IMPROVING JUVENILE FISH POPULATIONS BY ENHANCING FISH HABITAT – EVALUATING THE USE OF OYSTER REEFS AS A TOOL TO INCREASE FISH ABUNDANCE

RIMFI - Fall Meeting

University of Rhode Island - Graduate School of Oceanography

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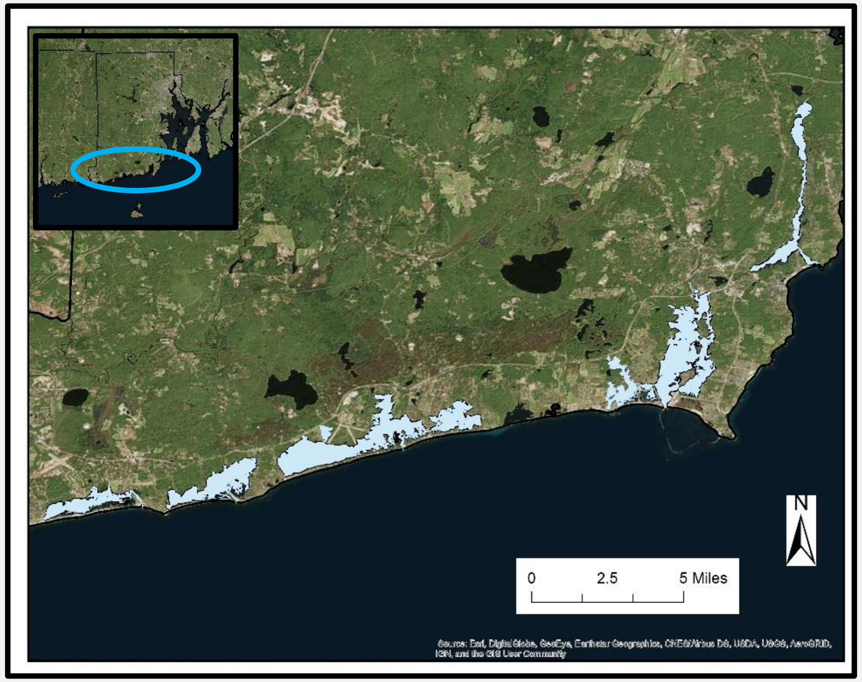
The Nature Conservancy
Protecting nature. Preserving life.

Northeastern University
Marine Science Center

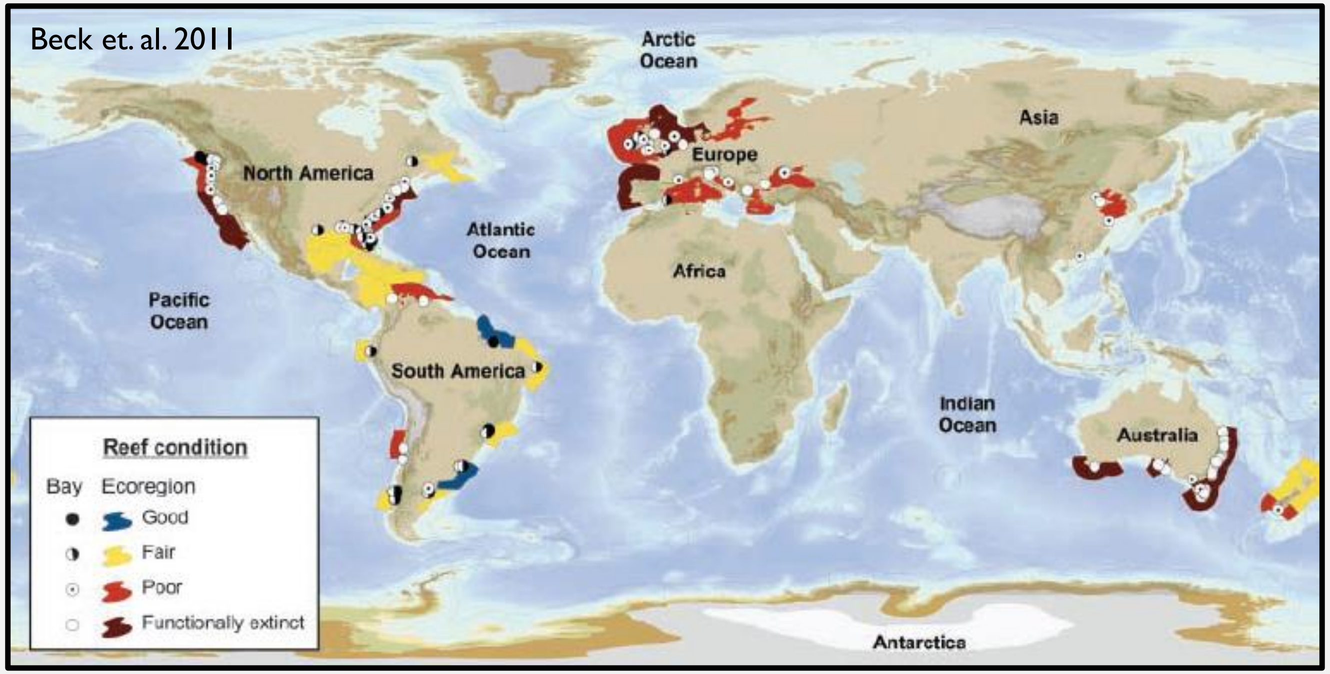
SPORT FISH RESTORATION

INTRODUCTION TO RI COASTAL PONDS



RI OYSTER HISTORY

- Decline of Oyster reef habitat world wide
  - 85% global reef loss (Beck et al 2011)
- RI specific decline
  - Decrease of ~99% of historical value since the mid 1900s (Zu Ermgassen et al 2012)



ECOSYSTEM IMPACTS

- Loss of ecosystem services
  - Nutrient cycling
  - Water Filtration
  - Shoreline Stabilization
  - Provisions
- Fish-Habitat Linkages
  - Oyster production and YOY finfish assemblage

Fish Habitat Enhancement Project
Rhode Island Coastal Ponds

- **Primary Goal:** Evaluate if construction of oyster reefs is a viable method for improving juvenile populations of important species of sportfish

1. Determine the appropriate location for reef establishment
2. Conduct pre-enhancement evaluation to establish baselines
3. Create and establish oyster reefs; and
4. Conduct post-enhancement evaluation to determine if there are changes in abundance and species composition of juvenile recreationally important fish

OYSTER REEF LOCATIONS

- Suitability Index
  - Depth
    - ~ 2-4 ft below mean low
  - Salinity
    - 21-30 ppt
  - Substrate
    - Soil index
- Adjacent Habitat
- Competing Uses

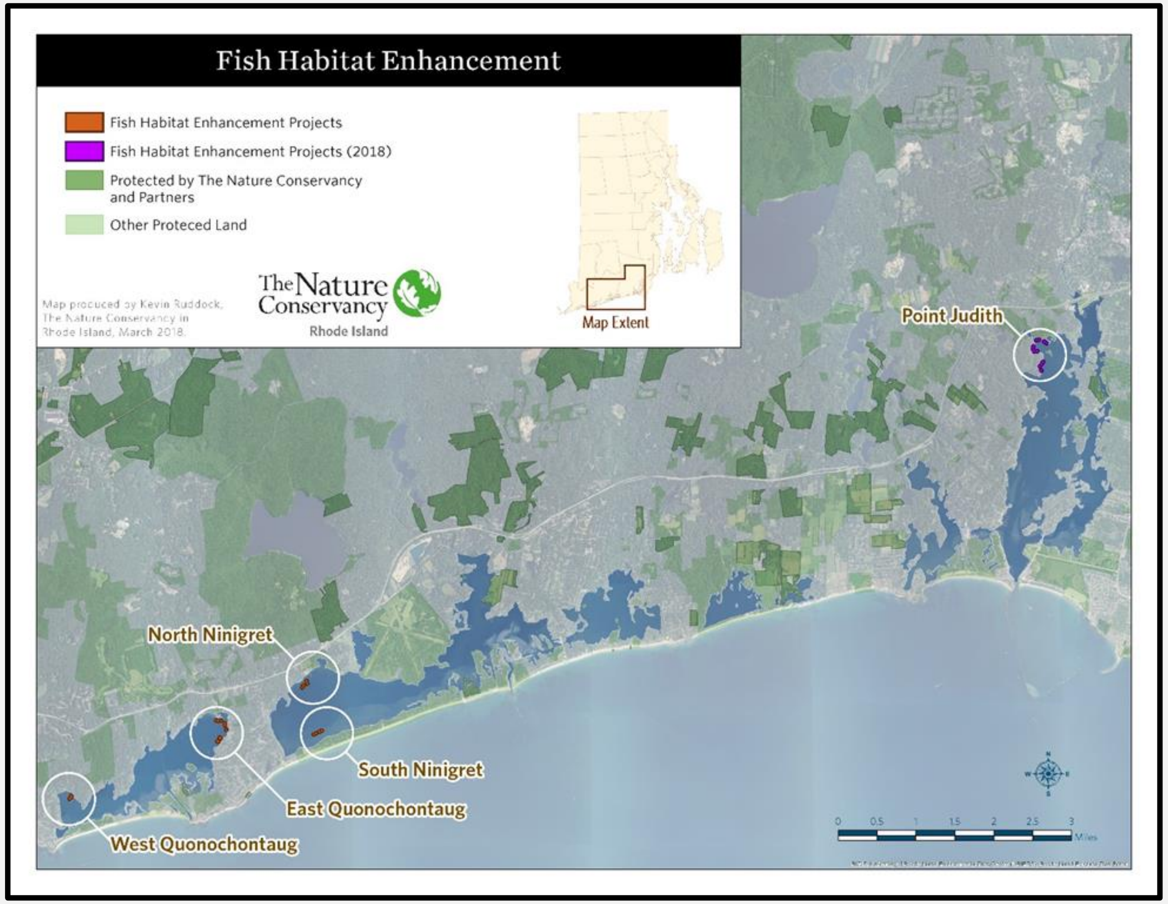
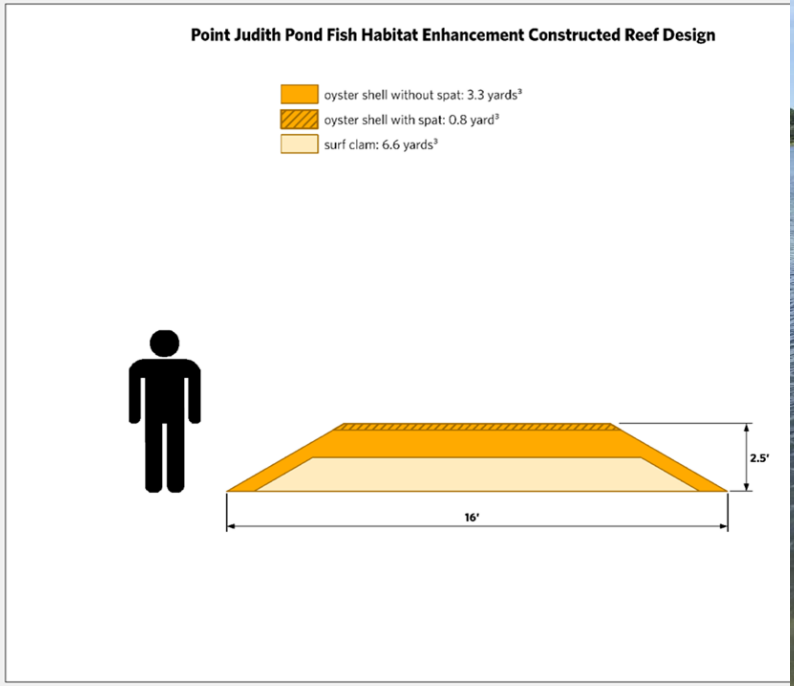


Photo credit: Kevin Ruddock (TNC)

REEF CONSTRUCTION

- Conditioning and spawning
  - Hatchery eyed larvae (delivered late April)
  - Wild lineage brood stock (collected late April)
- Transferred to leases in July
- Grown out until deployment in the Fall
  - Cultch deployed one week prior to seed on shell (Nov)



OYSTER MONITORING

- Spring and Fall Monitoring
  - Quadrat survey (n=6-8 per reef)
    - Counted total number living and recently dead, note boring sponge and oyster drill holes
    - Measured length of a sub sample (n~50 ind) from each 0.25 meter quadrat

FISH MONITORING

- Pre and Post Enhancement monitoring (May-Oct)
  - Ninigret Pond (2015-2019)
  - Quonochontaug Pond (2016-2019)
- Multi-gear survey
  - Eel Pots, Minnow Traps, and Gillnets

FHE ANALYSIS

- BACI design
  - Before and After Oyster Reef Creation

- Pre Enhancement Baseline Question
  - Do sites differ pre-enhancement? (Catch per haul; Kruskal Wallis)

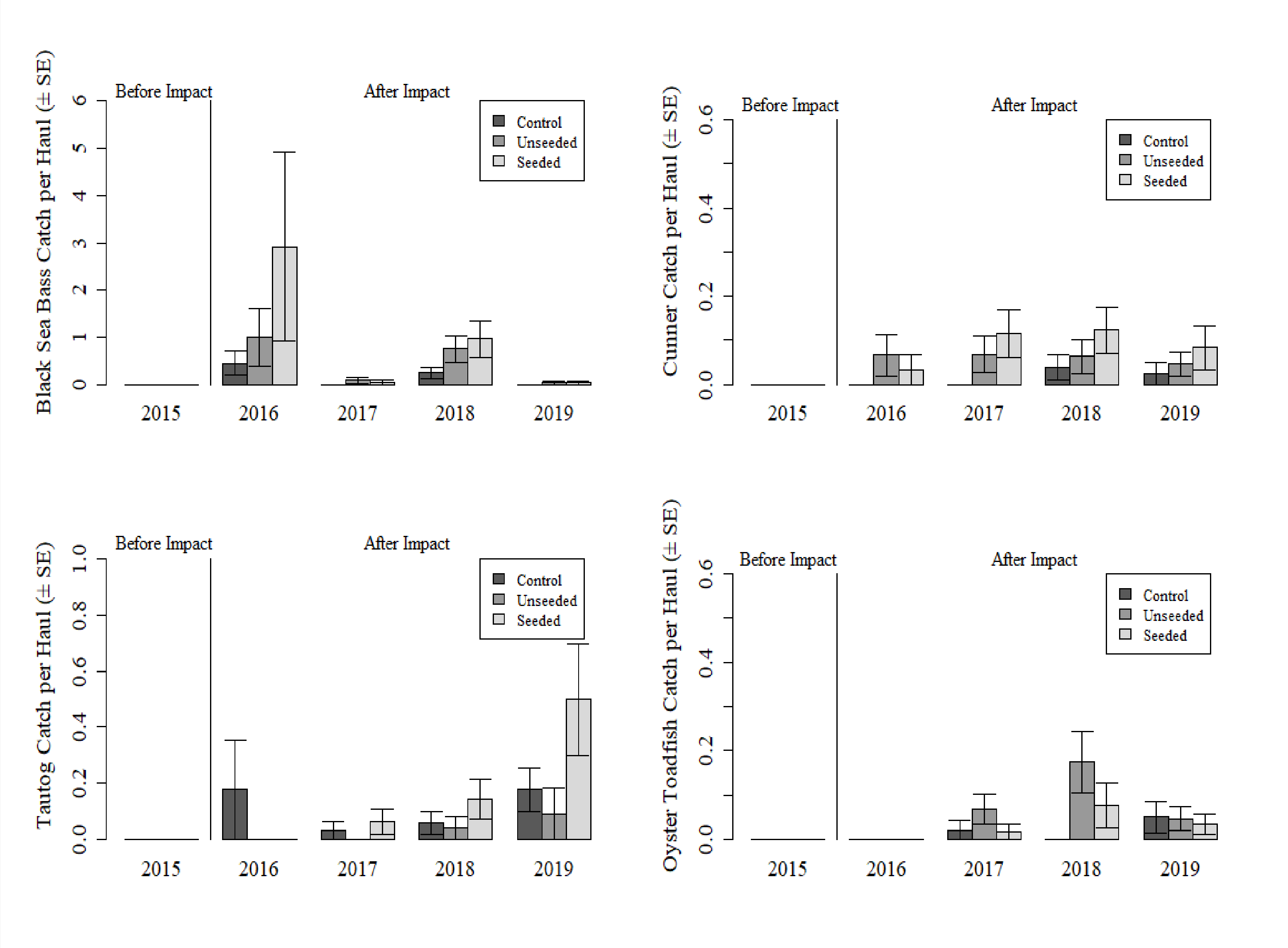
- Post Enhancement Comparisons
  - How do YOY abundances differ on reefs compared to unstructured and structured controls post enhancement? (Categorical Seed Treatment GAM)
  - What aspects of healthy oyster reefs (i.e., growth, mortality) may be influencing the success of these seeded reefs in attracting YOY sportfish? (Continuous Oyster Metric GAMs)

NINIGRET POND

- Treatments
  - Control
  - Unseeded
  - Seeded (Hatchery)
- Sites
  - Site 1 NE
  - Site 2 NW
  - Site 3 SW
  - Site 4 SE

Photo credit: Kevin Ruddock (TNC)

NINIGRET BACI ANALYSIS

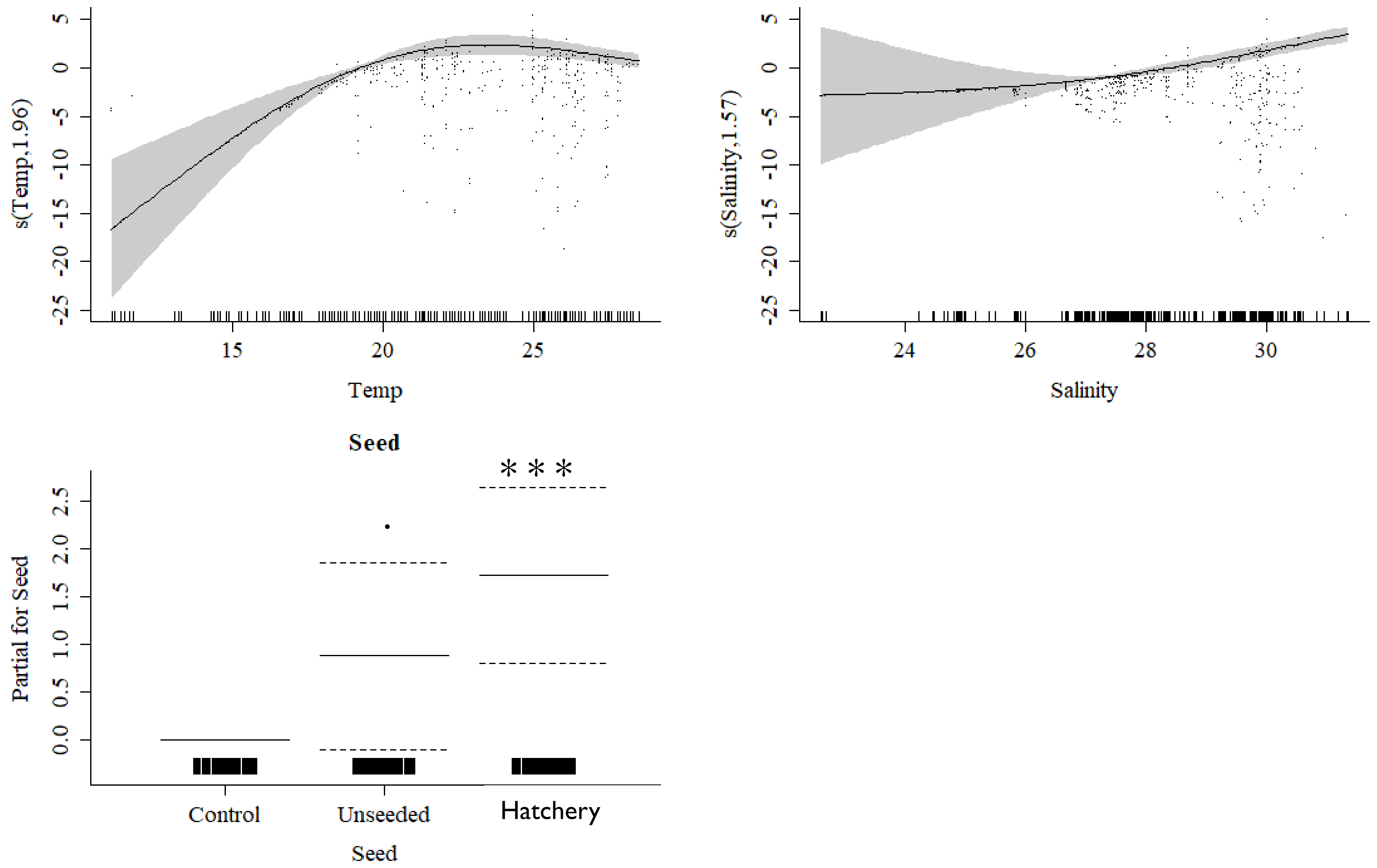


BLACK SEA BASS GAM

Catch ~ s(Temp) + s(Salinity) + Seed , offset = (log(hours.fished))

n=630, deviance explained = 10.1%

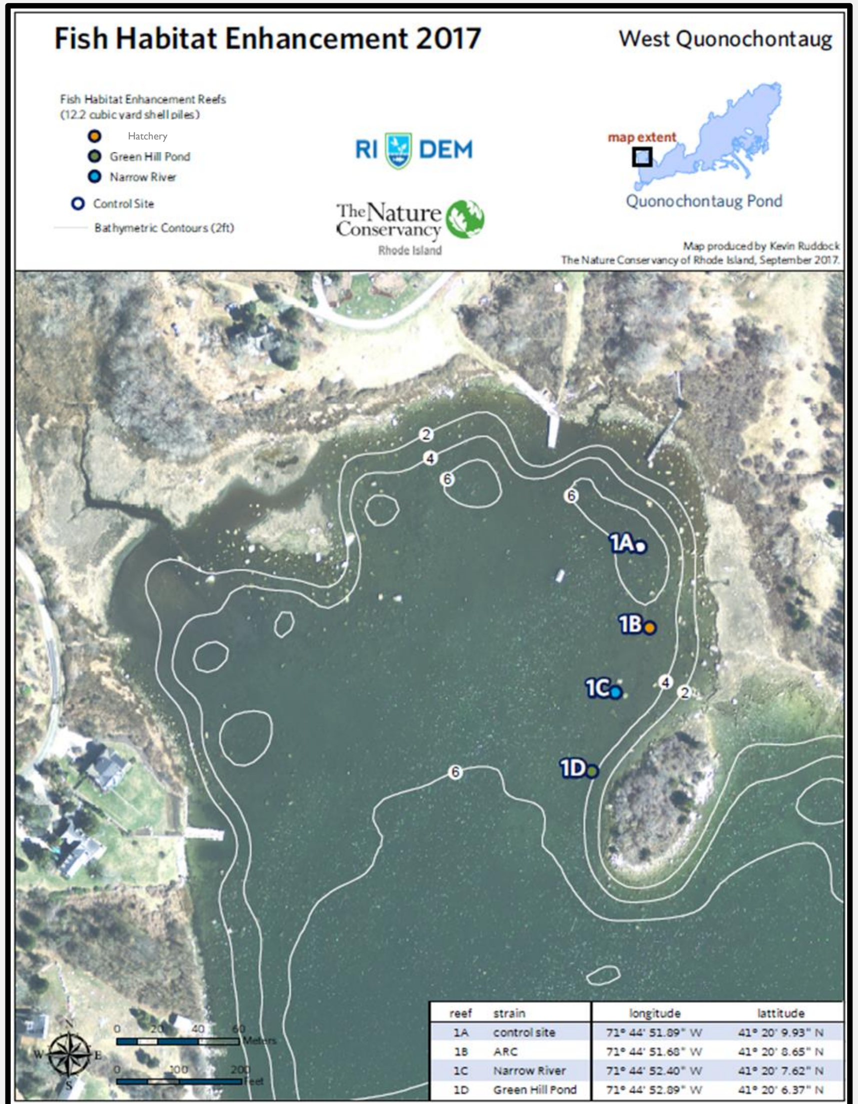
Distribution – zero inflated poison



FHE ANALYSIS

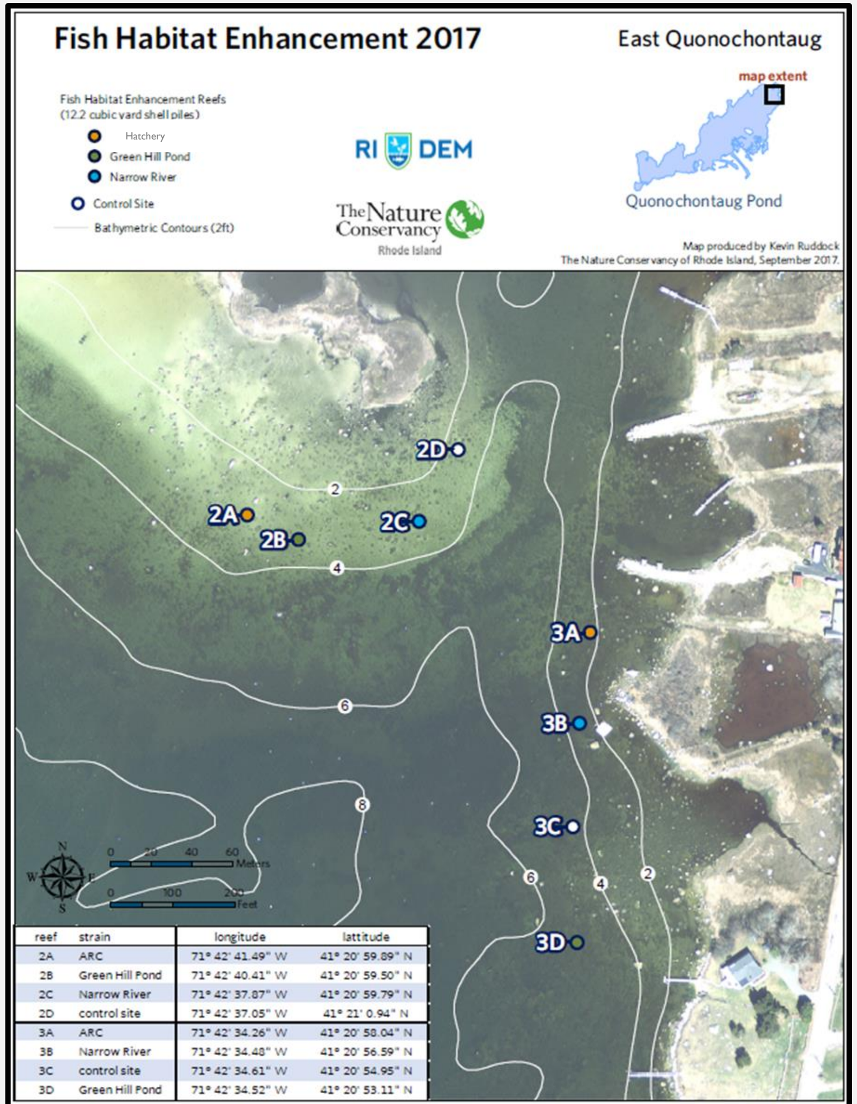
- Post Enhancement Comparisons
  - What aspects of healthy oyster reefs (i.e., growth, mortality) may be influencing the success of these seeded reefs in attracting YOY sportfish? (Continuous Oyster Metric GAMs)
    - GAMs with continuous benthic habitat parameters (estimated oyster biomass)

QUONOCHONTAUG POND



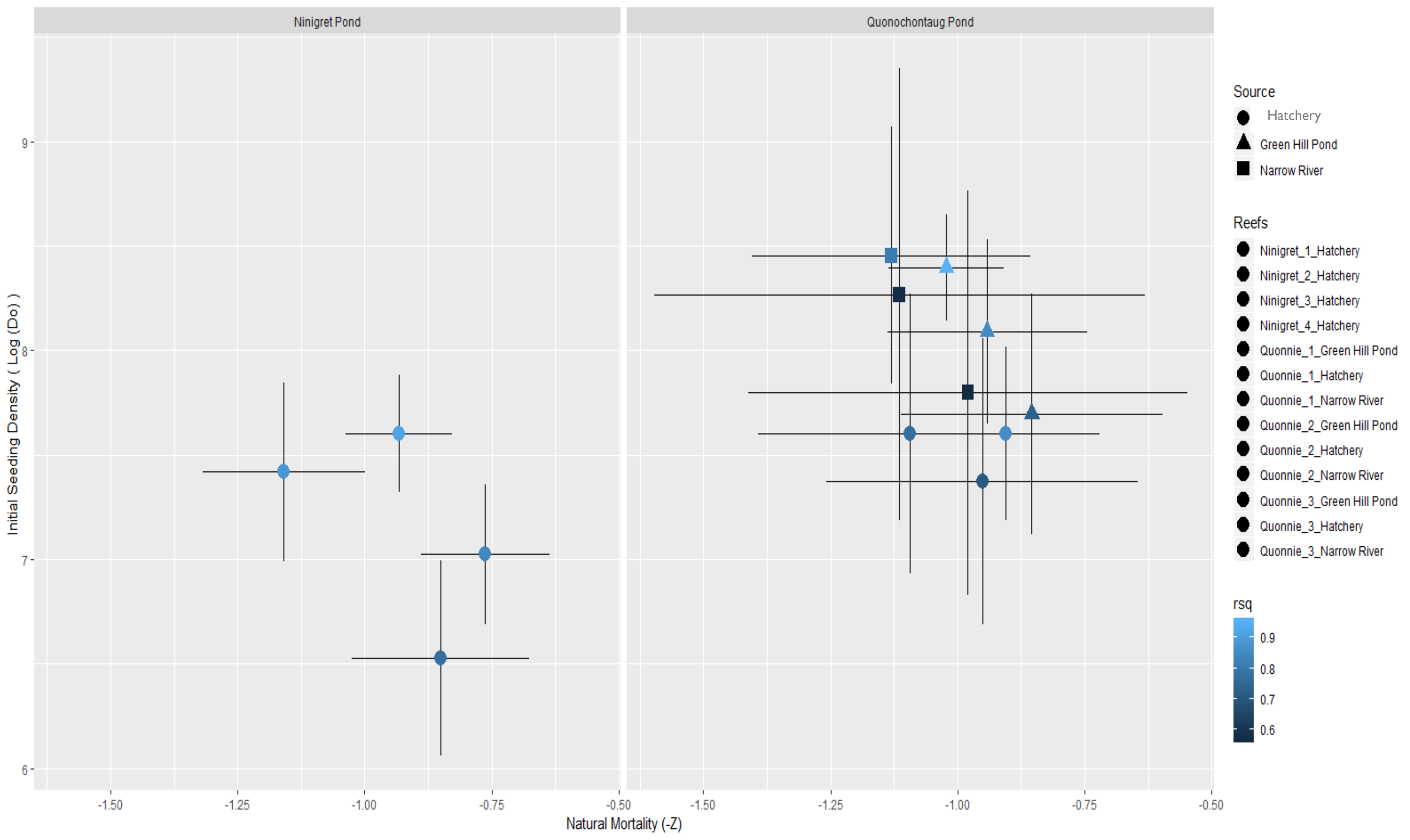
reef	strain	longitude	lattitude
1A	control site	71° 44' 51.89" W	41° 20' 9.93" N
1B	ARC	71° 44' 51.68" W	41° 20' 8.65" N
1C	Narrow River	71° 44' 52.40" W	41° 20' 7.62" N
1D	Green Hill Pond	71° 44' 52.89" W	41° 20' 6.37" N

- Treatments
  - Control
  - Hatchery (Hatchery Lineage)
  - Green Hill Pond (Wild Lineage)
  - Narrow River (Wild Lineage)
- Sites
  - Site 1 West Basin
  - Site 2 East Basin
  - Site 3 East Basin



reef	strain	longitude	lattitude
2A	ARC	71° 42' 41.49" W	41° 20' 59.89" N
2B	Green Hill Pond	71° 42' 40.41" W	41° 20' 59.50" N
2C	Narrow River	71° 42' 37.87" W	41° 20' 59.79" N
2D	control site	71° 42' 37.05" W	41° 21' 0.94" N
3A	ARC	71° 42' 34.26" W	41° 20' 58.04" N
3B	Narrow River	71° 42' 34.48" W	41° 20' 56.59" N
3C	control site	71° 42' 34.61" W	41° 20' 54.95" N
3D	Green Hill Pond	71° 42' 34.52" W	41° 20' 53.11" N

Photo credit: Kevin Ruddock (TNC)



OYSTER ANALYSIS

- Catch curves
  - lm (log(Density) ~ Δ(t))
- Decay Curves and Mortality Estimates (EOD)
  - $Dt = Do * e^{(-Z*(t-t0))}$
- Growth Curves and parameter estimates (EOL)
  - $Lt = L_{\infty} * (1 - e^{(-K\ (t - t0))})$
- Length-weight conversion (Grizzle et al 2008)
  - Weight = 0.00003 * (EOL ^2.1727)
  - Biomass = Weight * EOD

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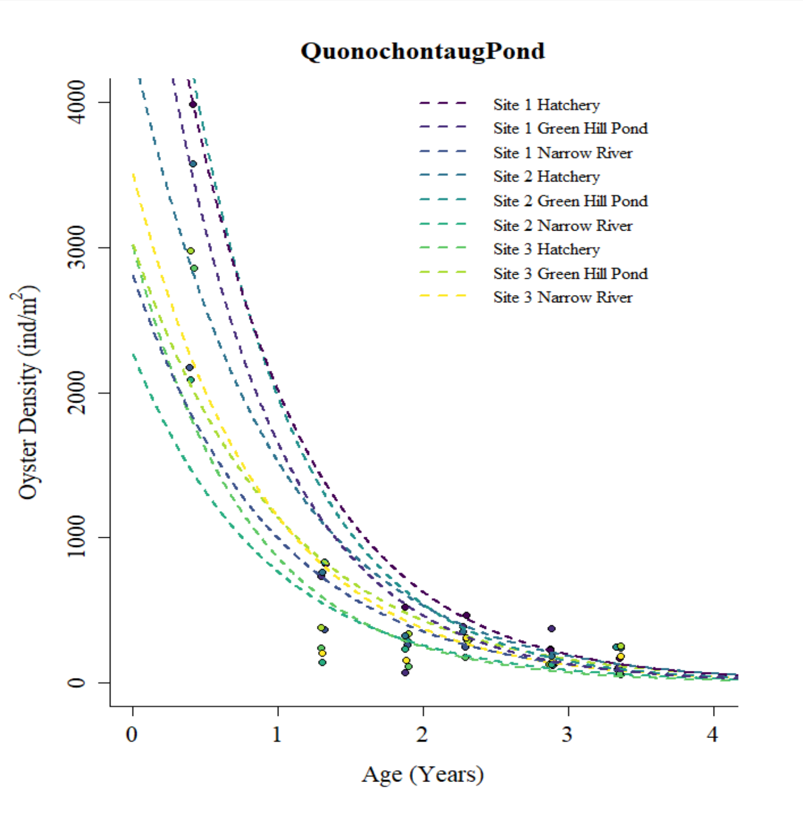

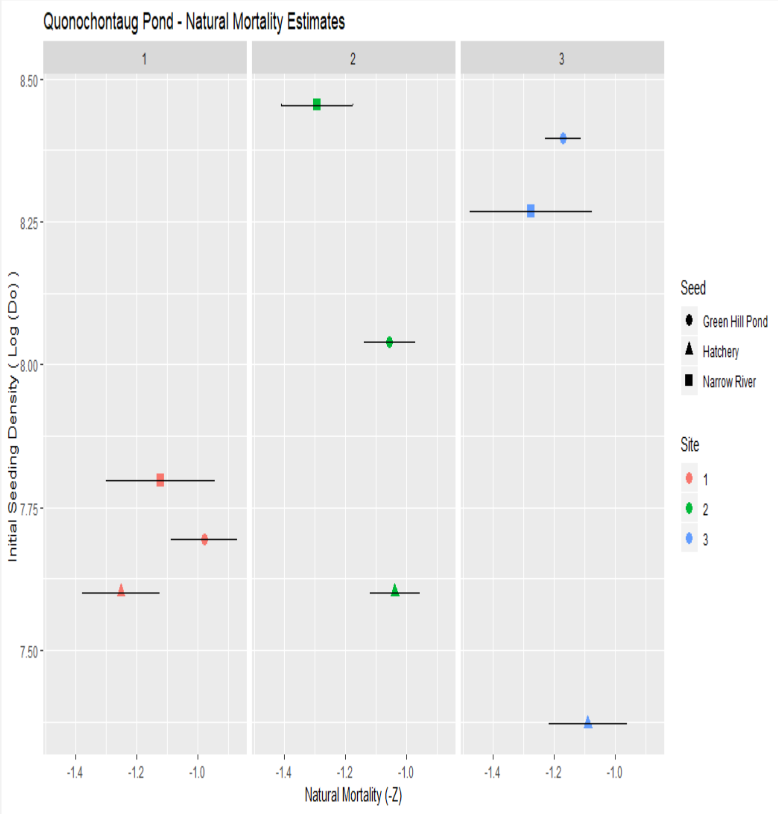

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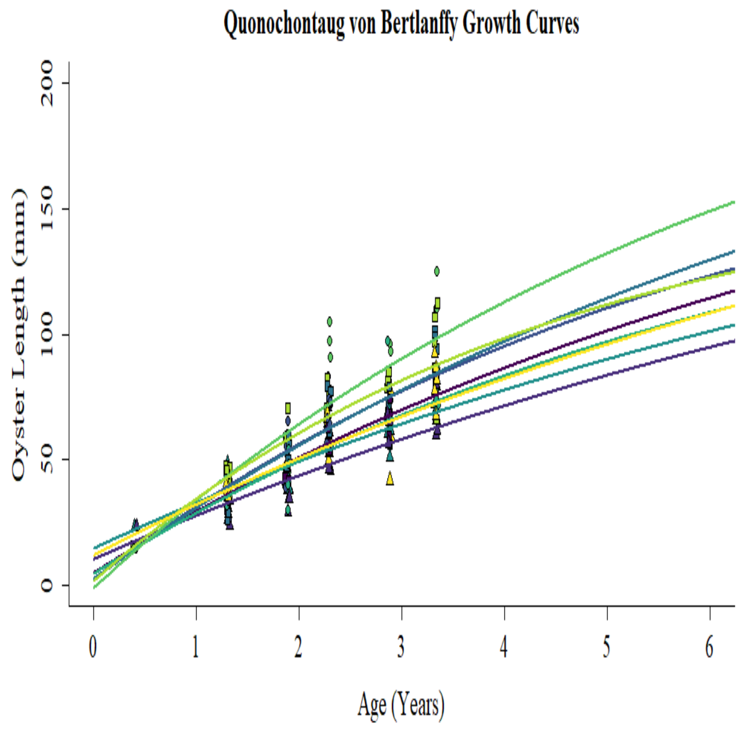

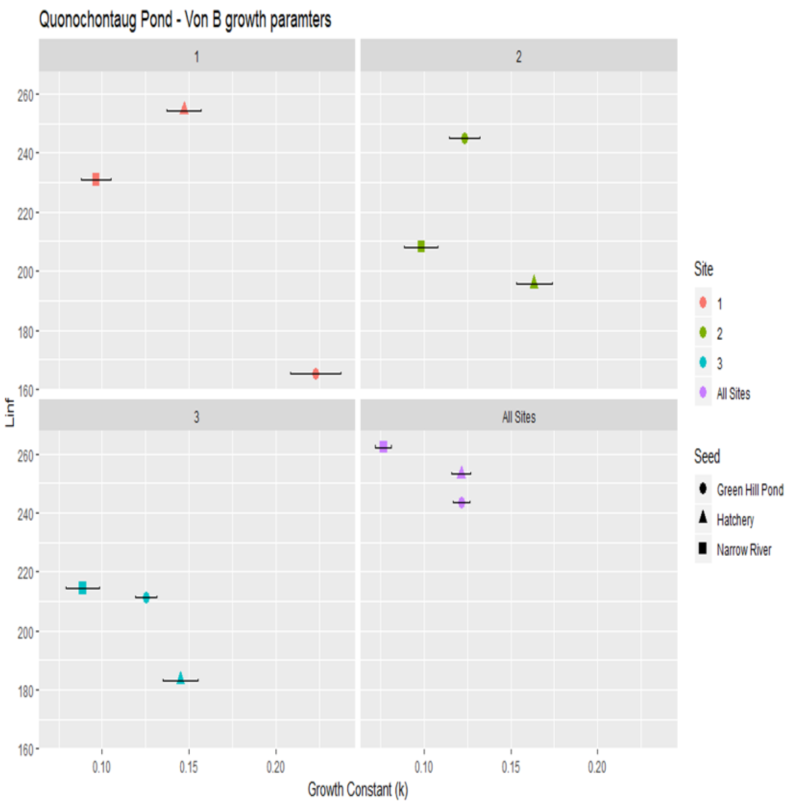

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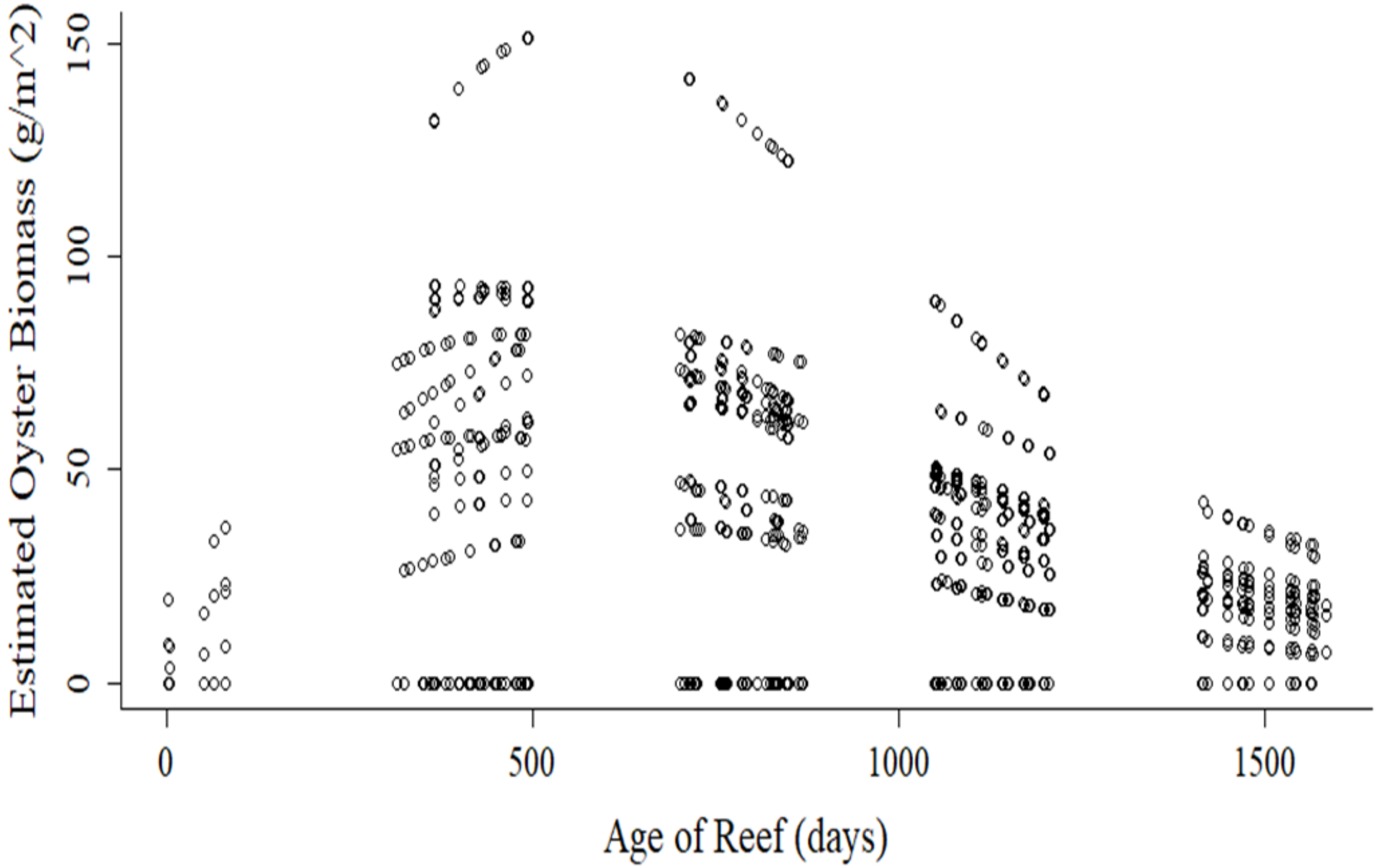

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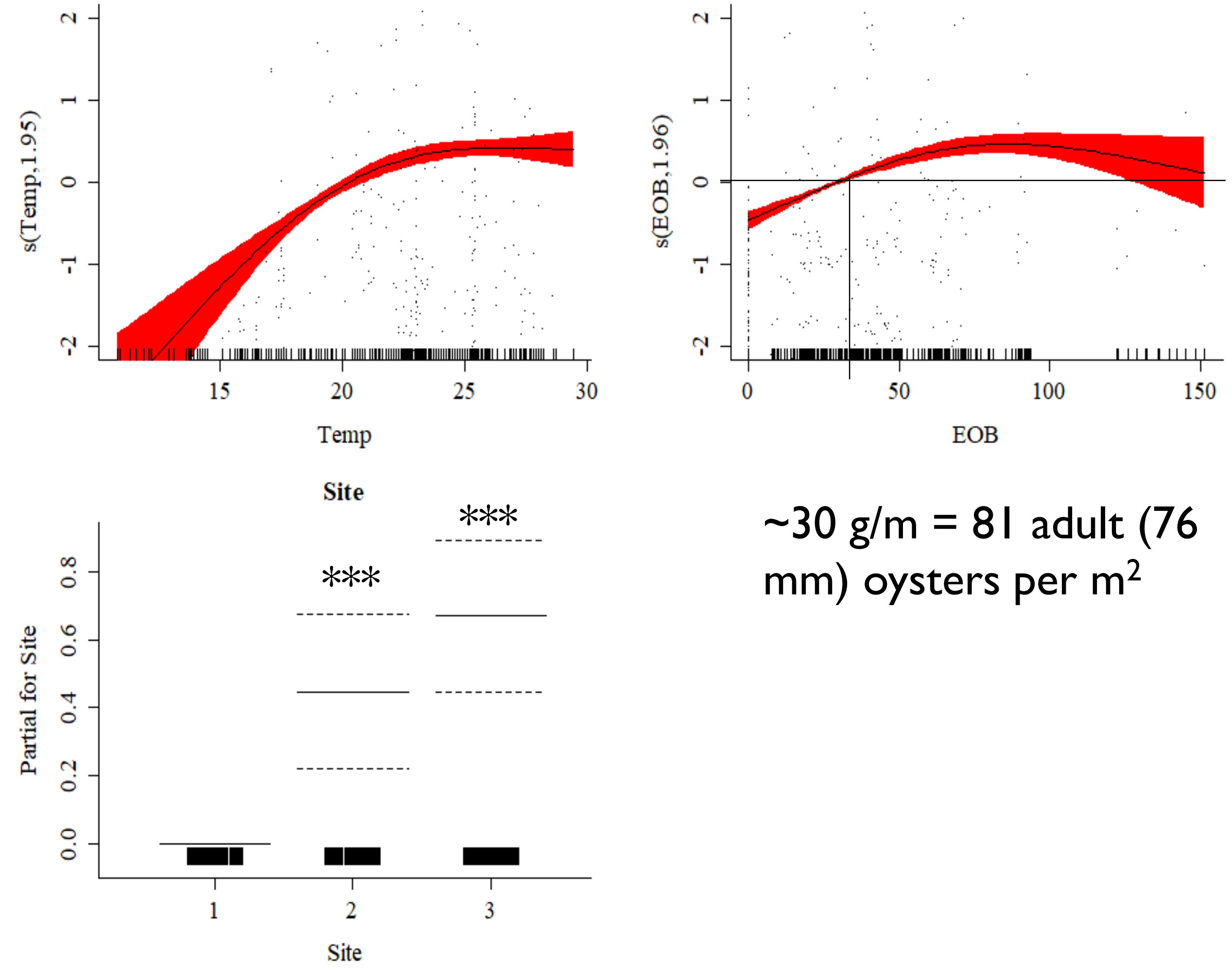
QUONNIE BLACK SEA BASS GAM

Catch ~ s(Temp) + Site + s(EOB) ,
offset = log(hours. fished)

n=698 , deviance explained = 7.2%

Distribution – zero inflated poison



~30 g/m = 81 adult (76 mm) oysters per m^2

CONCLUSIONS

- Technique to establish reefs is successful
  - Seeded reefs significantly attracted more demersal finfish than unseeded and control plots
  - Oyster Biomass positively enhanced young of the year black sea bass, tautog, and winter flounder
- Enhancement success is dependent on initial quality of habitat as well as abiotic and benthic habitat parameters
  - Oyster Growth and Mortality vary by seed source and location deployed
  - Implications for oyster enhancement work when the goal fish habitat

THANK YOU