CERP and killifish habitat in Biscayne Bay's littoral zone

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GEER 2015

Session 3 - Biscayne Bay Part I: Assessment of Current and Recent Ecosystem Conditions in Western Biscayne Bay

April 21, 2015; Coral Springs, FL USA

Outline

- **Study area & purpose**
- **Field methods & results**
- **Laboratory methods & results**
- **Application: habitat suitability & scenario testing**

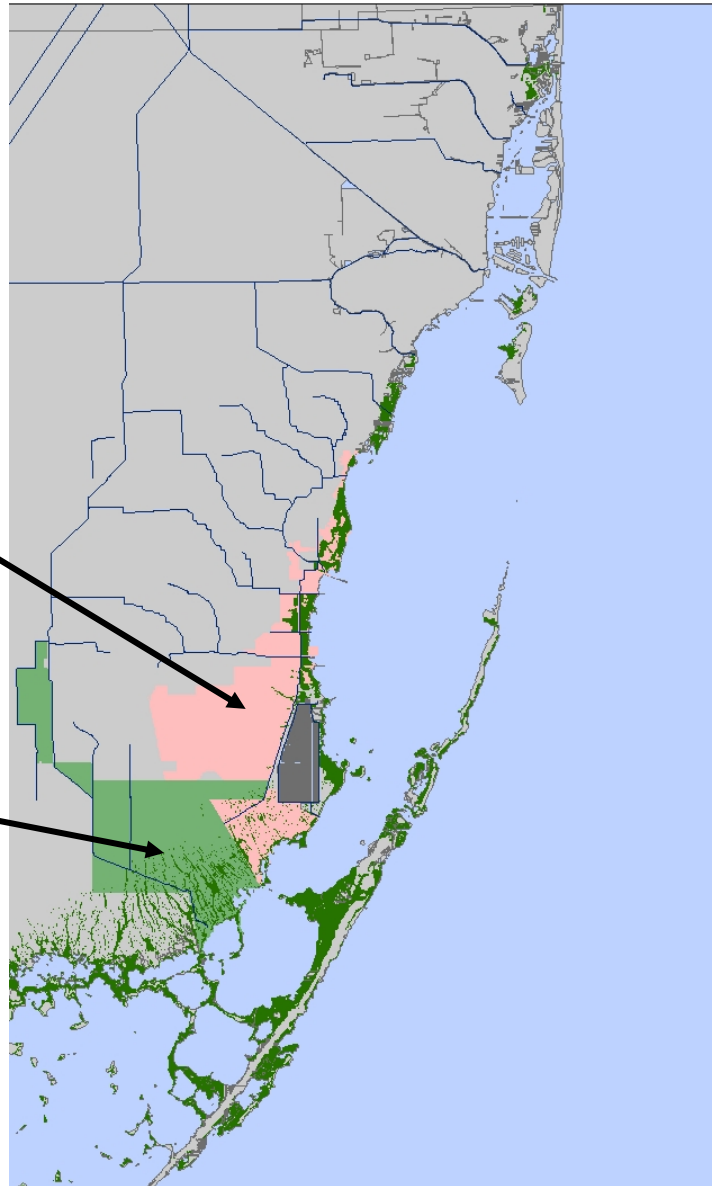
  McManus et al. (2014). Ecol. Indic. 44: 173-181.

- **Goldpotted killifish abundance and temperature/salinity extremes?**

Purpose

Biscayne Bay Coastal Wetlands Project

C111 Spreader Canal Project

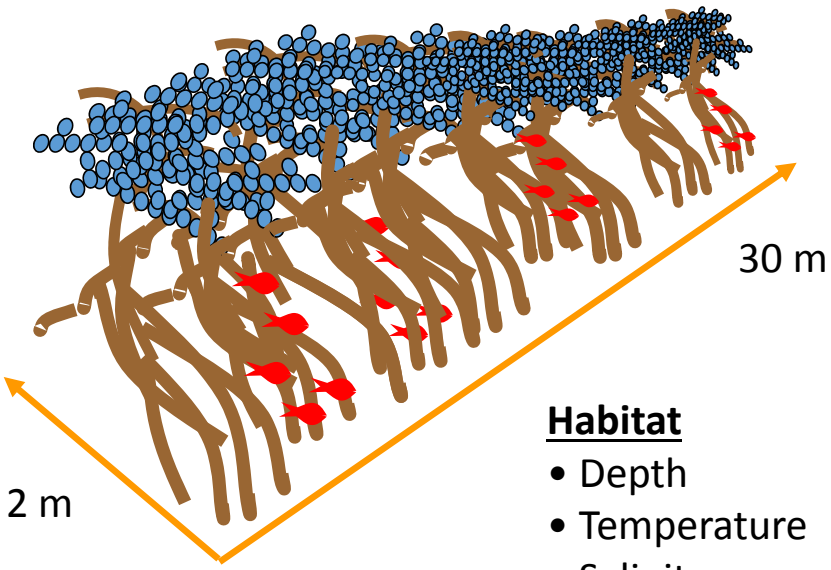


Problem
Loss/hydrologic isolation of wetlands; reduced and unnatural FW flows to the Bay.

Goal
Capture, treat, and redistribute fresh water to create more natural water deliveries and expand spatial extent and connectivity of coastal wetlands. Restore **mesohaline** (5 -18) and avoid **hypersaline** (>40) salinities along shoreline

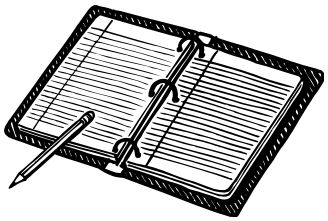
Action
- Land acquisition
- Pump stations
- Spreader swales
- Stormwater treatment areas
- Flow-ways
- Levees
- Culverts
- Canal backfilling

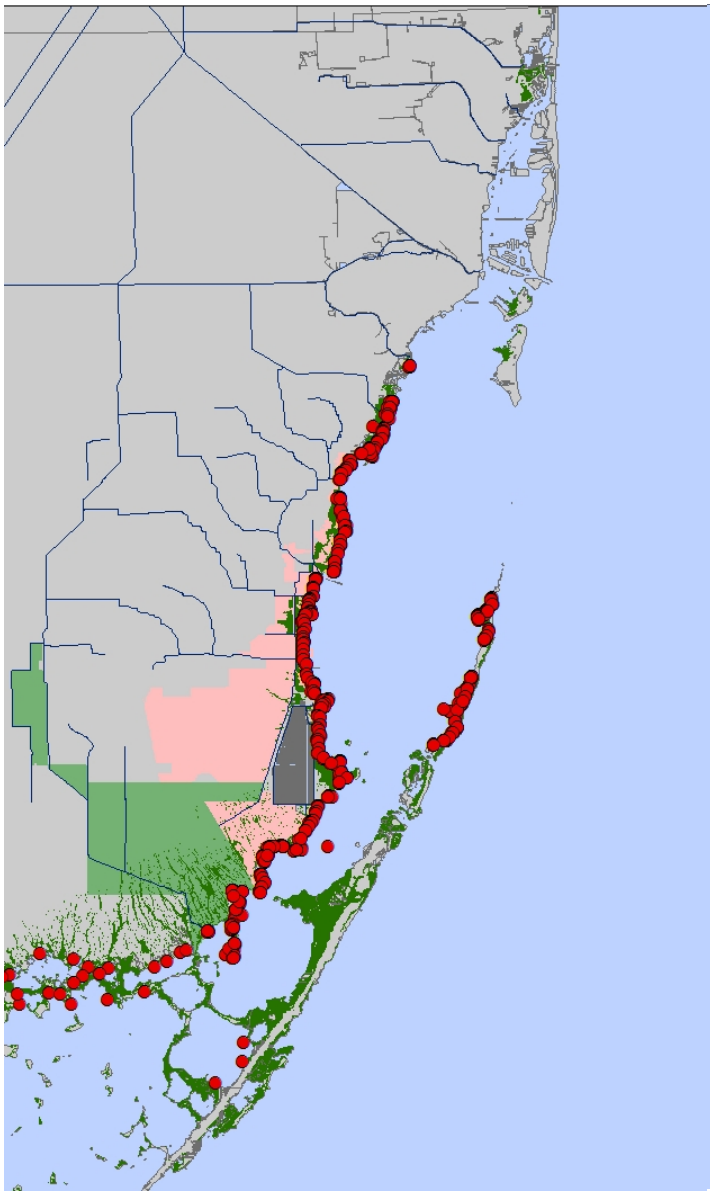
Field methods



Habitat
- Depth
- Temperature
- Salinity

Fishes
- Species/Taxon
- Number
- Total length (Min, Mean, Max)





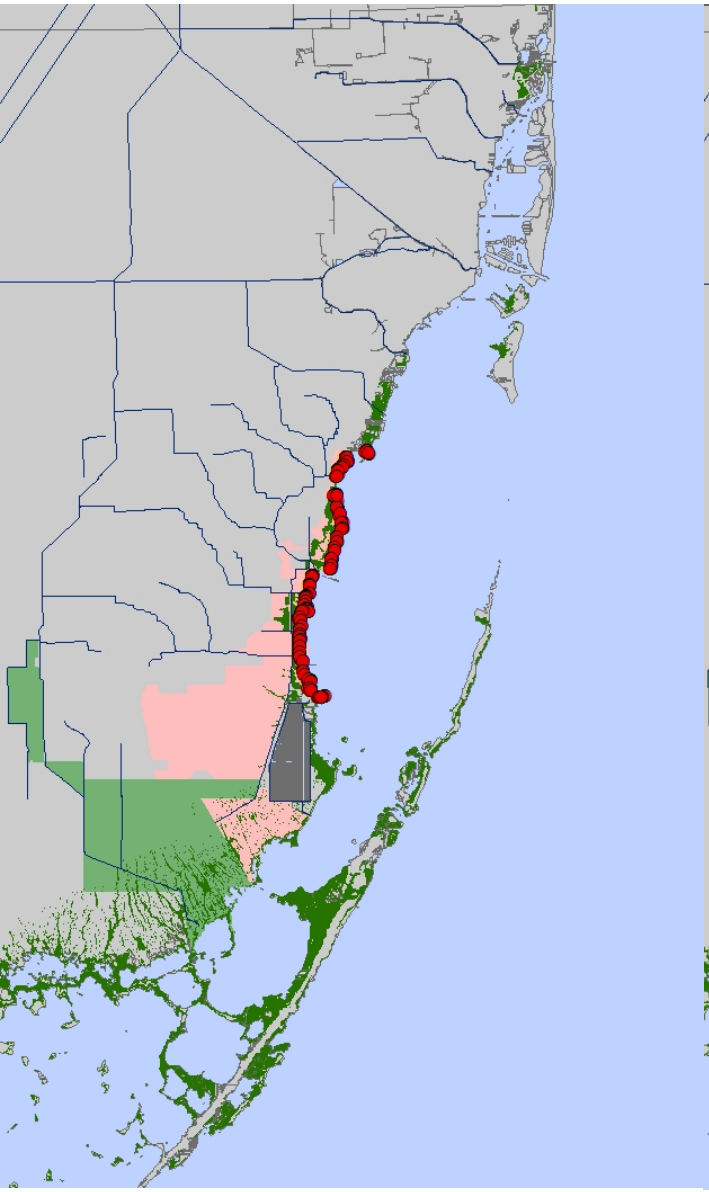
Study Duration
1998-present

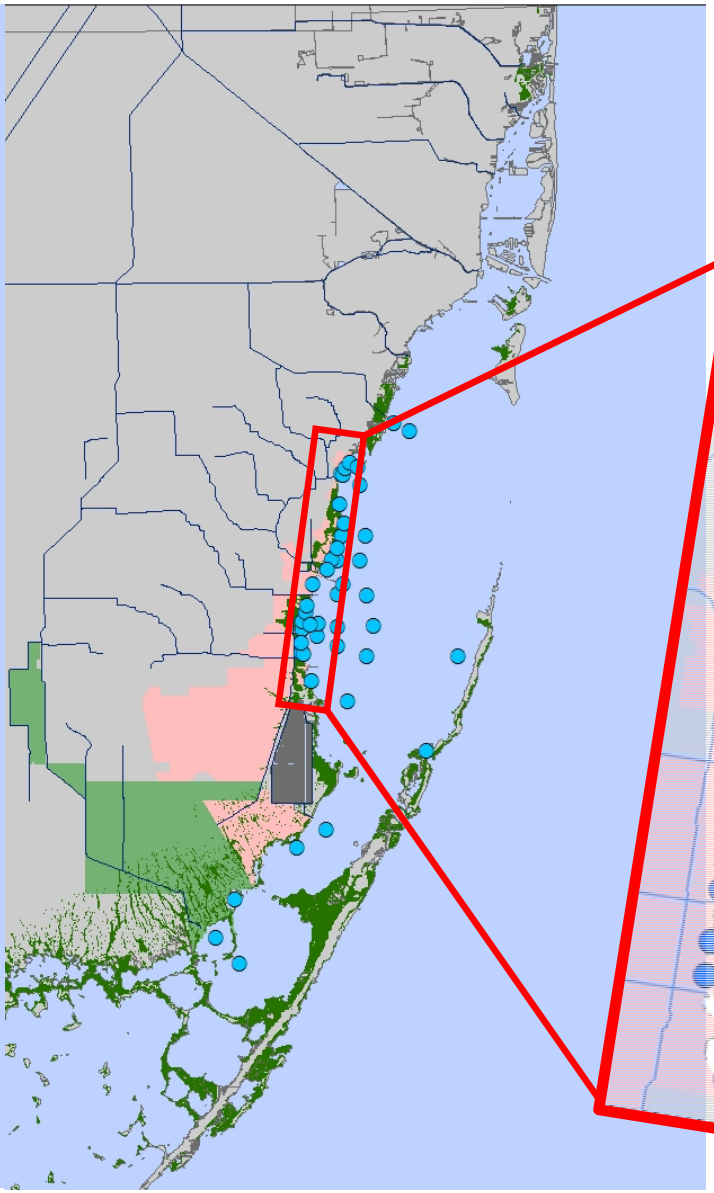
Seasonal
Wet & Dry
(Jul-Sep; Jan-Mar)

Total transects
>3,850

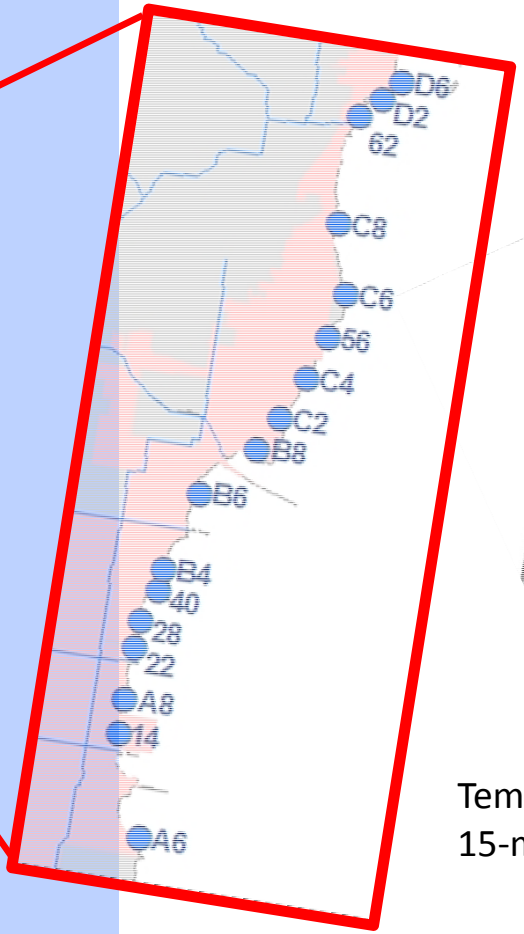
Fish Taxa
>100

No. sites
~120 (‘05 –’12)





2004 - present

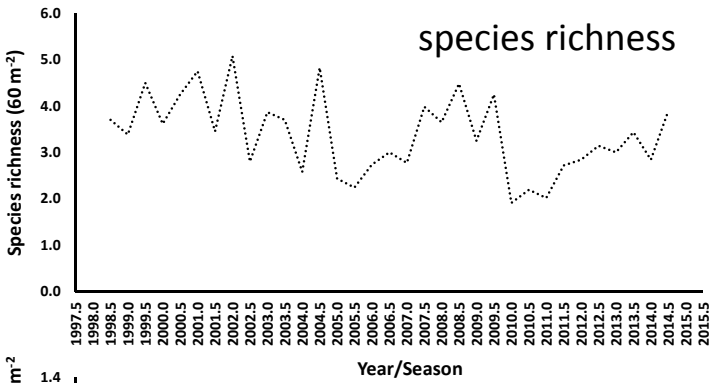


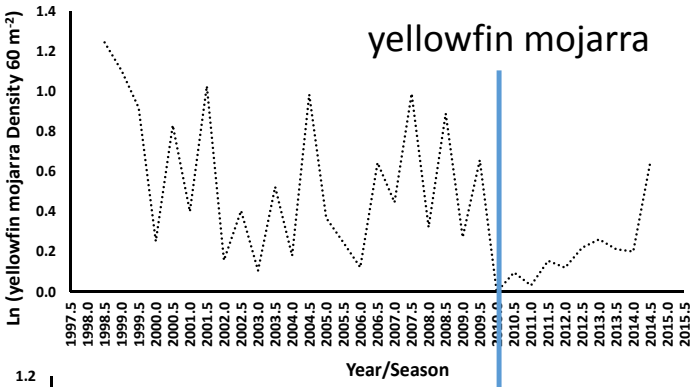
Temp, Salinity, Depth
15-minute resolution

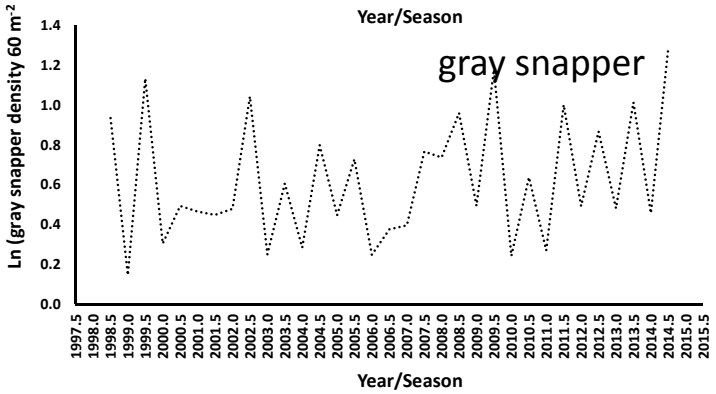
Temporal Trajectories

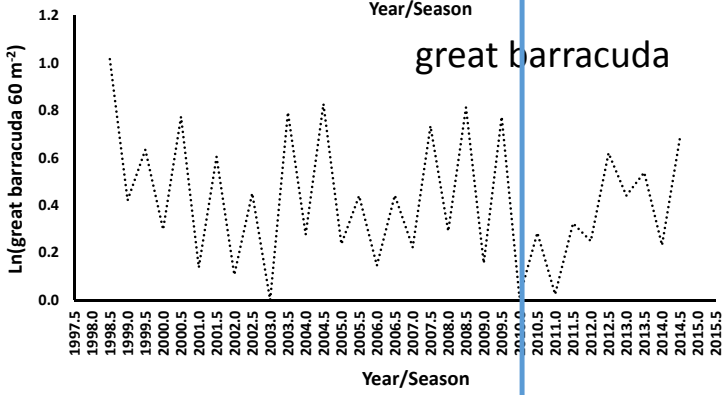
Time
'98 – '14

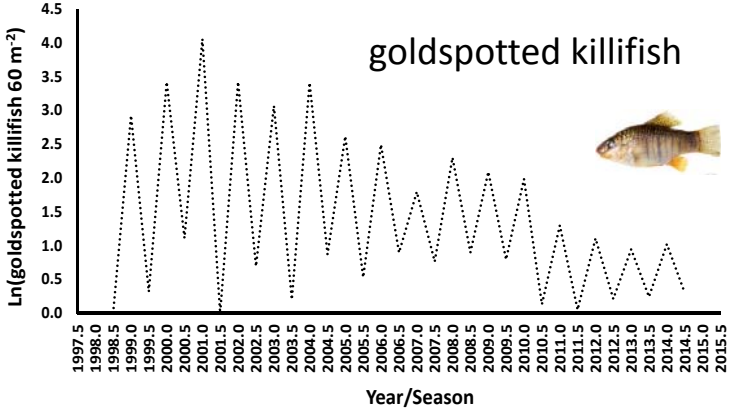
Mean Richness/Density per 60 m^2

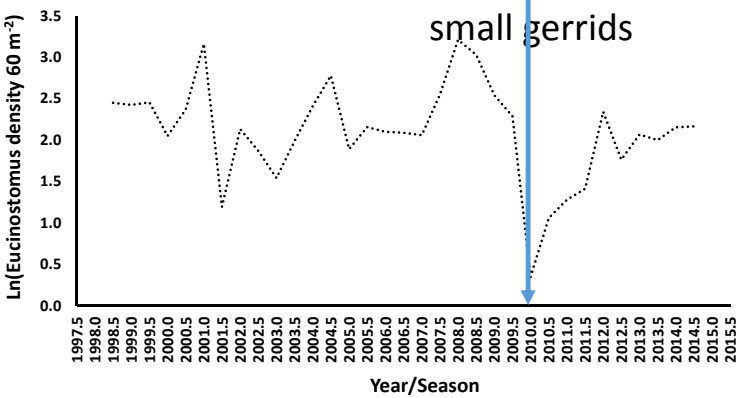


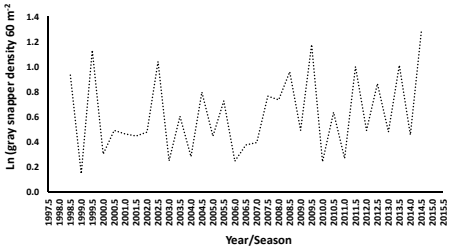


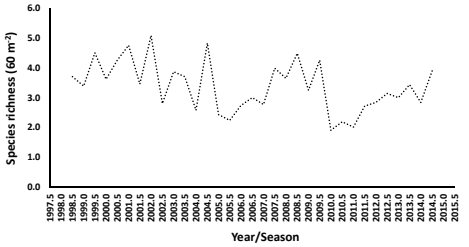


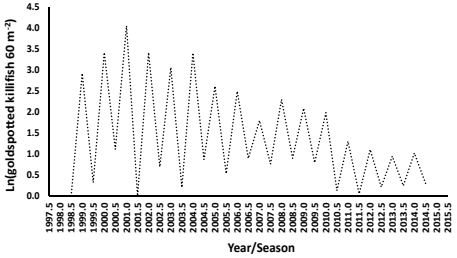












Measured variability:

salinity, temperature, depth, habitat structure

Variability more difficult to quantify:

- reproductive schedules
- egg/larval transport & recruitment success
- settlement/colonization pattern
- timing and quantity of food supply
- predation and fishing pressure
- social behavior
- representativeness of sampling

Habitat Suitability Approach

Identify “optimal” habitat properties (via examination distribution and abundance and laboratory studies) and manage to maximize those we can (or hope to) control

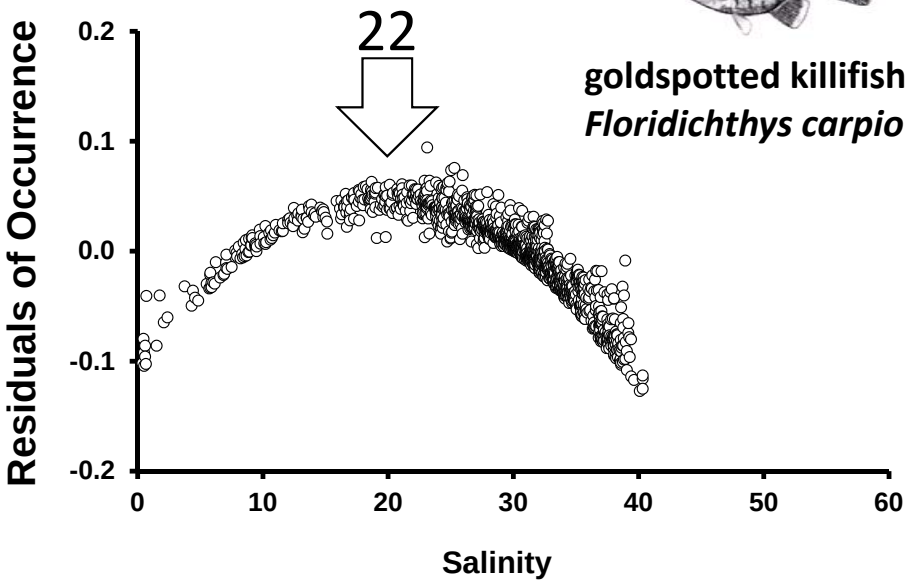
Killifish habitat suitability: regression

Dependent Variables: Occurrence (0,1)

Independent Variables:

Salinity (S)
Temperature (T)
Depth (D)
Salinity^2
Temperature^2
Depth^2

goldspotted killifish
Floridichthys carpio

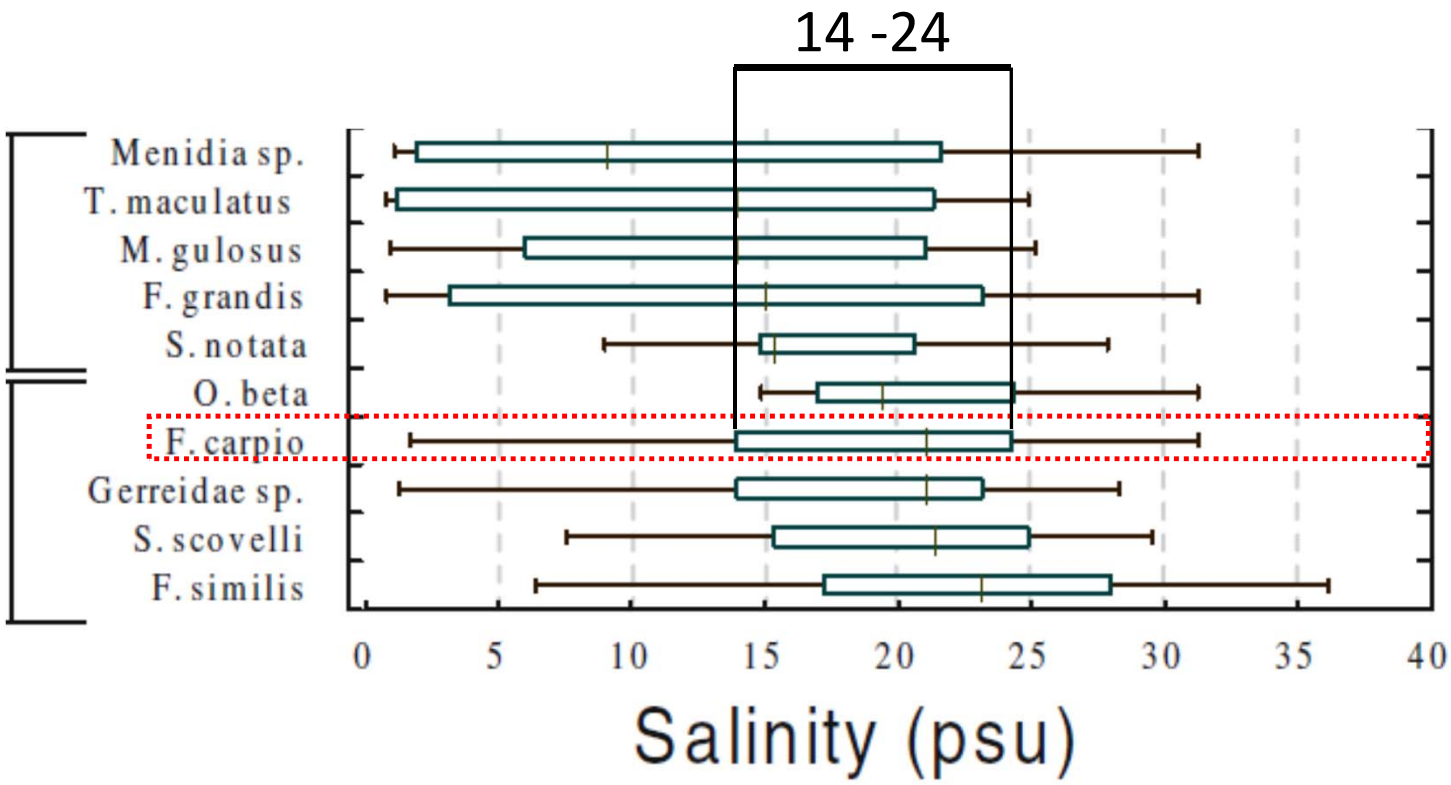


Approach: Backwards stepwise elimination

- Start with full model
- Sequentially eliminate non-sig. (P>0.05) terms
- Arrive at final model:

$$O = 5.2997 + (0.0693)S + (-0.0403)D + (-0.1504)T + (-0.00156)S^2$$

Independent field observations



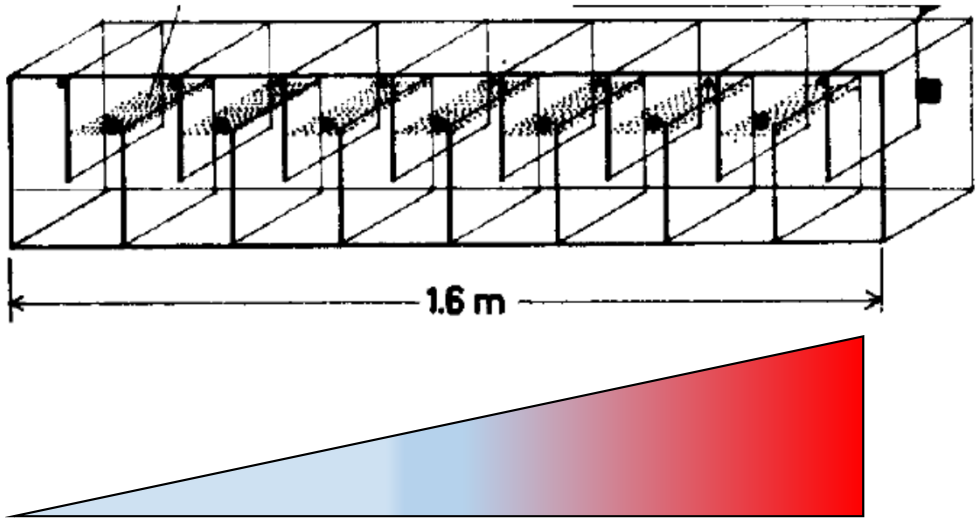
Lorenz and Serafy (2006) Hydrobiologia 569:401–422

Laboratory methods & results

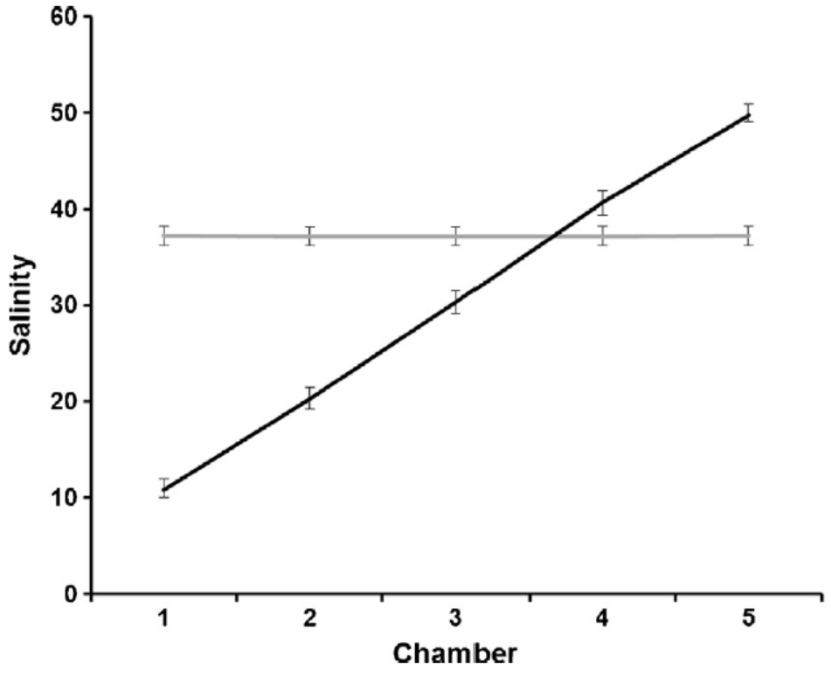
Comp. Biochem. Physiol., 1969, *Vol.* 29, *pp.* 853 *to* 857. *Pergamon Press. Printed in Great Britain*

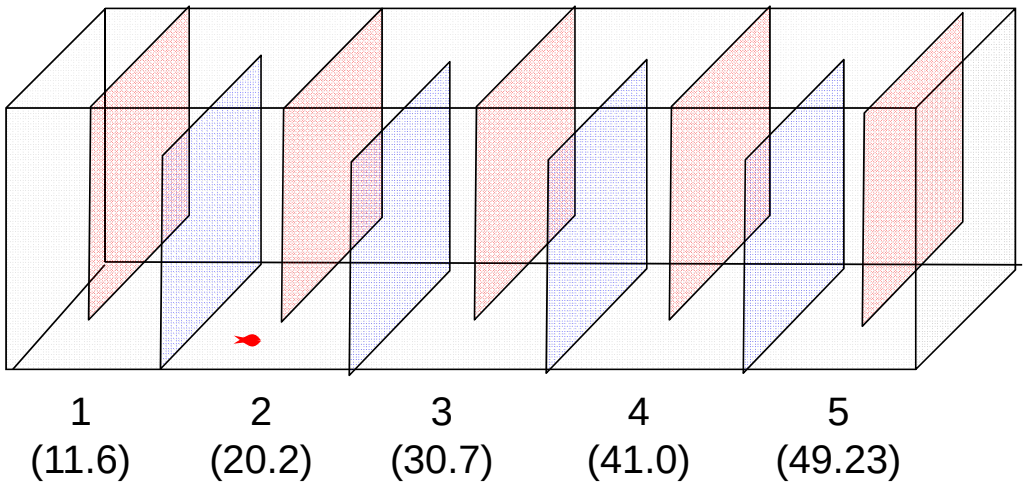
A DEVICE FOR THE STUDY OF SALINITY PREFERENCE IN MOBILE MARINE ANIMALS

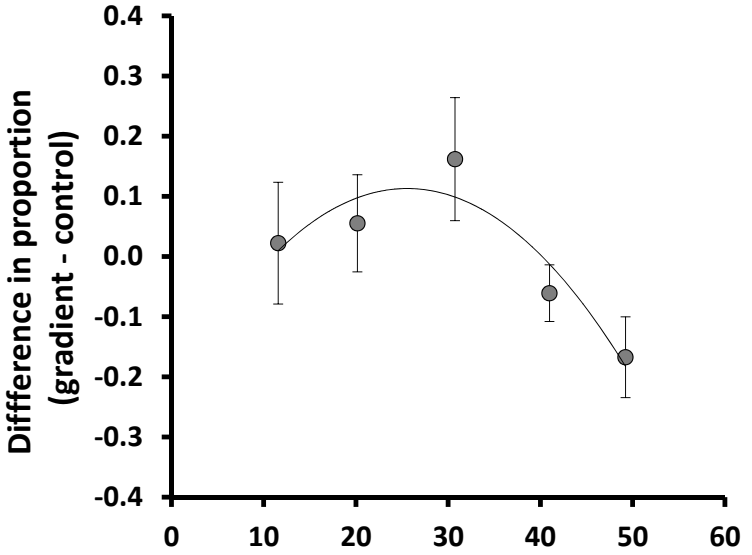
HANS STAALAND

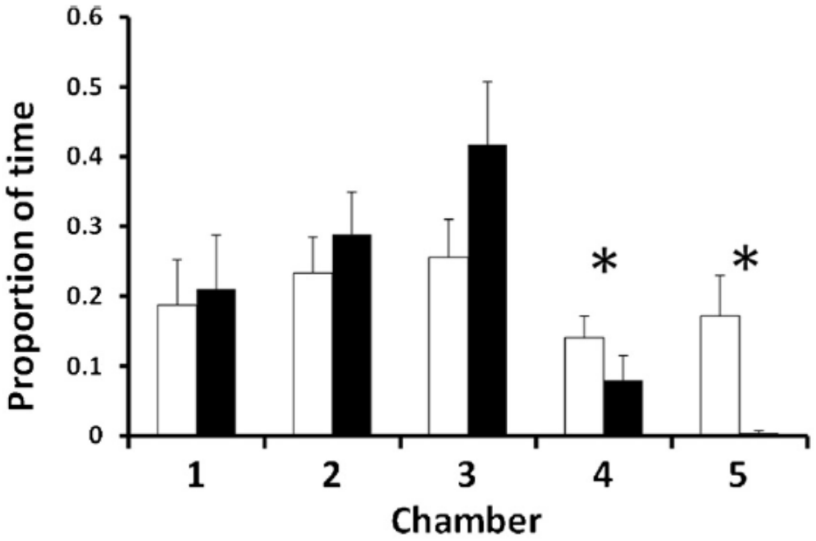


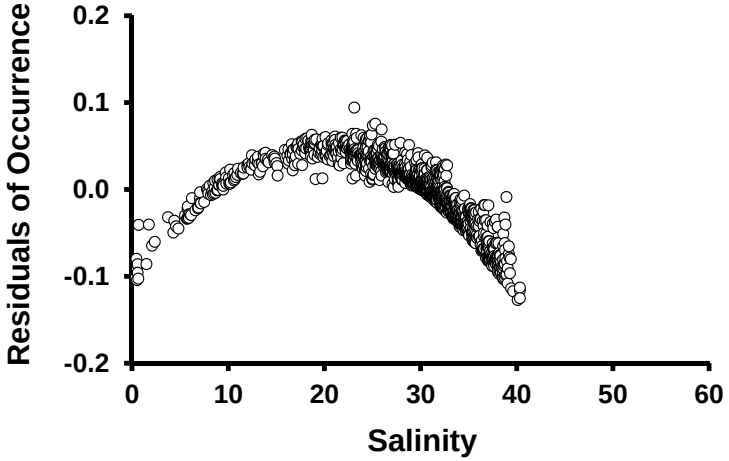
Salinity




1
(11.6)
2
(20.2)
3
(30.7)
4
(41.0)
5
(49.23)

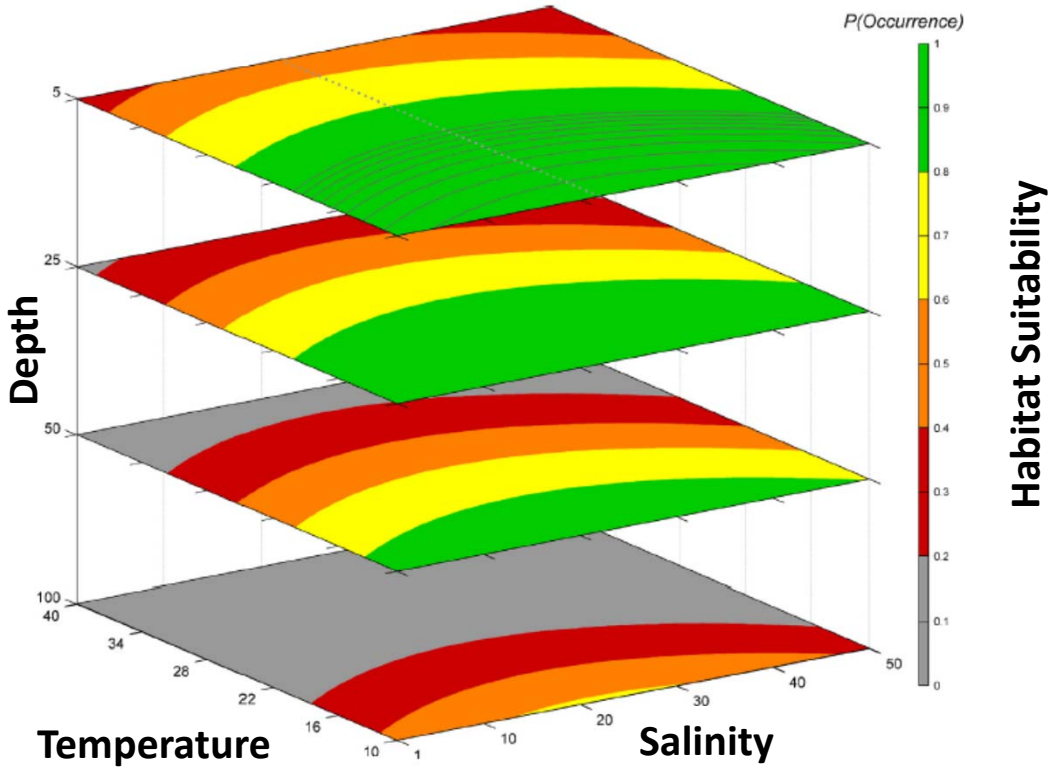

Difference in proportion
(gradient - control)
0.4
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
0
10
20
30
40
50
60

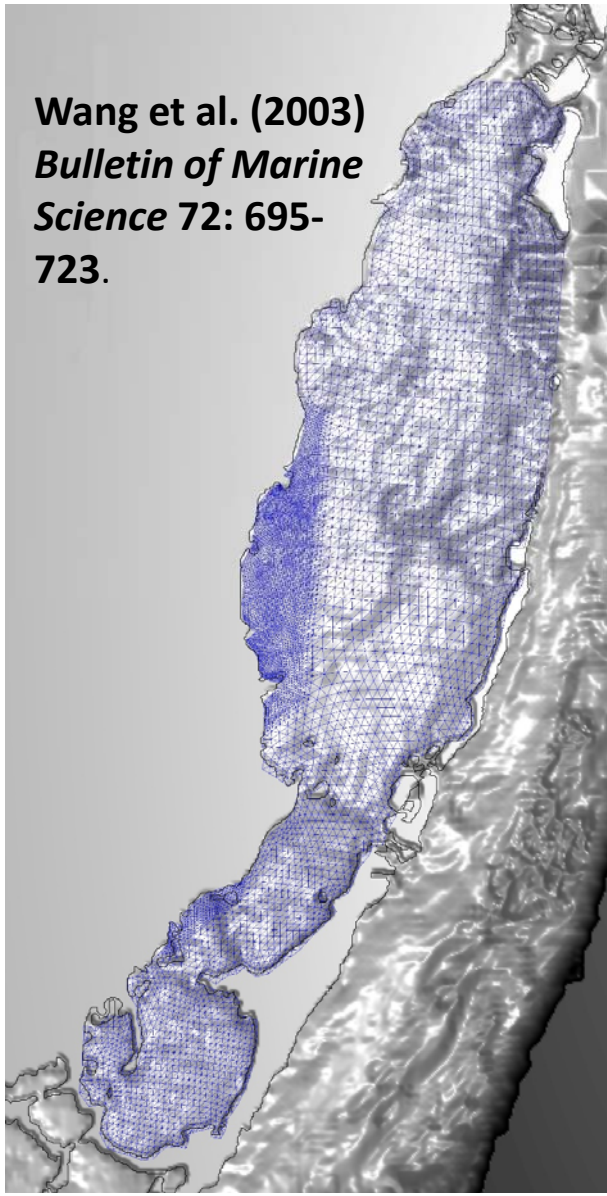

Proportion of time
0.6
0.5
0.4
0.3
0.2
0.1
0
*
*
1
2
3
4
5
Chamber

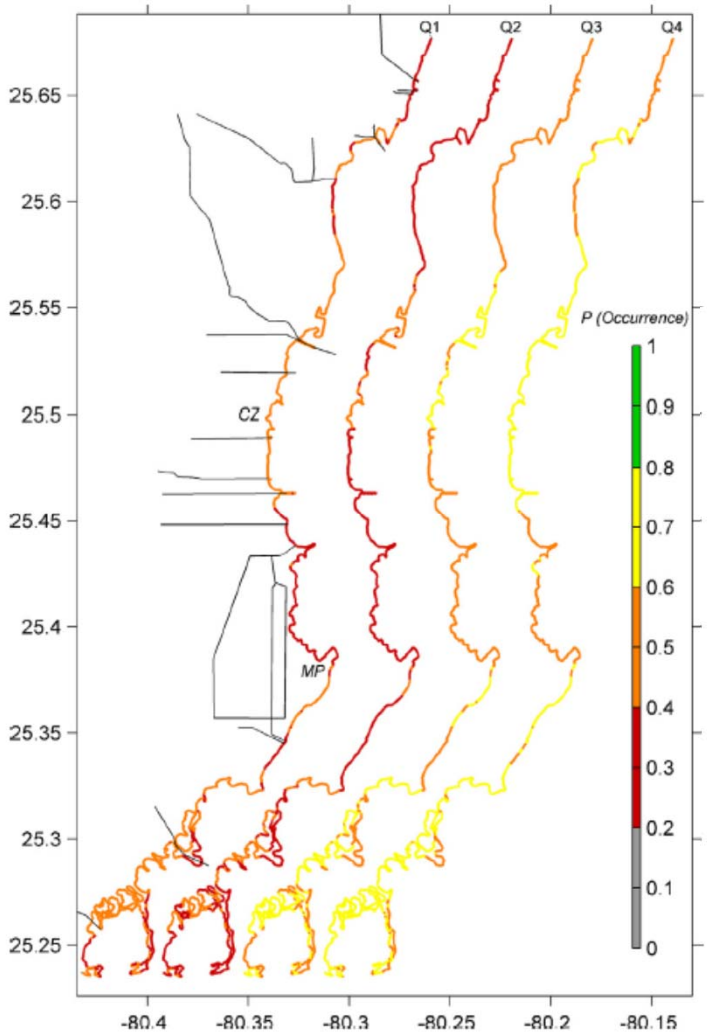

Residuals of Occurrence
0.2
0.1
0.0
-0.1
-0.2
0
10
20
30
40
50
60
Salinity

Application: habitat suitability & scenario testing

$O = 5.2997 + (0.0693)S + (-0.0403)D + (-0.1504)T + (-0.00156)S^2$





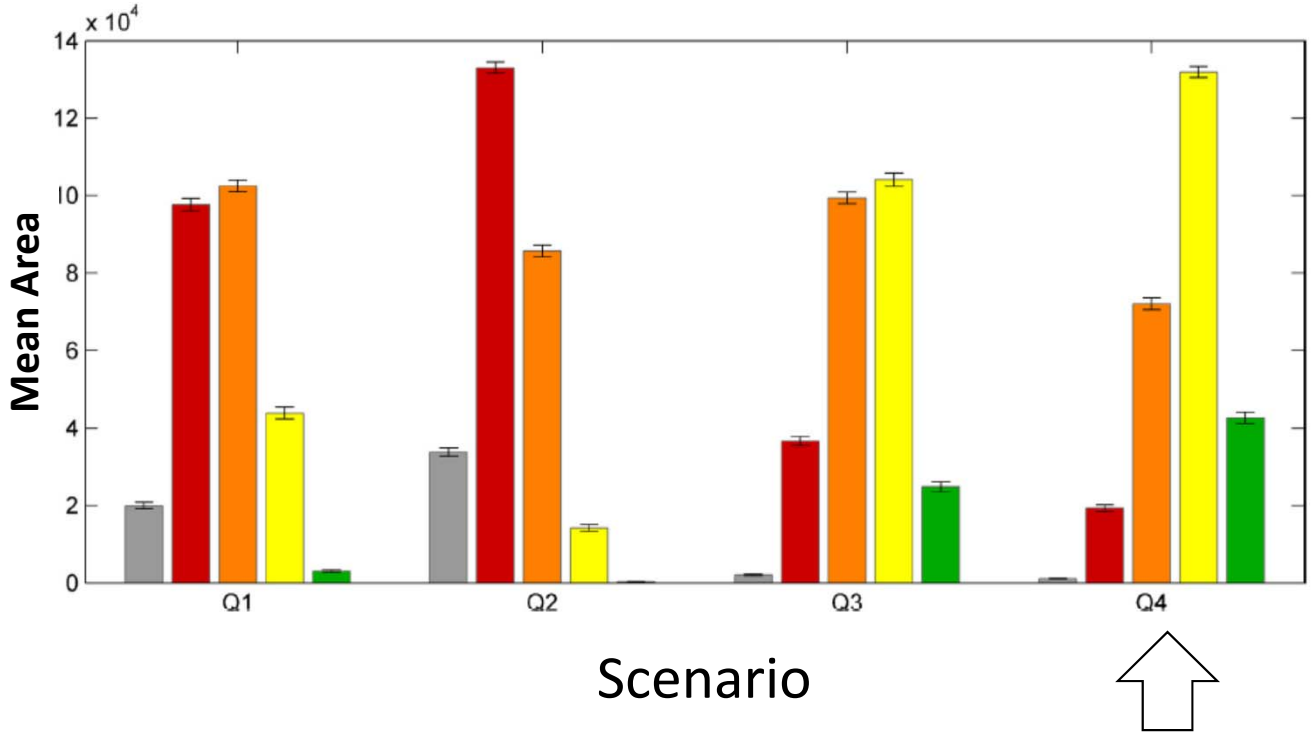


Habitat Suitability

Best

Worst

Application: scenario testing



Summary

- Mangrove-fish time series is now 17 years long (~33 consecutive seasons).
- Provides spatiotemporal trends in fish community and single-species metrics.
- Goldspotted killifish relationship with salinity consistent with independent field and laboratory results.
- This and other IBBEAM Habitat Suitability models have already been built (2 published) and these are ready for incorporation into hydrodynamic/hydrologic physical models for freshwater flow scenario testing.

However…

- Survey's spatial extent and statistical power compromised by funding cuts
- Need remains for an accepted hydrodynamic/hydrological model and provision of a realistic set of freshwater flow scenarios

Therefore…

- Expectations surrounding System Status Report accuracy, utility and predictions must be tempered accordingly

Ecological Indicators 44 (2014) 173–181

Contents lists available at ScienceDirect

Ecological Indicators

journal homepage: www.elsevier.com/locate/ecolind

Killifish habitat suitability as a measure of coastal restoration performance: Integrating field data, behavioral trials and simulation

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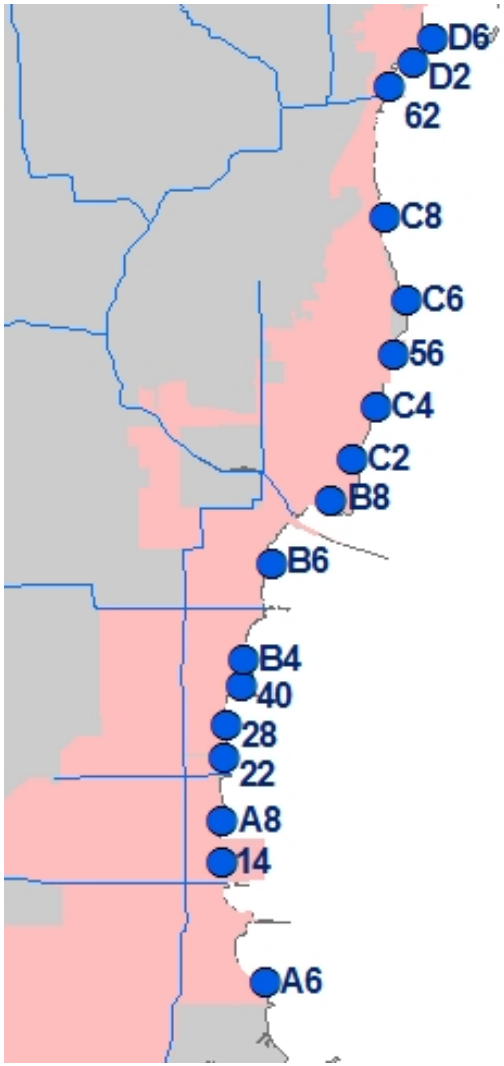
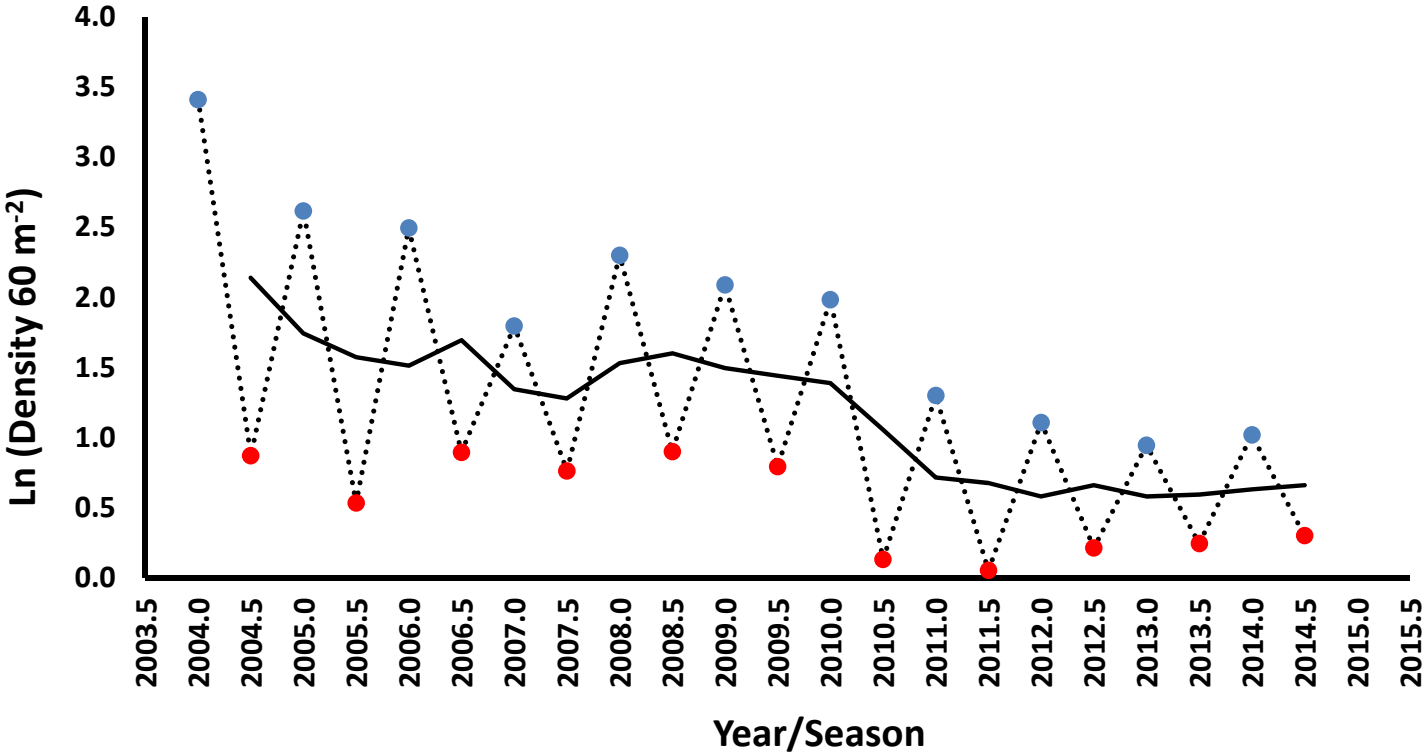
[b] Department of Biology, Cox Science Center, University of Miami, 1301 Memorial Drive, Coral Gables, FL 33124-0421, United States
[c] Southeast Fisheries Science Center, National Marine Fisheries Service, 75 Virginia Beach Drive, Miami, FL 33149, United States

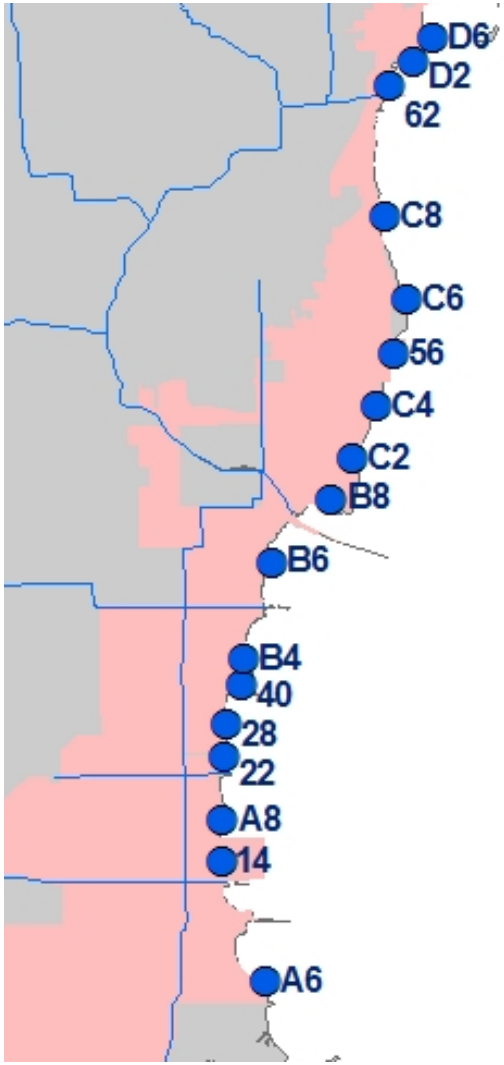
Goldpotted killifish abundance and temperature/salinity extremes?

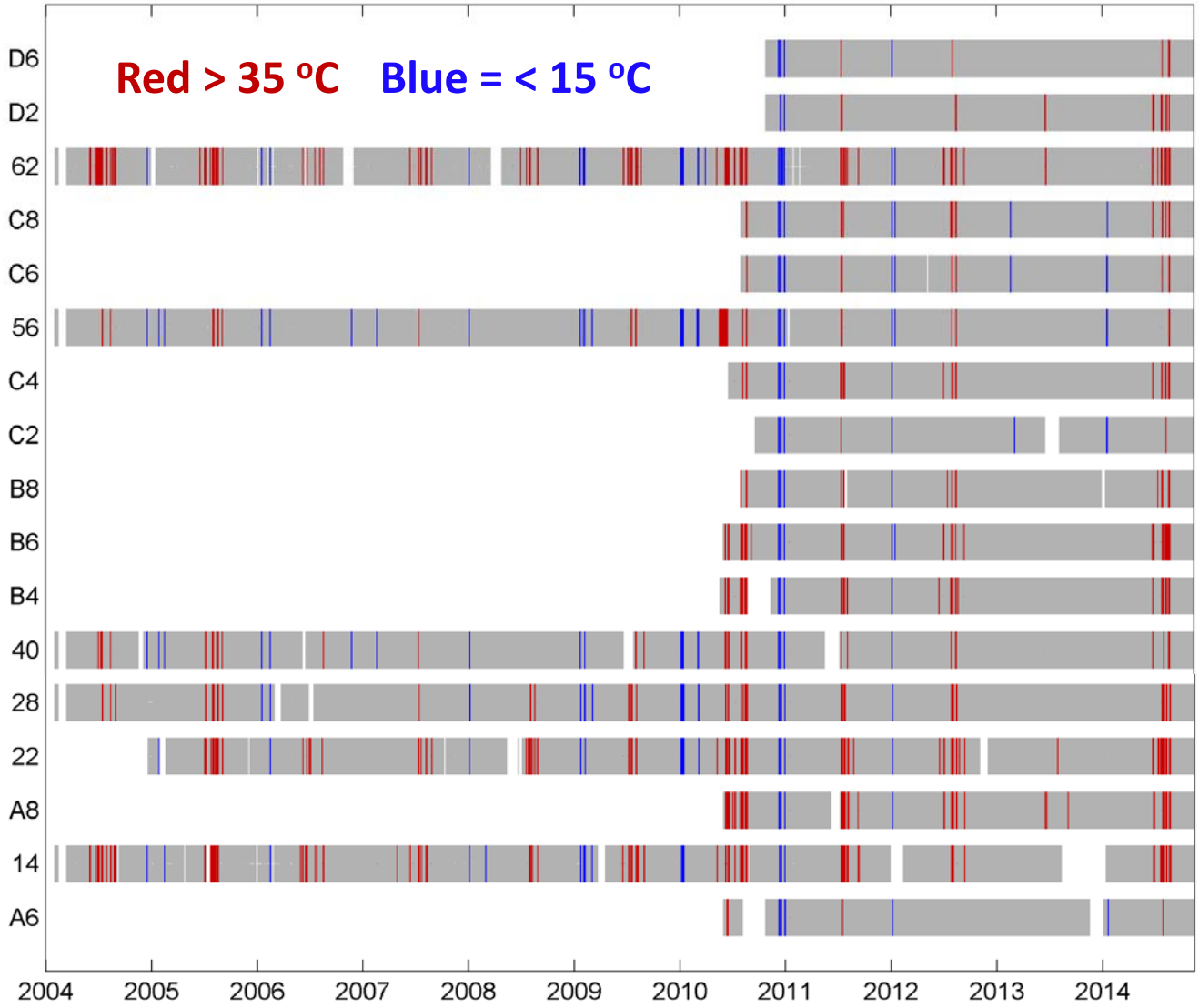


goldspotted killifish
Floridichthys carpio

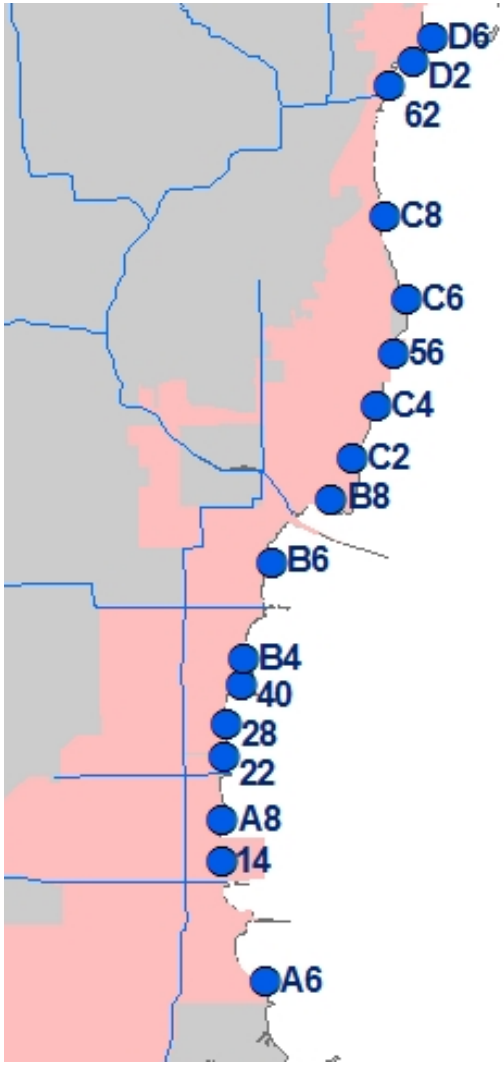


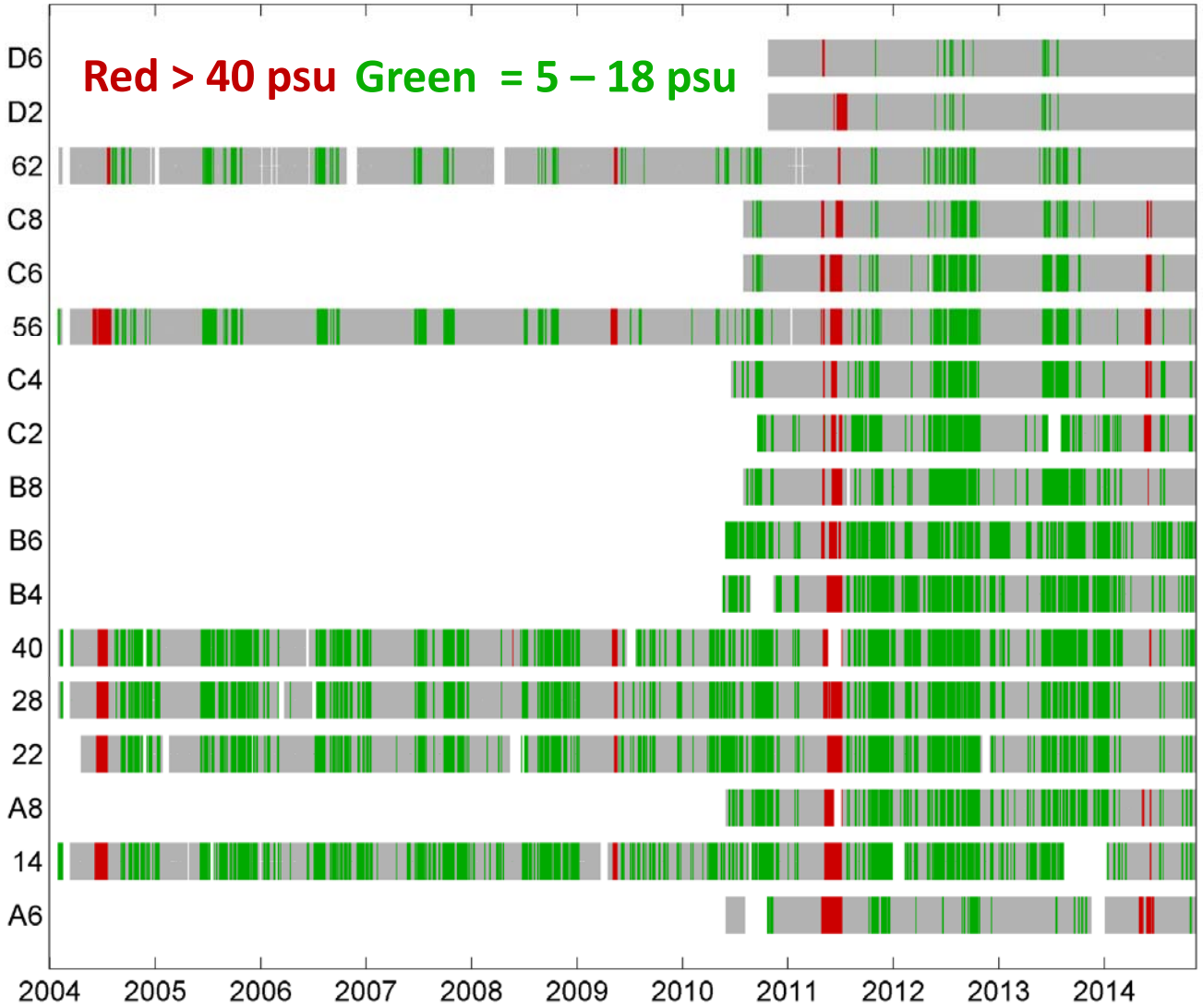
Event Durations: Temperature



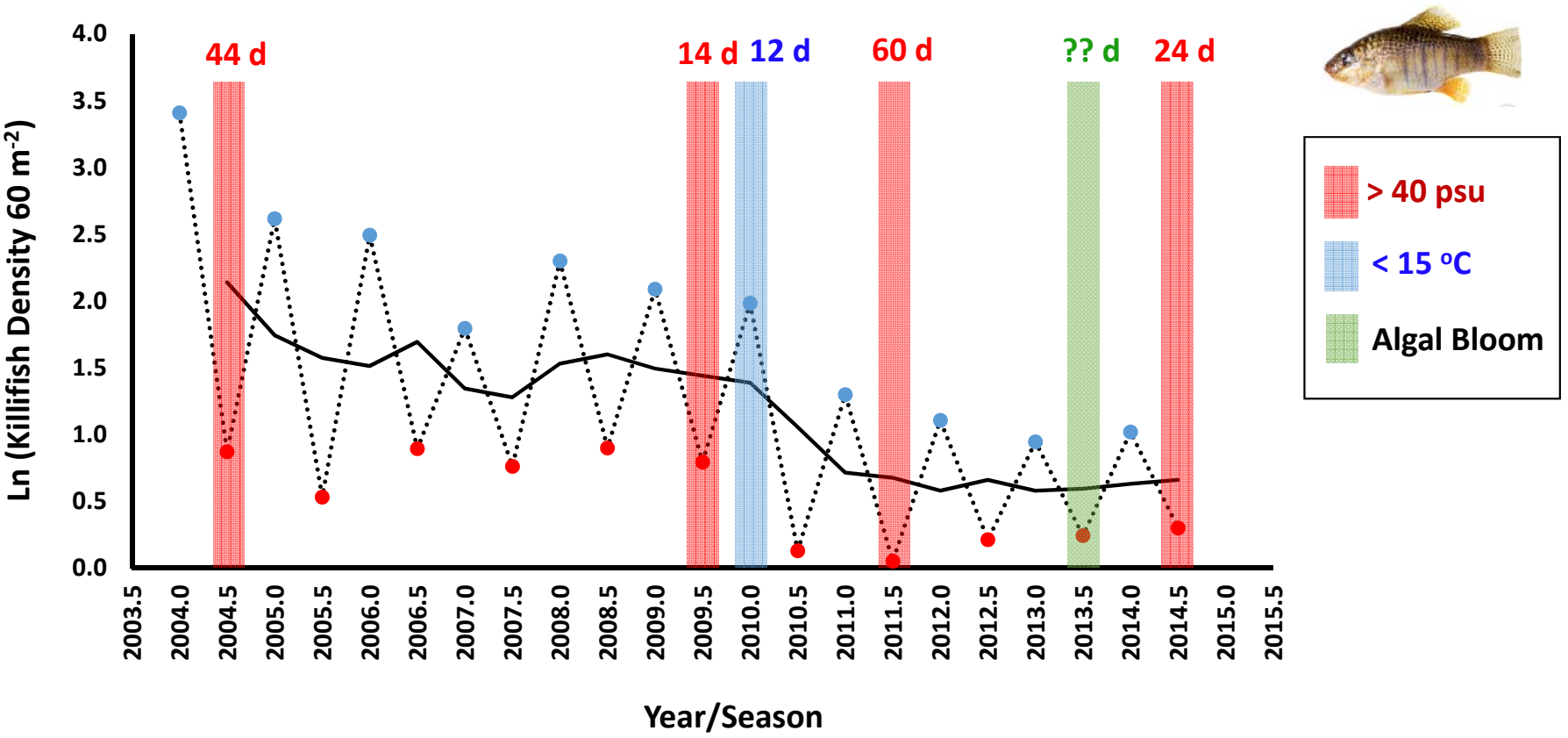


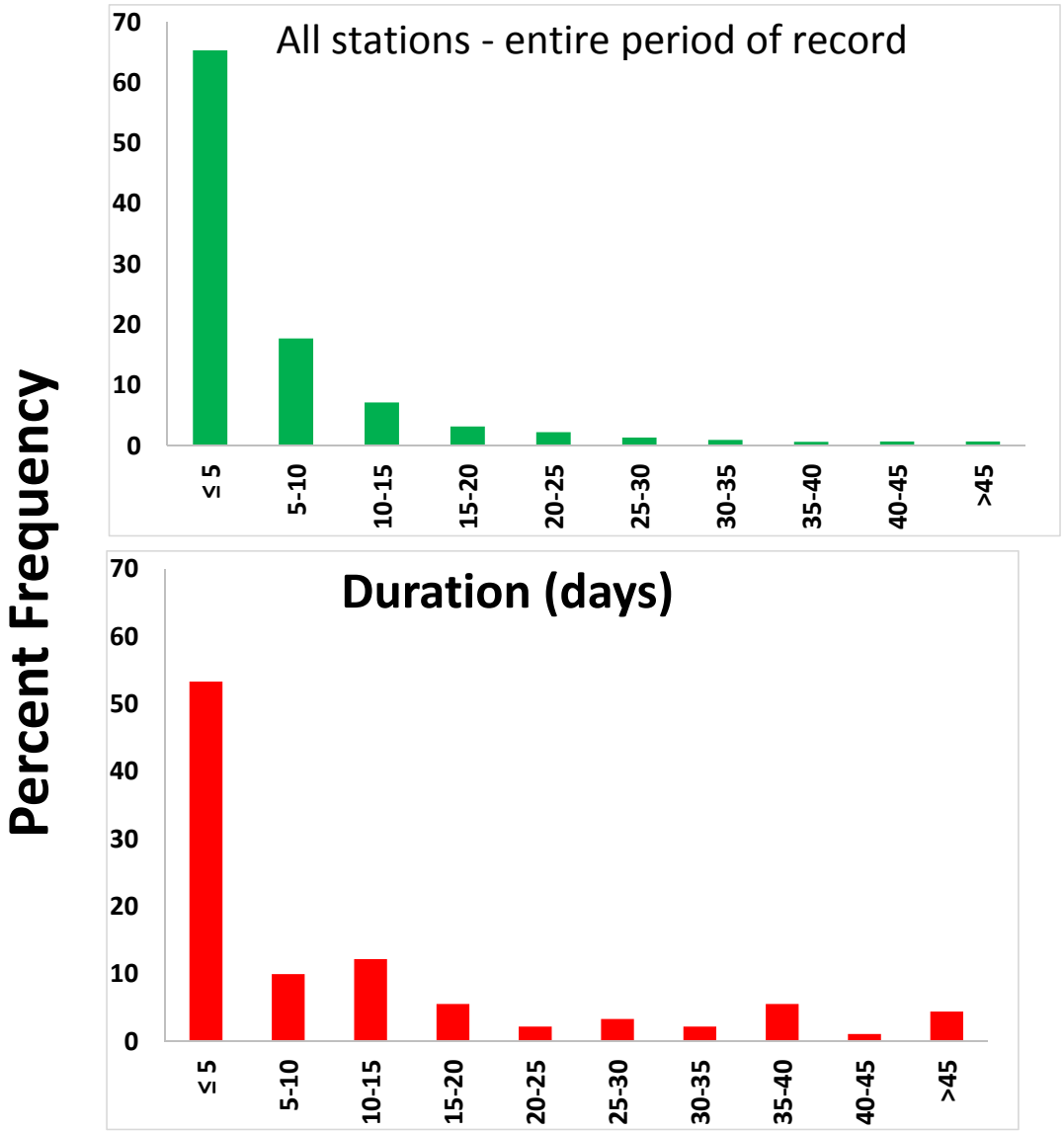
Event Durations: Salinity





Goldpotted killifish abundance and temperature/salinity extremes?





Currently, the duration of mesohaline events is too short to expect ecological transition

Hyperhaline events, while relatively infrequent, can still be quite long (e.g., 2011)

Suggests that water managers try to ***consolidate mesohaline events*** and ***fragment hyperhaline events.***

These may be the most important adaptive management objectives to pursue in this coastal system.