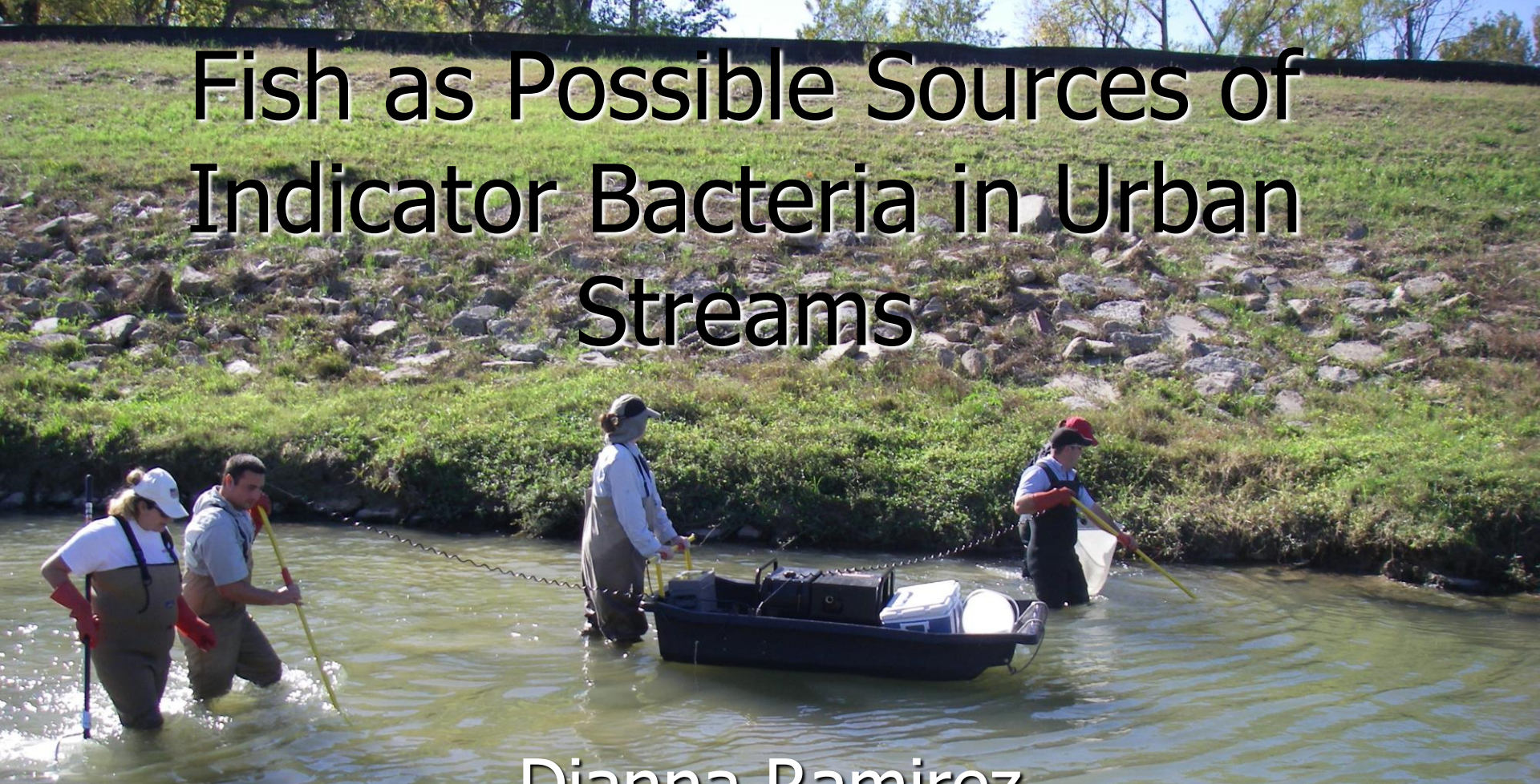
Reviewed: 7/27/2021

Fish as Possible Sources of Indicator Bacteria in Urban Streams



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Outline

- Background
- Field
- Aquarium
- Conclusions
- Future work

Indicator bacteria use for water quality management

- 303 (d) list
- Indicator bacteria include fecal coliform, *Escherichia coli* (*E. coli*) and Enterococci bacteria
  - Not generally harmful, correlated with pathogenic microorganisms that are present in human & animal digestive systems
  - High levels of indicator bacteria suggest increased risk of exposure to pathogenic microorganisms

Sources of *E. coli* within urban streams & bayous in Harris County

- Contaminated runoff & stormwater
- Malfunctioning wastewater collection systems
- Improperly functioning wastewater plants
- Treated wastewater effluent
- Wildlife & domesticated animals
- Waterfowl
- Reservoirs of E. Coli include:
  - Algae & periphyton
  - Soils & sediments

Sources of *E. coli*

- Source identification is the barrier to effective management
- Warm-blooded organisms such as mammals & also birds are vectors for these bacteria
- Recent studies identified reptiles as potential sources of *E. coli*
- Clark et al 2007, documented the presence of *E. coli* in some pelagic & demersal fishes
  - Origin of bacteria was Canadian geese & human sewage

E. coli isolate frequency

Mammals	56%
Birds	23%
Crocodile	33%
Turtles	4%
Snakes	2%
Lizards	10%
Frogs	12%
Fish	10%

From Gordon & Cowling, 2003

Omnivores	87.2%
Herbivores	70.0%
Carnivores	57.3%

From Gopee et al. 2000

POTENTIAL MECHANISMS OF E. COLI PRODUCT & TRANSPORT

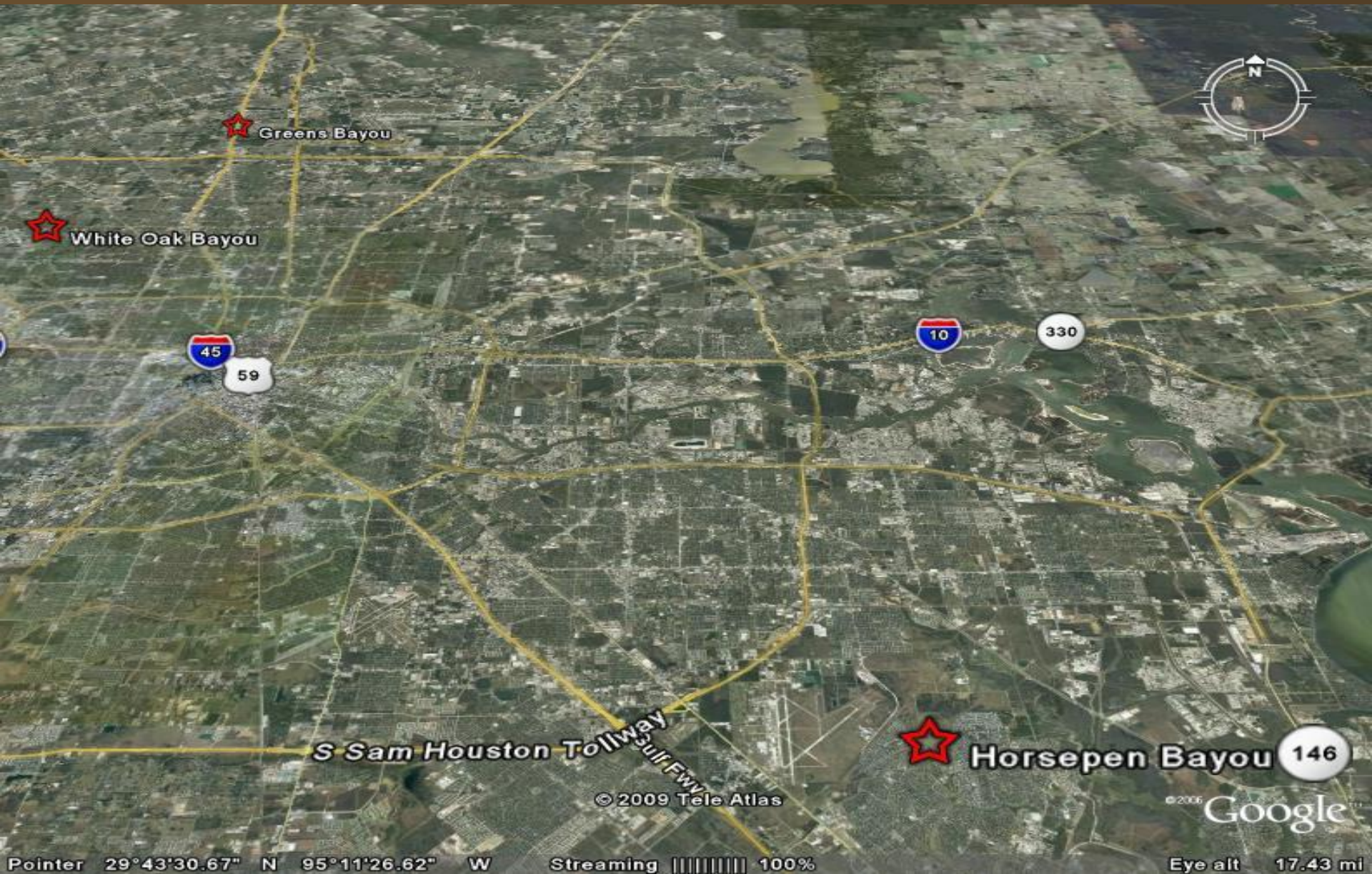
- Fish species can harbor E. coli (Guzman et al. 2004)
- Hansen et al. 2008 Pelagic & Benthic Fish:
  - Percentage of benthic fish harboring fecal coliforms not sig. diff. than Pelagic fish
  - Verified E. coli from Benthics 10x that of pelagics (42%, 4%)
  - Source identified for 65% of E. coli isolated
- Fecal coliforms found in every species examined, but not every fish
- Not dominated by a single strain
  - Fish may acquire microorganisms while feeding

Objectives

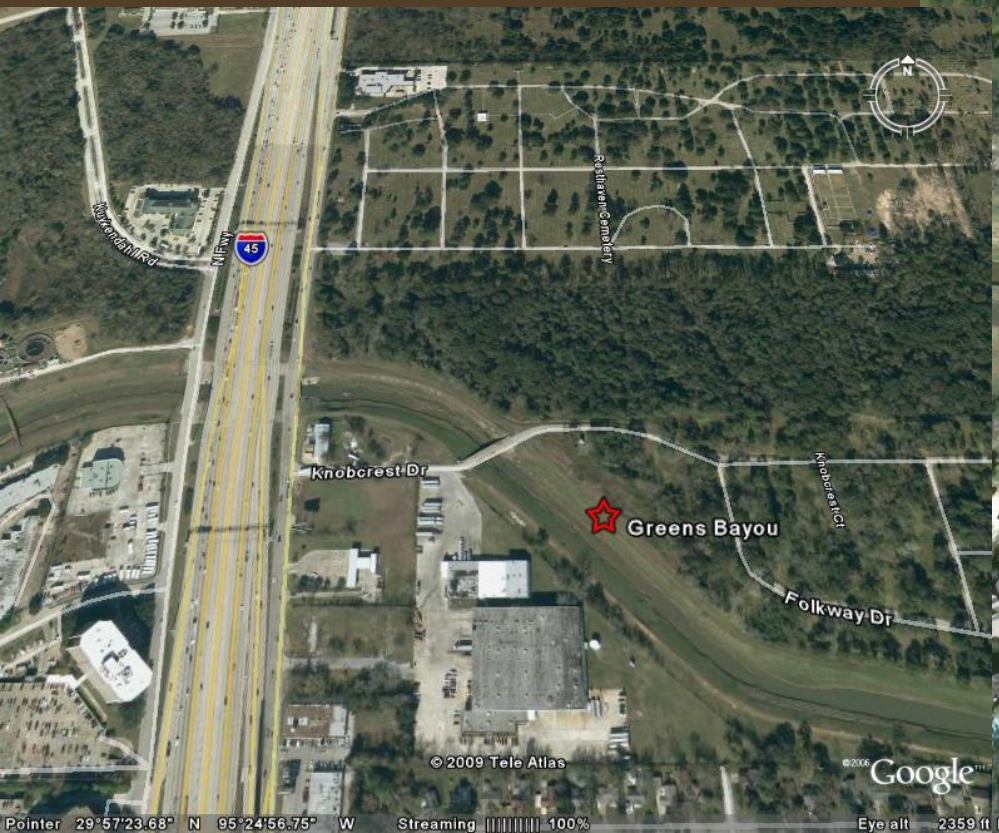
To evaluate potential loading of *E. coli* from fish by:

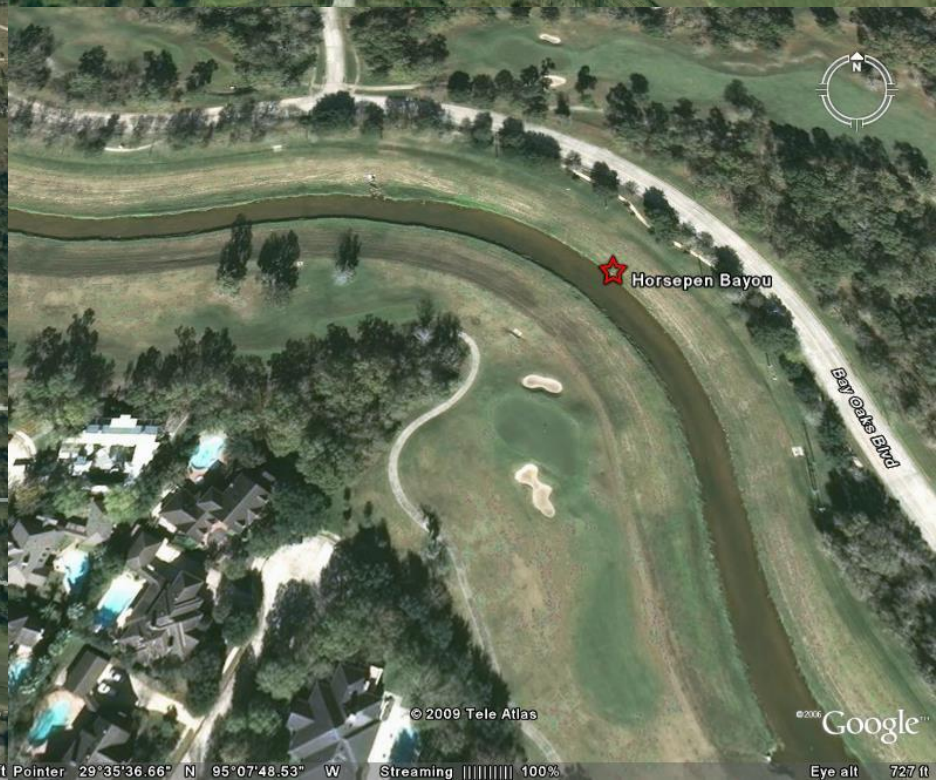
- 1) Determining whether wild caught fish from Harris County waterways representing various species and trophic groups produce feces with detectable levels of indicator bacteria, *E. coli*
- 2) Determining whether farmed fish retained in aquaria transmit *E. coli* bacteria to ambient water

Field Study Locations



Sampling Sites





Target Species

Trophic Group	Candidate Species
Herbivore	Armored Catfish
	Grass Carp
	Striped mullet
Benthic omnivore	Channel catfish
	Carp
	Smallmouth buffalo
Insectivore	Bluegill
	Rio Grande Cichlid
	Redear Sunfish
	Longear Sunfish
Omnivore	Gizzard or Threadfin shad
	Gulf Menhaden
	Tilapia
Piscivore	Largemouth Bass
	Spotted Bass
	Green Sunfish Spotted Gar
Benthic predator	Blue catfish

Field study

- Fish Collection
  - Tote barge Electroshocker
  - Euthanized in MS-222

Field study

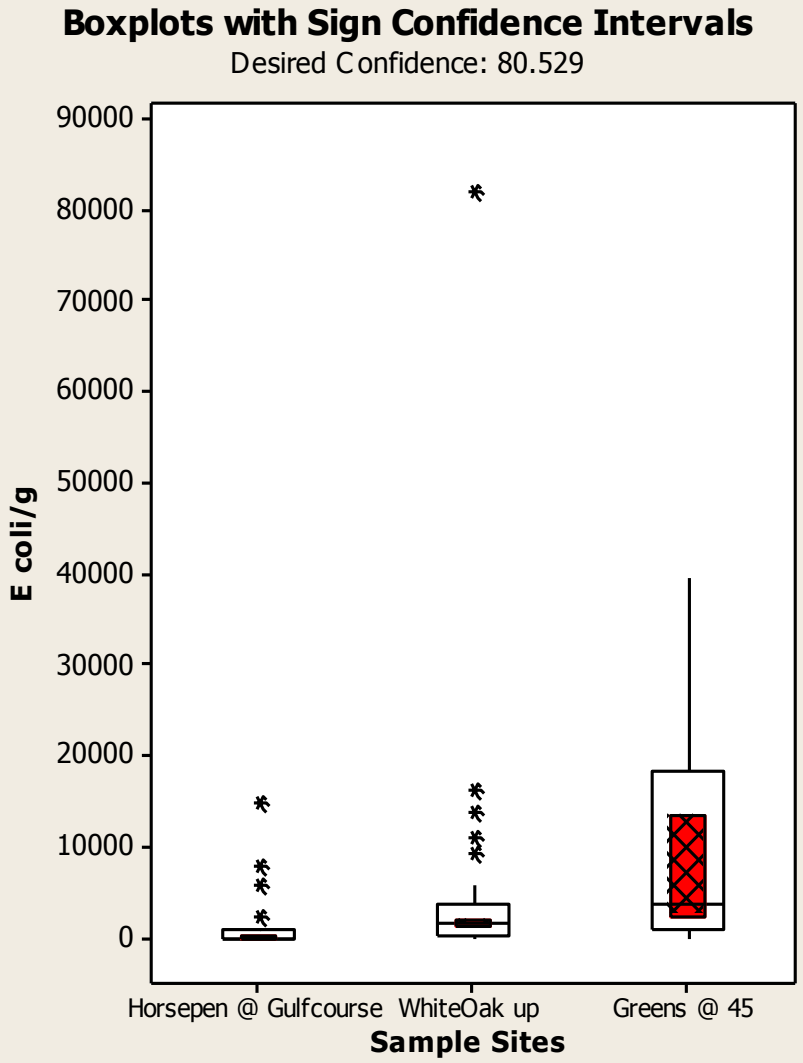
- Fecal Material Extraction
  - Fish measured & weighed
  - Large intestine removed
  - Fecal material extracted into pre-weighed Bacti-bottles with 100 ml of sterile water

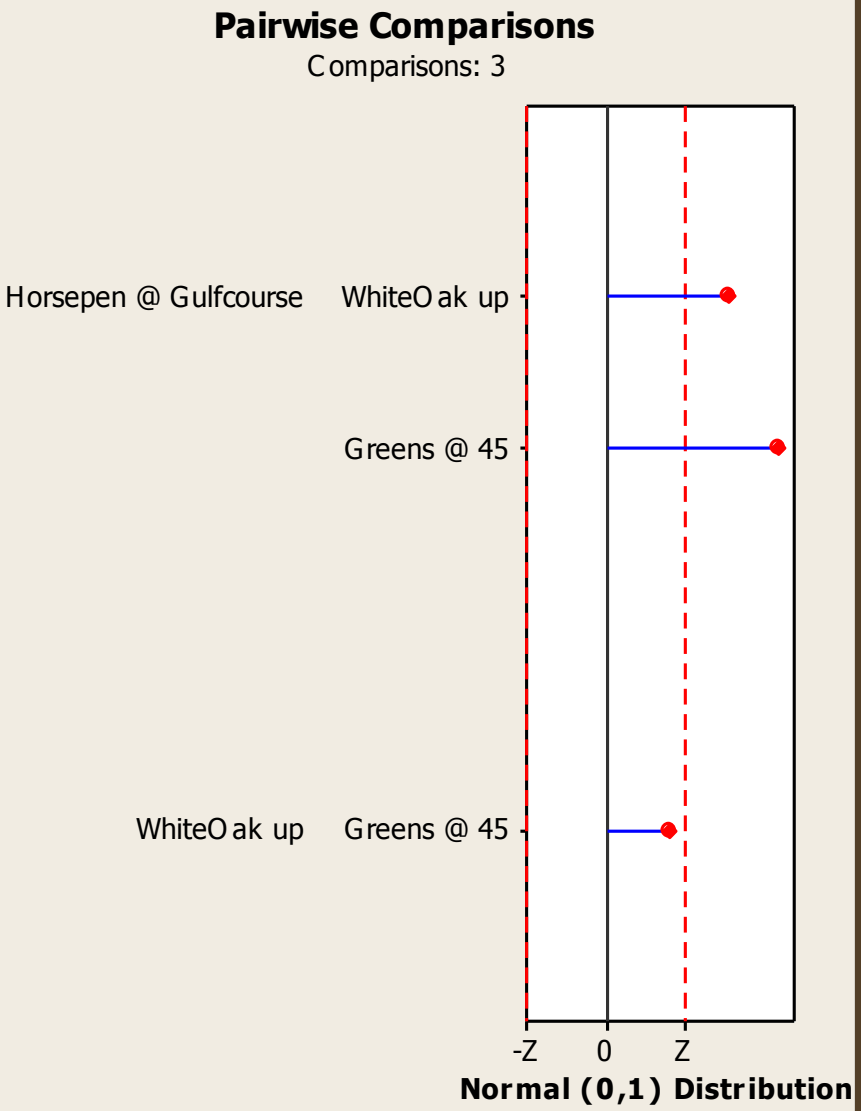
Fecal Matter Extraction

Laboratory Processing:

IDEXX Method

Kruskal-Wallis Multiple Comparisons with Dunn's Test

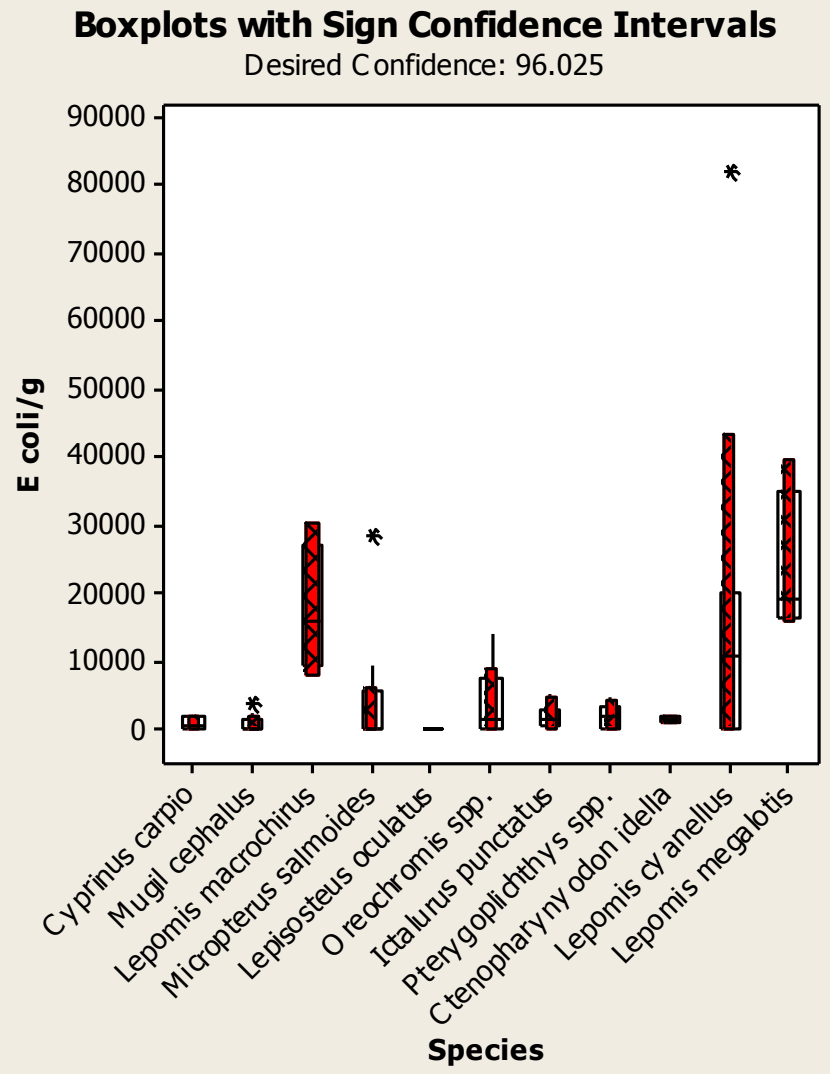




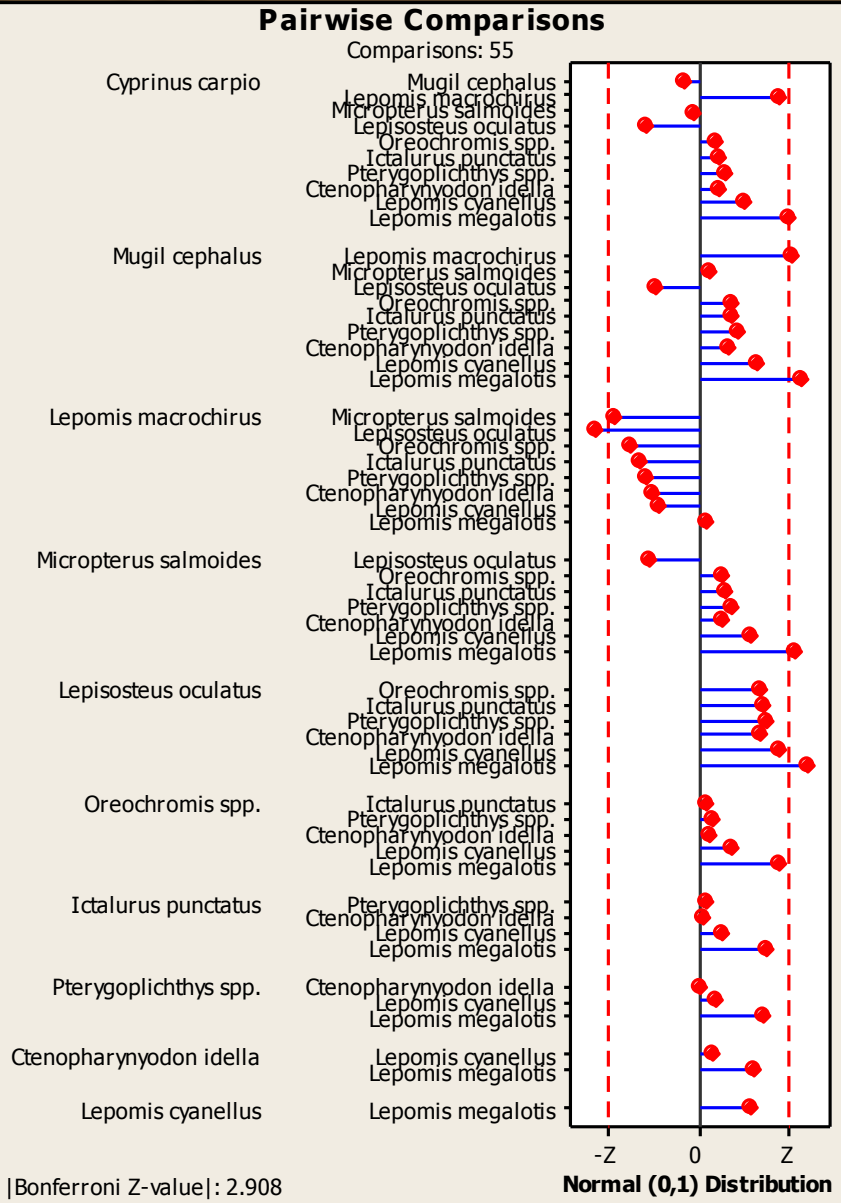
Family Alpha: 0.2
Bonferroni Individual Alpha: 0.067

|Bonferroni Z-value|: 1.834

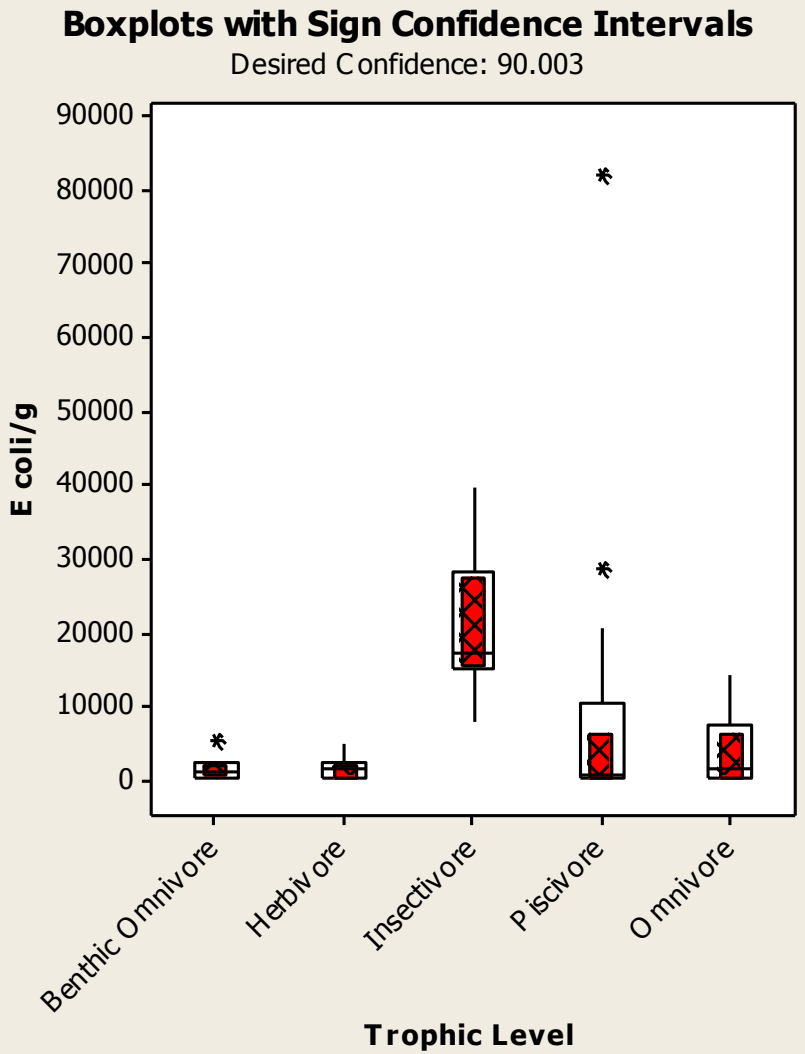
Kruskal-Wallis Multiple Comparisons with Dunn's Test

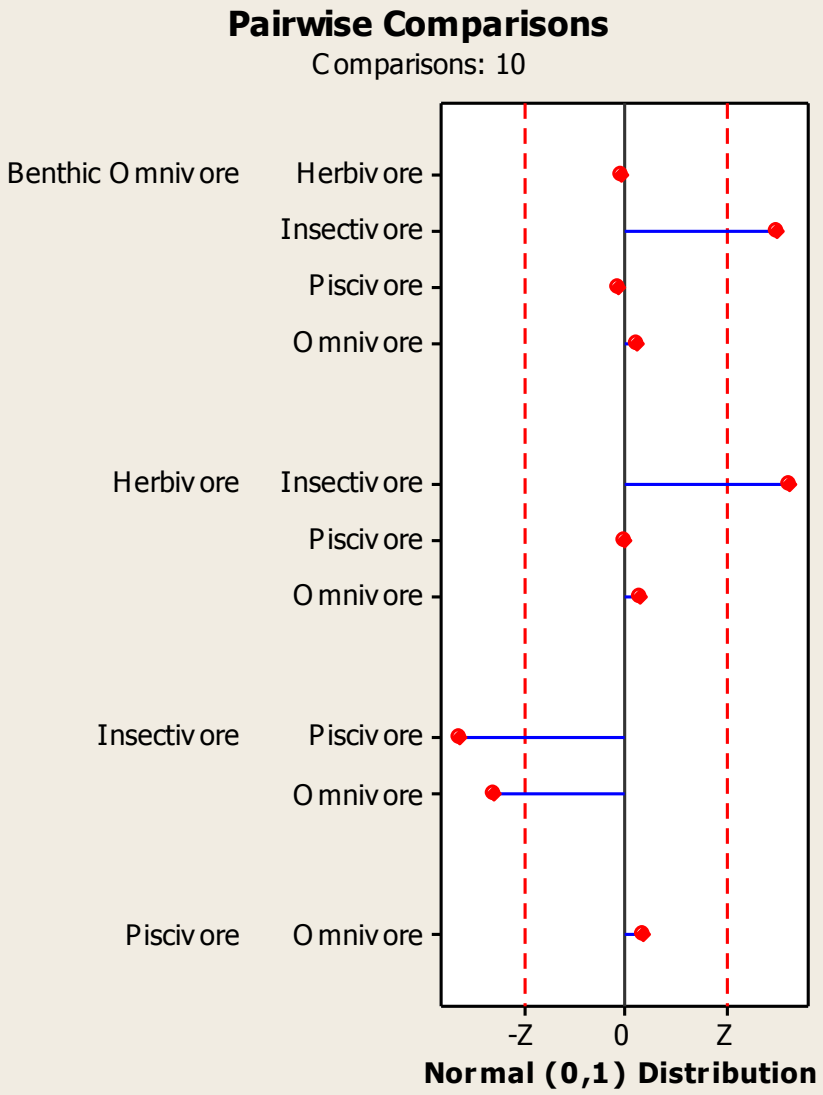


Family Alpha: 0.2
Bonferroni Individual Alpha: 0.004



Kruskal-Wallis Multiple Comparisons with Dunn's Test





Family Alpha: 0.2
Bonferroni Individual Alpha: 0.02

|Bonferroni Z-value|: 2.326

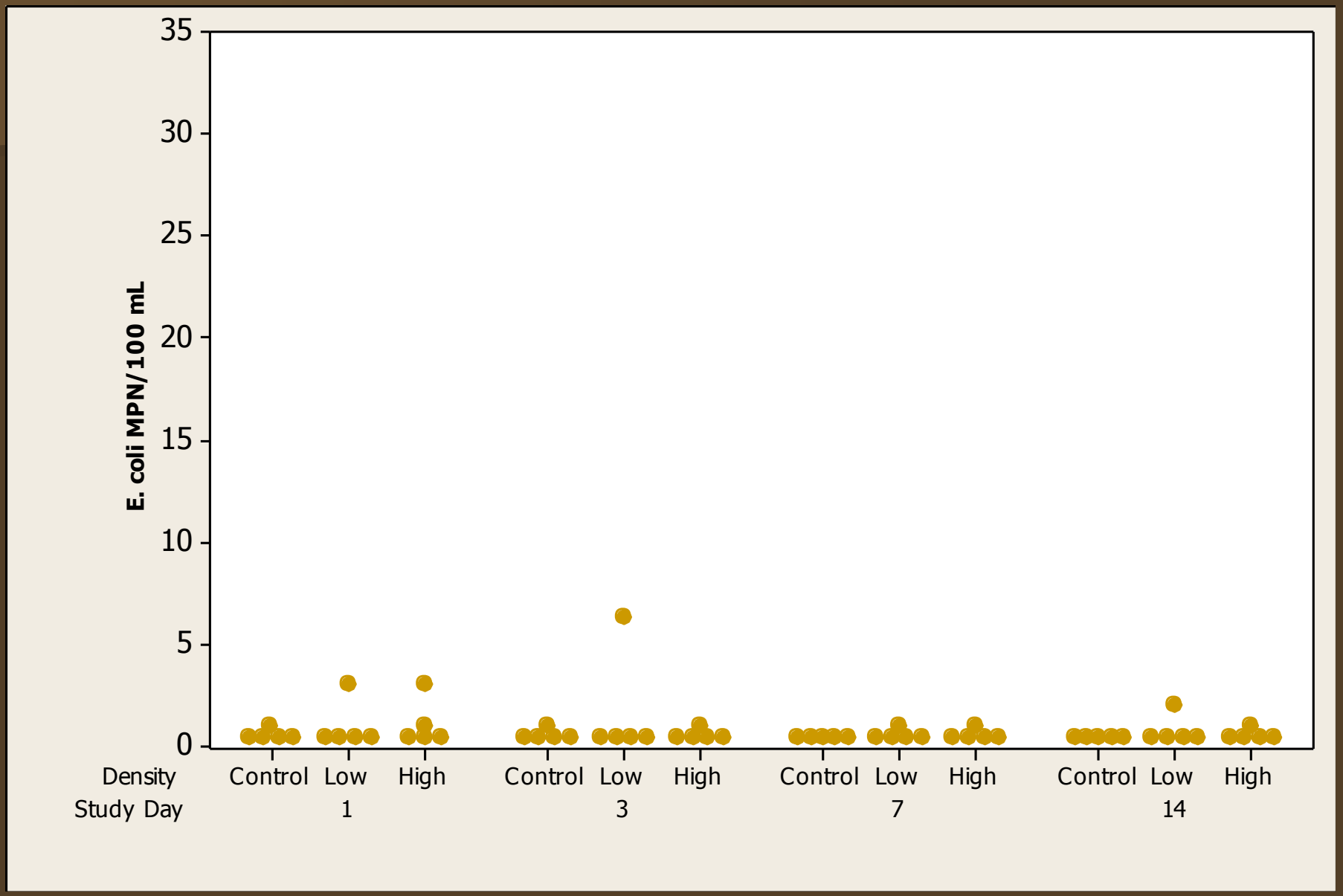
Aquarium Study

- 1st round used Bluegill (*Lepomis macrochirus*)
  - 2nd round still in progress with channel catfish
- 15 15 gal. aquaria
  - 5 replicates
    - Control
    - Low density (1 fish/tank)
    - High Density (3 fish/ tank)
- Basic WQ parameters monitored daily
  - Additional parameters measured on bacteria sampling days

Aquarium Study

- Bacteria sampled
  - Pre-stocking
  - 1d post-stocking
  - 3d post-stocking
  - 7d post-stocking
  - 14d post-stocking

Aquarium Water *E. coli* (MPN) Values



Conclusions

- Fish in the stream study seem to be transporters of *E.coli*
- Supported by aquarium study using farmed fish
  - Showed no increase in *E.coli* levels due to stocking density or over time
  - Fish fecal matter tested after 14d aquarium study showed low levels of *E. coli*
- Diet plays an important role in amount of *E. coli* in fish fecal matter

Conclusions/Future Implications

- Bacteria in fish maybe indicators of bacteriological pollution in the waterbodies they inhabit
- Fish seem to absorb the bacteria from their food as well as their environment
- Therefore fish maybe significant transport mechanisms not captured by current modeling efforts
- Future studies on isolating bacteria strains need to be conducted to determine source loadings

Future Work

- Spring & Summer field sampling
  - Determine if there is a seasonal difference in bacteria levels in the fish fecal matter
- Aquarium Study with channel catfish
  - Difference in fish species
  - Preliminary results similar to bluegill
    - After 7d all tanks have <1 MPN of E. coli









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