides** – high cost and non-target mortality
- **predators** – some present, but not enough to substantially effect snail populations
- **physical removal** – will help somewhat (esp. eggs), but probably of limited effectiveness

# Sediments

- Net burial of nutrient laden sediments has occurred for over 50 years
- Estimated 900 tons of phosphorus in the first foot of sediment (Bartel, 1992)
- May contribute up to 40% of the phosphorus concentration of the lake (Bartel, 1992)

# Sediments, cont.

- The bottom sediments are also poor substrate for
  - Plants
    - Stable Substrate for growth
  - Animals
    - Lack of spawning sites
    - Fluctuating dissolved oxygen levels
    - Limited plant community

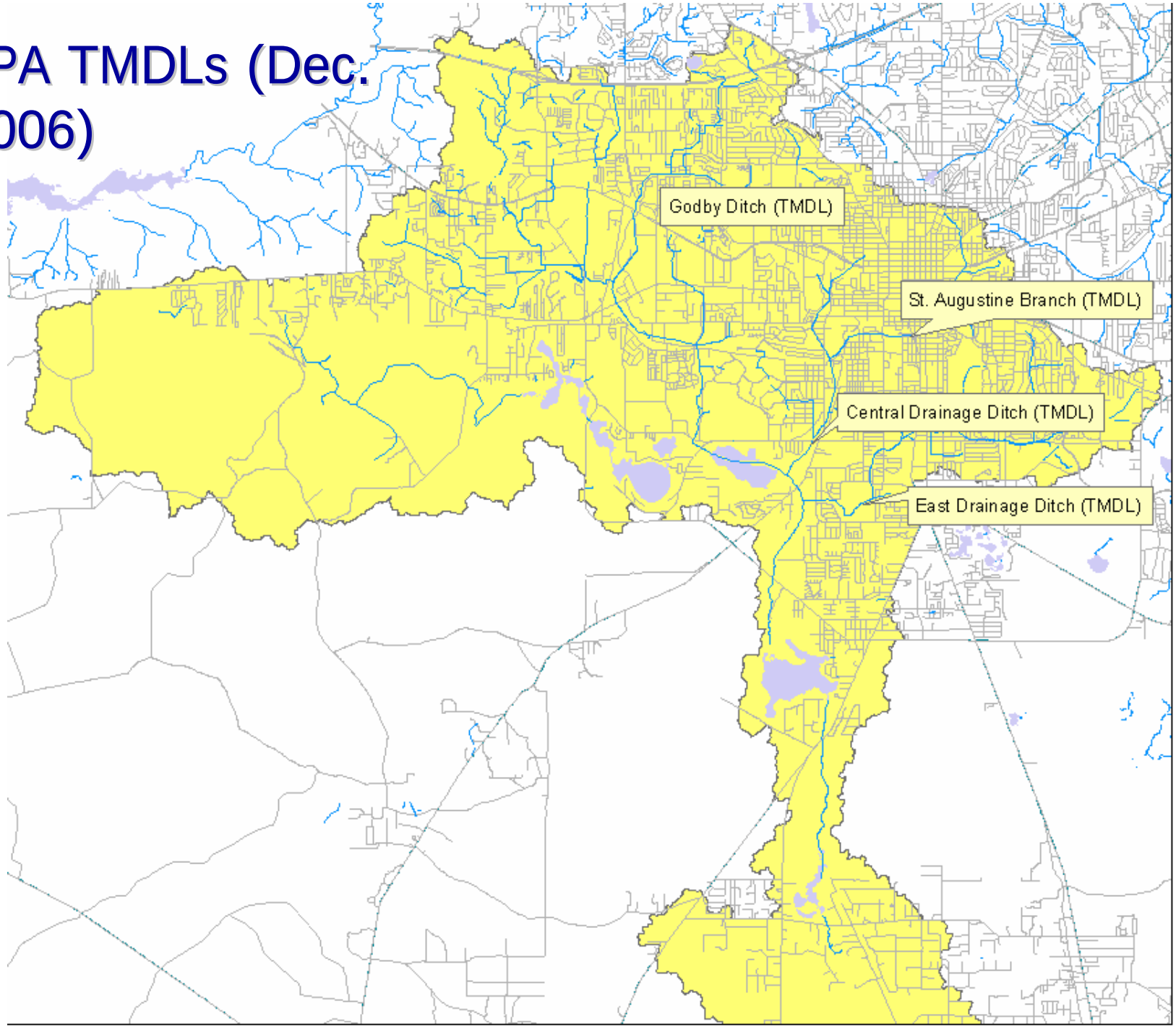
# By removing the sediments

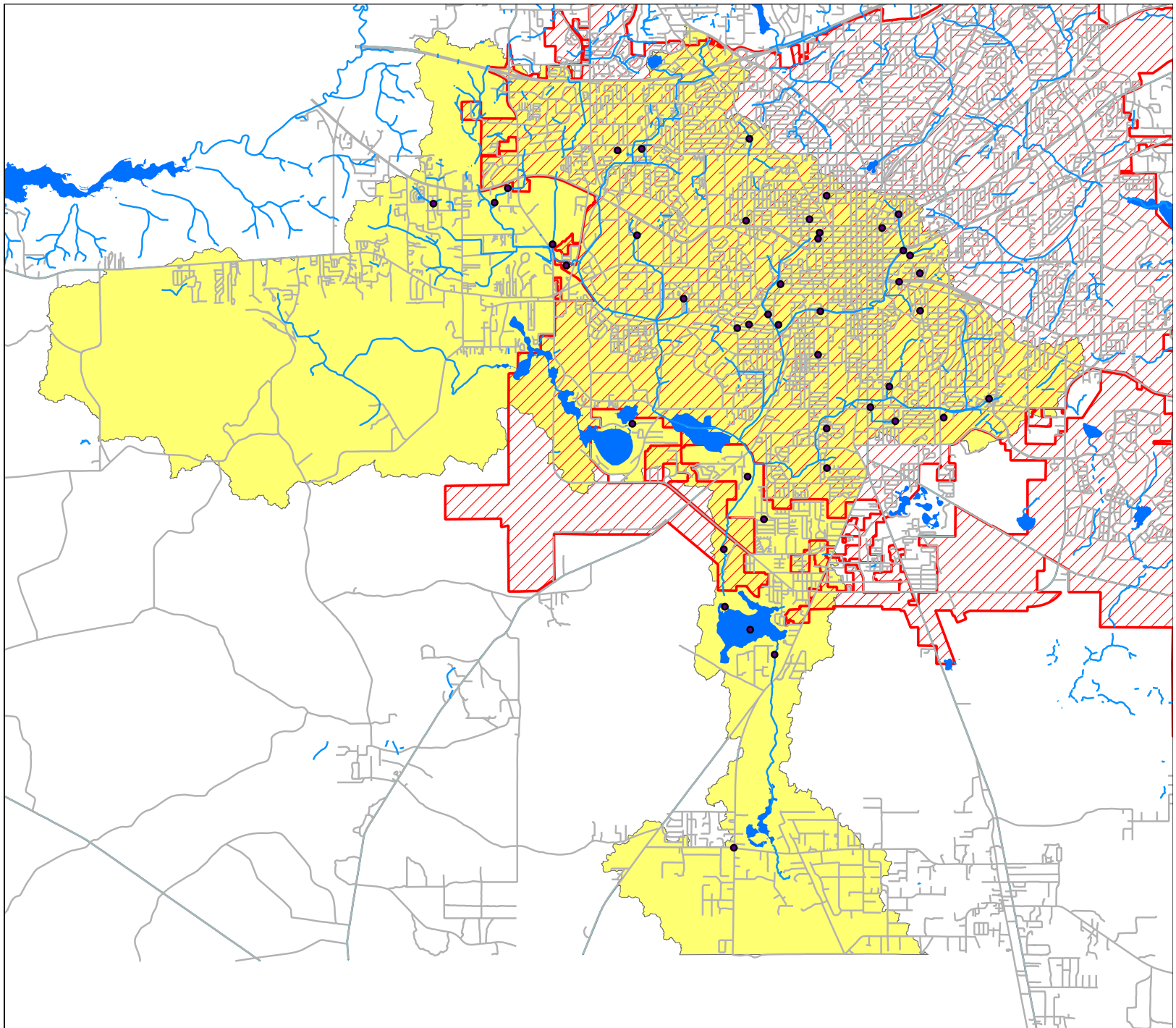
- Regain lost lake volume and depth
- Improve water quality by the control of internally released nutrients
- Improve lake substrate
- Remove possible toxic substances

# Further reduction of upstream nutrient loadings

- EPA and FDEP's TMDL programs
- EPA TMDLs (late 2006) on four tribs. entering Munson Slough
- Munson Slough and Lake Munson should have TMDLs next year (2008) (nutrients)

- EPA TMDLs (Dec. 2006)





# Further Research

- Apple Snails - eradication efforts
- *Microcystis aeruginosa* – Vascular plant toxicity?
- Restoration efforts – “Best bang for the buck”
- Continued sampling of Munson Slough and Lake Munson

# Information

- Leon Water Quality Database

http://www.leoncountyfl.gov/pubworks/Engineering/Stormwater_Management/LakeData.asp

# Contact

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  Richardsonjo@leoncountyfl.gov
  (850) 606-1500