MODEL-BASED PROJECTION OF NILE TILAPIA'S (*OREOCHROMIS NILOTICUS*) INVASIVE ABILITY IN COASTAL MISSISSIPPI

Mark S Peterson, Michael R Lowe, Wei Wu,, and Nancy J Brown-Peterson.
The University of Southern Mississippi

Pamela J Schofield. U.S. Geological Survey

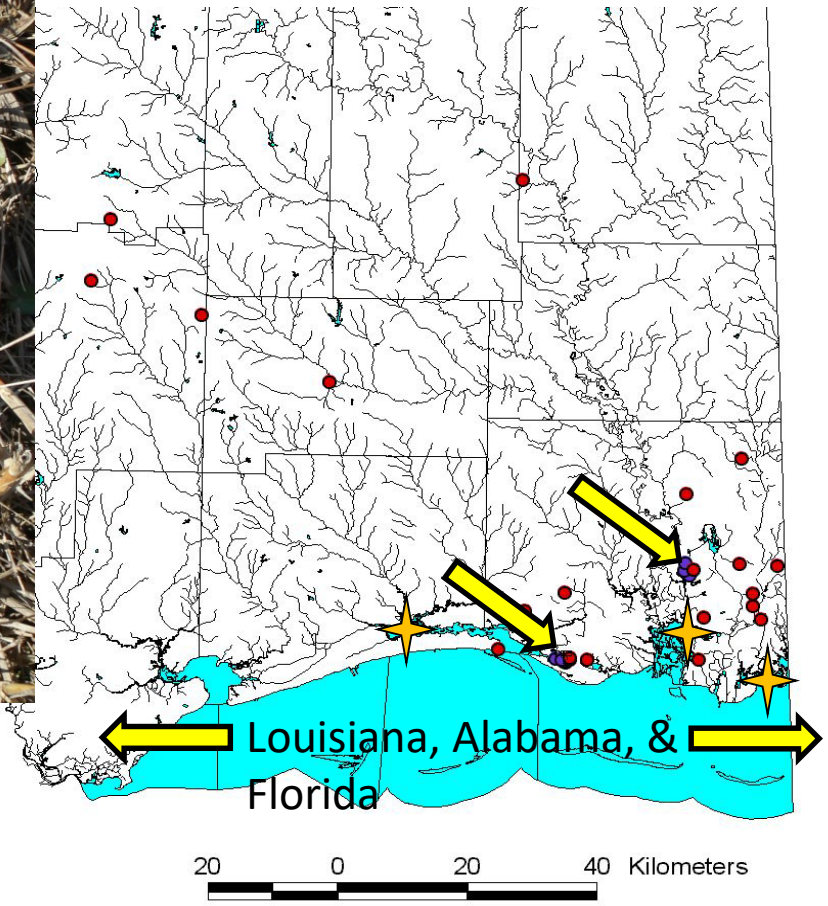
W. Todd Slack. U.S. Army ERDC

Coastal Ecosystems Group

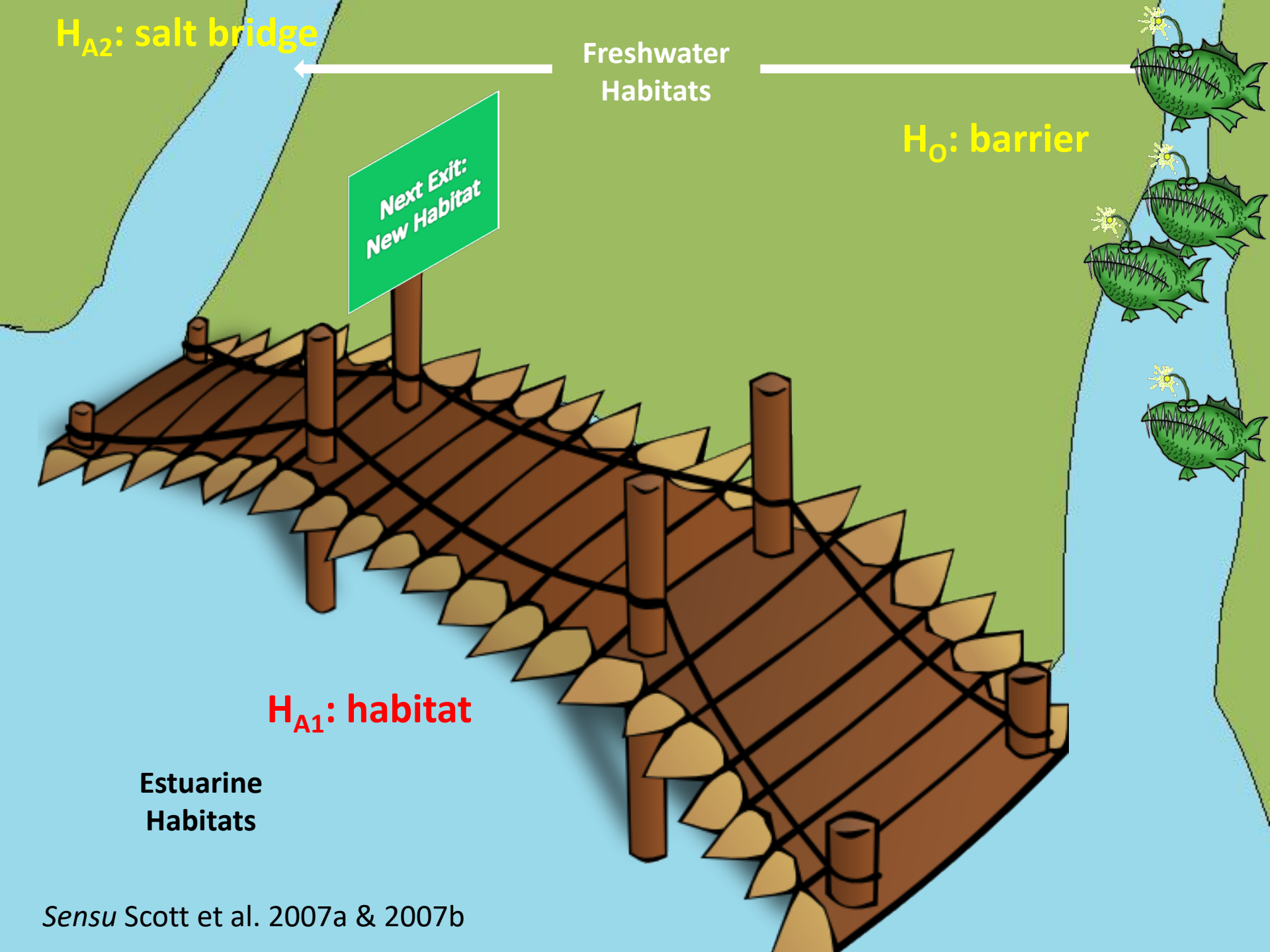
USGS science for a changing world

US Army Corps of Engineers®
Engineer Research and Development Center

NILE TILAPIA IN MS

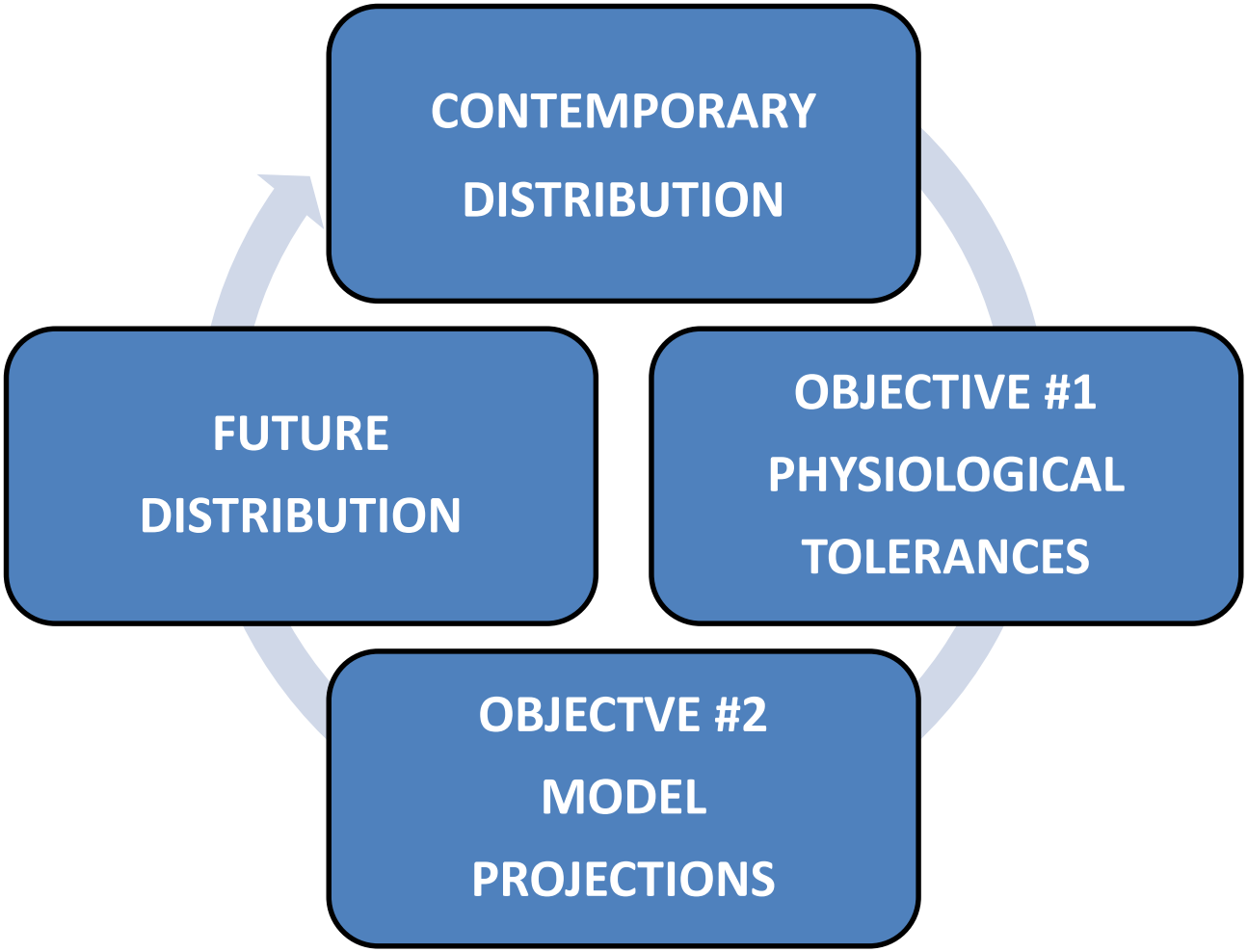


- What is the role of estuarine waters?



Sensu Scott et al. 2007a & 2007b

OBJECTIVES


CONTEMPORARY DISTRIBUTION
OBJECTIVE #1 PHYSIOLOGICAL TOLERANCES
OBJECTVE #2 MODEL PROJECTIONS
FUTURE DISTRIBUTION

OBJECTIVES

CONTEMPORARY DISTRIBUTION

OBJECTIVE #1 PHYSIOLOGICAL TOLERANCES

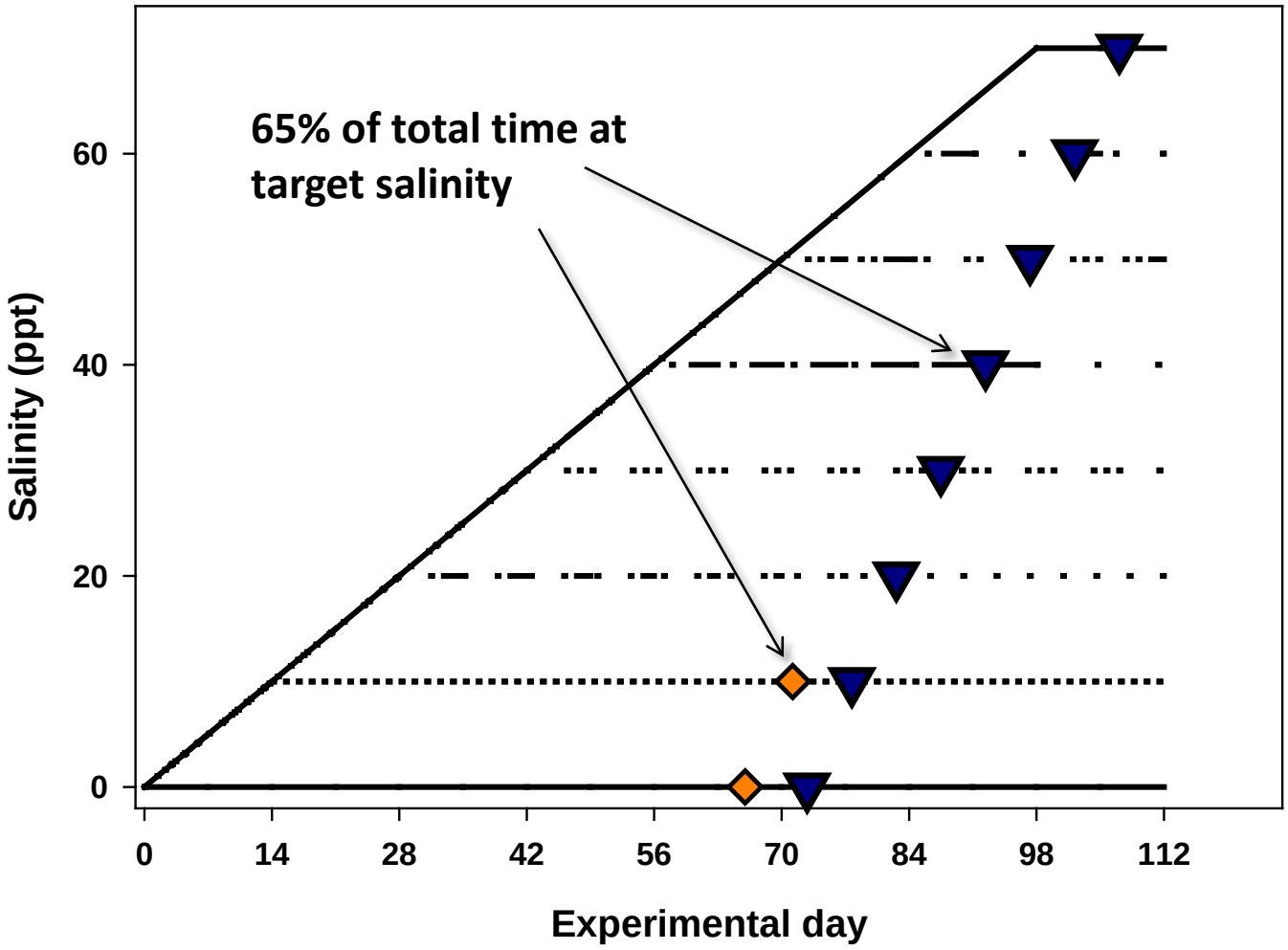
OBJECTVE #2 MODEL PROJECTIONS

FUTURE DISTRIBUTION

METHODS

- Nile tilapia from Robinson Bayou, MS (Pascagoula River)
- Summer (29.4°C ± 1.1 SD) and Winter (13.9 °C 0.3 SD)
- 0, 10, 20, 30, 40, 50, 60, and 70‰ salinity
- 12 fish per treatment in summer (n = 192)
- 10 fish per treatment in winter (n = 176)

Design



Summer (▽)

- 112 d total

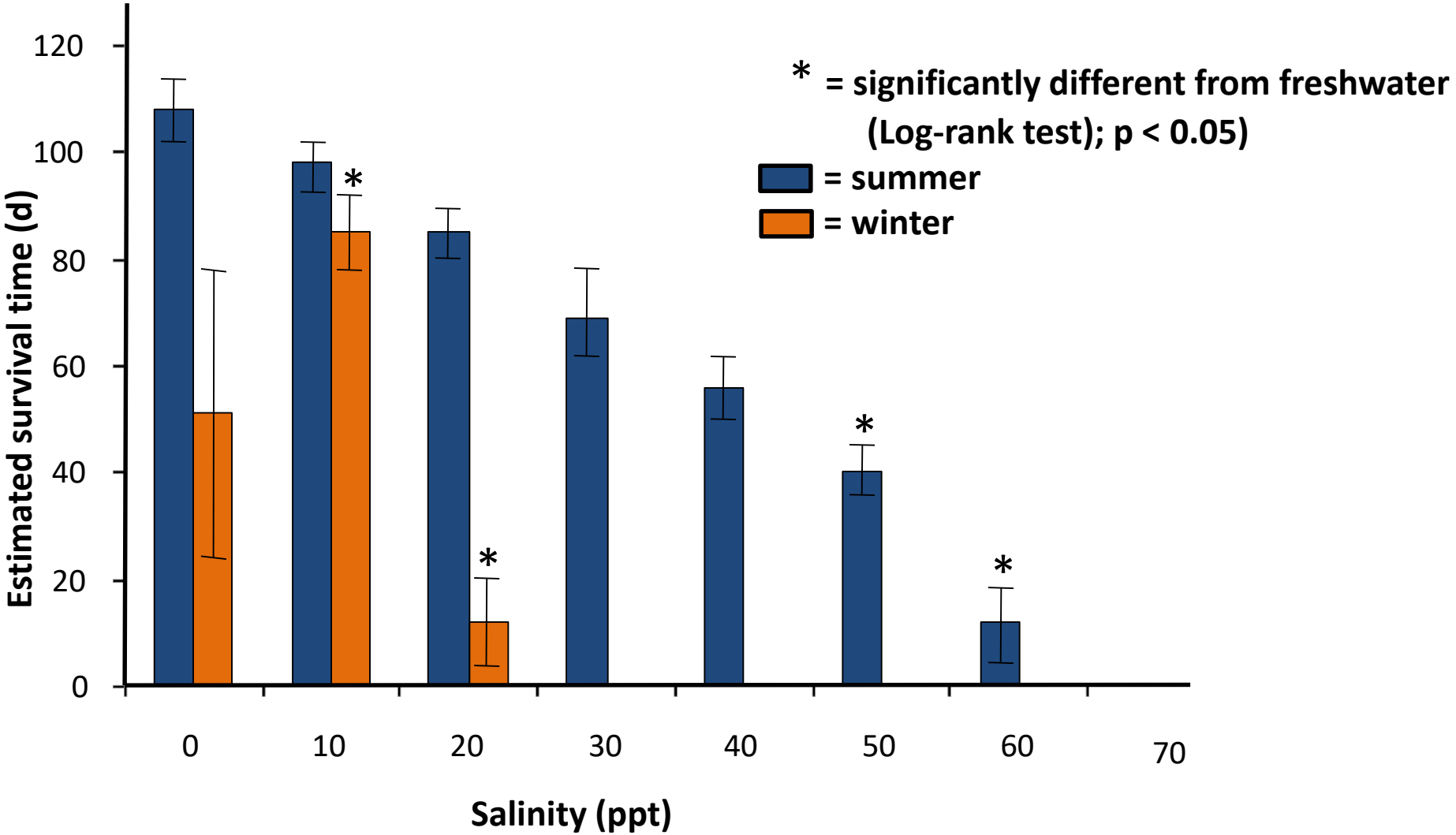
Winter (◆)

- 102 d total

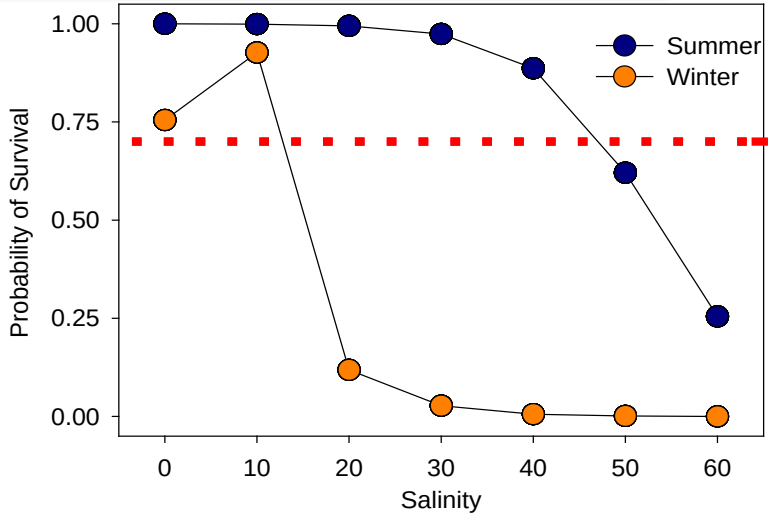
METHODS

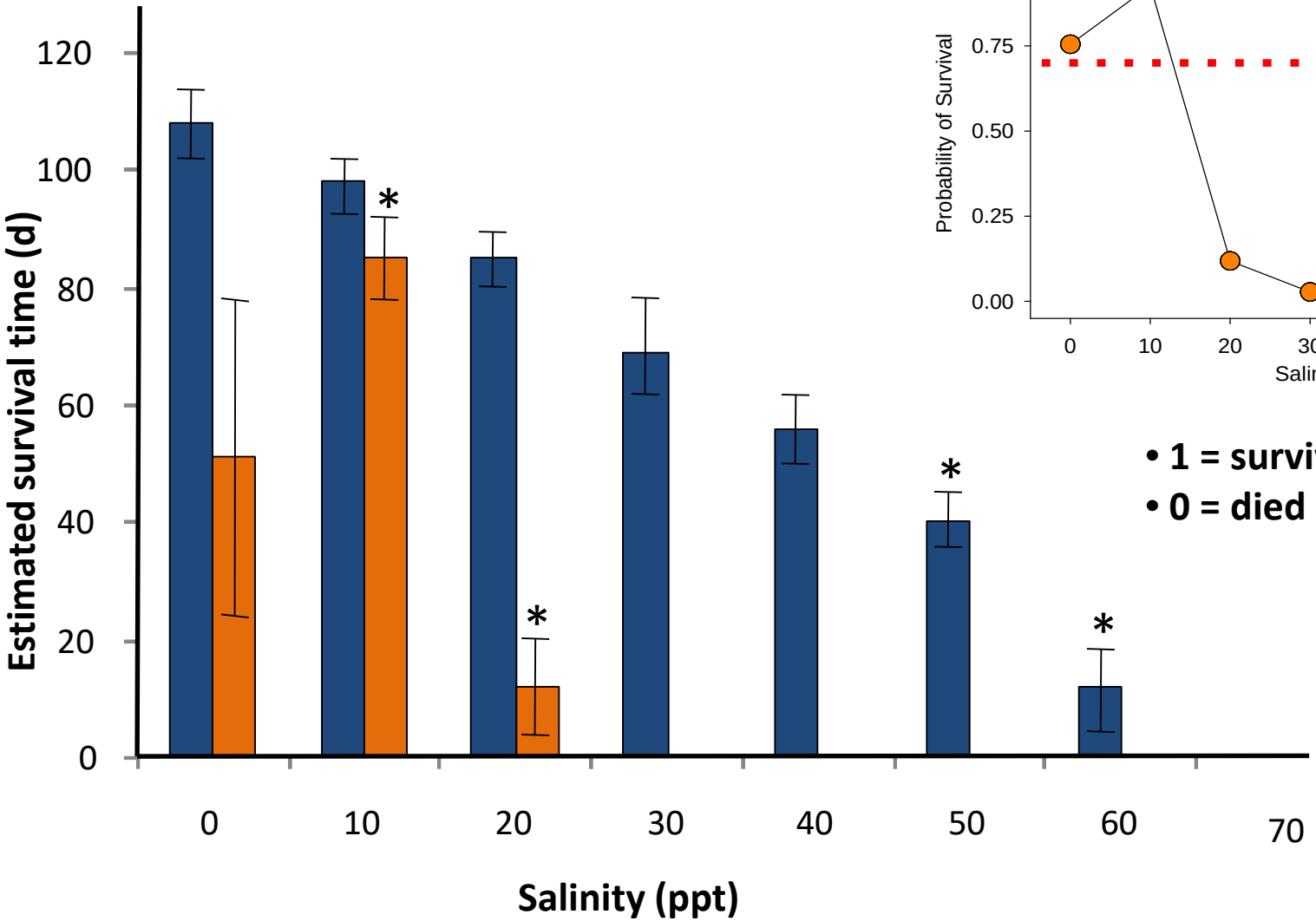
- **Mortality (both sexes)**
  - Kaplan-Meier estimator
    - Log-rank test
- **Female growth (**g BW• day^{-1})
  - Kruskal-Wallis
    - Mann-Whitney U tests
- **Female Gonado-Somatic Index (GSI)**
  - One-way ANOVA
    - Adjusted for final body mass (g)
  - Relative oocyte abundance and batch fecundity
    - Relative batch fecundity mirrored GSI
- **Logistic Regression**
  - Survival
    - 1 = survived
    - 0 = died
  - Growth
    - 1 = positive growth
    - 0 = negative growth
  - Reproduction
    - 1 = GSI > 1.8
    - 0 = GSI < 1.8
  - Biologically relevant thresholds
    - Minimum probability for each variable

SURVIVAL


120
100
80
60
40
20
0
Estimated survival time (d)
0
10
20
30
40
50
60
70
Salinity (ppt)
* = significantly different from freshwater (Log-rank test); p < 0.05)
= summer
= winter
*
*
*
*

SURVIVAL

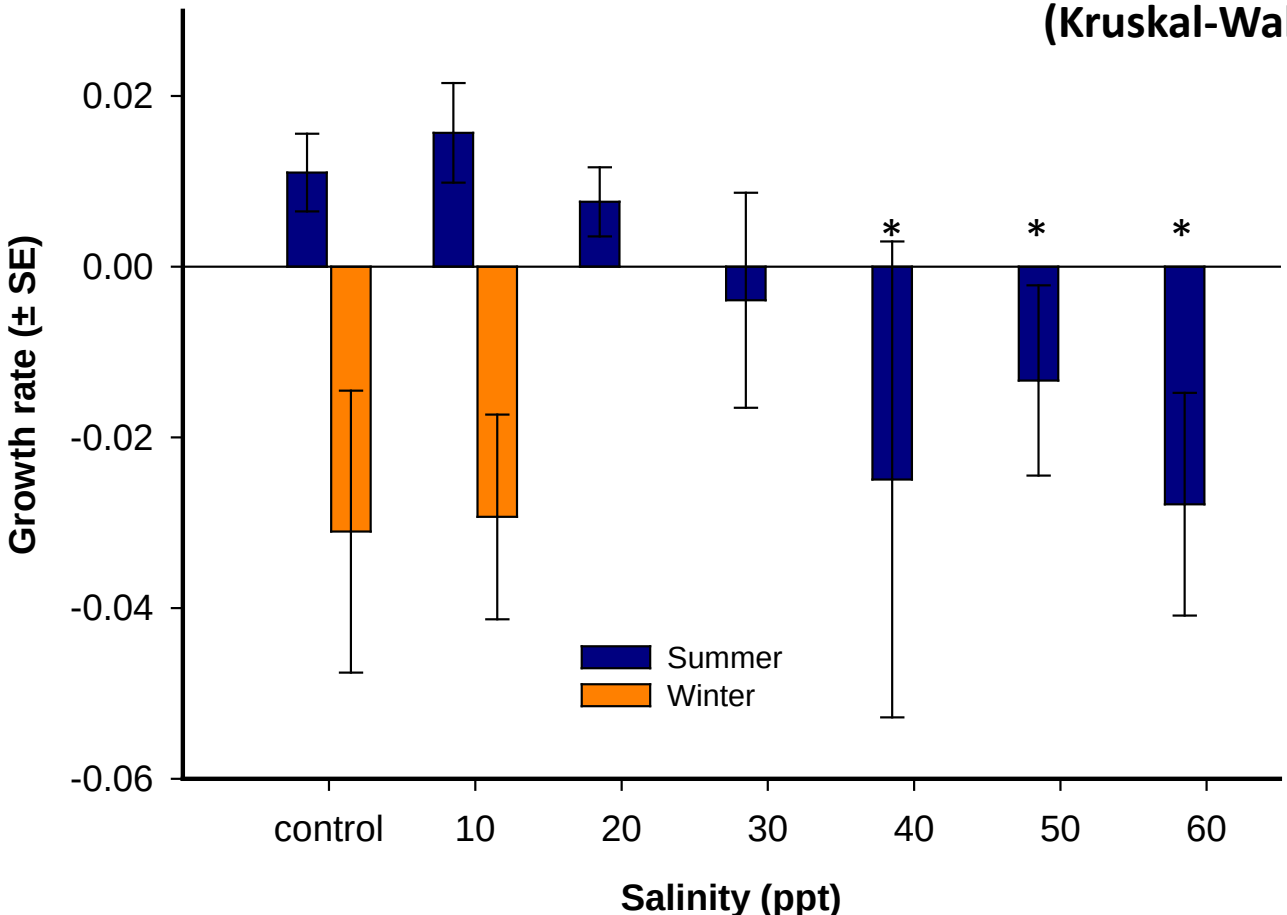




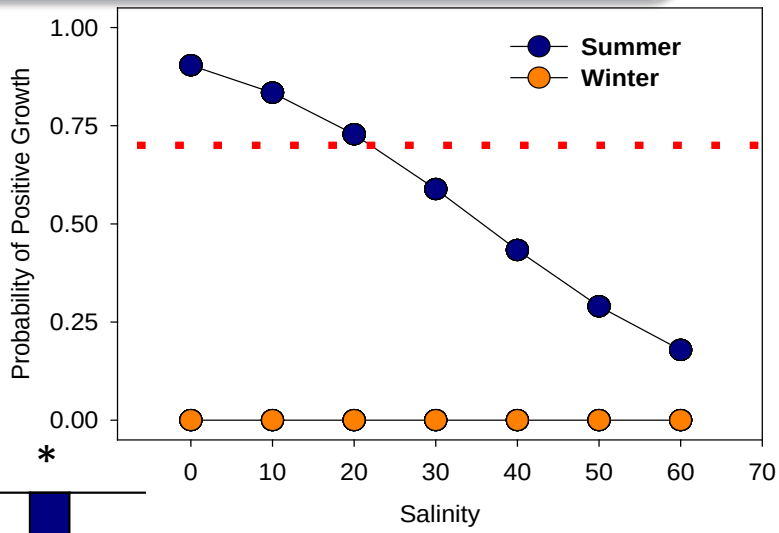
- **1 = survived**
- **0 = died**

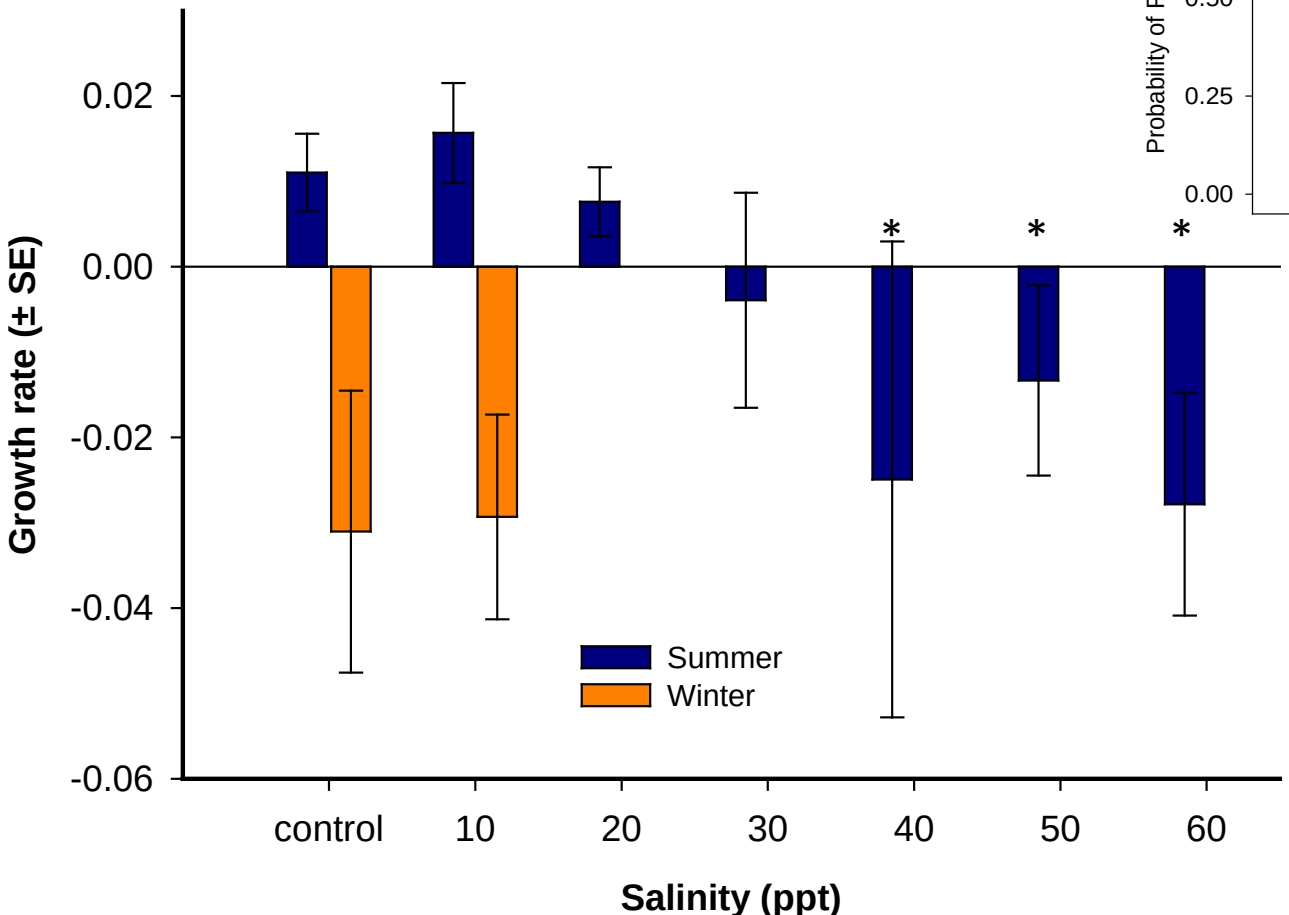
FEMALE GROWTH

*** = significantly different from freshwater (Kruskal-Wallis; p < 0.05)**



FEMALE GROWTH

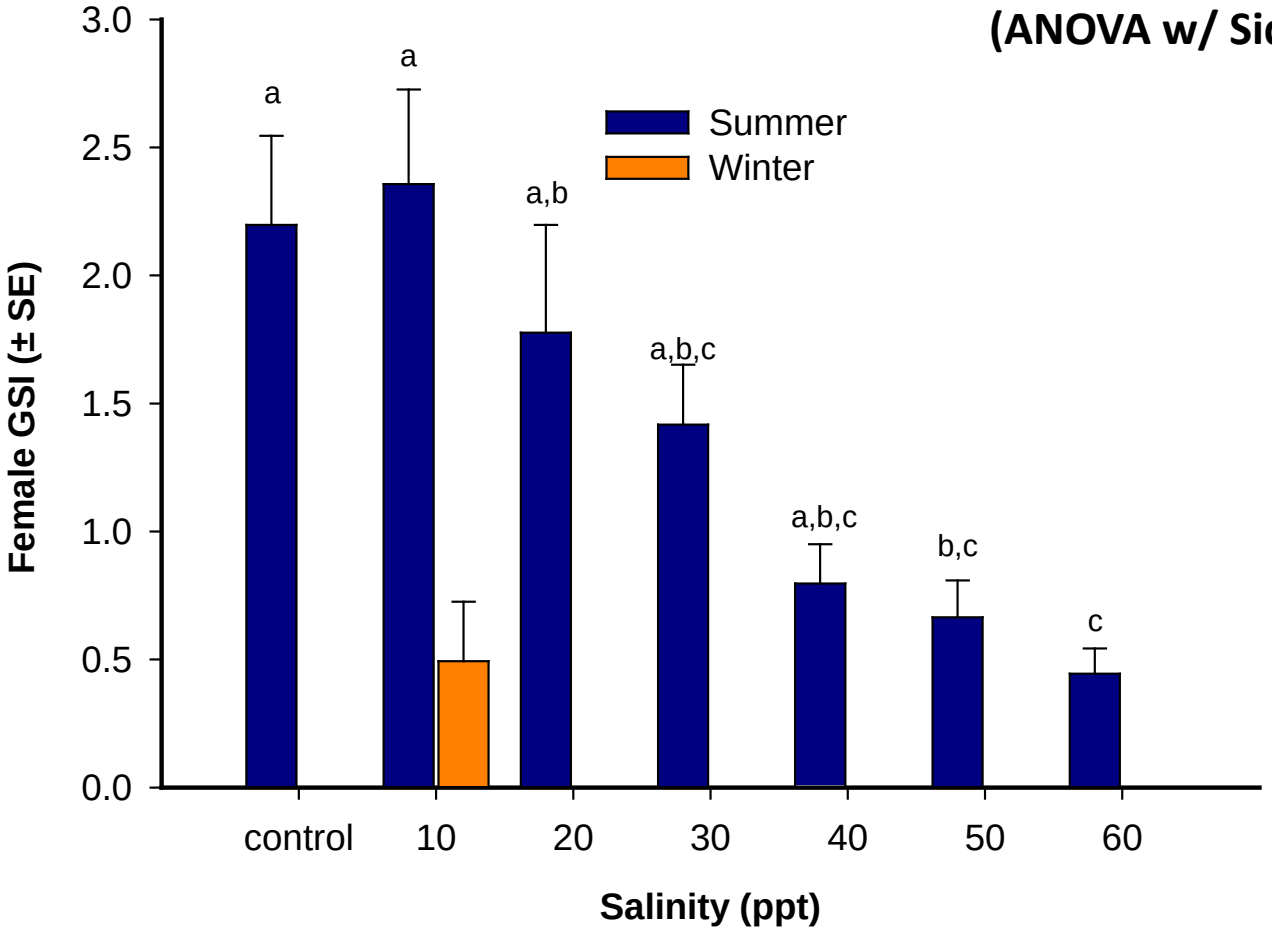




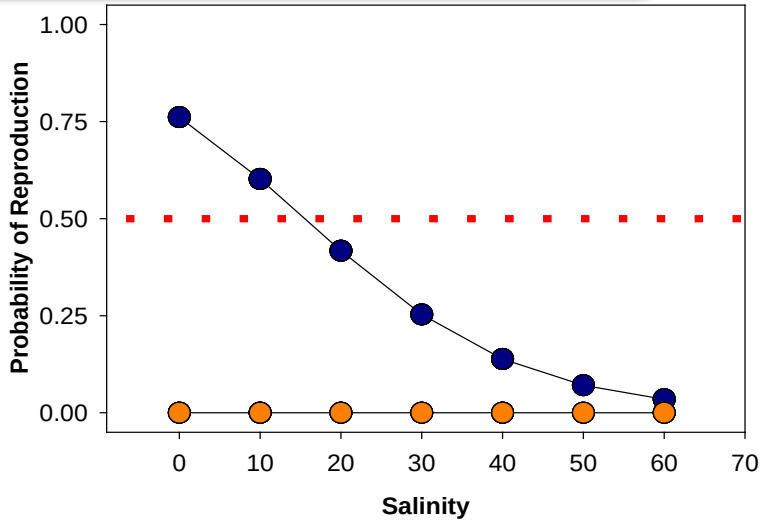
- **1 = positive growth**
- **0 = negative growth**

FEMALE GSI

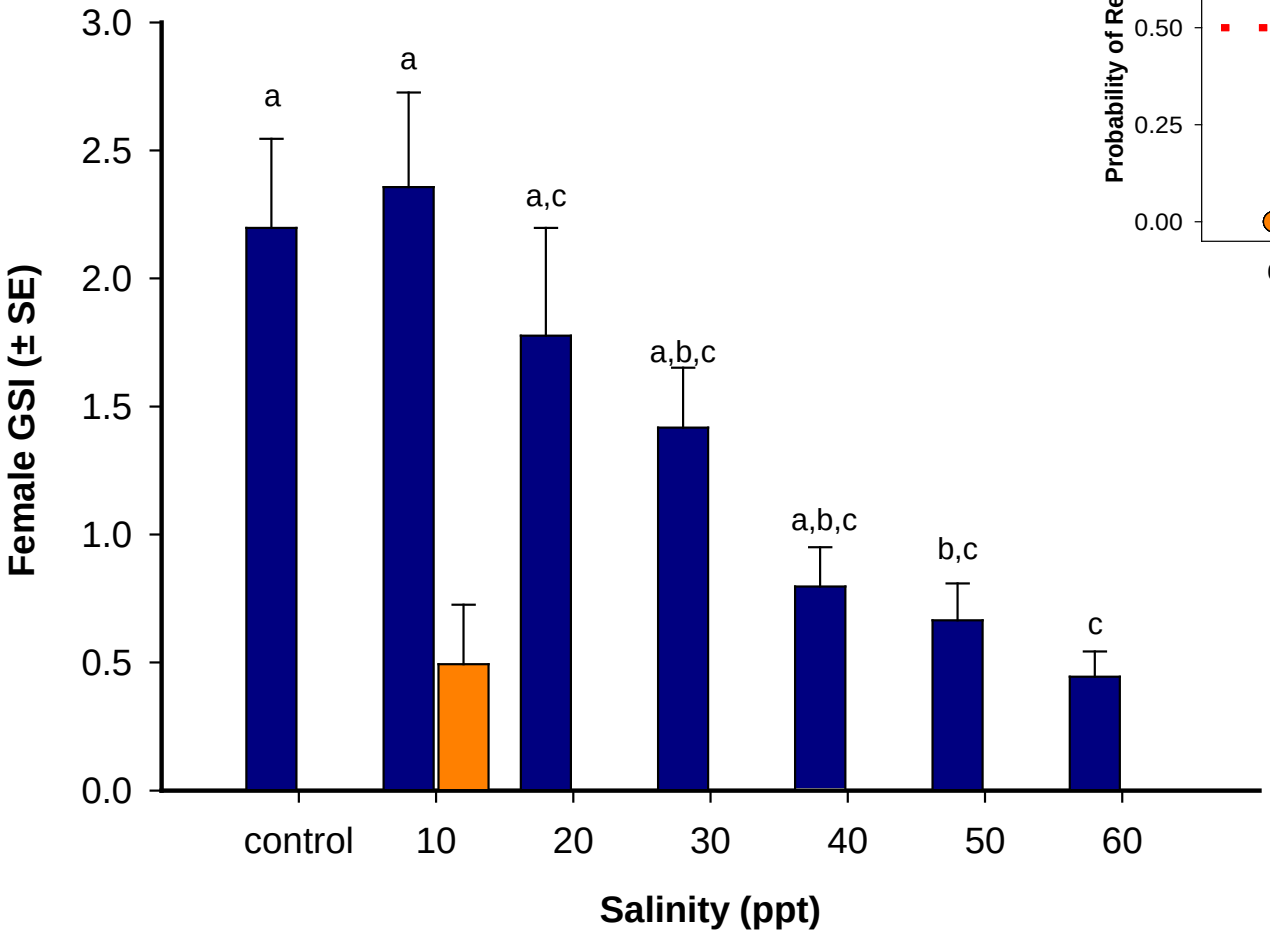
a,b,c = significantly different
(ANOVA w/ Sidak test; p < 0.05)



REPRODUCTION



- **1 = GSI > 1.8**
- **0 = GSI < 1.8**



OBJECTIVES

CONTEMPORARY DISTRIBUTION

OBJECTIVE #1 PHYSIOLOGICAL TOLERANCES

OBJECTVE #2 MODEL PROJECTIONS

FUTURE DISTRIBUTION

METHODS

- **Salinity and Temperature data**
  - Multiple data sources (GCRL, MS-DEQ, MS-DMR, and USGS)
  - 1992-2009

- **Universal kriging**
  - Two separate salinity maps
    - Summer (27.5 – 32.5 °C)
    - Winter (12.5 – 17.5 °C)
  - *P(x)* of survival (S), growth (G), and reproduction (R)

$$\text{where, } P(x) = \frac{\exp(\alpha + \text{salinity}' \bullet \beta)}{1 + \exp(\alpha + \text{salinity}' \bullet \beta)}$$

  - Biologically relevant threshold

STATIONS

Summer Stations (n = 230)

Winter Stations (n = 222)

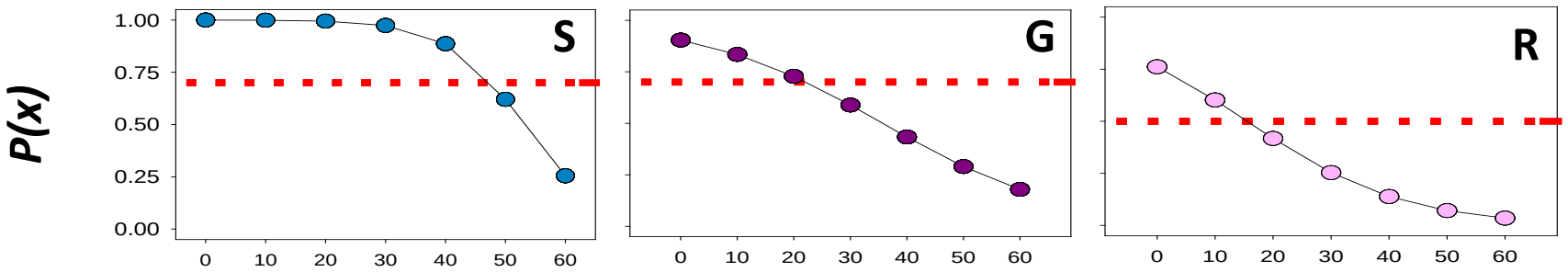
SUMMER SALINITY

SUMMER S, G, & R

S & G

S, G, & R

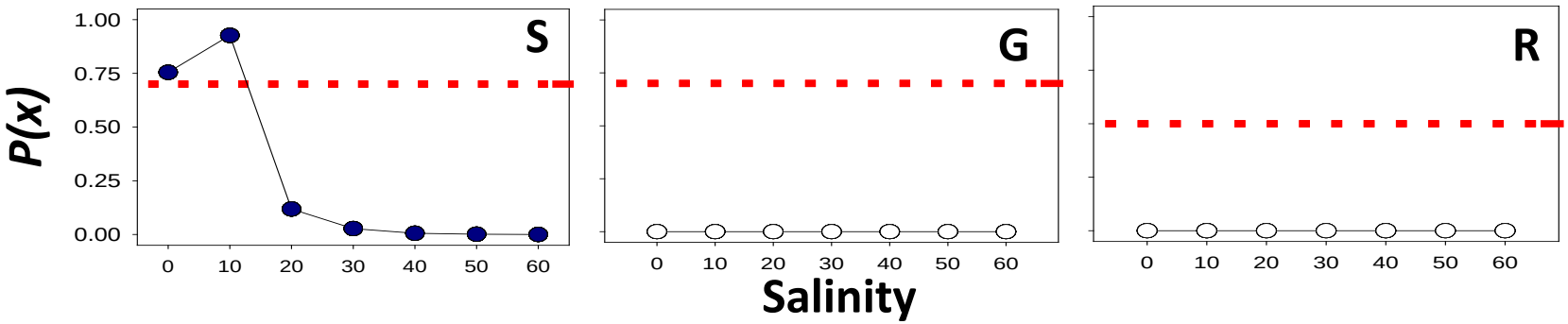
S only

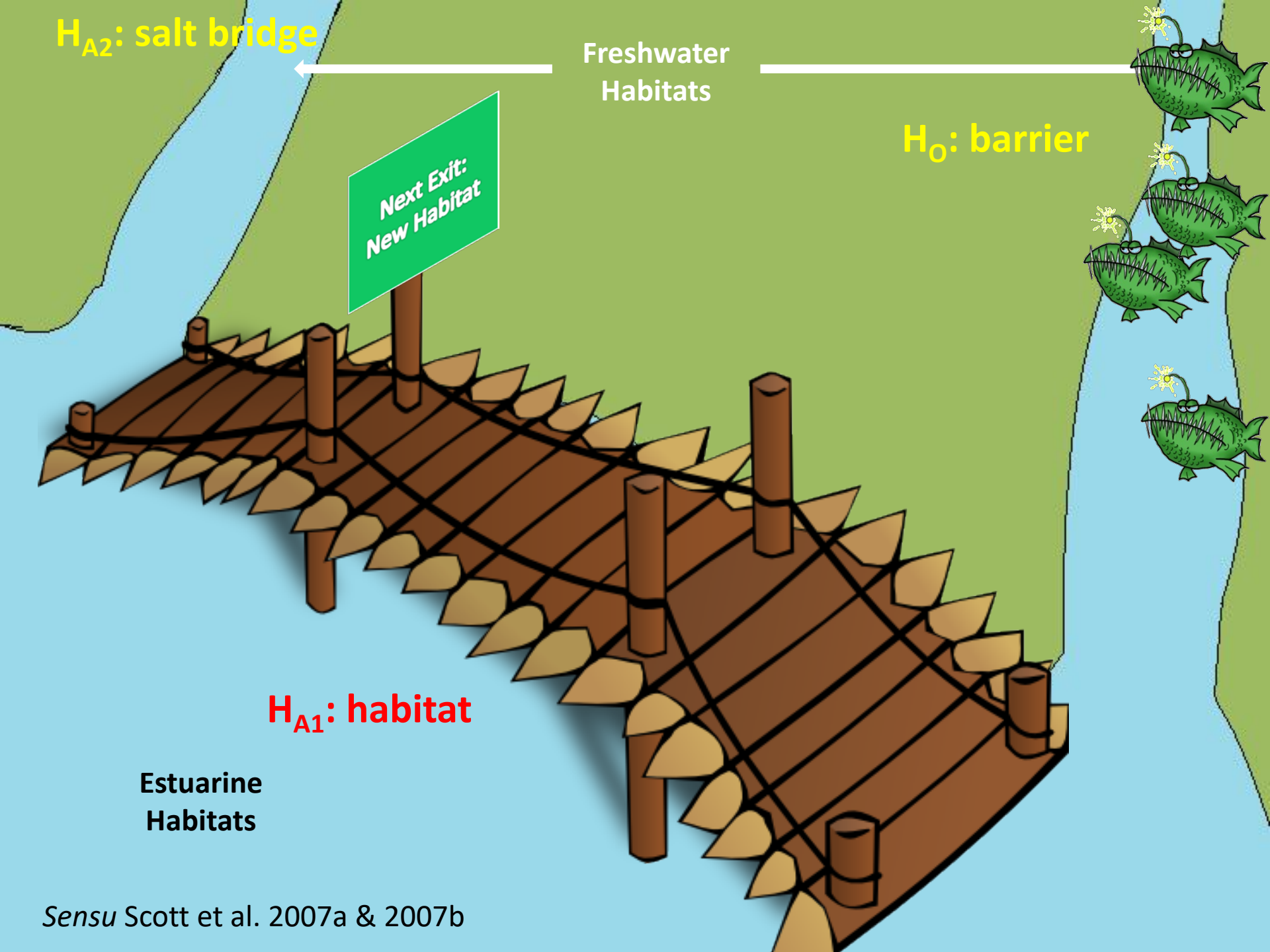


WINTER SALINITY

Winter S, G, & R

S only





Sensu Scott et al. 2007a & 2007b

ACKNOWLEDGEMENTS

- **Laboratory Assistance**
  - Jacqueline N. Langston & Denise R. Gregoire

- **Data Sources**
  - Fisheries Assessment and Monitoring Program-GCRL
  - Mississippi Department of Marine Resources
  - Mississippi Department of Environmental Quality
  - Shark Laboratory-GCRL

- **Funding Agencies**
  - Mississippi Department of Wildlife, Fisheries, and Parks
  - U.S. Fish and Wildlife Service Region 4
  - U.S. Geological Survey Invasive Species Program