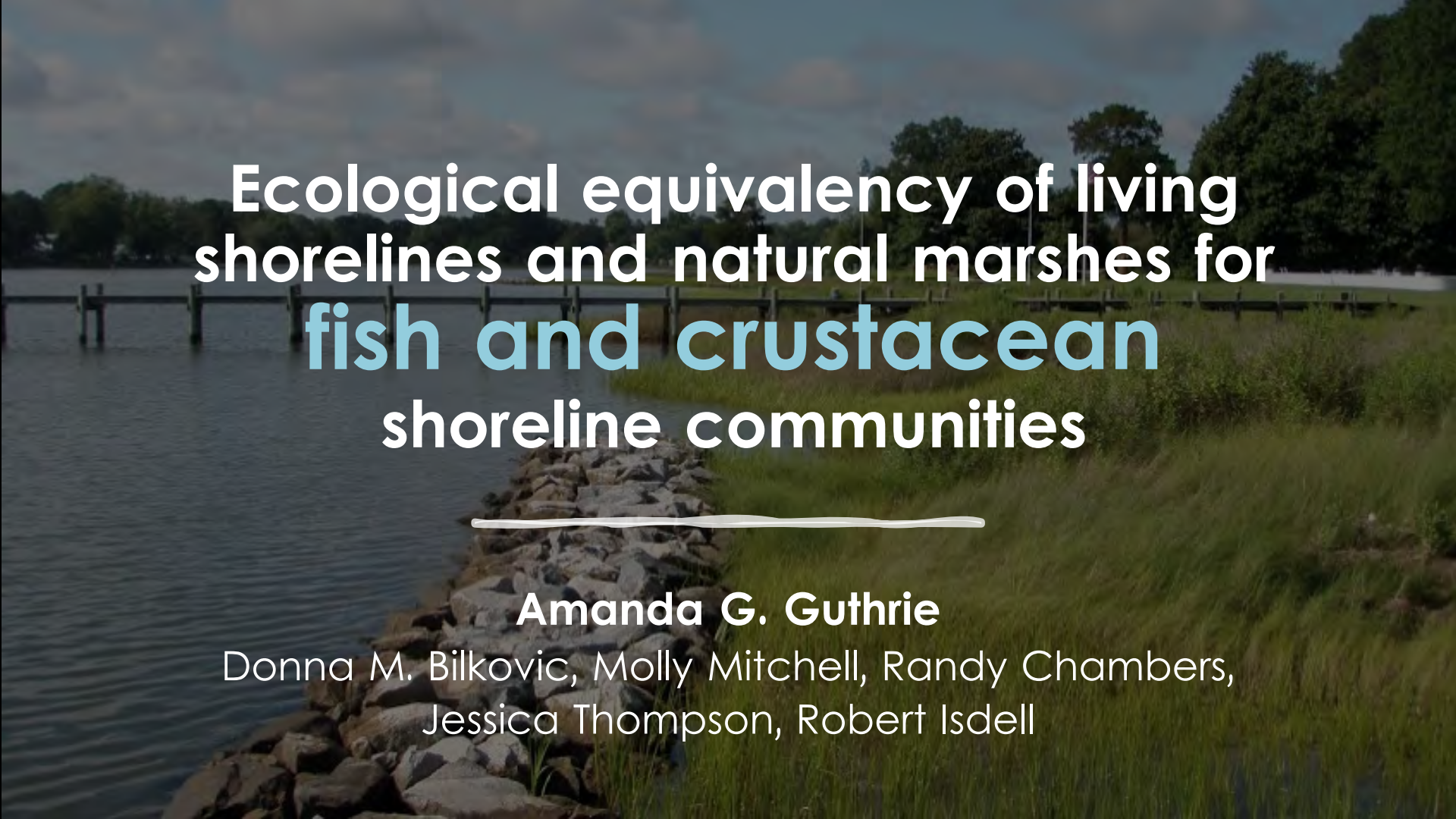


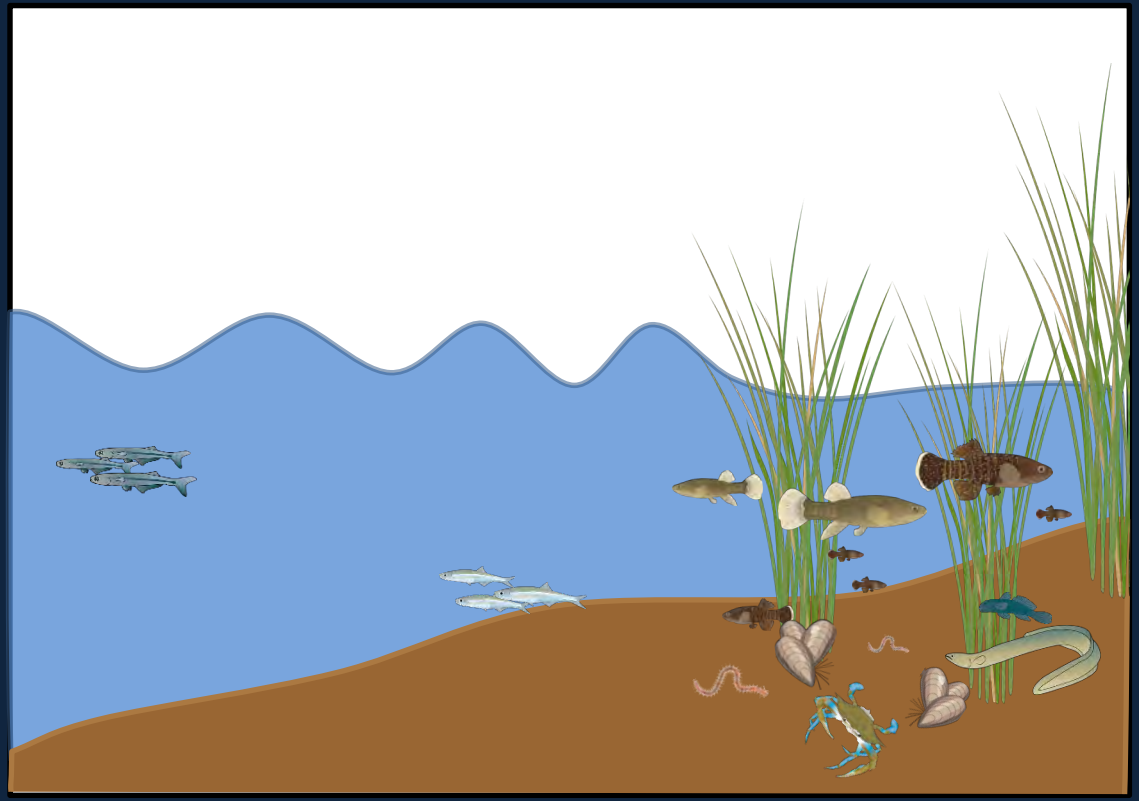
Ecological equivalency of living shorelines and natural marshes for fish and crustacean shoreline communities

Amanda G. Guthrie

Donna M. Bilkovic, Molly Mitchell, Randy Chambers, Jessica Thompson, Robert Isdell

Marshes: nekton habitat

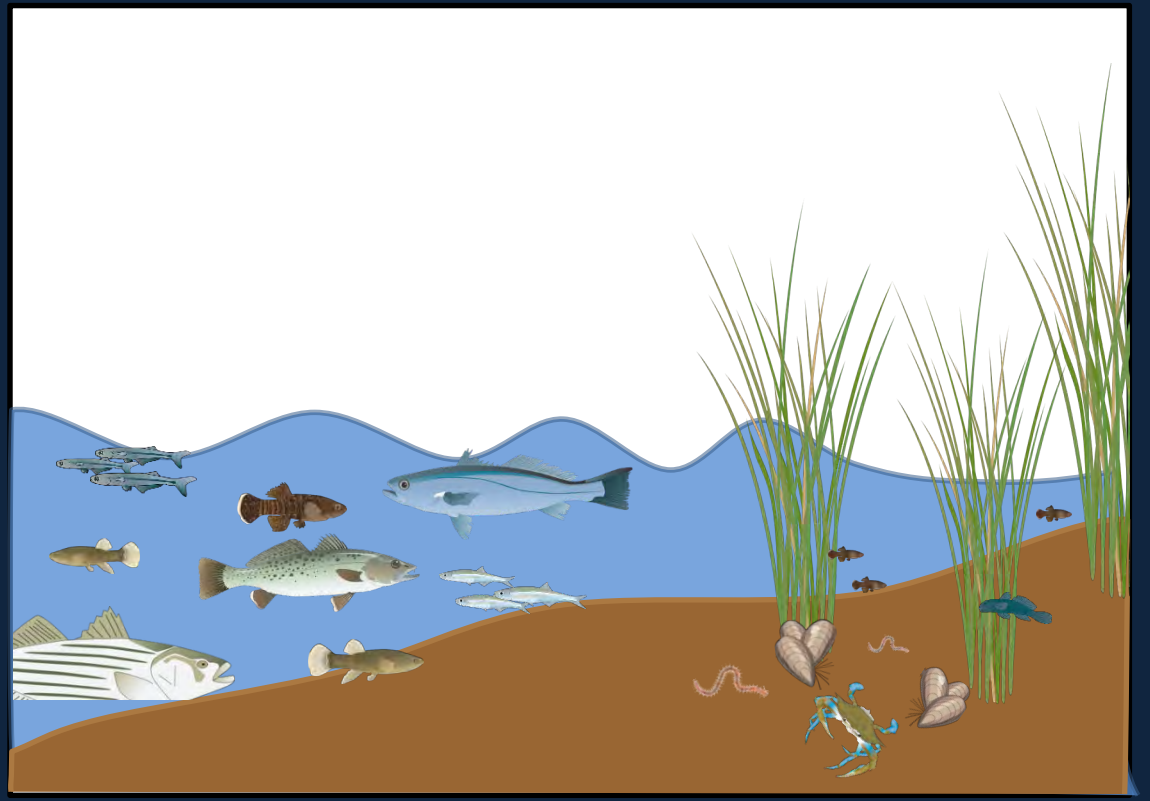
- Refuge & food



(Minello et al. 2003; Quan et al. 2007; Sheaves 2009; Banikas and Thompson 2012, Kneib and Wagner 1994; Deegan et al. 2002).

Marshes: nekton habitat

- Refuge & food
- Trophic transfer



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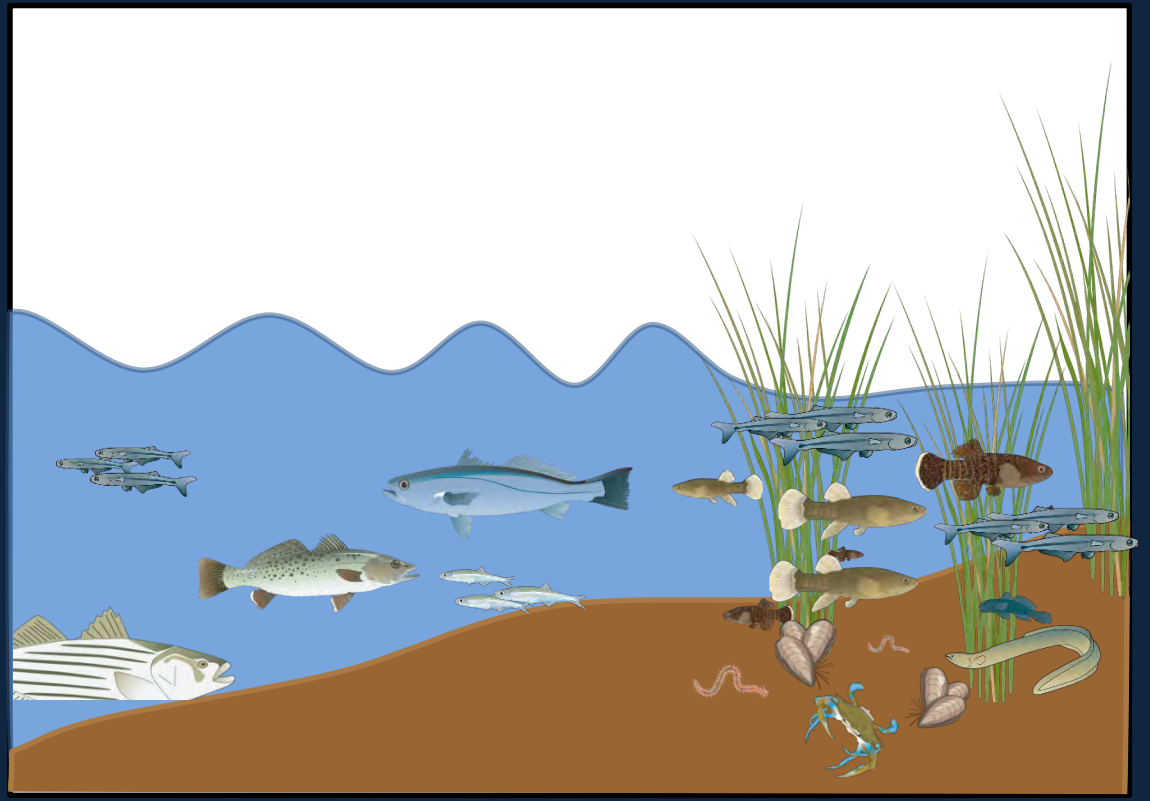
Marshes: nekton habitat

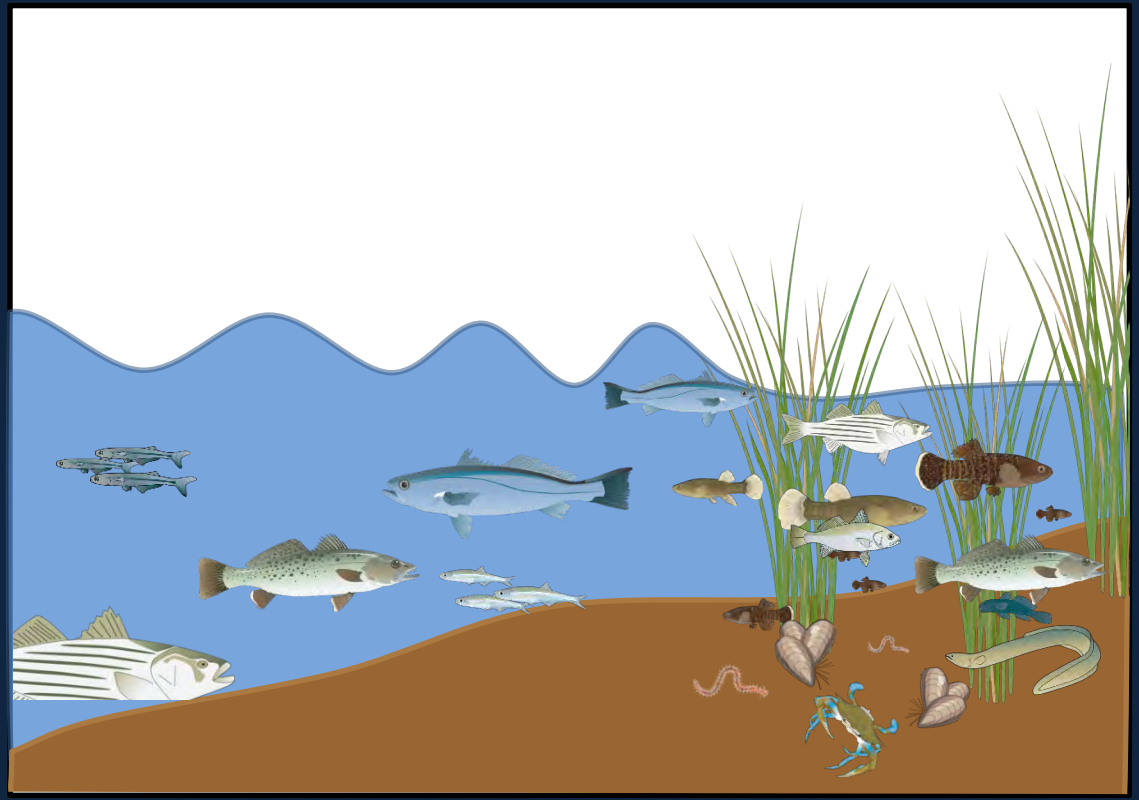
- Refuge & food
- Trophic transfer
- Reproduction



(Minello et al. 2003; Quan et al. 2007; Sheaves 2009; Banikas and Thompson 2012, Kneib and Wagner 1994; Deegan et al. 2002).

Marshes: nekton habitat

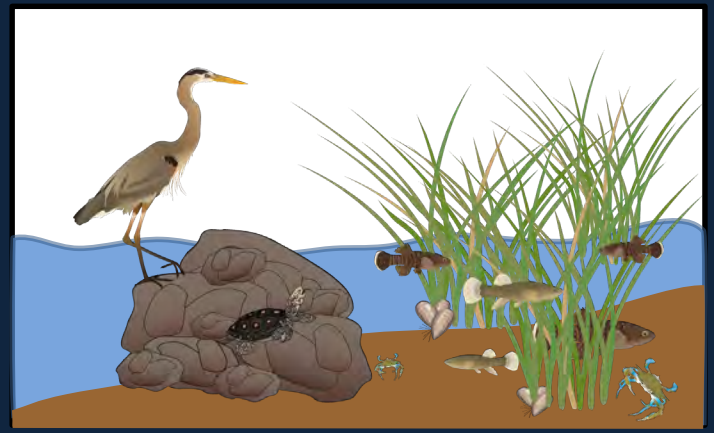
- Refuge & food
- Trophic transfer
- Reproduction
- Nursery support



(Minello et al. 2003; Quan et al. 2007; Sheaves 2009; Banikas and Thompson 2012, Kneib and Wagner 1994; Deegan et al. 2002).

Living Shoreline habitat

- Used for erosion control (wave attenuation)
- Limited comprehensive living shoreline nekton habitat studies
- Living shoreline differences
  - Rock sill
  - Soil composition



(Currin et al. 2008; Gittman et al. 2016, Davis et al. 2008, Balouskus and Targett 2016)

Objectives

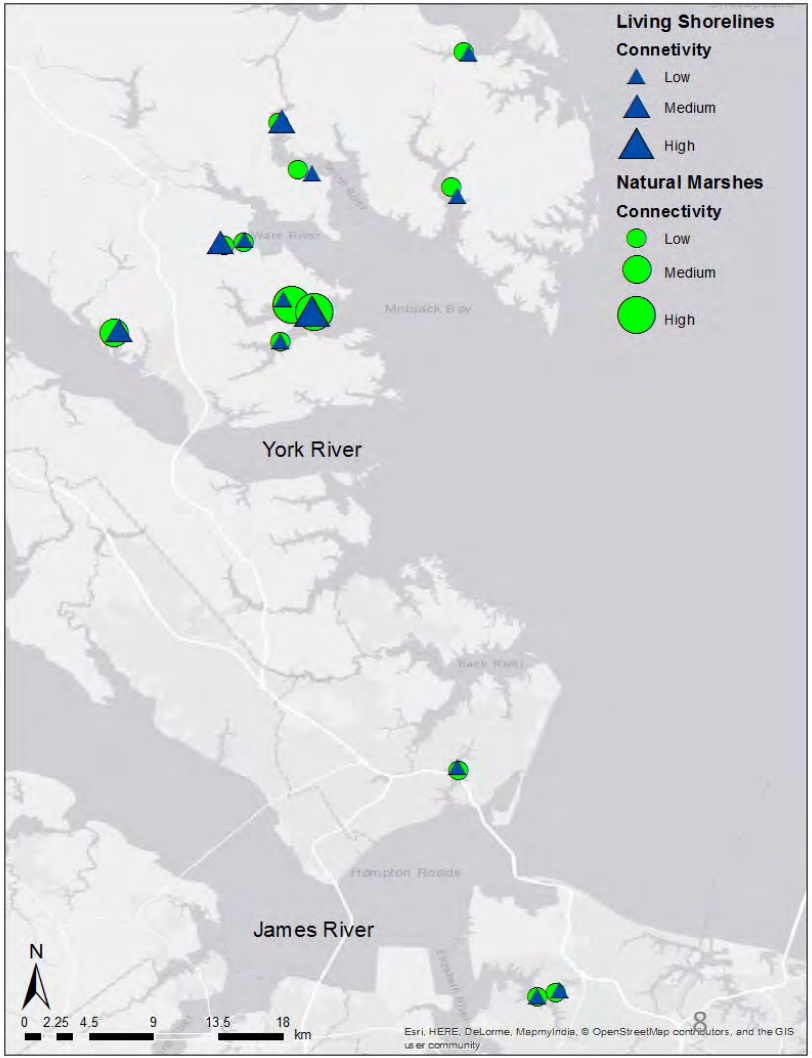
Examine nekton communities

1. along a chronosequence of living shorelines in relation to natural fringing marshes

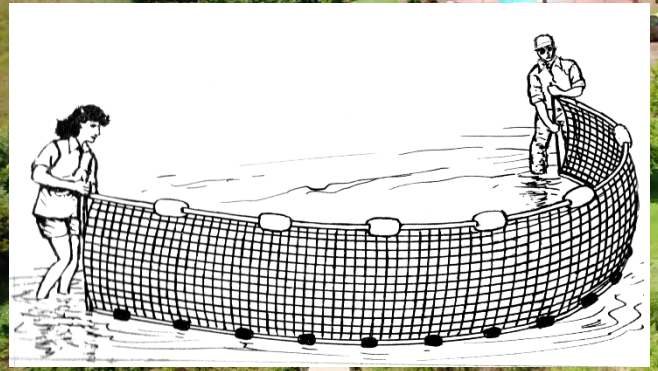
2. across environmental and marsh characteristics

Study sites

- 13 paired sites
  - marsh connectivity
  - urban & rural locations
- Sampled summer 2018 & 2019
  - 2–16 years since construction



Nekton Sampling



Minnow traps (x10)

Seines (x3)

Fyke Nets (x2)

Not to scale

Habitat Categories

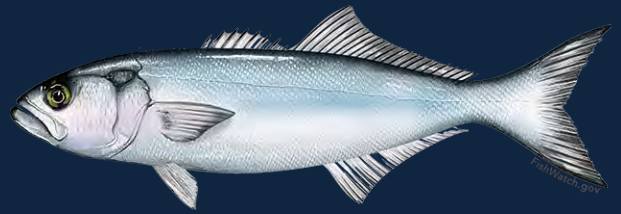
Nekton Categories

Forage base: common species & regularly consumed by piscivorous fish

Mummichog

Atlantic silverside

Juvenile: Young–of–year, using total length (cm)



Bluefish

Striped Bass

Nekton captured

	Summer 2018	Summer 2019
fish	22,680	20,525
crabs	792	1,262
shrimp	3,487	5,545
biomass	65,084 g *(143 lbs)*	56,087 g *(124 lbs)*
species *(43 total)*	37 species	36 species

Analysis overview

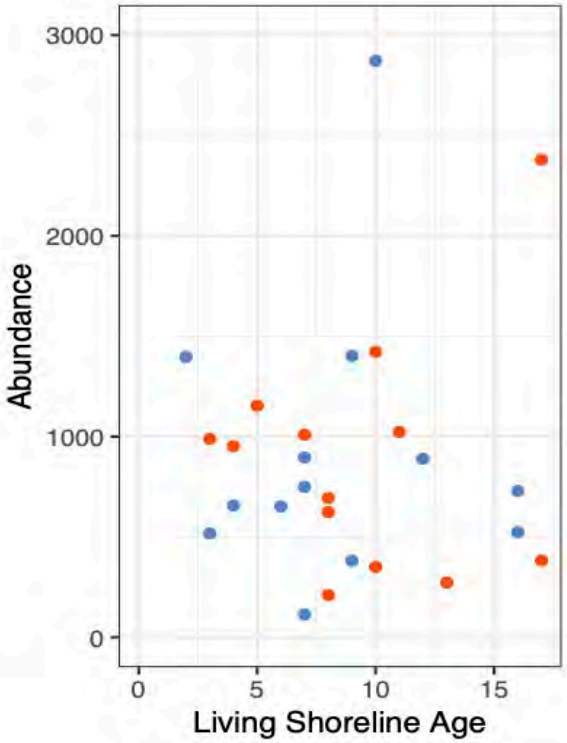
- **Living Shoreline Age**: Pearson Correlation
- **Community Analysis**: PERMANOVA & SIMPER
- **Size frequency comparisons**: Kolmogorov–Smirnov
- **Juvenile Abundance & Forage abundance**

  Marsh Characteristic & Site Setting models

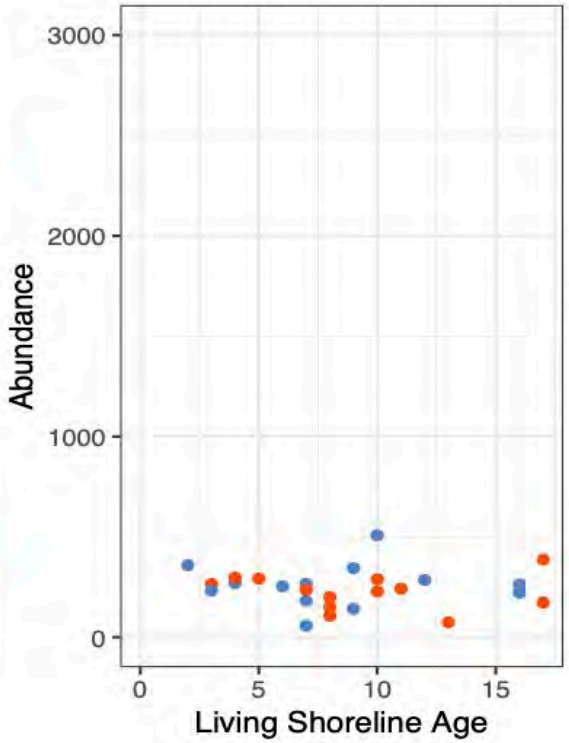
Living Shoreline Age vs Abundancies

No Correlation: $r \leq \pm 0.1$ for all comparisons

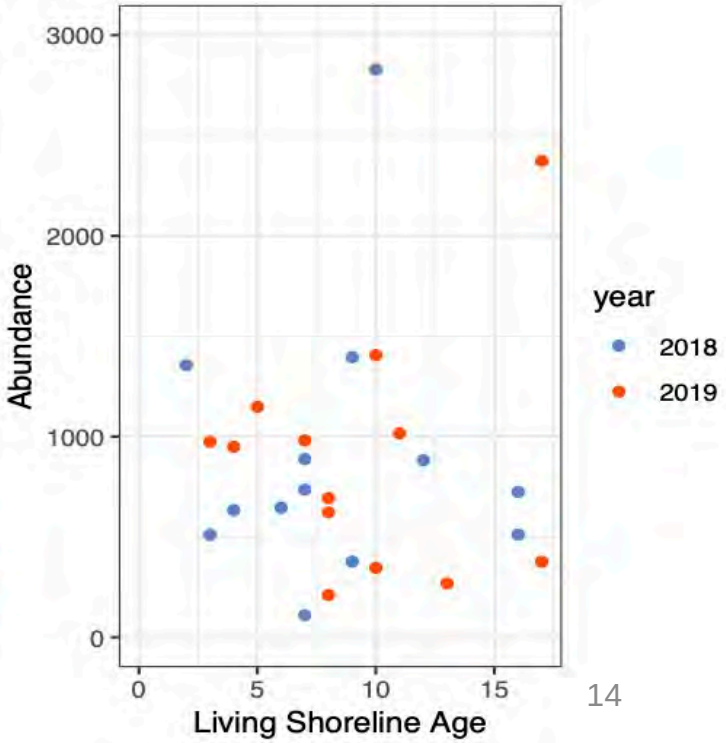
All Nekton



Forage Base



Juveniles



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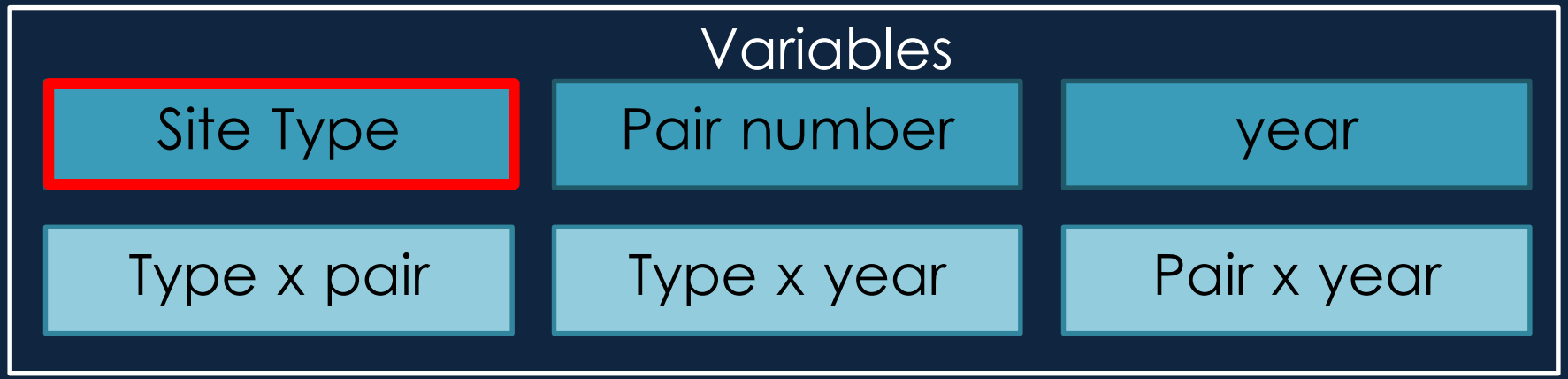
Community Comparisons

- Looked at the community composition *(not species individually)* for **biomass** (weight) and total **abundance**



Analysis: Biomass & Abundance

Site Level
- All Nekton

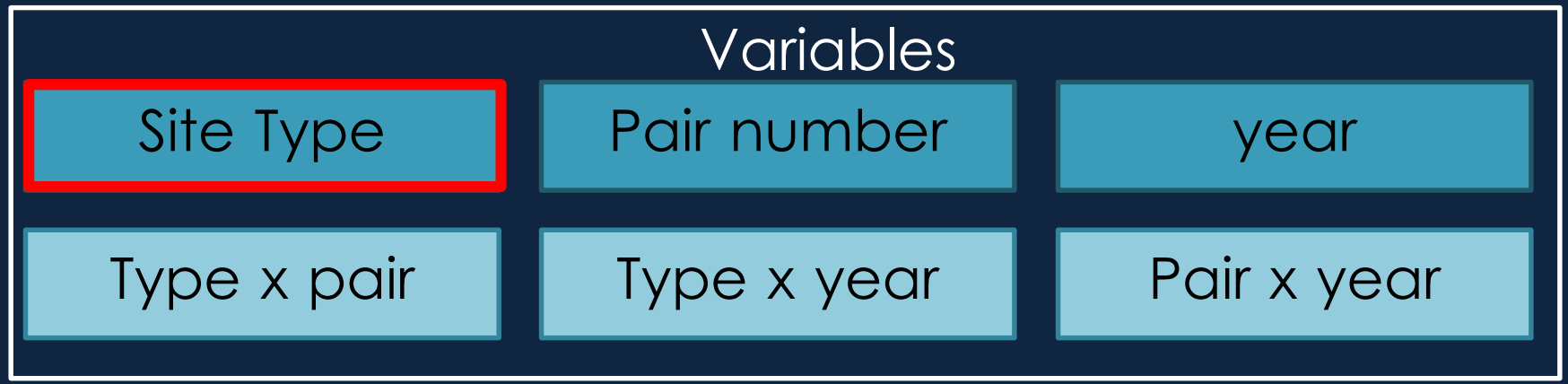
Marsh Community
- All Nekton
- Forage *(trophic support)*
- Juveniles *(nursery support)*

Shallow Water
- All Nekton

Variables		
Site Type	Pair number	year
Type x pair	Type x year	Pair x year

Species assessment: SIMPER

- Identify **which species** were driving the differences among the communities *(if differences were detected)*



Community comparisons, *type*

	Site-level: *All Nekton*	**Shallows:** *All Nekton*	**Marsh:** *All Nekton*	*Forage*	*Juvenile*
Abund.	no difference				

Community comparisons, *type*

	Site-level: *All Nekton*	**Shallows:** *All Nekton*	**Marsh:** *All Nekton*	*Forage*	*Juvenile*
Abund.	no difference				
Biomass		no difference			no diff.

Species size frequency

- For the 4 species driving the differences **compared size frequency** distributions at living shorelines and reference marshes
  - Kolmogorov–Smirnov tests
    - All tests $p < 0.05$

Mummichog

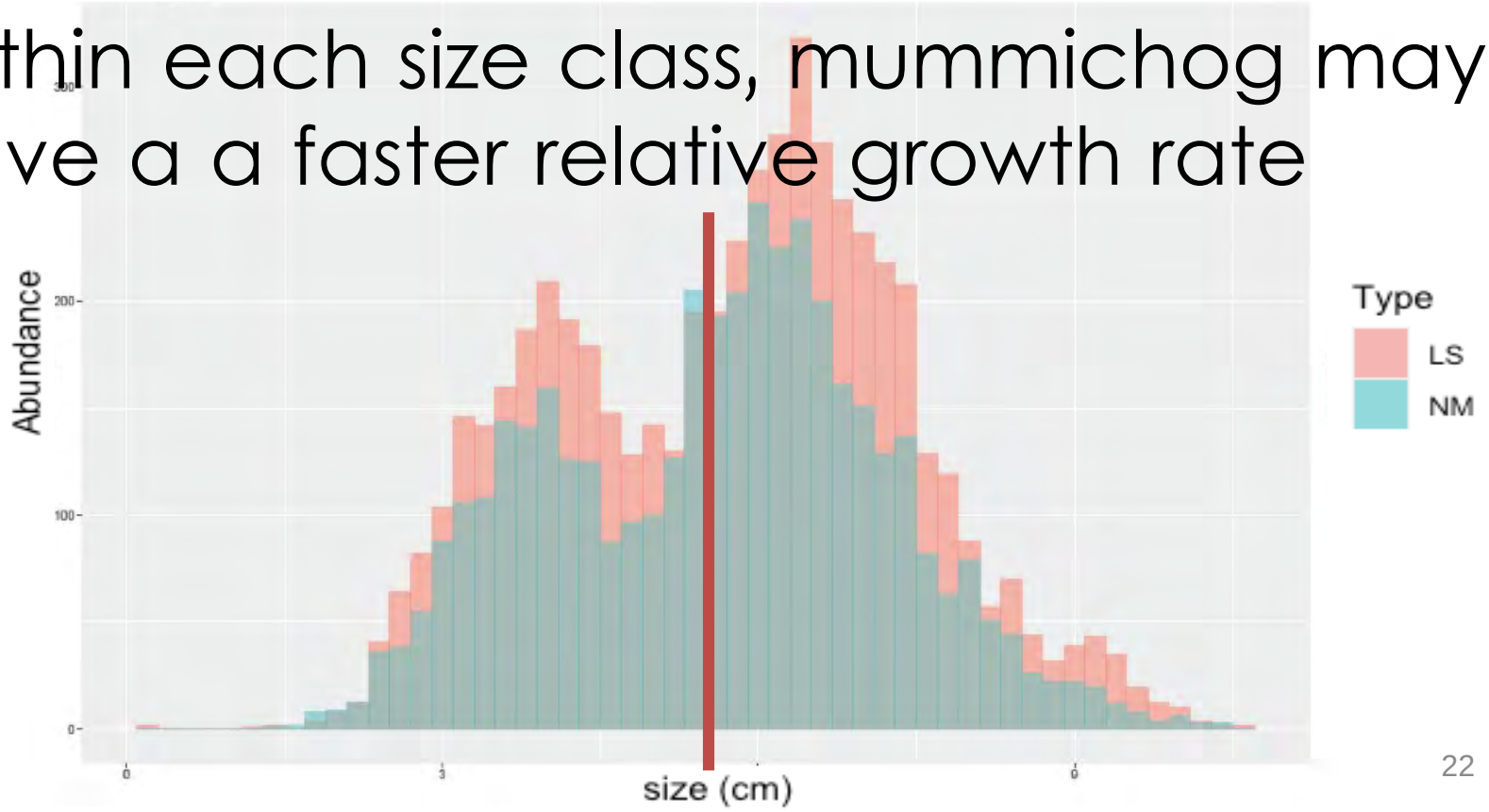
Atlantic silverside

Striped killifish

Blue crab

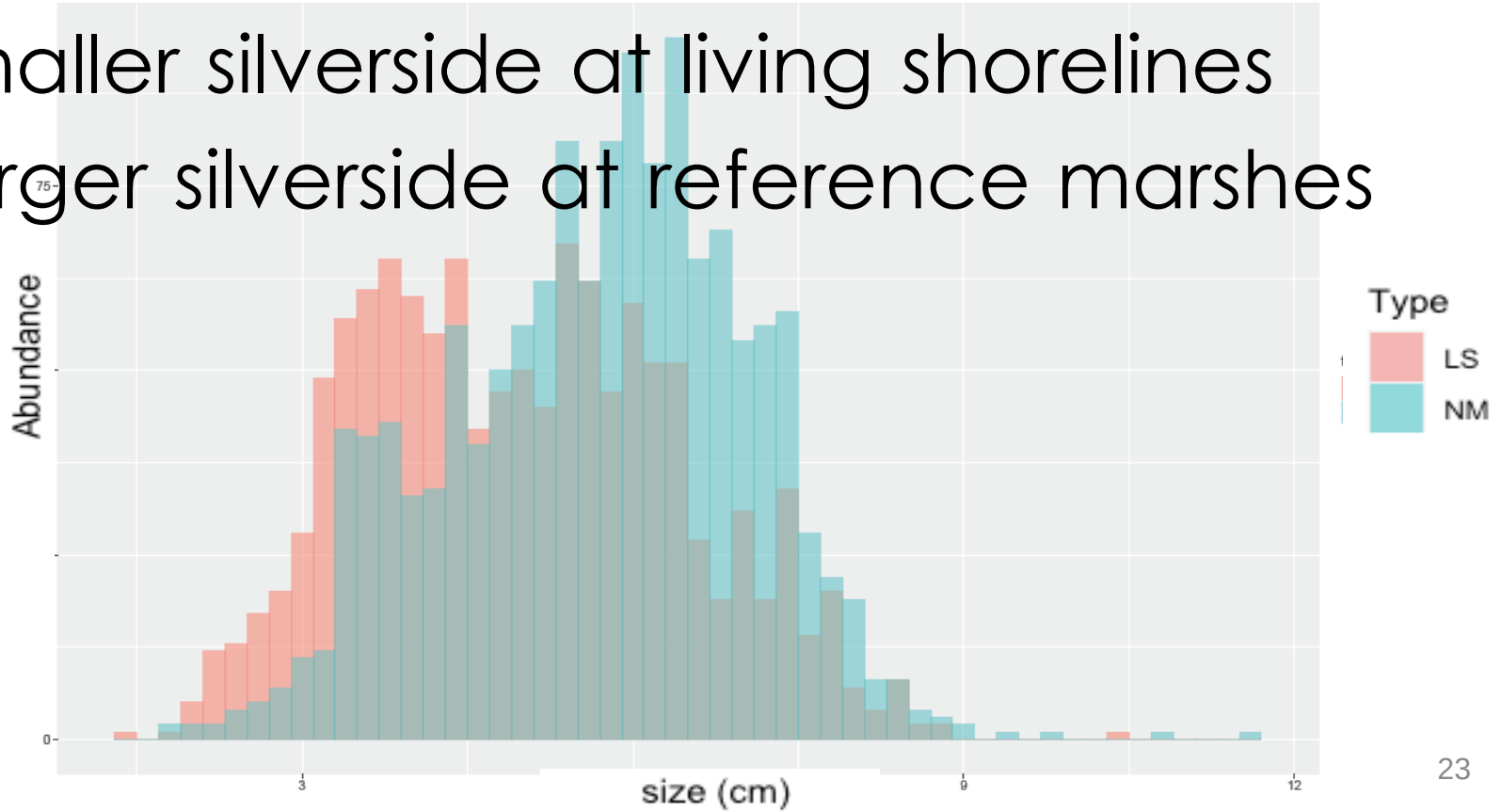
Mummichog

- Within each size class, mummichog may have a a faster relative growth rate



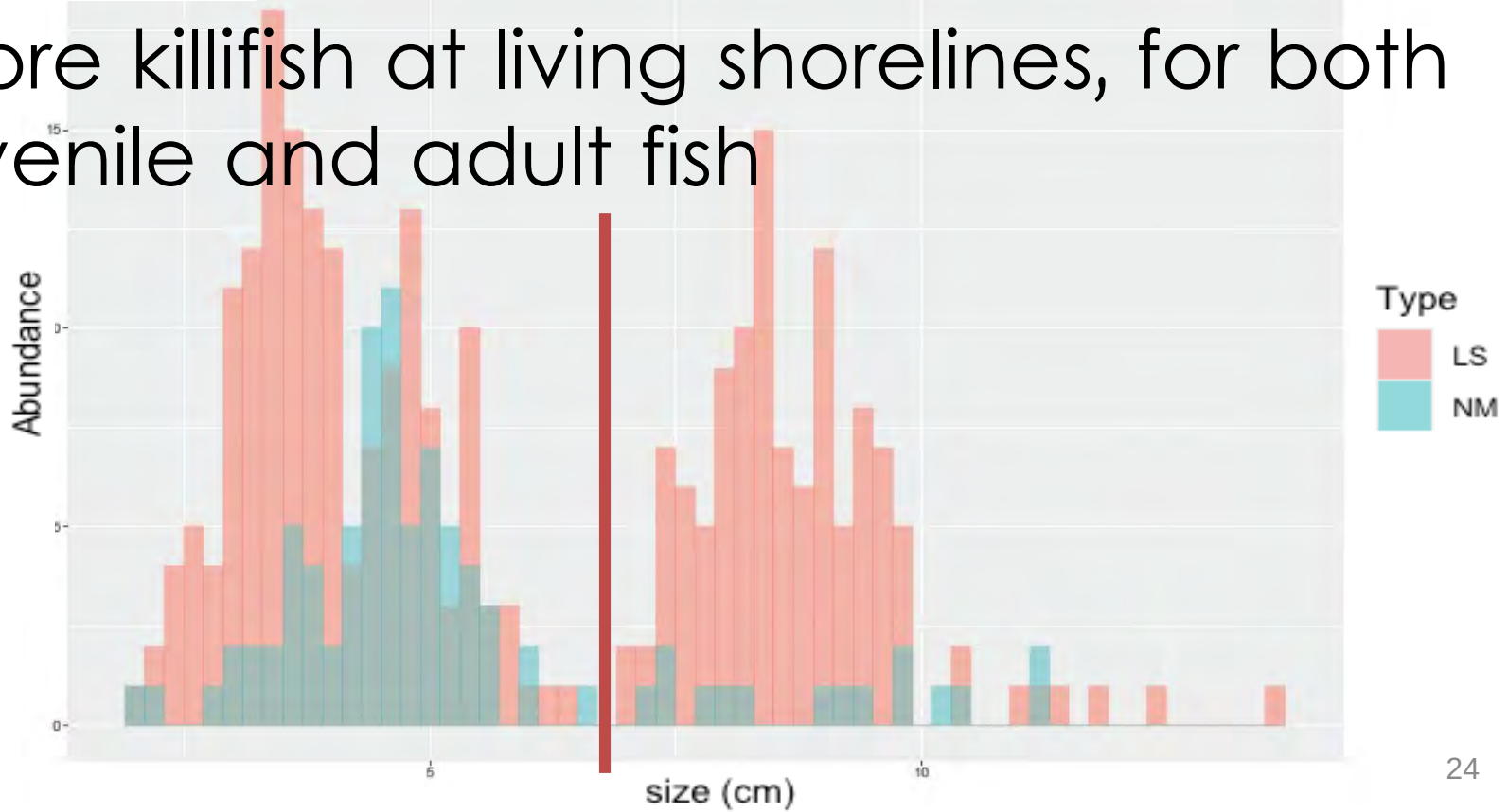
Silverside

- Smaller silverside at living shorelines
- Larger silverside at reference marshes



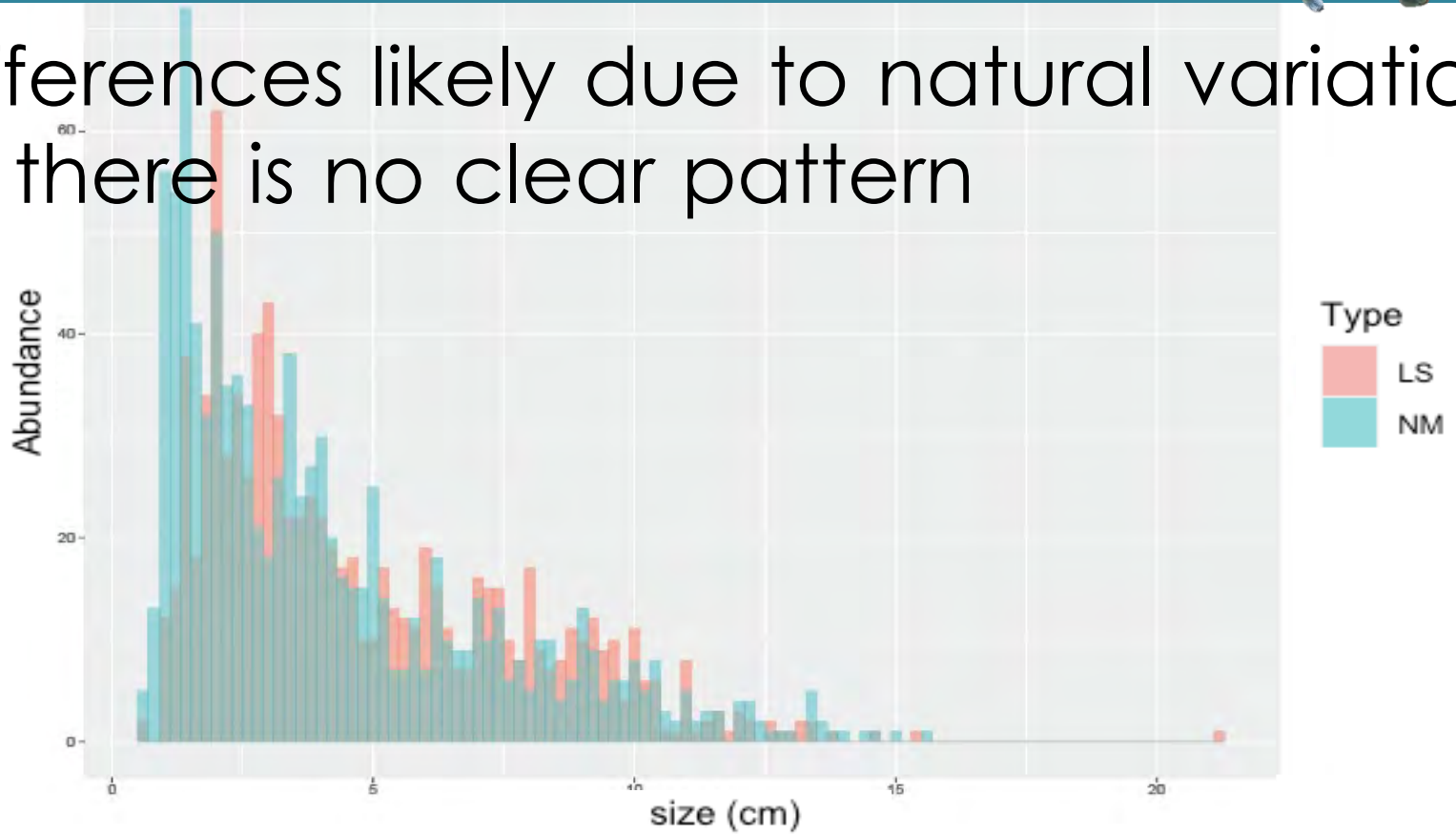
Striped killifish

- More killifish at living shorelines, for both juvenile and adult fish



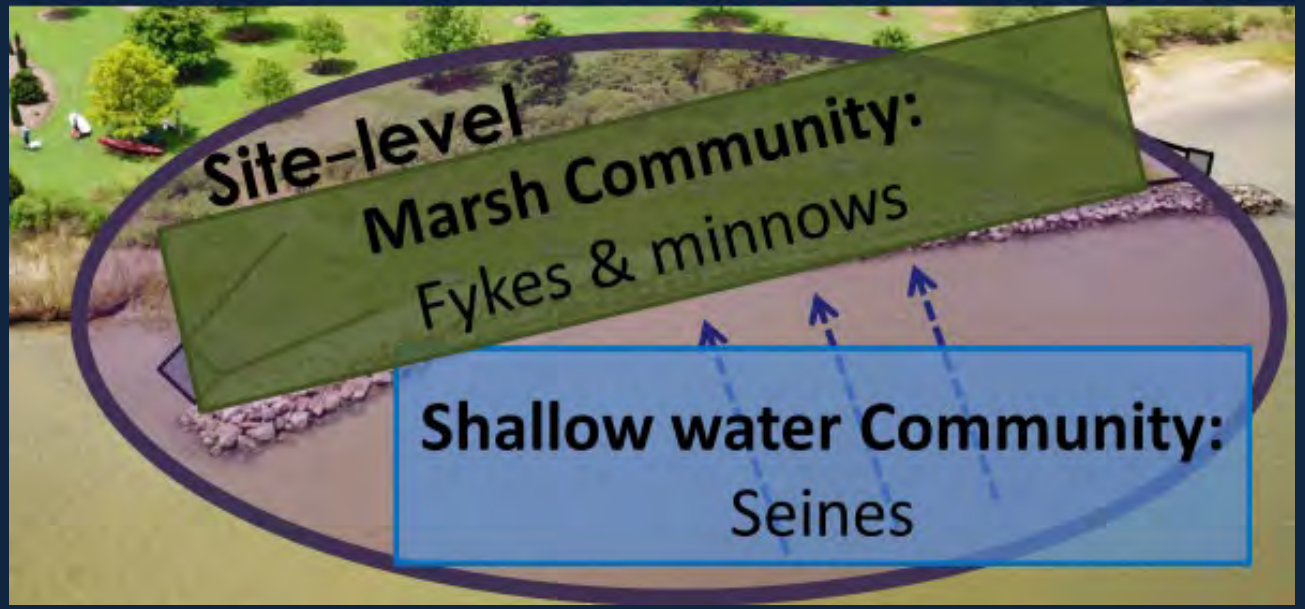
Blue crab

- Differences likely due to natural variation as there is no clear pattern



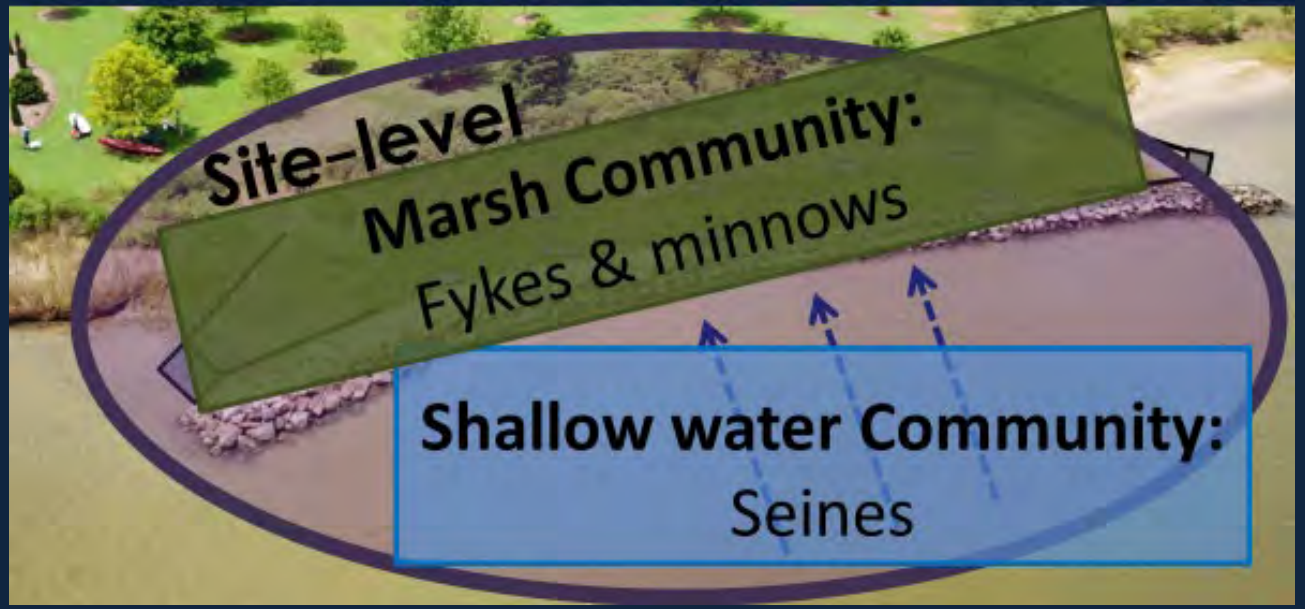
Community Recap

- Living shorelines **provide similar habitat** for nekton **(SITE LEVEL)**



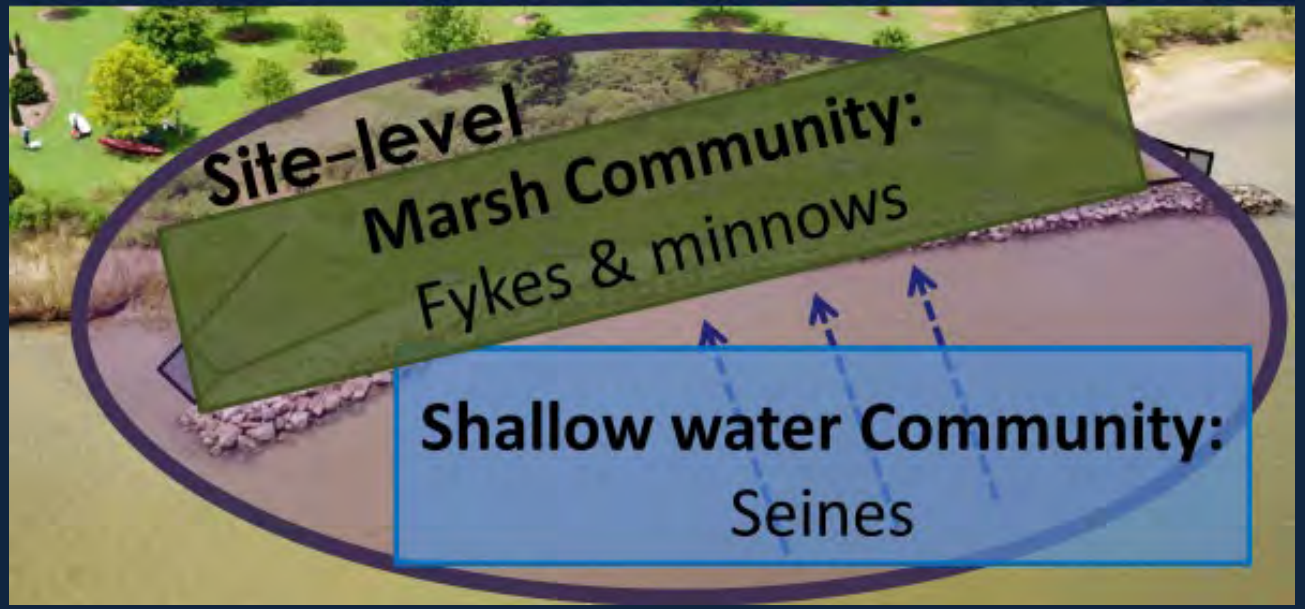
Community Recap

- Living shoreline construction **does not alter** the **shallow water community**



Community Recap

- Living shoreline marshes **provide similar or enhanced marsh habitat** *(forage & juveniles)*



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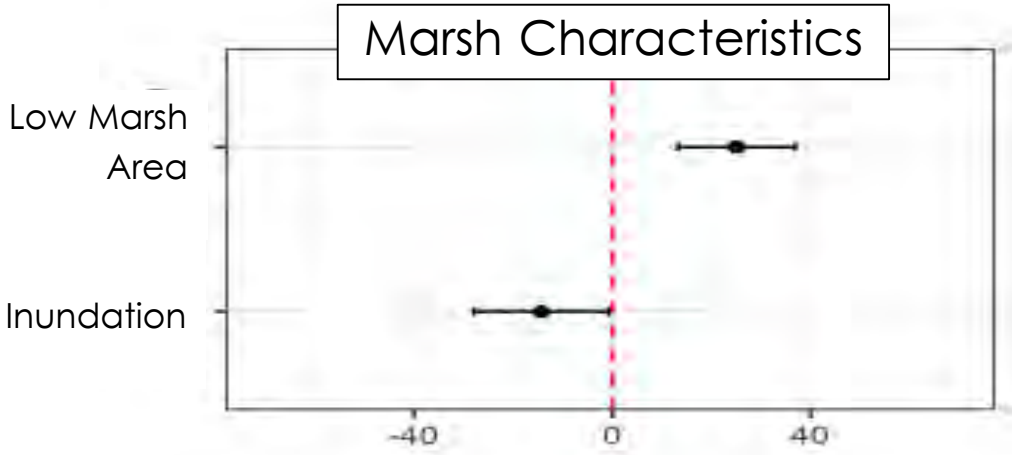
Juvenile, Forage Abundance

Two models:

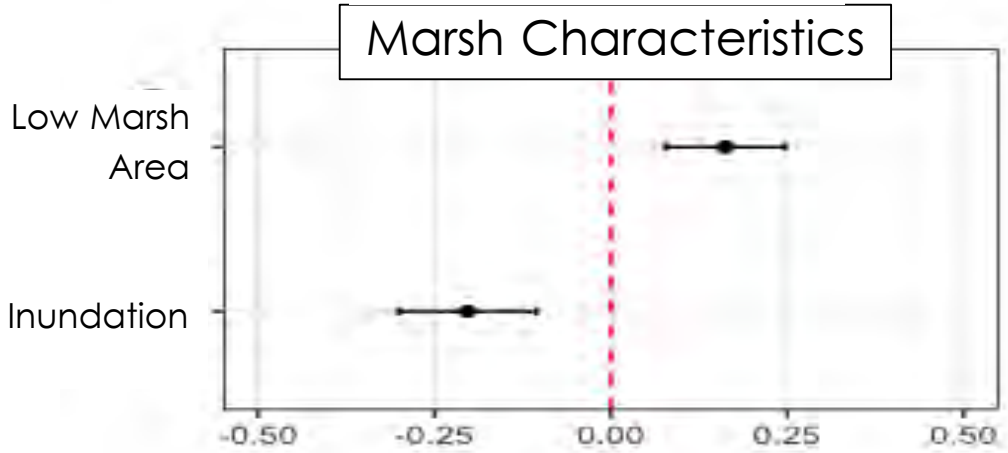
1. Marsh characteristics:
   - **Low marsh area**
   - **Inundation**
   - *Pair number*
2. Site setting
   - **Marsh distance**
   - **Bay mouth distance**
   - *Pair number*

Forage Base



- **More low marsh area** indicates more edge habitat
- **Shorter inundation** related to shallower depths → providing increased predator refuge

Juveniles



- **More low marsh area** indicates more edge habitat
- **Shorter inundation** related to shallower depths → providing increased predator refuge

Discussion: All Nekton

- **No trends in time,** after 2 years of establishment

- **Similar abundances**, **higher biomass** at living shorelines
  - Differences in marsh habitat use
  - Shallow waters similar, *similar to benthic studies*
  - Contrast shoreline hardening techniques

- **Structural differences**
  - Looser, less nutrient soils do not have a substantial effect
  - Sills → Abundant fauna, potential additional structural refuge

(Chambers et al. 2021 Bilkovic and Mitchell 2013, Kornis et al 2017, 2018, Bilkovic et al 2021)

Discussion: trophic support

- Providing **similar or enhanced support** for forage base & the greater estuary

Marsh characteristics (contributing to more forage)

- Refuge: *Lower inundation*
- Habitat use: *Larger marsh area*

Setting characteristics (contributing to more forage)

- Sounding habitat: *more nearby marshes*

(Pardieck et al. 1999, Kornis et al 2017, Ruiz et al. 1993)

Discussion: nursery support

- Providing **similar nursery support** for juveniles
- Non–forage species were **>90% juvenile**

Marsh characteristics (contributing to more juveniles)

- Refuge: *Lower inundation*
- Habitat use: *Larger marsh area*

Setting characteristics (contributing to more juveniles)

- Bay Mouth*: closer to bay mouth*

(Ruiz et al. 1993; Baker and Sheaves 2005)

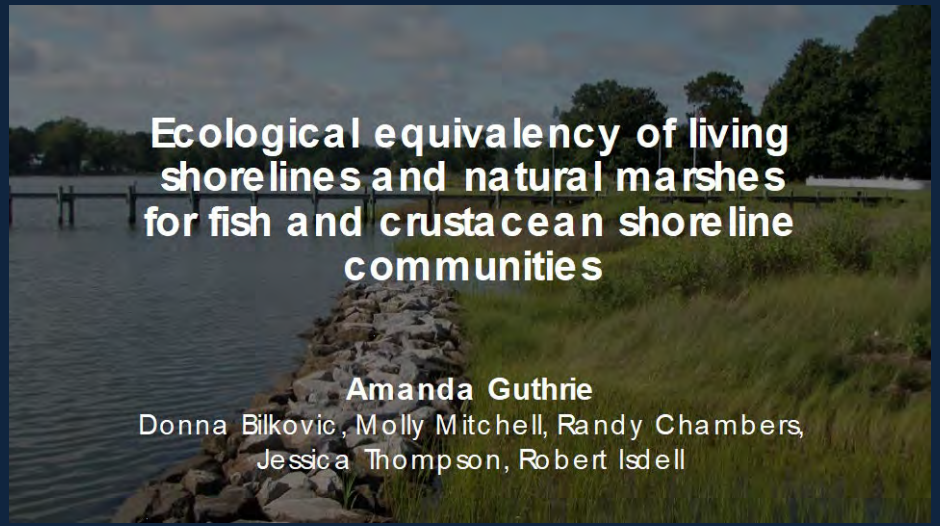
Conclusions

- Living shorelines can supplement efforts to **combat marsh habitat loss** by providing essential habitat

- Living shorelines can support fish habitat under climate change
  - Site specific response
  - Depending on marsh migration, sedimentation rates, below ground biomass growth

Questions or comments?

agguthrie@vims.edu



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