# Does Tidal Management Affect Sub-adult Fish Assemblages in South Carolina’s Historic Impounded Marshes?

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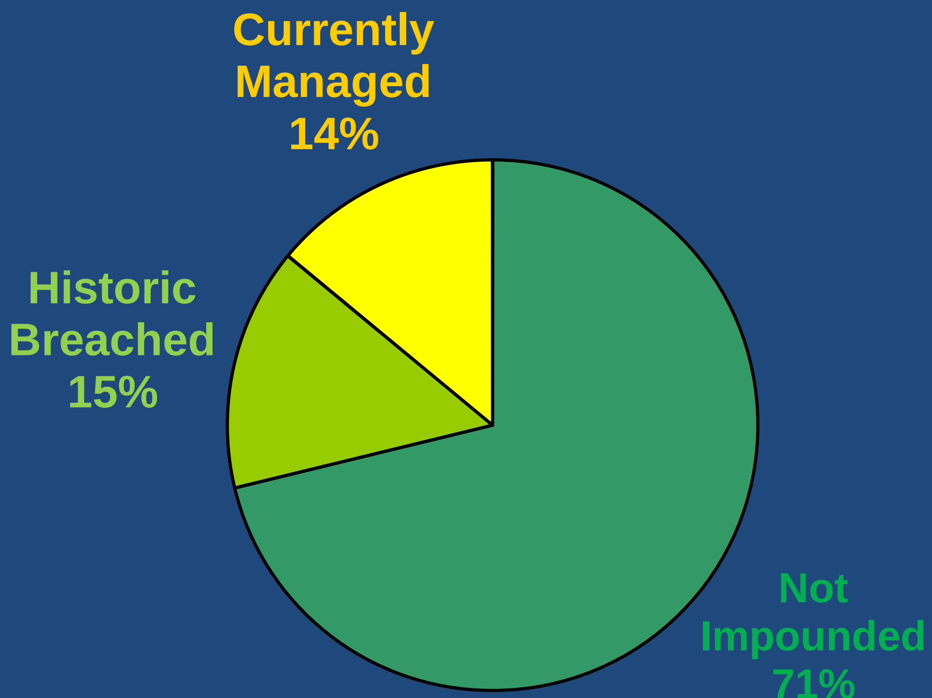
# Outline

- Overview of marsh impoundments including history and ecology
- Study objectives, site, materials, methods, experimental design, etc.
- Results
- Conclusion and discussion of  management and policy implications
- Questions

# History of Southern Coastal Marsh Impoundments

- Rice plantation era, 1720's – 1890's
  - NC, SC, GA, FL, LA
- Largely abandoned until mid-1900's
- Purchased by wealthy landowners (mid-1900's)
  - Repaired and managed as hunting preserves
  - Some controversy in 70's and 80's about permitting to repair or reestablish impoundments



# Resource Values

Cultural value

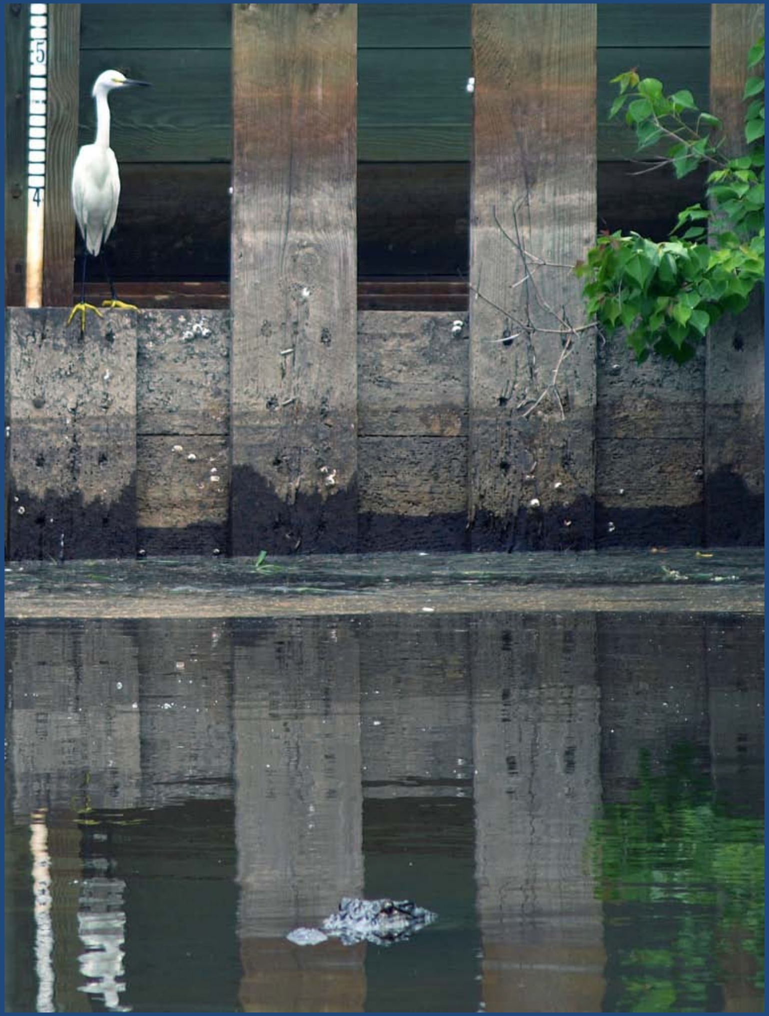
- History
- Recreation
- Education

Wildlife value

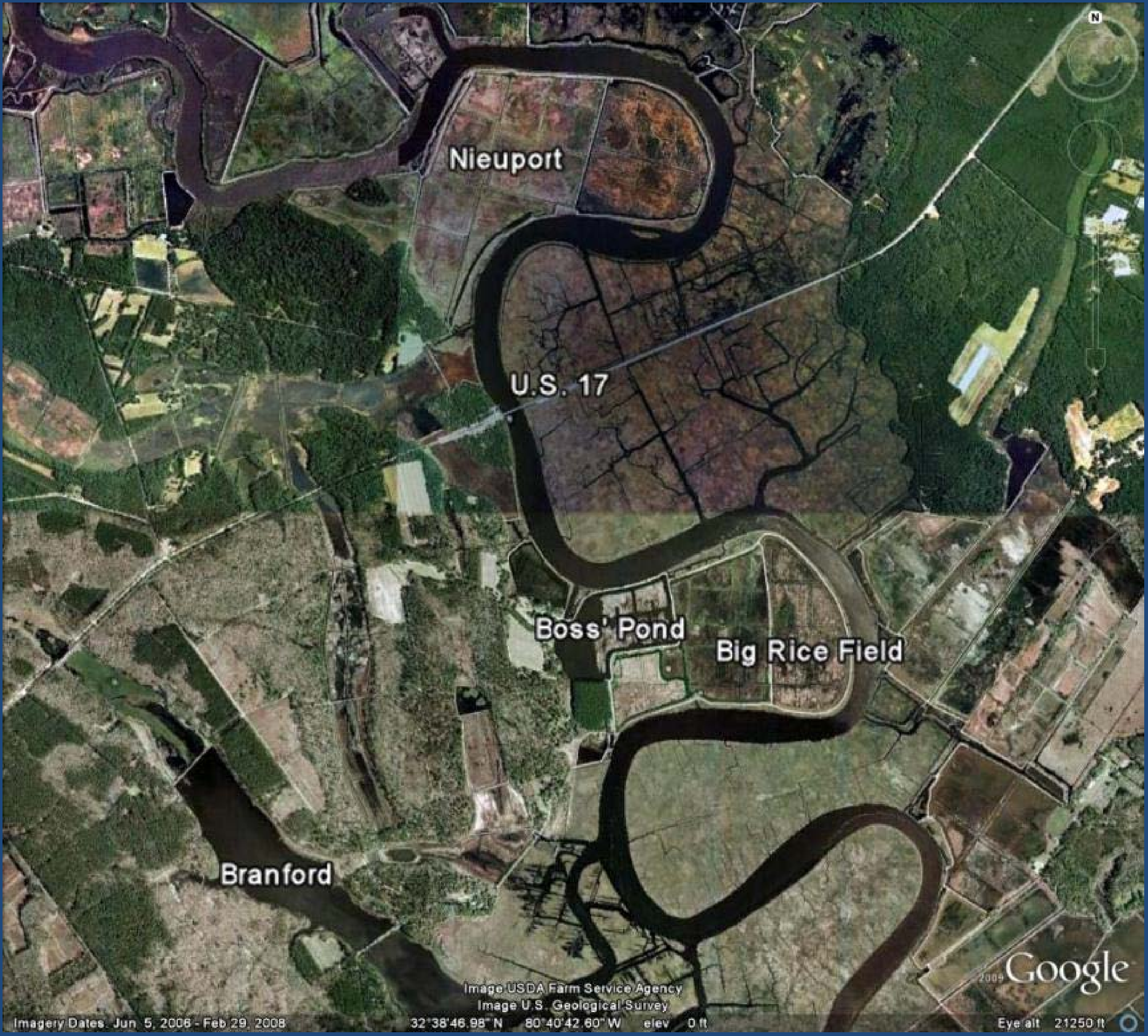
- Waterfowl, shorebirds, wading birds, raptors
- Fish, Crustaceans
- Alligators

# Ecological context for fishes

- High productivity systems
- highly variable water quality (dynamic habitat)
- Barriers to immigration and emigration
- ❖ Impoundments affect resident and migrant fishes differently
- Lots of predators, also lots of prey



# Study area


Nieuport
U.S. 17
Boss' Pond
Big Rice Field
Branford
Image USDA Farm Service Agency
Image U.S. Geological Survey
Imagery Dates: Jun 5, 2006 - Feb 29, 2008
32°38'46.98" N 80°40'42.60" W elev 0 ft
Eye alt 21250 ft
Google

# “Waterfowl” impoundments

Nieuport

295 acres

Big Rice Field

119 acres

# “Fish” impoundments



Branford Lake

150 acres

Boss’ Pond

75 acres

# Management differences

## Waterfowl

- Spring drawdown
- No tidal exchange for long periods in summer and winter
- Interior emergent vegetation burned during drawdown
- Levels gradually increased through fall

## Fish

- Not drained, water levels relatively stable
- Daily tidal exchange for most of the year
- Exchange occurs when tide rises above fixed height

# Project objectives

- Assess abundance and diversity of larval and early juvenile fishes over one recruitment season (1 year).

- Analyze differences in diversity and abundance between “waterfowl” impoundments and “fish” impoundments

# Sampling methods

- Designed to sample larval and early juvenile fish
- Set in the evening, pulled in the morning
- Whole sample preserved in ethanol for sorting, species ID, and life stage ID in lab

# Sampling design

• 3 samples taken at each of 3 stations in each impoundment

• DO, Temperature and Salinity Data collected at surface using YSI 85 at each station in the AM.

• Sampling Conducted at the new moon for 10 months July – Aug. ‘08, Nov.-June ’09

• No samples Sept & Oct. ‘08

# Analysis

- Water Quality
  - Summary Statistics, 90% CI's

- Diversity
  - Species Richness
  - Effective # of species (Jost's True Diversity)
  - H' (Shannon Index) = $\Sigma P_i \ln P_i$, Where $P_i$ = the proportion of individuals in the $i^{th}$ ranked species
  - $e^{H'}$ is a linearized, more comparable, expression of the Shannon index

# Analysis

- Hierarchical linear models (HLM) to estimate catch per unit effort (CPUE), evaluated using $AIC_c$

- Extension of General Linear Model (ANOVA, regression, etc.)

- Allows interpretation of hierarchically structured data while accounting for dependencies among variables

- Includes random error terms at both the individual (species) and group (resident/transient) level reflecting the complex and unique variance structure of a particular dataset

$$Y_{ij} = \gamma_{00} + \gamma_{01}W_j + \gamma_{10}X_{ij} + \gamma_{11}W_jX_{ij} + u_{0j} + u_{1j}X_{ij} + r_{ij}$$

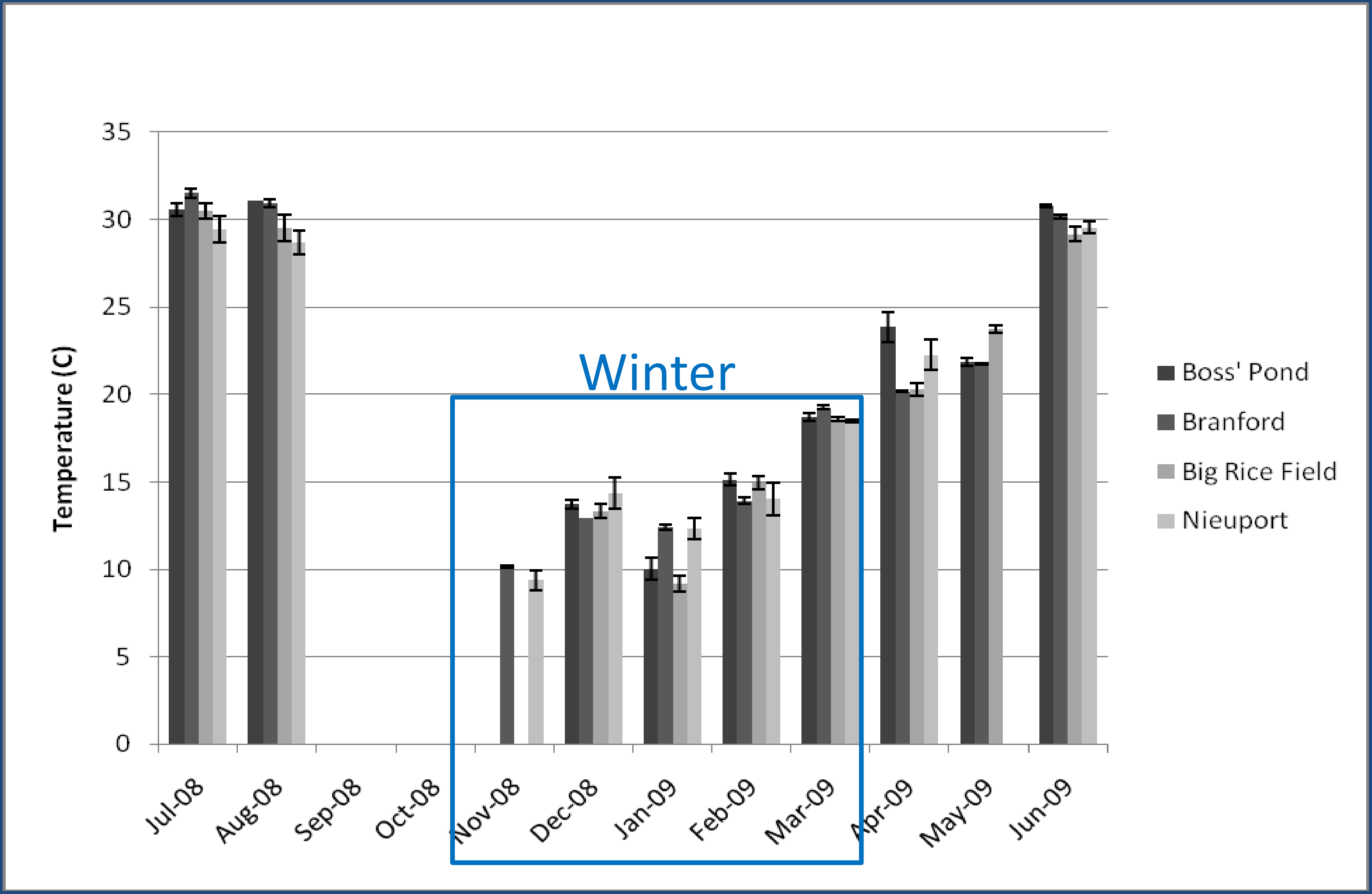
- SAS PROC MIXED

- Catch data log transformed to meet assumption of normality

# 21 species, 16 families sampled

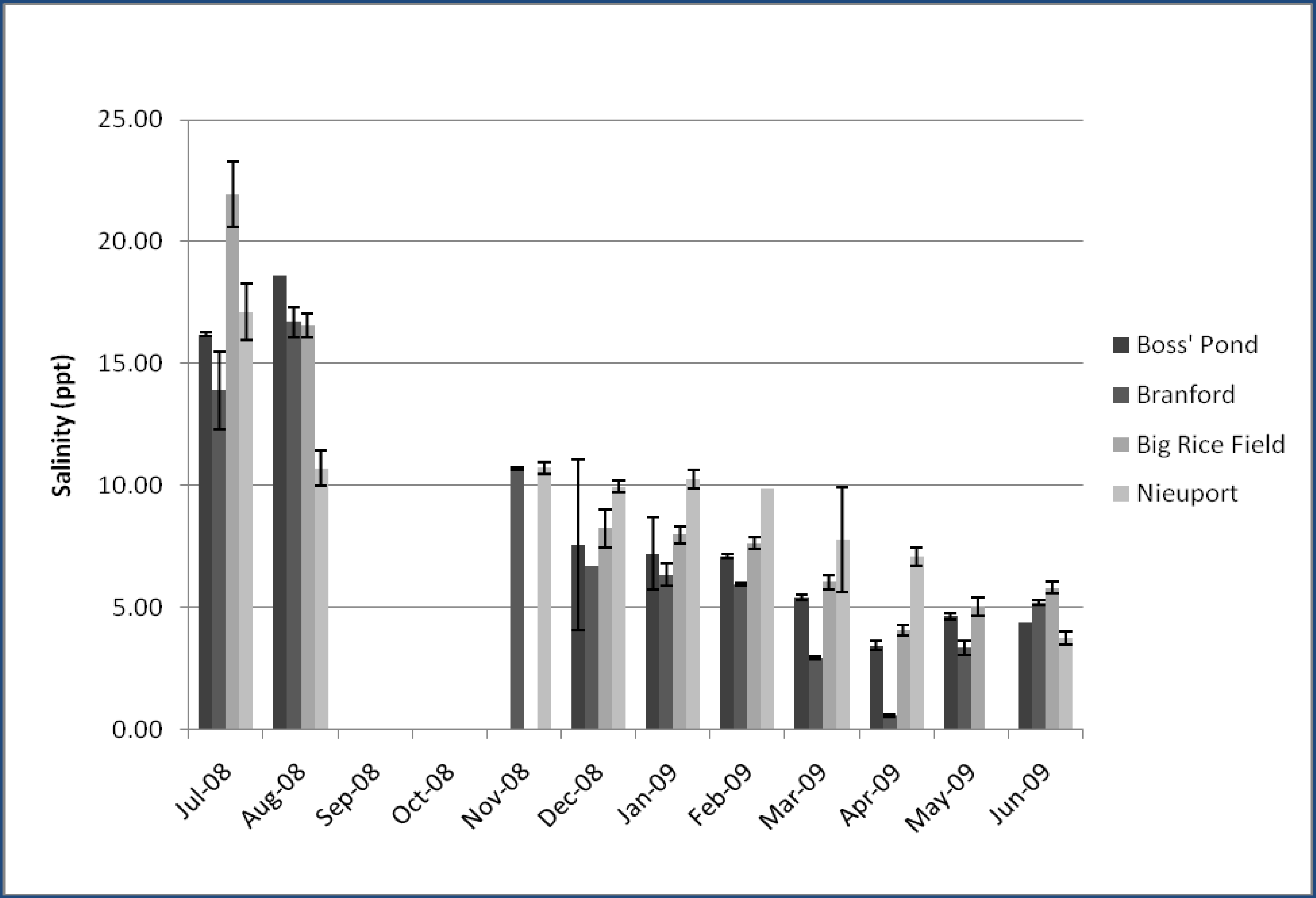
| Common Name | Scientific Name | Waterfowl Impoundments<br>Big Rice Field | Waterfowl Impoundments<br>Nieuport | Fish Impoundments<br>Boss' Pond | Fish Impoundments<br>Branford |
|---|---|---|---|---|---|
| inland silverside | *Menida beryllina* | 11844 | 32892 | 9780 | 11133 |
| bay anchovy | *Anchoa mitchilli* | 786 | 52 | 1342 | 2285 |
| menhaden | *Brevortia tyrannus* | 307 | 2 | 739 | 674 |
| mosquitofish | *Gambusia affinis* | 106 | 1026 | 35 | 1 |
| sailfin molly | *Poecilia latipinna* | 60 | 204 | 26 | 10 |
| spot | *Leiostomus xanthurus* | 37 | 0 | 112 | 81 |
| gulf pipefish | *Sygnathus scovelli* | 29 | 1 | 123 | 34 |
| naked goby | *Gobiosoma boscii* | 11 | 2 | 35 | 30 |
| rainwater killifish | *Lucania parva* | 8 | 60 | 0 | 6 |
| white mullet | *Mugil curema* | 62 | 1 | 1 | 2 |
| sheepshead minnow | *Cyprinodon variegatus* | 2 | 30 | 1 | 1 |
| ladyfish | *Elops saurus* | 9 | 1 | 7 | 0 |
| unidentified goby | *Microgobius sp.* | 0 | 0 | 1 | 8 |
| Atlantic croaker | *Micropogonius undulatus* | 5 | 0 | 1 | 1 |
| pinfish | *Lagodon rhomboides* | 1 | 0 | 4 | 1 |
| Weakfish | *Cynoscion regalis* | 4 | 0 | 0 | 0 |
| common carp | *Cyprinus carpio* | 0 | 0 | 0 | 2 |
| southern flounder | *Paralichthys lethiostigma* | 0 | 0 | 0 | 2 |
| mummichog | *Fundulus heteroclitus* | 1 | 0 | 0 | 0 |
| speckled worm eel | *Myrophis punctatus* | 0 | 0 | 1 | 0 |
| hogchoker | *Trinectes maculatus* | 0 | 1 | 0 | 0 |

# Mean monthly water temperature

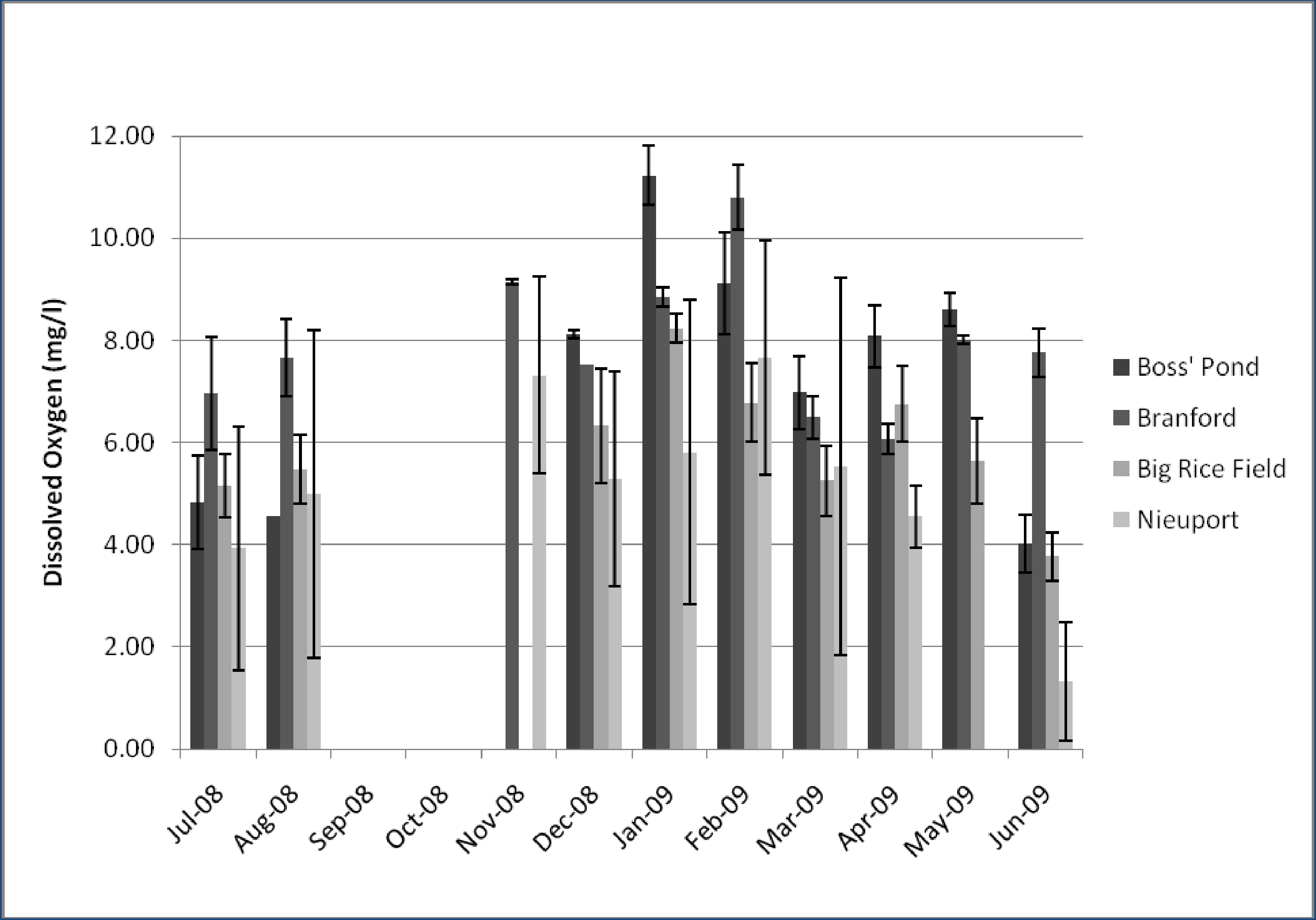



Light Shades = Waterfowl Impoundments, Dark Shades = Fish Impoundments

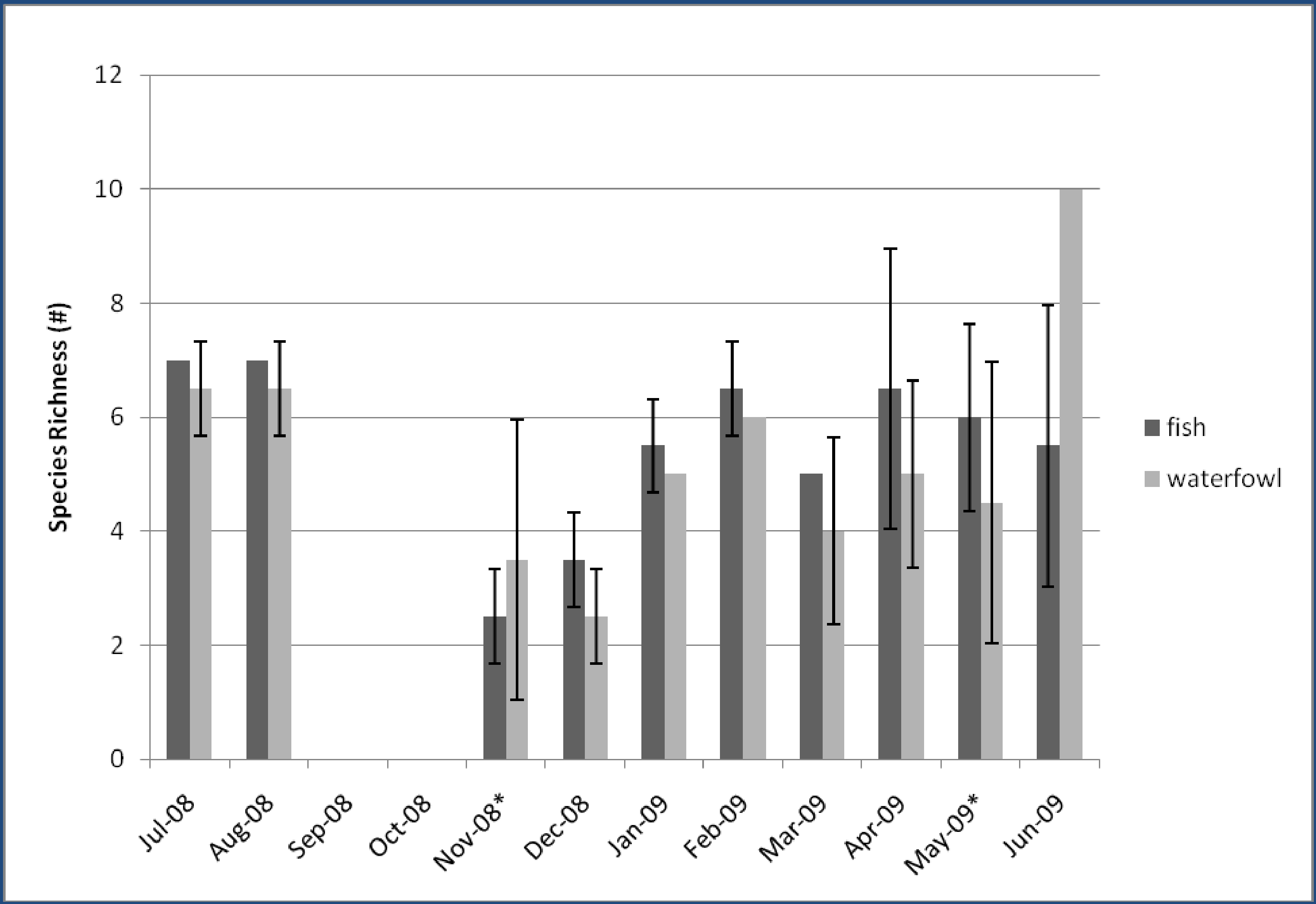
# Mean monthly salinity



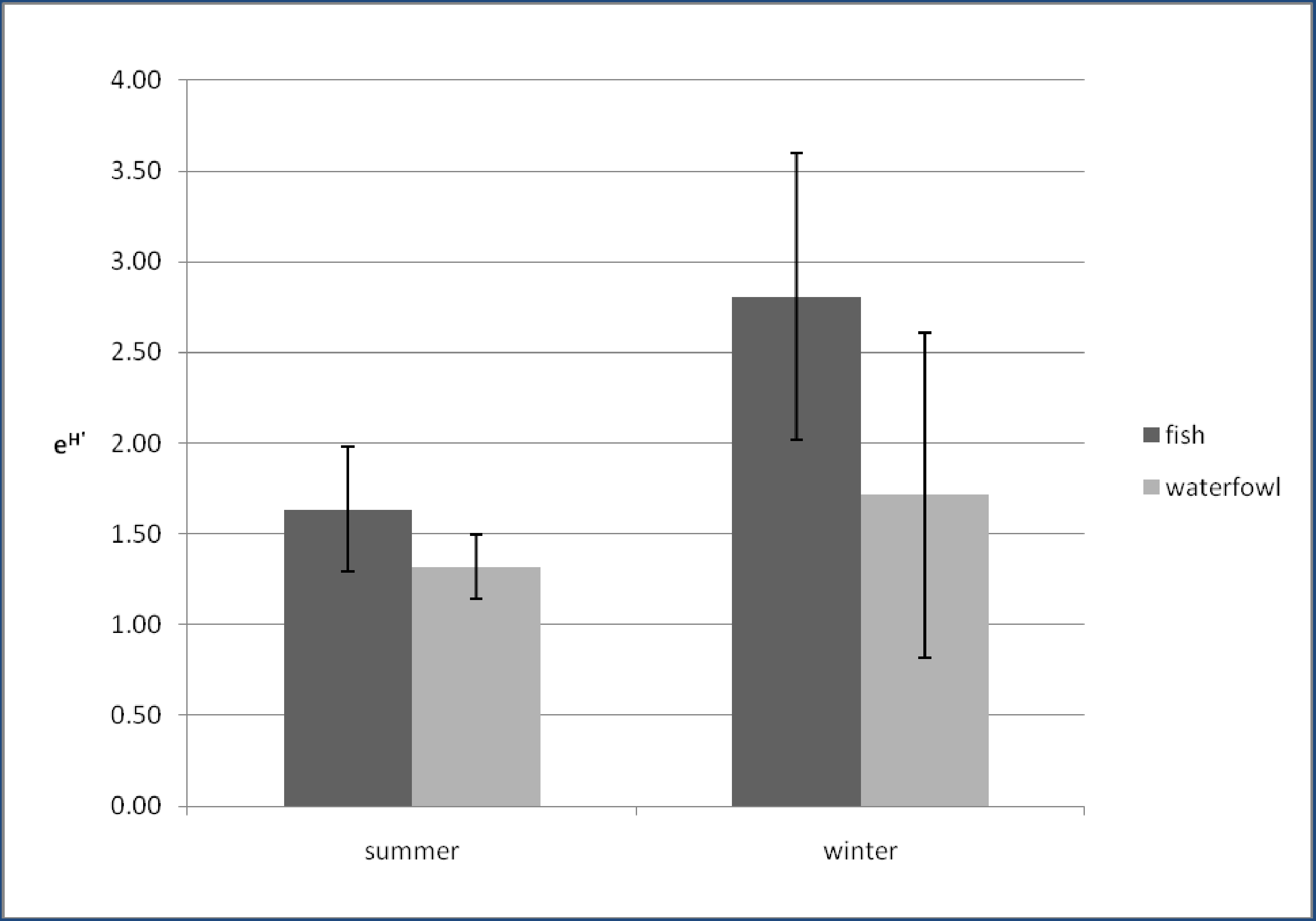
# Mean monthly dissolved oxygen concentration



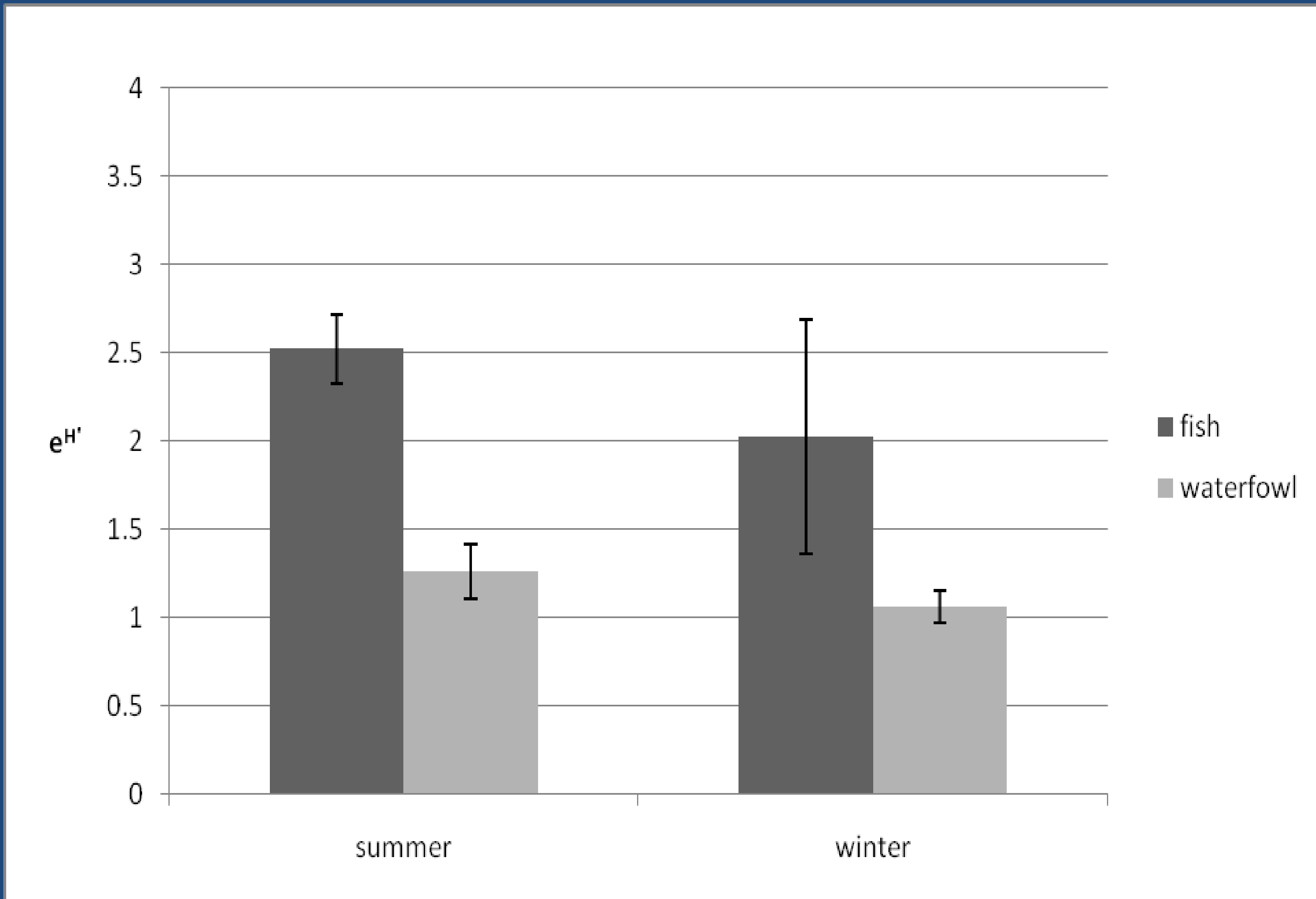
# Mean monthly, sub-adult, species richness



# Effective number of species, sub-adult stage



# Effective number of species, larval stage



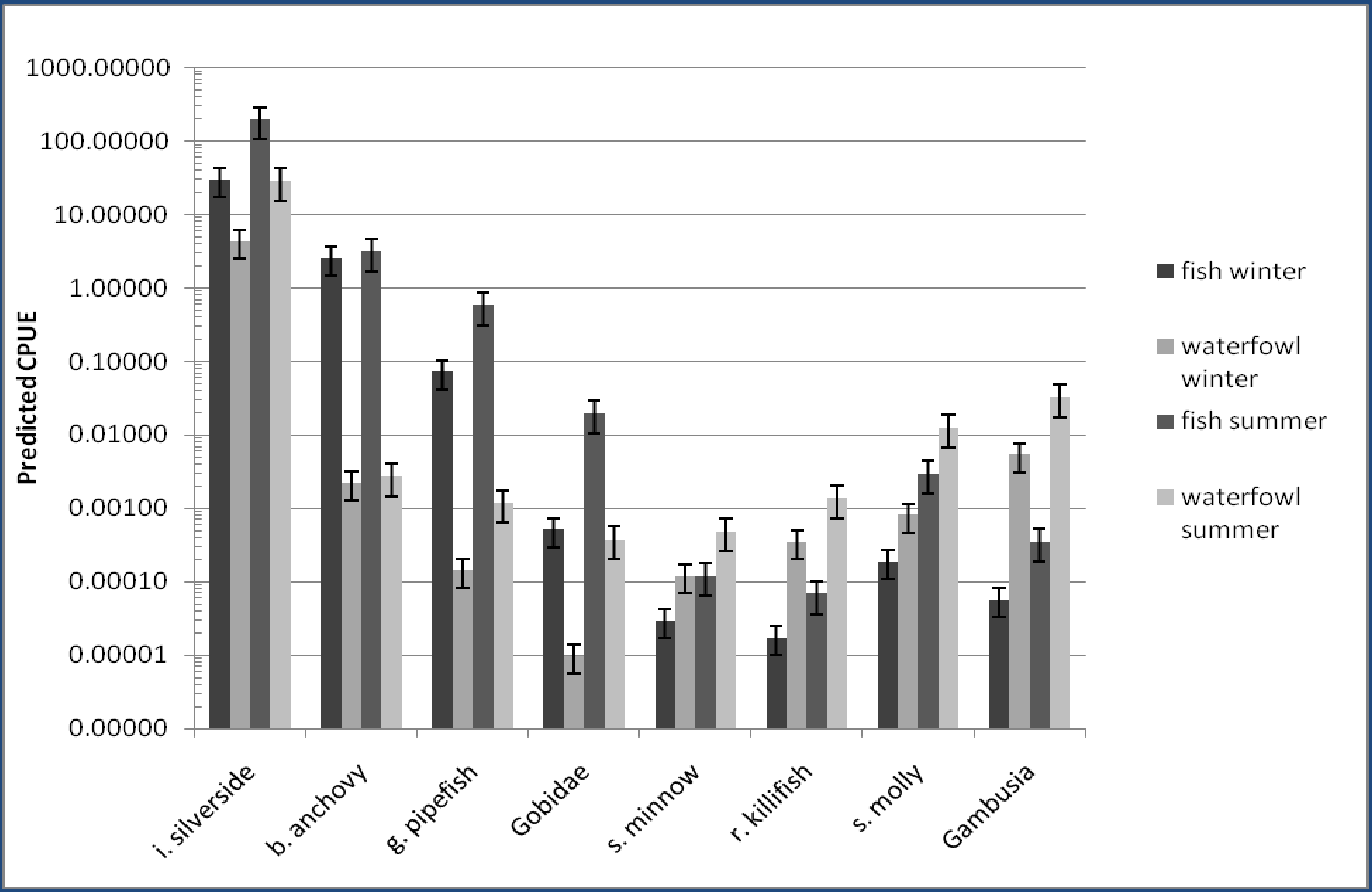
# Best approximating model for CPUE

Parameters (Fixed Effects):

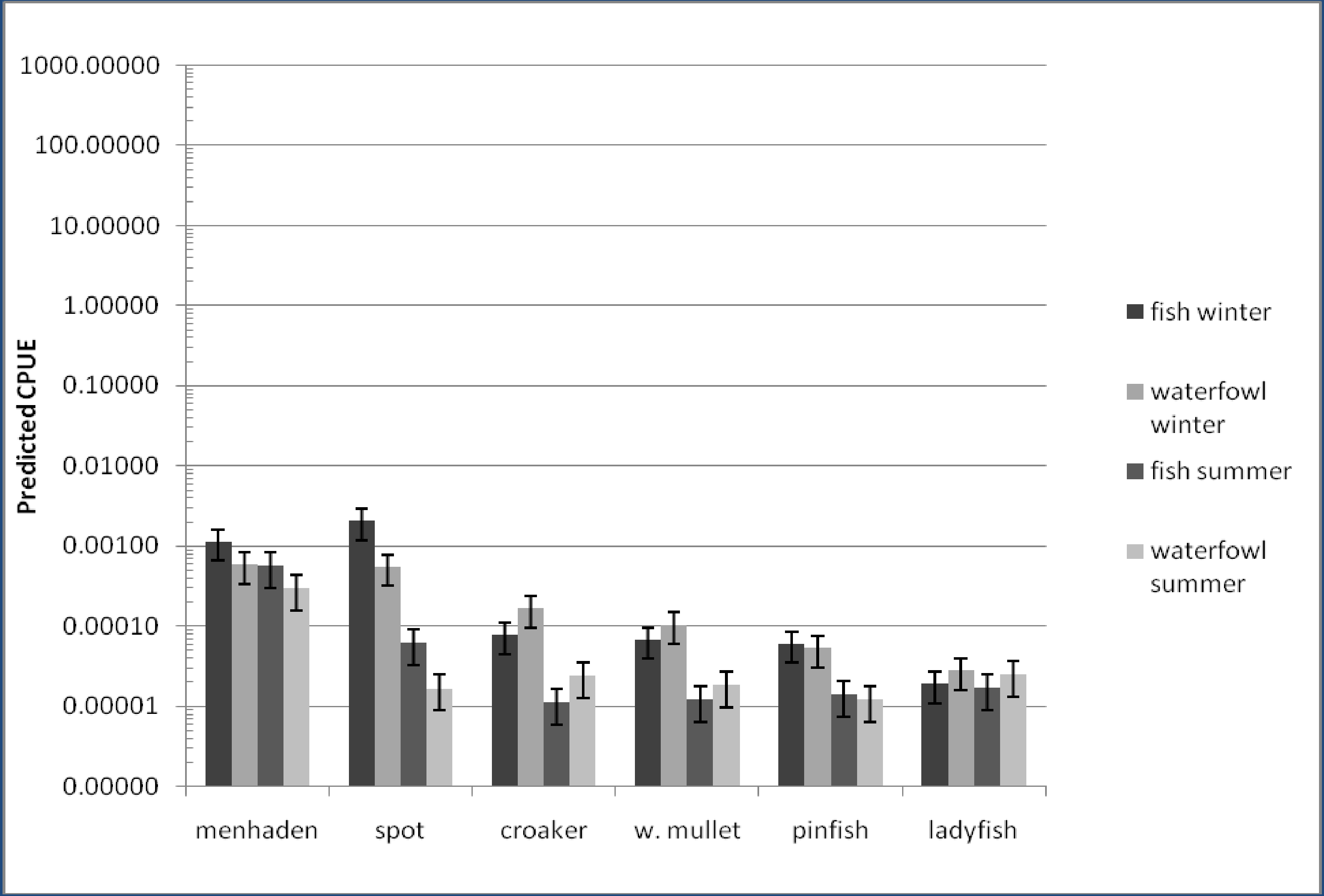
Management , Transience, Season, DO, Salinity, Transience*Management, Transience*Season, Transience*DO, Transience*Salinity

- 3.48 times more likely than next best model based on Akaike weight
- $R^2 = 0.62$

# CPUE estimates resident species



# CPUE estimates transient species



# Conclusions

- Increased tidal circulation may increase diversity of sub-adult fishes in impoundments, especially at larval stages.

- Fishes that are more abundant in “waterfowl” impoundments are resident species (but not true of all residents).

# Implications for management

- Decisions about tidal circulation will affect fish assemblages in impoundments
- Sea Level rise or other factors may force decisions about impoundment management creating an opportunity to consider alternatives
- Future research should investigate fish passage at water control structures, the effect of incremental changes to tidal management at waterfowl impoundments, diversity gradients in the Combahee River, and the contribution of diversity in management techniques to landscape scale diversity.

# Acknowledgments

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Dedicated to the conservation of fish, wildlife and plants, and the habitats on which they depend.


Questions?