Water quality, *P. parvum* and fecal coliform monitoring for Lake Granbury, TX

Support from
2006/07 congressional earmark

Championed by
Rep. Chet Edwards

Leading Institutions
Texas A&M University
University of Texas at Arlington
Baylor University

Collaborators
Texas Water Research Institute
Brazos River Authority
Texas Parks and Wildlife

Water quality, *P. parvum* and fecal coliform monitoring for Lake Granbury, TX

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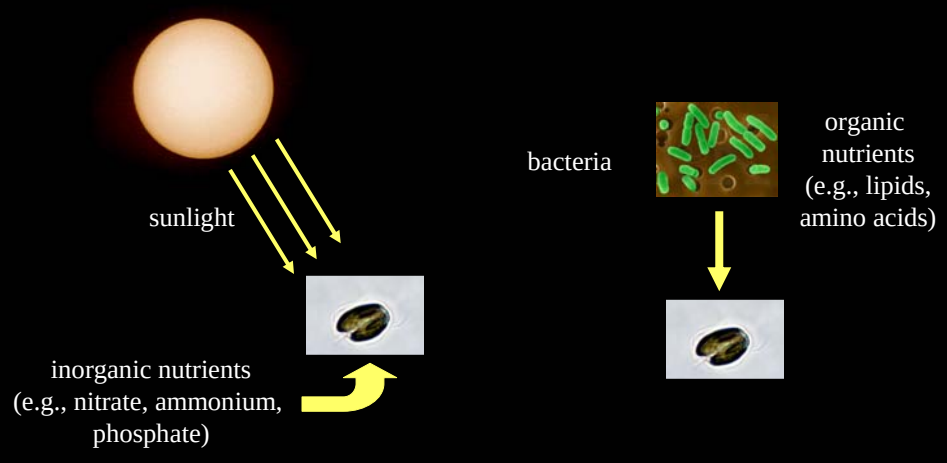
Prymnesium parvum: life as a mixotroph

TAMU, UTA, BU



life as a plant

life as a animal

Prymnesium parvum blooms (golden algae)

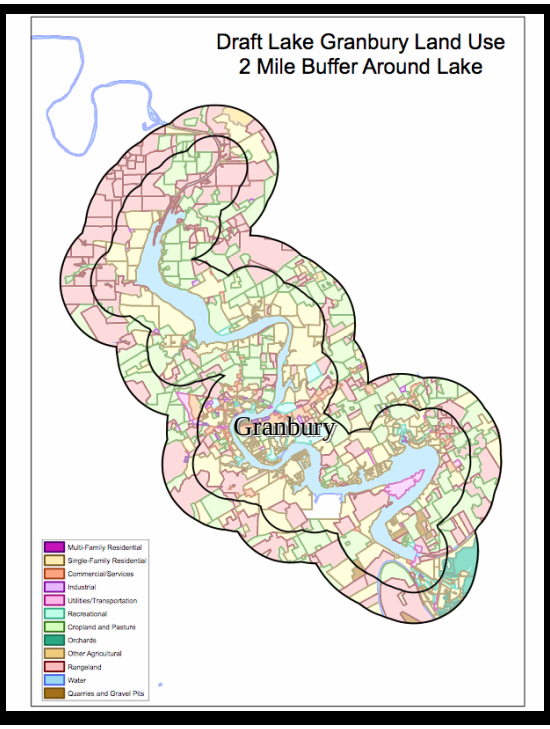
TAMU, UTA, BU

Prymnesium parvum blooms (golden algae)

TAMU, UTA, BU

Dead Fish from Golden Algal Bloom in Lake Granbury

Pat and Dan Loomis

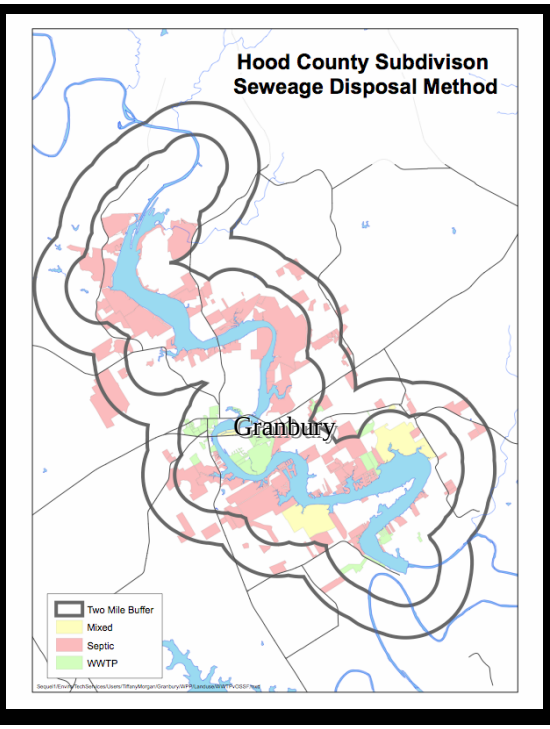


Lake Granbury, TX: Land use

TAMU, UTA, BU

- Well developed shoreline

- Brazos River Authority

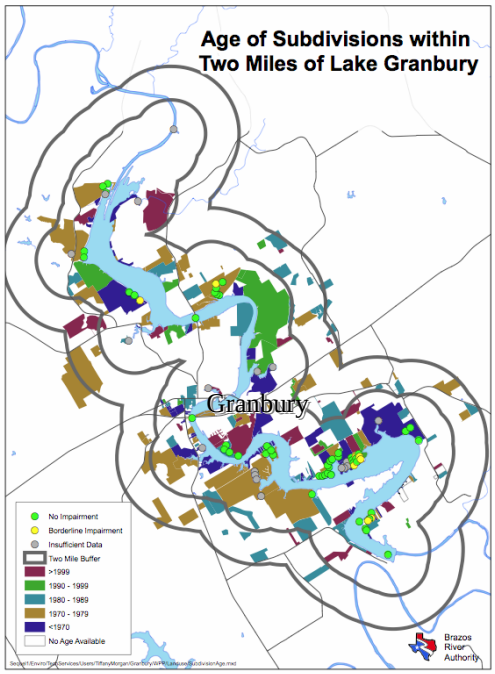


Lake Granbury, TX: Waste disposal

TAMU, UTA, BU

- Septic systems are common

- Brazos River Authority

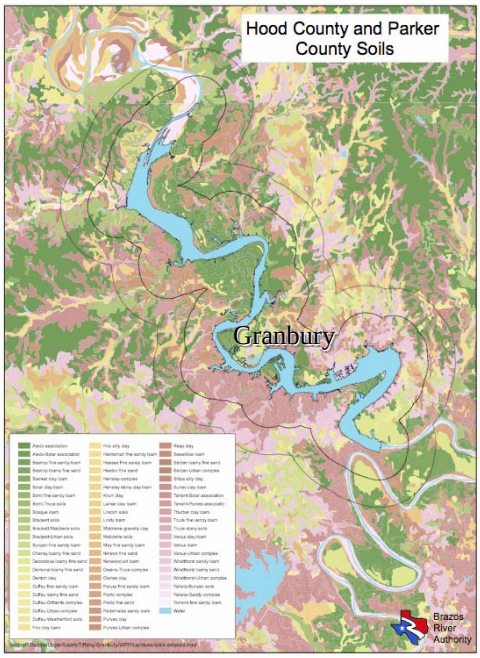


Lake Granbury, TX: Development history

TAMU, UTA, BU

- Impaired sites correspond with older developed areas

- Brazos River Authority

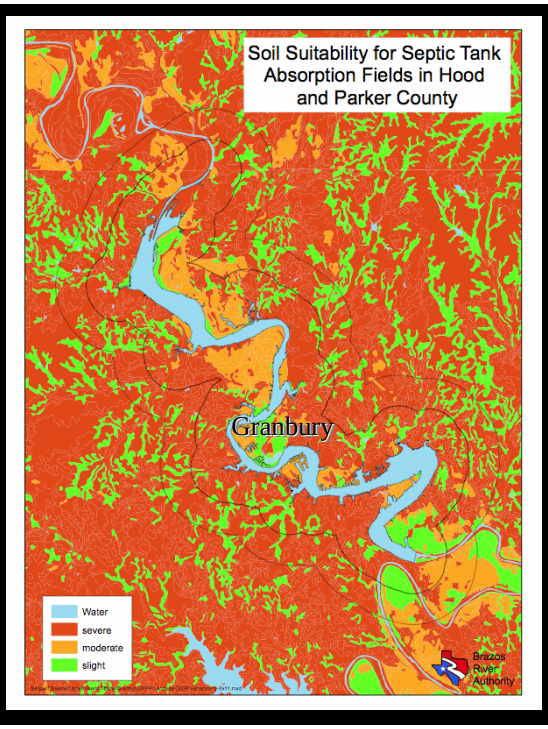


Lake Granbury, TX: Soil types

TAMU, UTA, BU

- Knowledge of soil types extensive
- Enables modeling and prediction of landscape response

- Brazos River Authority



Lake Granbury, TX: Risk

TAMU, UTA, BU

- Not the best substrate for septic systems

- Brazos River Authority

Lake Granbury, TX: Water quality questions

TAMU, UTA, BU

- What causes and terminates golden algae blooms?
- Are golden algae and *E. coli* problems linked?
- Might “leaky” septic systems play a role?

Research approach

TAMU, UTA, BU

1. In-lake monitoring
   - fixed-station sampling
   - high-resolution spatial mapping
2. Direct measurements of toxicity
   - bioassays using a fish
   - bioassays using a crustacean

1. In-lake monitoring: Fixed-stations

TAMU, UTA, BU

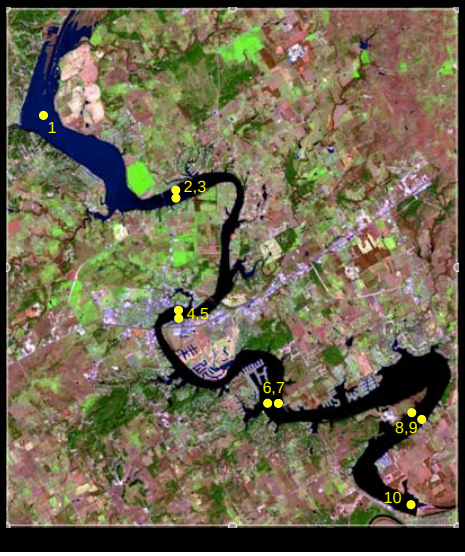
Ten locations

#1 Head of reservoir

#2, 3
#4, 5
#6, 7
#8, 9

Paired-stations (shallow and deep)

#10 Dam



1. In-lake monitoring: Fixed-stations

TAMU, UTA, BU

Parameters sampled

P. parvum
E. coli
Fecal coliform
Dissolved org.-carbon
Toxicity

Chlorophyll *a*
Phytoplankton composition
Zooplankton composition
Total bacteria

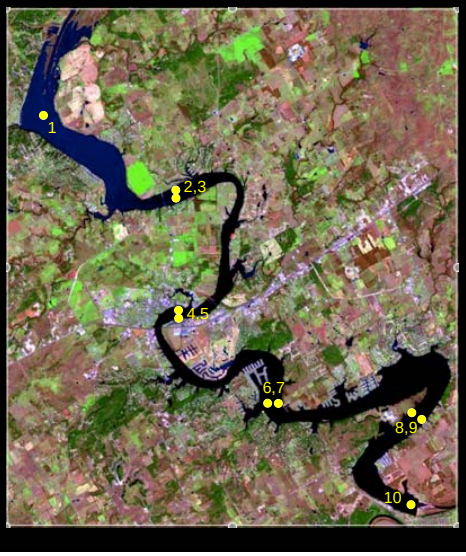
1. In-lake monitoring: Fixed-stations

TAMU, UTA, BU

Parameters sampled

Nutrients
- Nitrate/nitrite
- Ammonium
- Phosphate
- Total nitrogen
- Total phosphorus

Light
- Transmission
- Secchi depth



1. In-lake monitoring: Fixed-stations

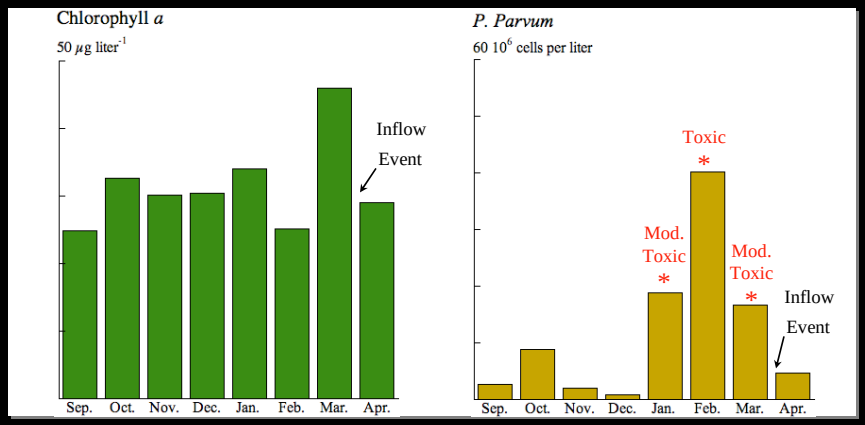
TAMU, UTA, BU

Parameters sampled

Temperature
Salinity
Dissolved oxygen
pH
Total suspended solids
Oxidation-Reduction Potential

1. In-lake monitoring: Fixed-stations

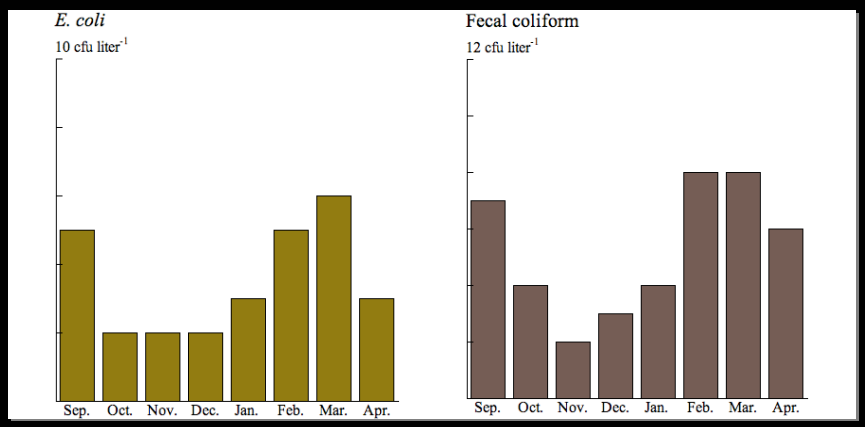
TAMU, UTA, BU



"Upper" Lake Granbury - Representative trends

1. In-lake monitoring: Fixed-stations

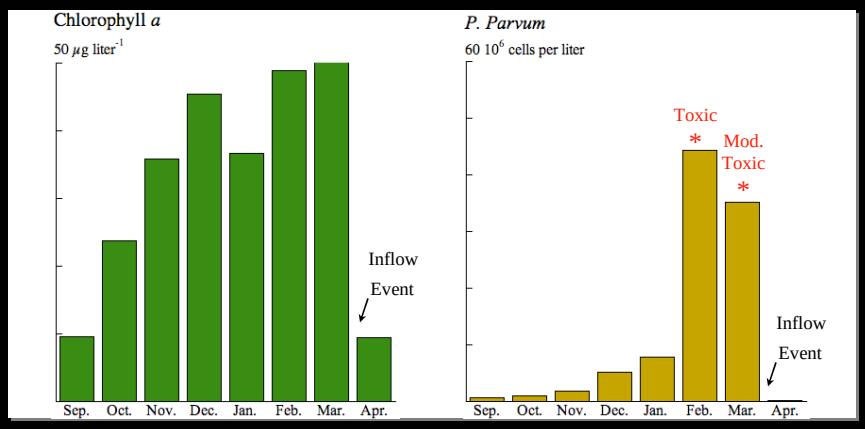
TAMU, UTA, BU



"Upper" Lake Granbury - Representative trends

1. In-lake monitoring: Fixed-stations

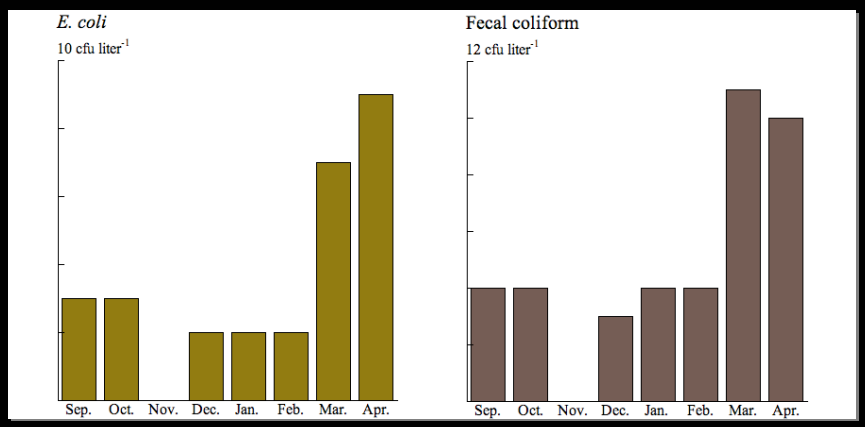
TAMU, UTA, BU



"Lower" Lake Granbury - Representative trends

1. In-lake monitoring: Fixed-stations

TAMU, UTA, BU



"Lower" Lake Granbury - Representative trends

1. In-lake monitoring: Fixed-stations

TAMU, UTA, BU

Persistent phytoplankton biomass, and golden algal bloom/termination

Growing phytoplankton biomass and golden algal bloom/termination

2. Direct measurements of toxicity

TAMU, UTA, BU

Coal miners used canaries to signal if there was a problem in the mine shaft

Similarly, we use sensitive organisms to signal if toxic *P. parvum* blooms occur

Daphnia magna
- A "water flea"

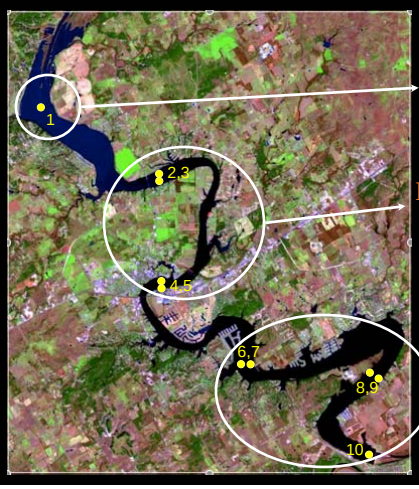
Pimephales promelas
- A common minnow

2. Direct measurements of toxicity

TAMU, UTA, BU

Fish Biosensor Responses to the January 2007 Toxic Bloom

Site Number	LC50
1	>100%
2	~64%
3	~60%
4	~70%
5	~76%
6	>100%
7	>100%
8	>100%
9	>100%
10	>100%



Not Toxic

Moderately Toxic

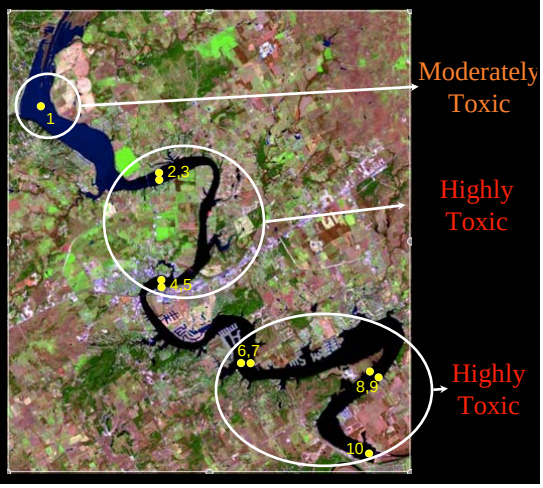
Not Toxic

2. Direct measurements of toxicity

TAMU, UTA, BU

Fish Biosensor Responses to the February 2007 Toxic Bloom

Site Number	LC50
1	~57%
2	~4%
3	~4%
4	~3%
5	~6%
6	~17%
7	~22%
8	~35%
9	~58%
10	~21%

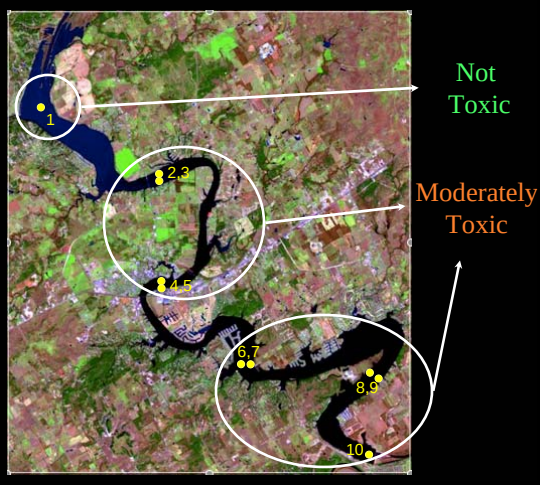


2. Direct measurements of toxicity

TAMU, UTA, BU

Fish Biosensor Responses to the March 2007 Toxic Bloom

Site Number	LC50
1	>100%
2	~75%
3	>100%
4	~38%
5	~41%
6	>100%
7	~71%
8	~53%
9	~59%
10	~64%

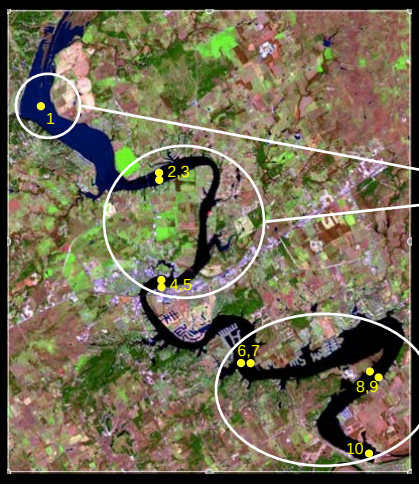


2. Direct measurements of toxicity

TAMU, UTA, BU

Fish Biosensor Responses to the April 2007 Bloom Termination

Site Number	LC50
1	>100%
2	>100%
3	>100%
4	>100%
5	>100%
6	>100%
7	>100%
8	>100%
9	>100%
10	>100%



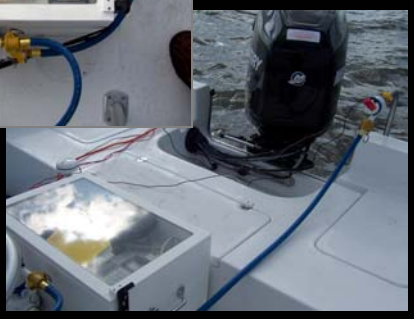
Not Toxic

1. In-lake monitoring: Mapping

TAMU, UTA, BU

Dataflow

On-board, flow through system with geo-referenced data collection

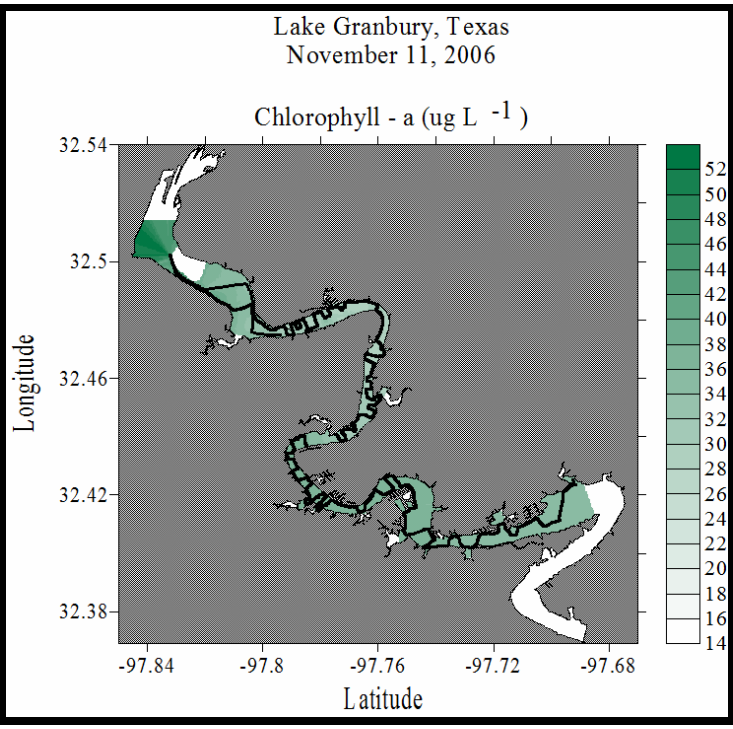


1. In-lake monitoring: Mapping

TAMU, UTA, BU

Parameters sampled

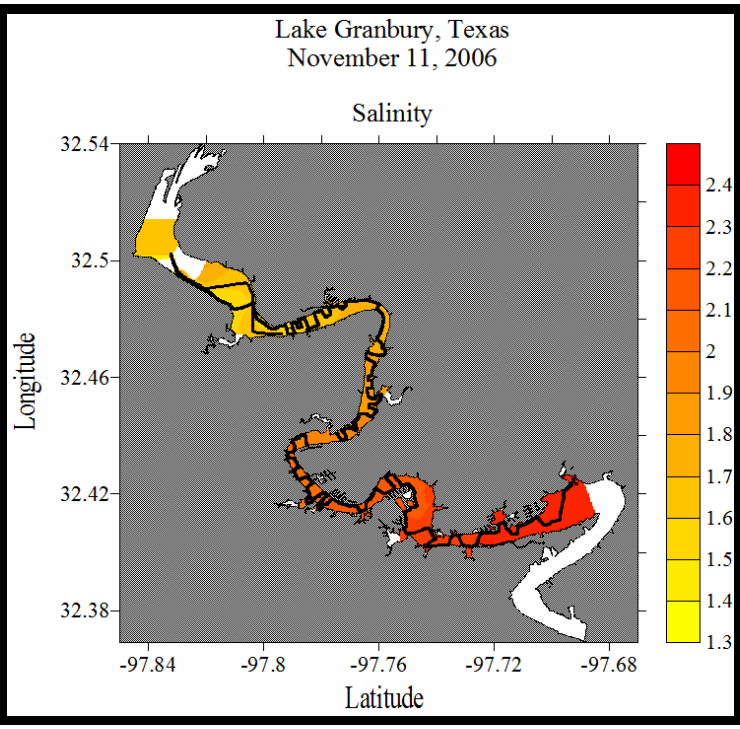
Chlorophyll *a*
Dissolved org. matter
Salinity
Temperature
Transparency
pH



1. Mapping

TAMU, UTA, BU

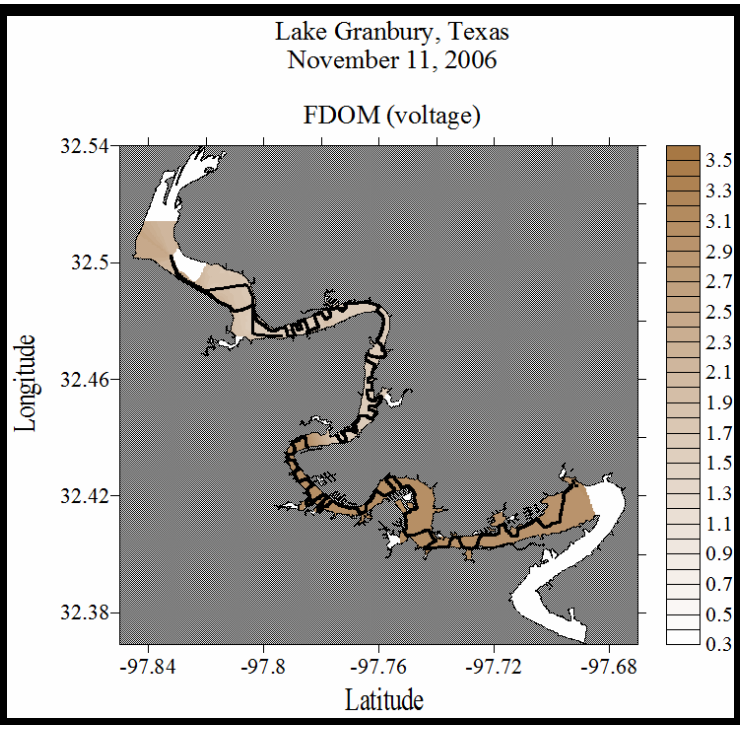
Well-mixed conditions



1. Mapping

TAMU, UTA, BU

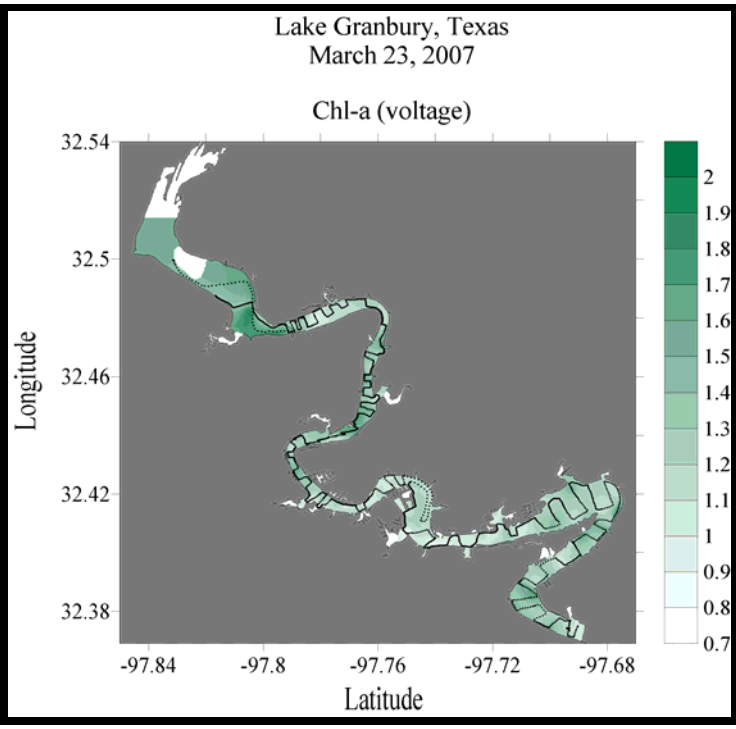
Well-mixed conditions



1. Mapping

TAMU, UTA, BU

Well-mixed conditions



1. Mapping

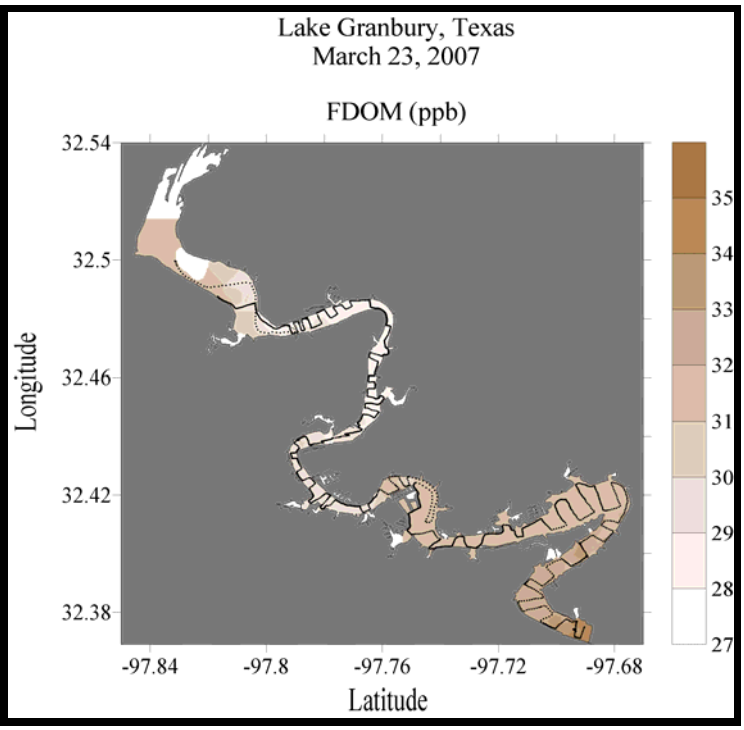
TAMU, UTA, BU

Spatial Heterogeneity

1. Mapping

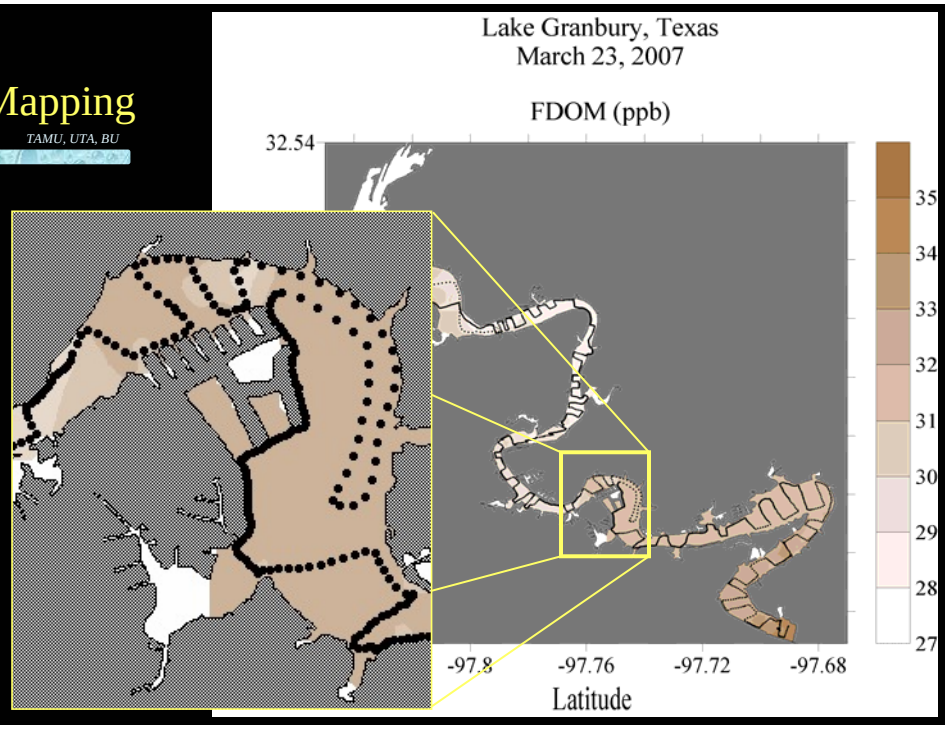
TAMU, UTA, BU

Spatial heterogeneity



1. Mapping

TAMU, UTA, BU



Direction of future research

Trouble shooting phase for new Dataflow technology and methods

Continued multiple year sampling

Determine spatial correlations between P. parvum, E. coli, DOC, and FDOM

Experimental phase to determine causation