Evaluation of habitat quality for juvenile summer flounder in two seascapes

Shannon Smith

Presentation to the Scientific, Technical Assessment & Reporting Team

17 Nov 2022

Acknowledgments

Advisor and dissertation committee:

- Mary Fabrizio
- Rob Latour
- Chris Patrick
- Jon Spurgeon
- Ryan Woodland

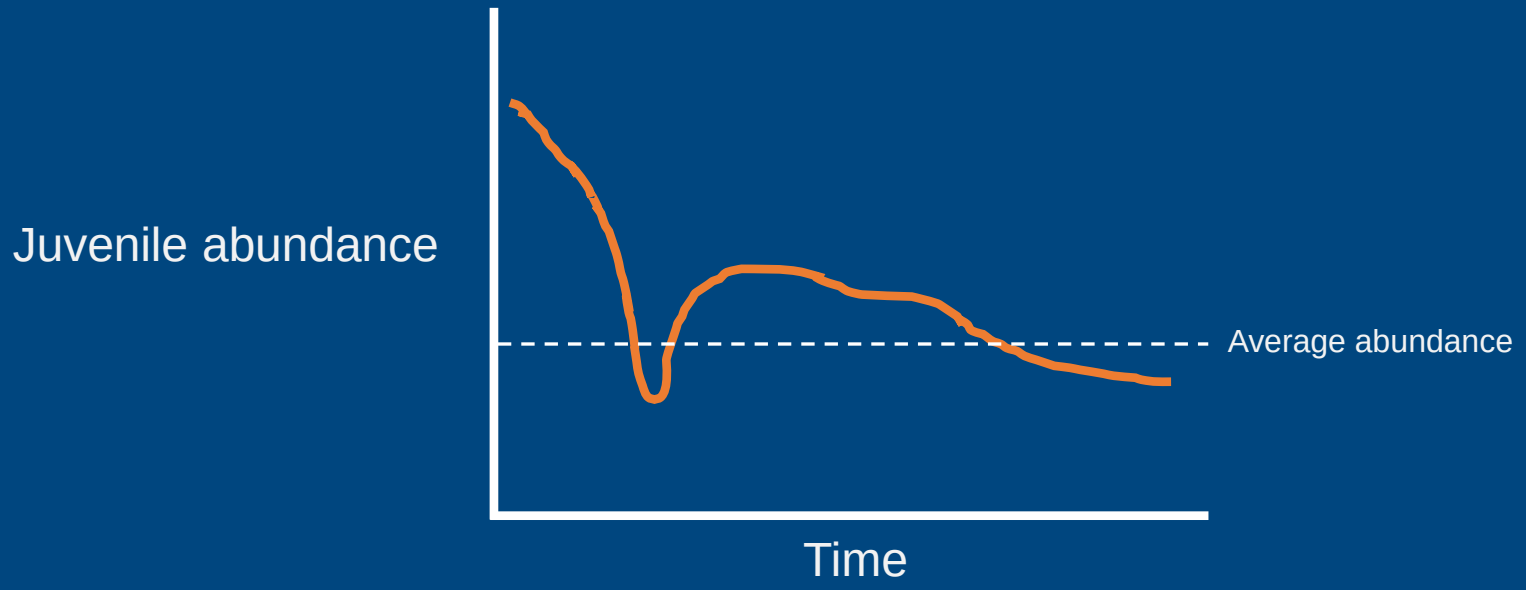
Field and lab support:

- VIMS' Eastern Shore Lab
- Juvenile Fish Trawl Survey crew

Symbol art:

- Tracey Saxby, Integration and Application Network (ian.umces.edu/media-library)

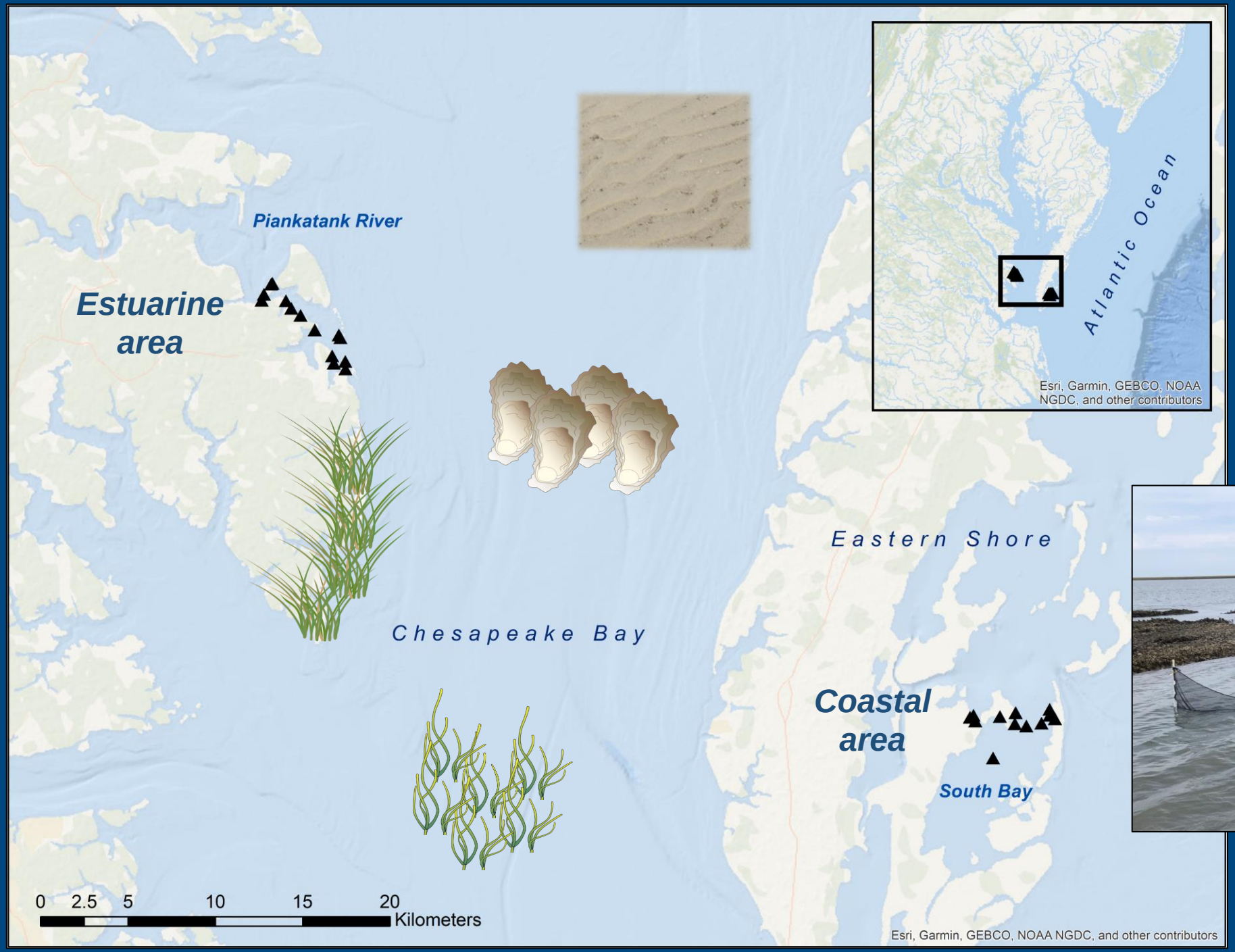
Habitats are integral for fisheries management



Are Virginia estuaries serving as essential fish habitats for juvenile summer flounder?

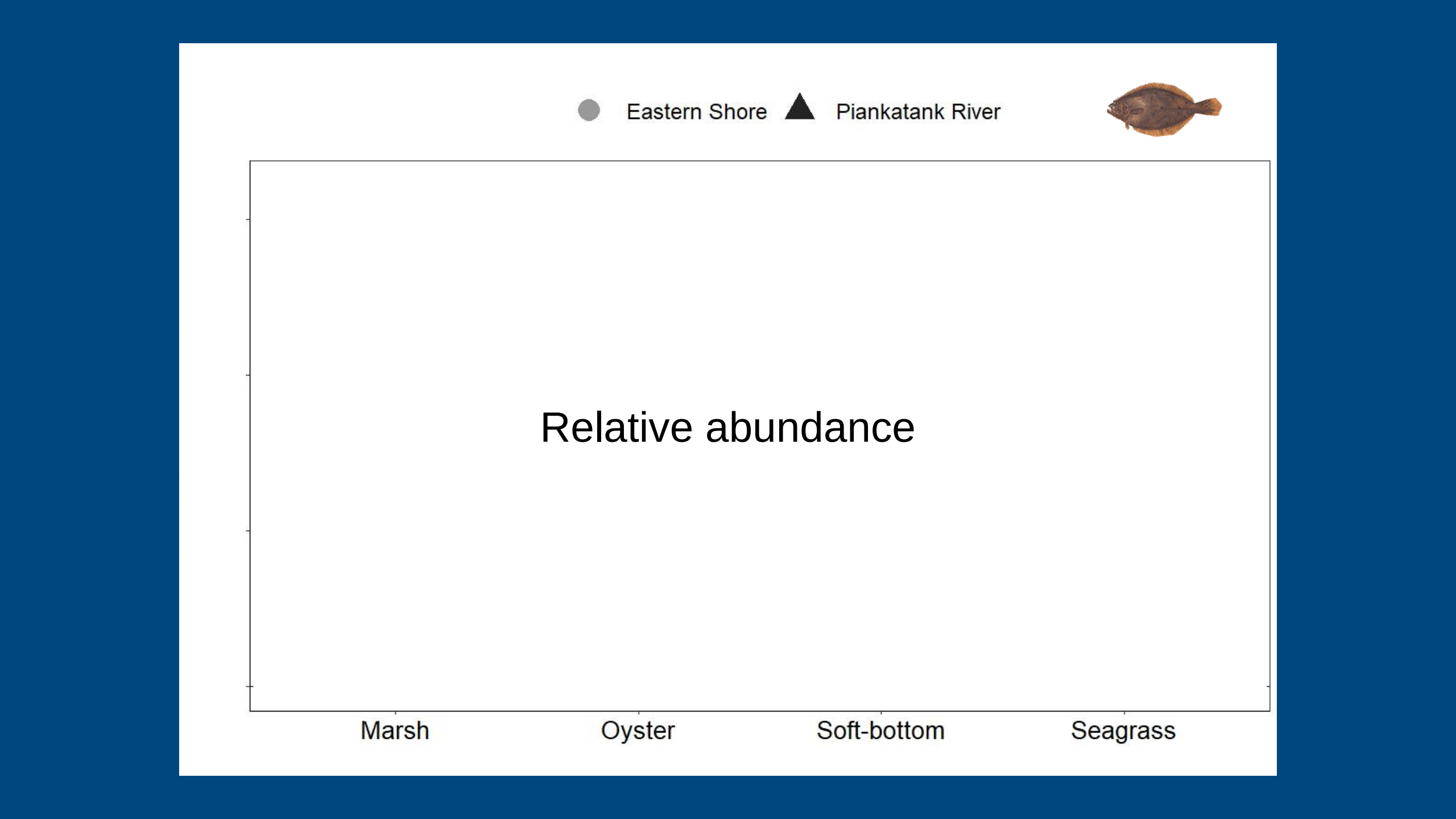
Field study

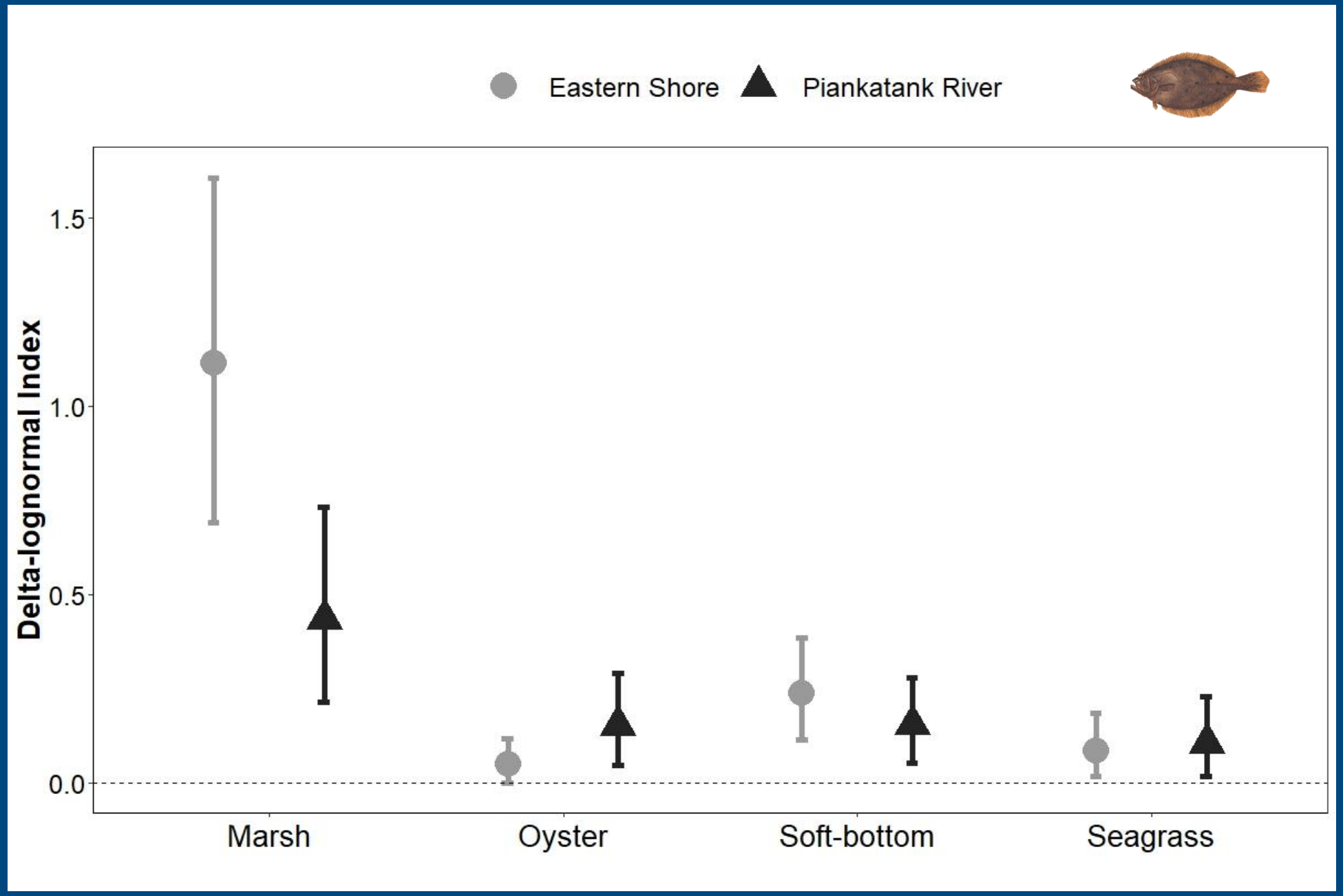
- 12 sites / area
- 2019 & 2020



Evaluation of habitat quality

- Relative abundance
- Recent growth
- Body condition

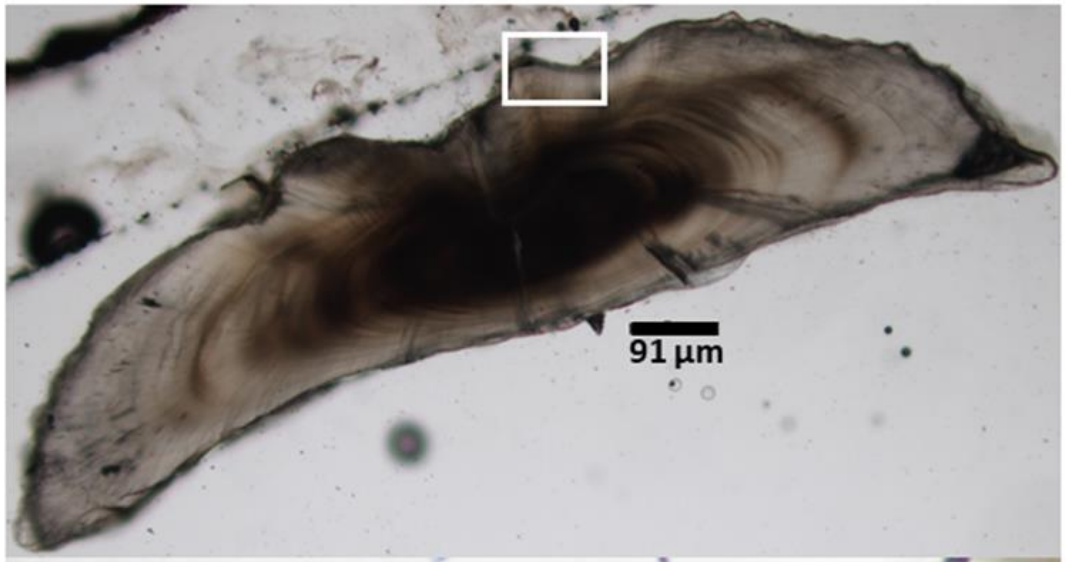

Eastern Shore
Piankatank River
Relative abundance
Marsh
Oyster
Soft-bottom
Seagrass

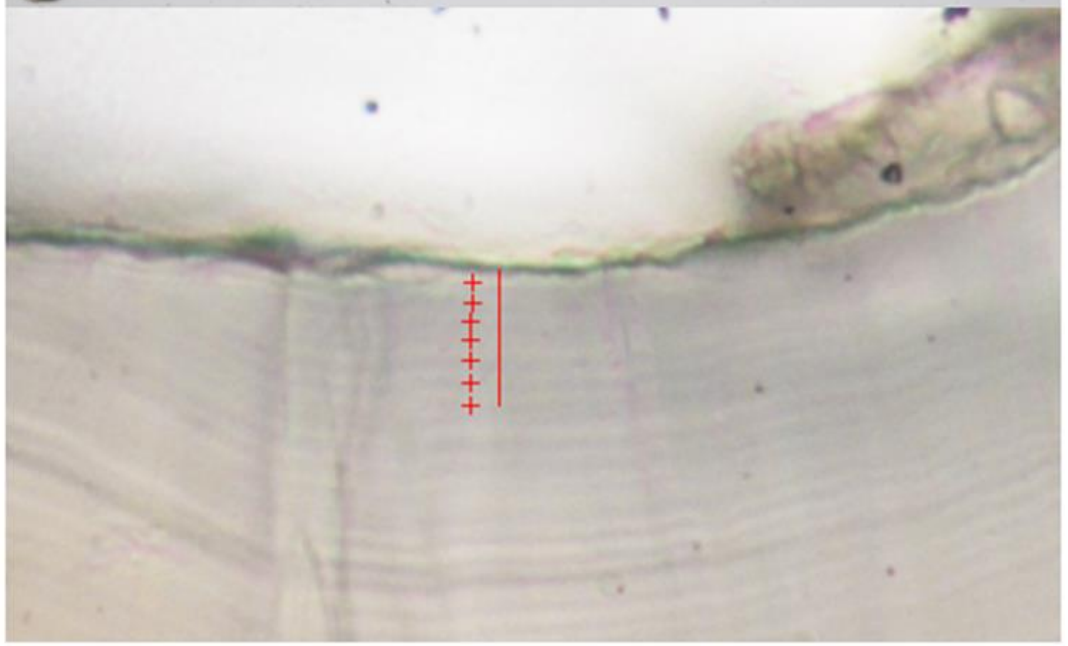

Eastern Shore
Piankatank River
Delta-lognormal Index
1.5
1.0
0.5
0.0
Marsh
Oyster
Soft-bottom
Seagrass

Eastern Shore Piankatank River

Recent growth

Marsh Oyster Soft-bottom Seagrass





Marsh

Seagrass

Eastern Shore ▲ Piankatank River

$$recent\ growth \approx fixed\ effects + random\ effect + variance$$

Marsh Oyster Soft-bottom Seagrass

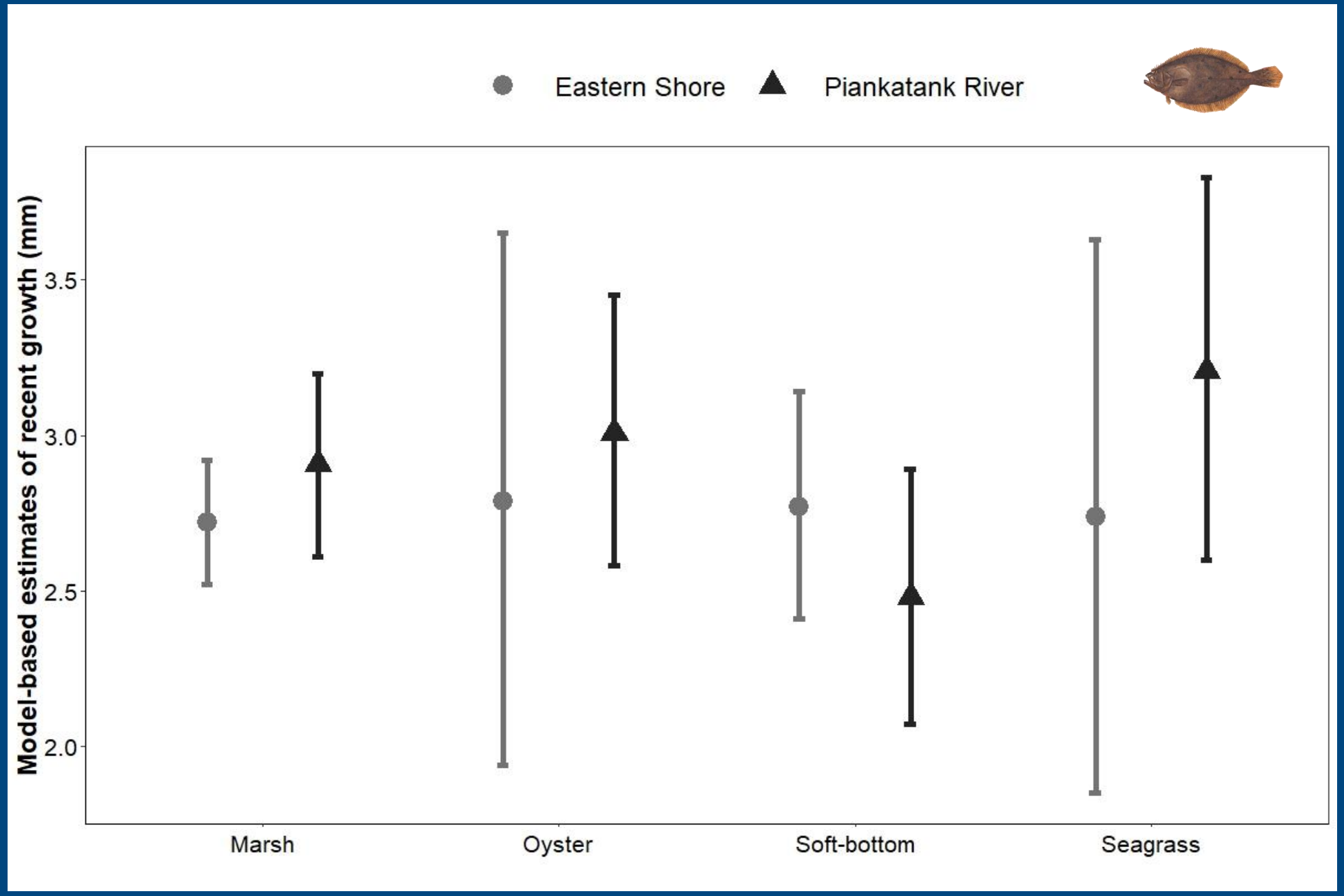
Eastern Shore Piankatank River

$$recent\ growth \approx fixed\ effects + random\ effect + variance$$

Area-habitat combination
Fish size

Site nested in area-habitat

Marsh Oyster Soft-bottom Seagrass


Eastern Shore
Piankatank River
Model-based estimates of recent growth (mm)
3.5
3.0
2.5
2.0
Marsh
Oyster
Soft-bottom
Seagrass

Eastern Shore Piankatank River

Body condition

Marsh Oyster Soft-bottom Seagrass

Eastern Shore Piankatank River

$$relative\ condition\ K_n = \frac{observed\ weight}{estimated\ weight}$$

Marsh Oyster Soft-bottom Seagrass

Eastern Shore Piankatank River

$$relative\ condition\ K_n = \frac{observed\ weight}{estimated\ weight}$$

$$K_n \approx fixed\ effect + random\ effect + variance$$

Marsh Oyster Soft-bottom Seagrass

● Eastern Shore ▲ Piankatank River

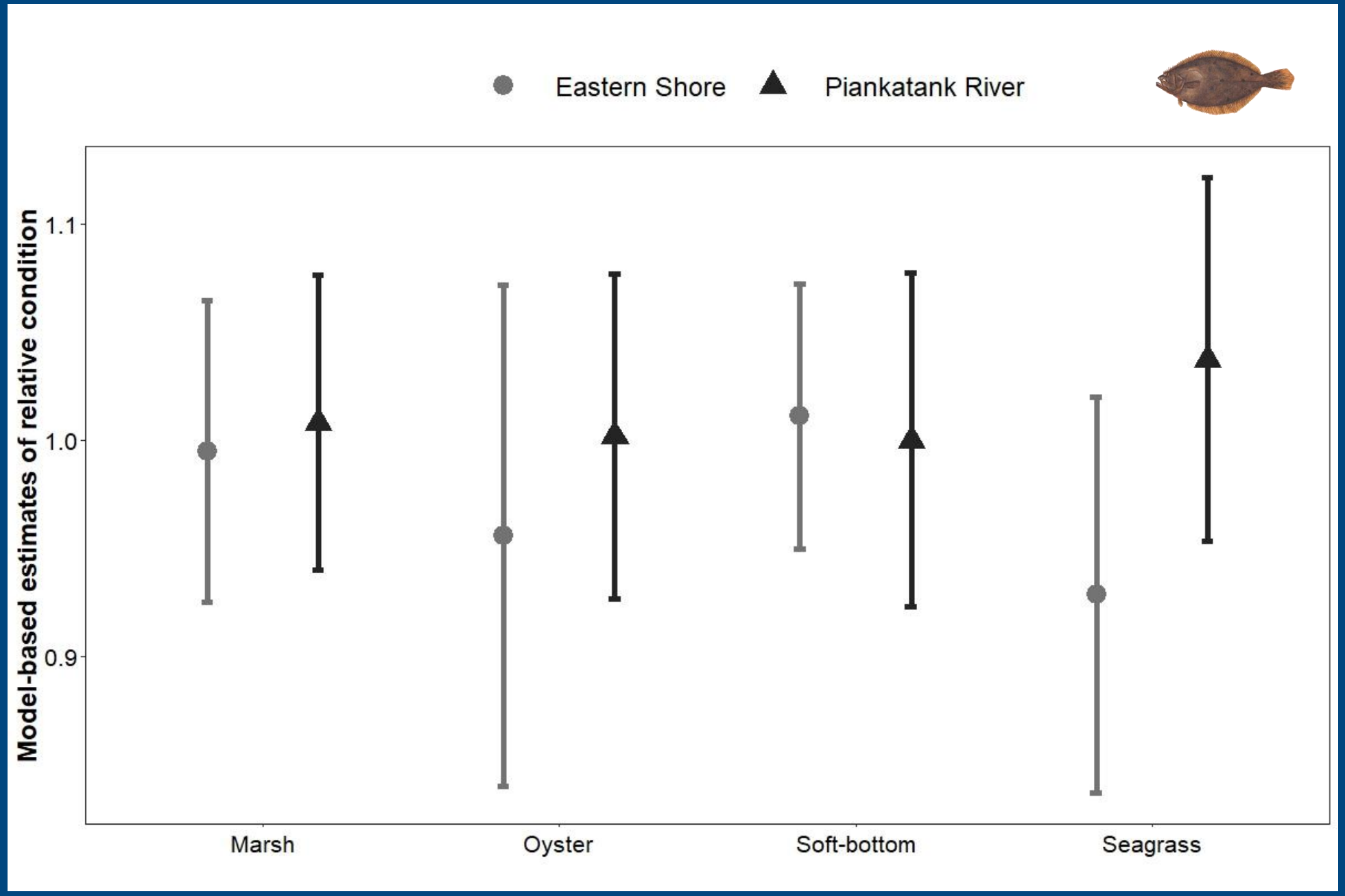
$$relative\ condition\ K_n = \frac{observed\ weight}{estimated\ weight}$$

$$K_n \approx fixed\ effect + random\ effect + variance$$

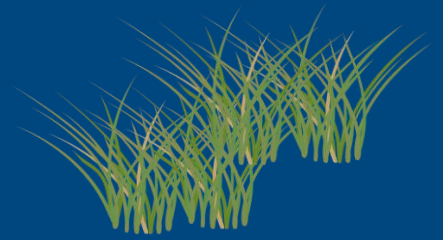
Area-habitat combination

Site nested in area-habitat

Marsh Oyster Soft-bottom Seagrass


Eastern Shore
Piankatank River
Model-based estimates of relative condition
1.1
1.0
0.9
Marsh
Oyster
Soft-bottom
Seagrass

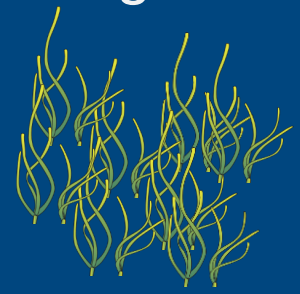
Marsh



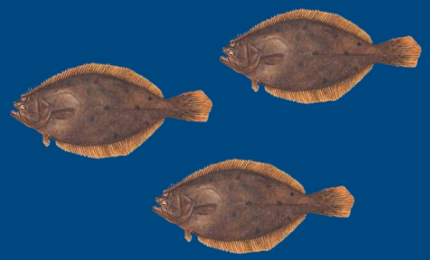
Oyster

Soft-bottom

Seagrass



- Abundance



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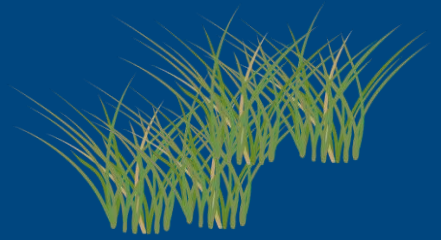
≈ 

≈ 

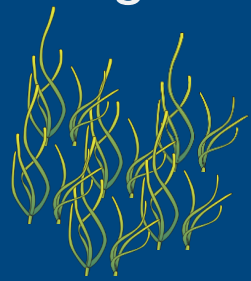
Marsh



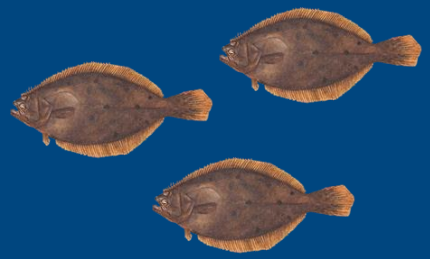
Oyster

Soft-bottom

Seagrass



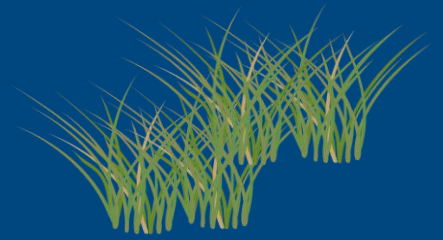
- Abundance

 >  ≈  ≈ 

- Recent growth

 ≈  ≈  ≈ 

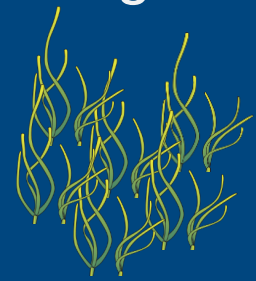
Marsh



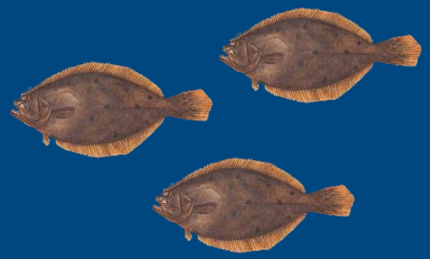
Oyster

Soft-bottom

Seagrass



- Abundance

 >  ≈  ≈ 

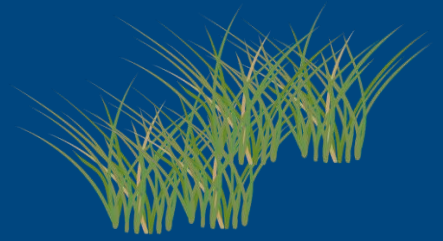
- Recent growth

 ≈  ≈  ≈ 

- Body condition

 ≈  ≈  ≈ 

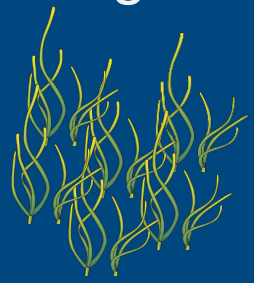
Marsh



Oyster

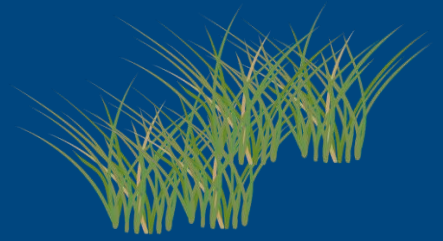
Soft-bottom

Seagrass



- Abundance – higher mean abundance in Eastern Shore marshes
  - Marshes provide prey resources & refuge
  - Supports previous work in other systems

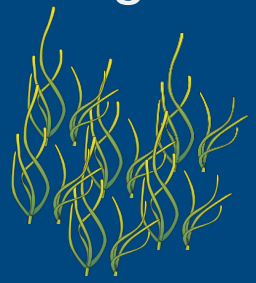
Marsh



Oyster

Soft-bottom

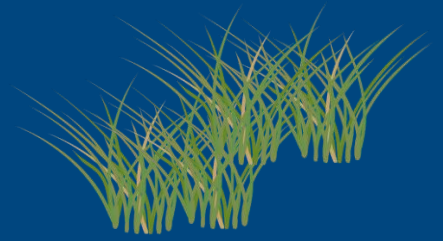
Seagrass



- Abundance – higher mean abundance in Eastern Shore marshes

- Recent growth – no difference between areas or habitat types
  - Insufficient sample size
  - Availability of prey resources
  - Use of the seascape

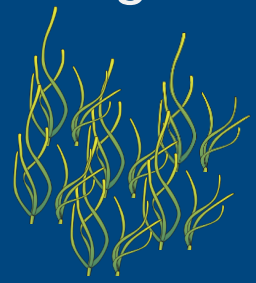
Marsh



Oyster

Soft-bottom

Seagrass



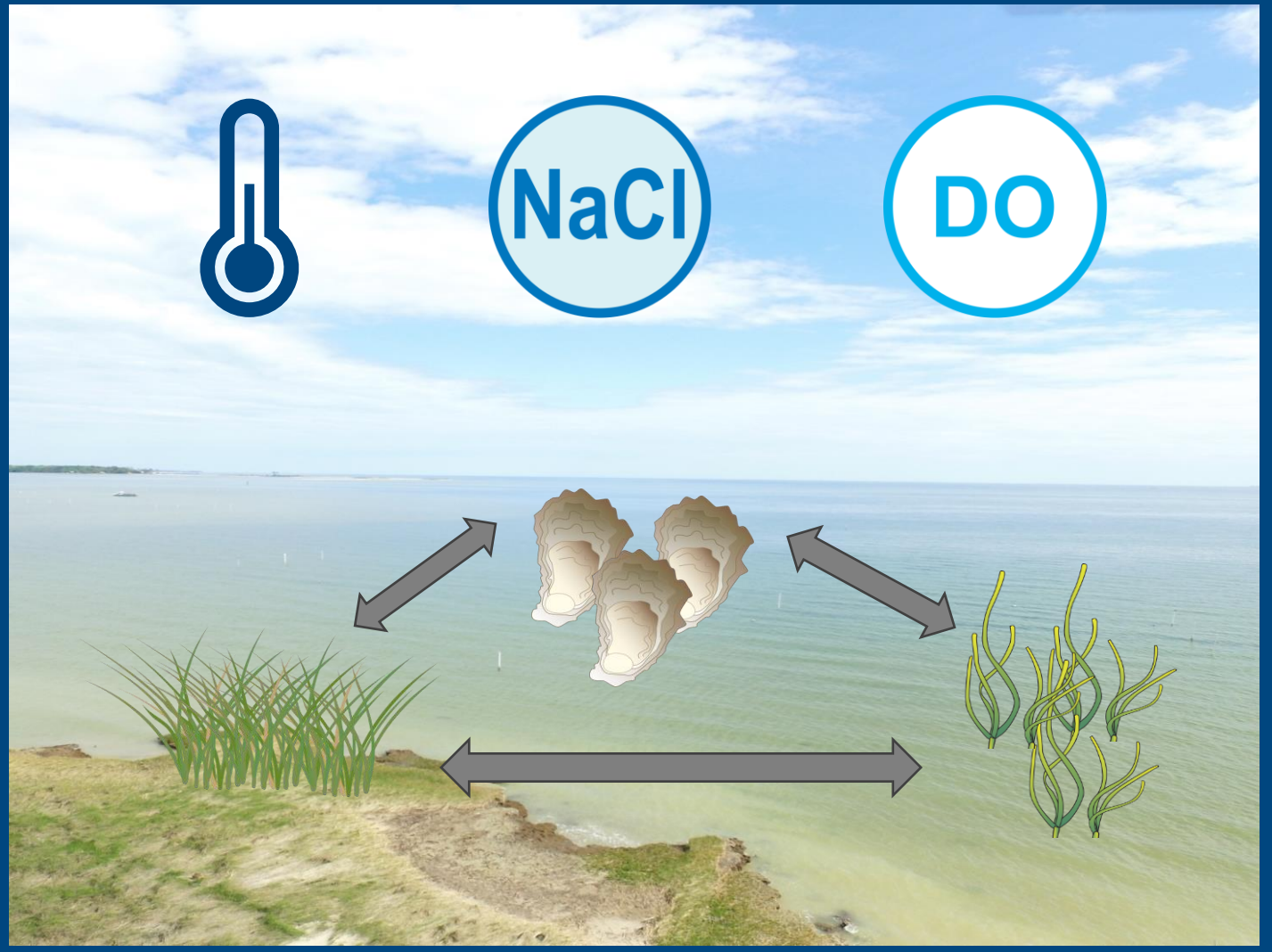
- Abundance – higher mean abundance in Eastern Shore marshes
- Recent growth – no difference between areas or habitat types
- Body condition – no difference between areas or habitat types

Why no difference in mean body condition?

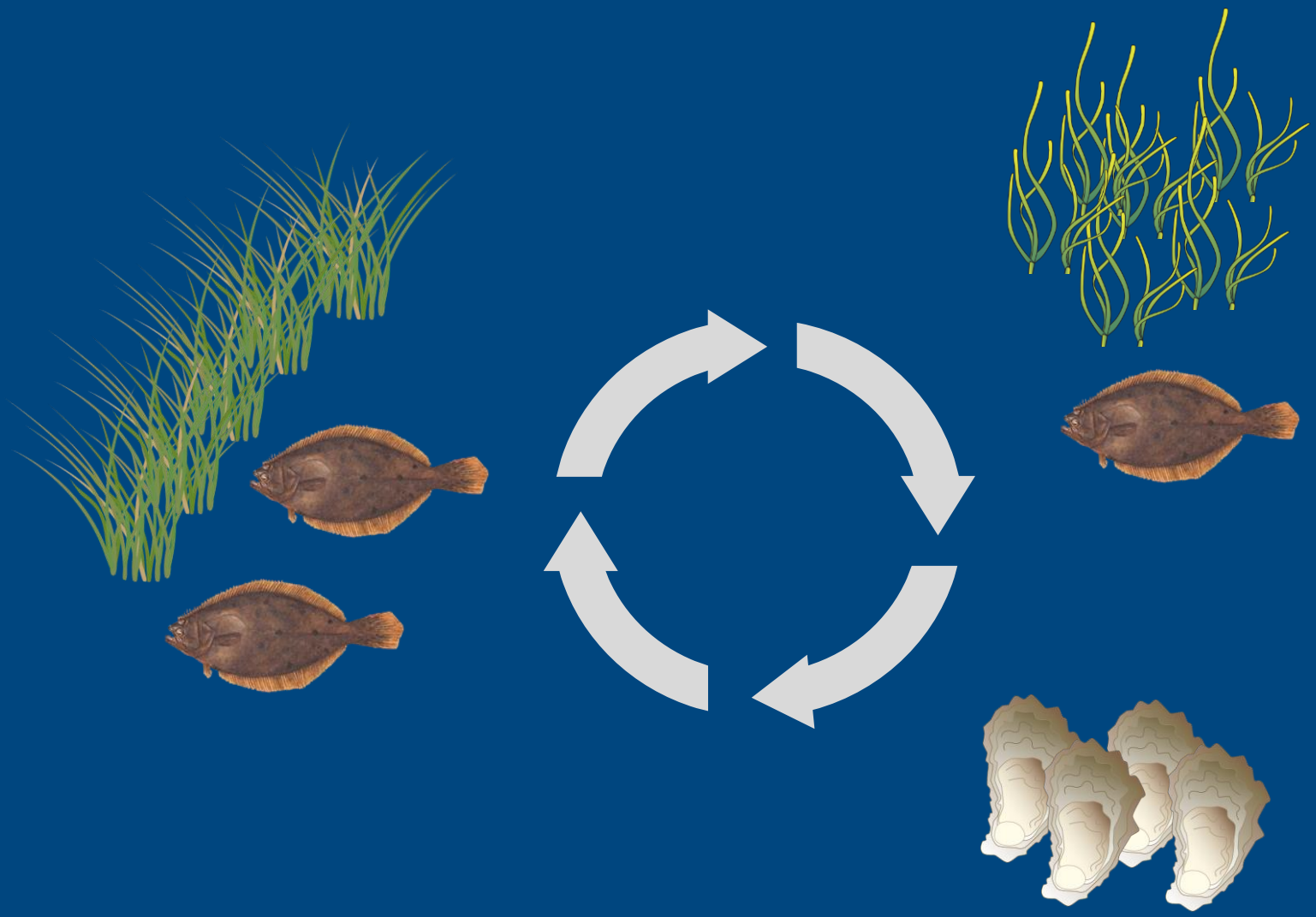
- Schloesser & Fabrizio 2019
  - Mean body condition greater in Eastern Shore compared with Chesapeake Bay sub-estuaries
  - Sampling locations & gear differed
- Potential effect of depth and body size on mean body condition
  - Larger fish in deeper areas – observed difference
  - Smaller fish in shallow areas – no difference
- Additional considerations
  - Allocation of energy
  - Insufficient sample size
  - Use of the seascape

Seascapes can define function

- Seascape
  - Environmental context
  - Physical structures
  - Spatial relationships

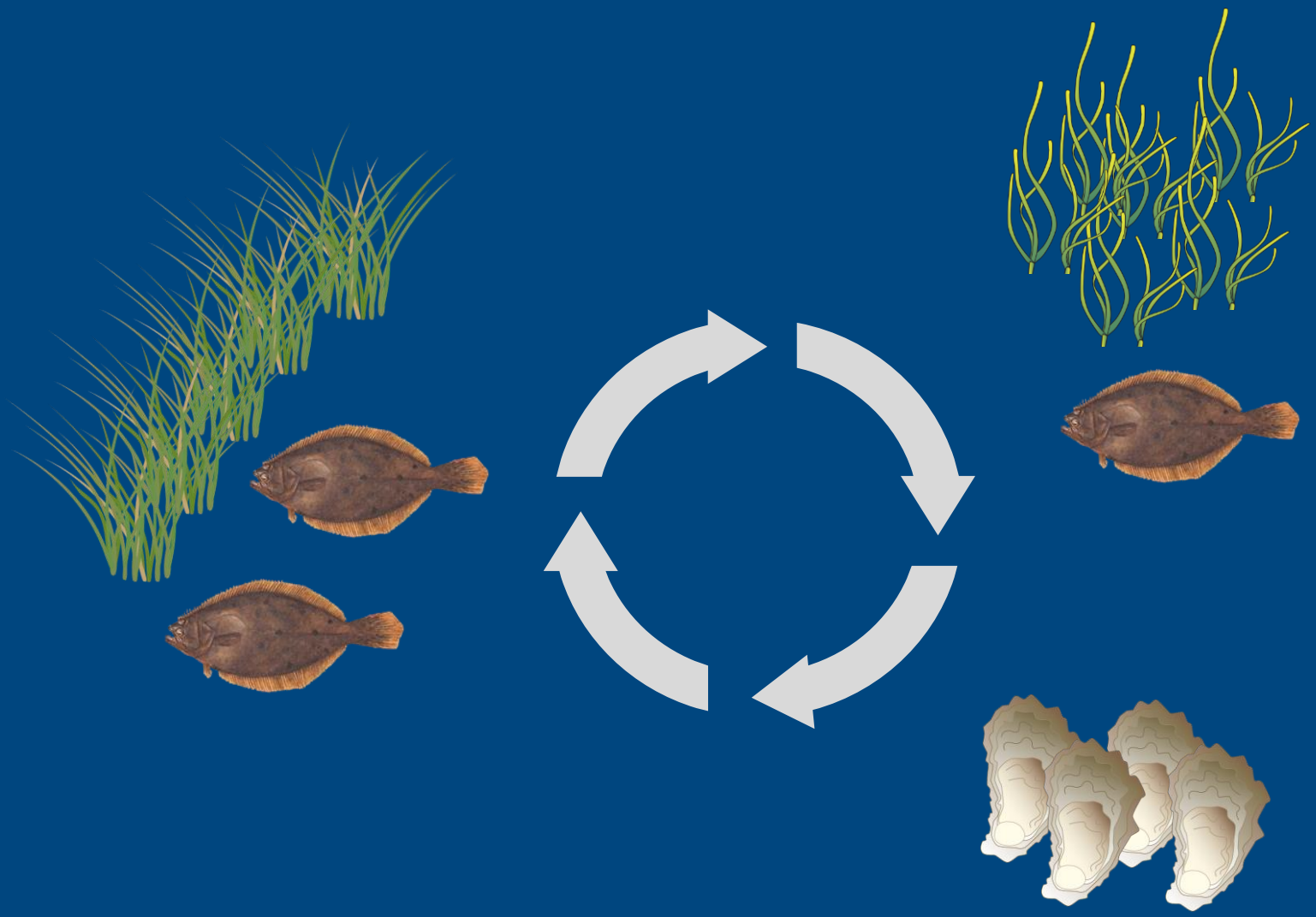


Seascapes affect movement of fish and resources



Heck et al. 2008; Davis et al. 2017; Litvin et al. 2018

How can we characterize seascapes?



Heck et al. 2008; Davis et al. 2017; Litvin et al. 2018

landscapemetrics

Last updated: 2022-11-01

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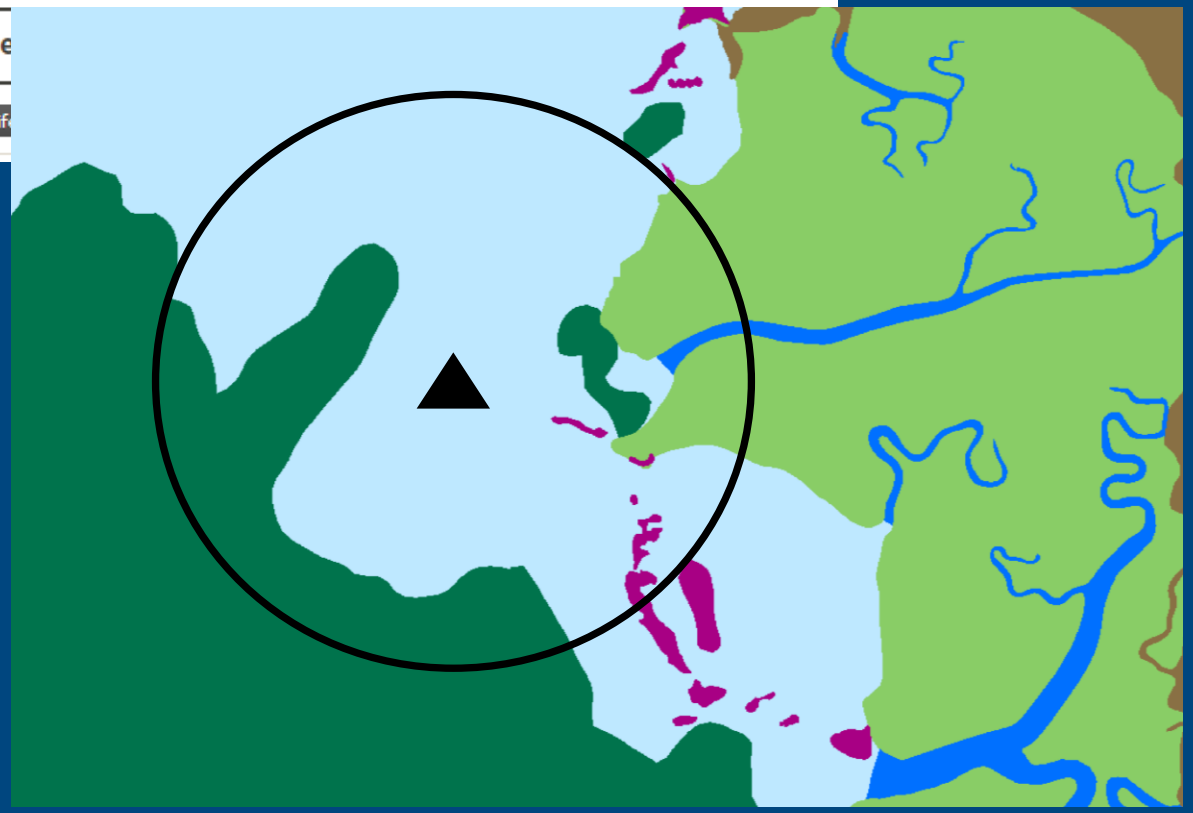

Hesselbarth, M.H.K., Sciaini, M., With, K.A., Wiegand, K., Nowosad, J. 2019. landscapemetrics: an open-source R tool to calculate landscape metrics. Ecography, 42: 1648-1657

Comprehensive characterization of seascapes

- Proximity
  - Distance from location of fish capture to structured habitat
- Availability
  - Area, patch density, edge density
- Connectivity
  - Cohesion and contiguity
- Diversity
  - Simpson’s diversity
- Bathymetry & environmental conditions

Comprehensive characterization of seascapes

- Proximity
  - Distance from location of fish capture to structured habitat
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  - Area, patch density, edge density
- Connectivity
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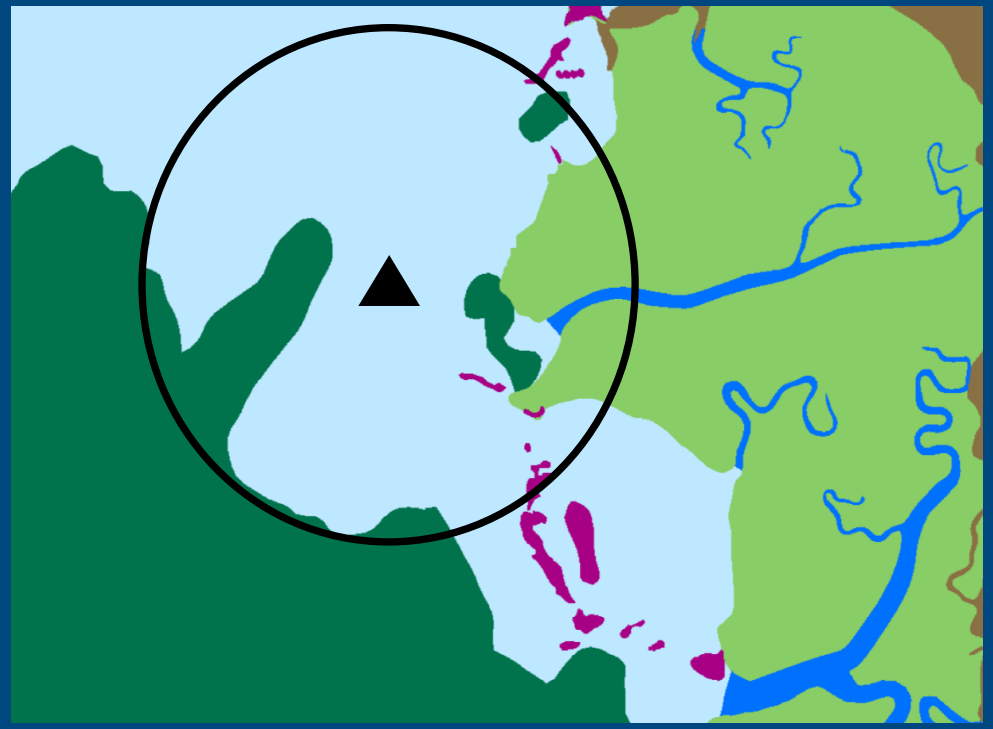
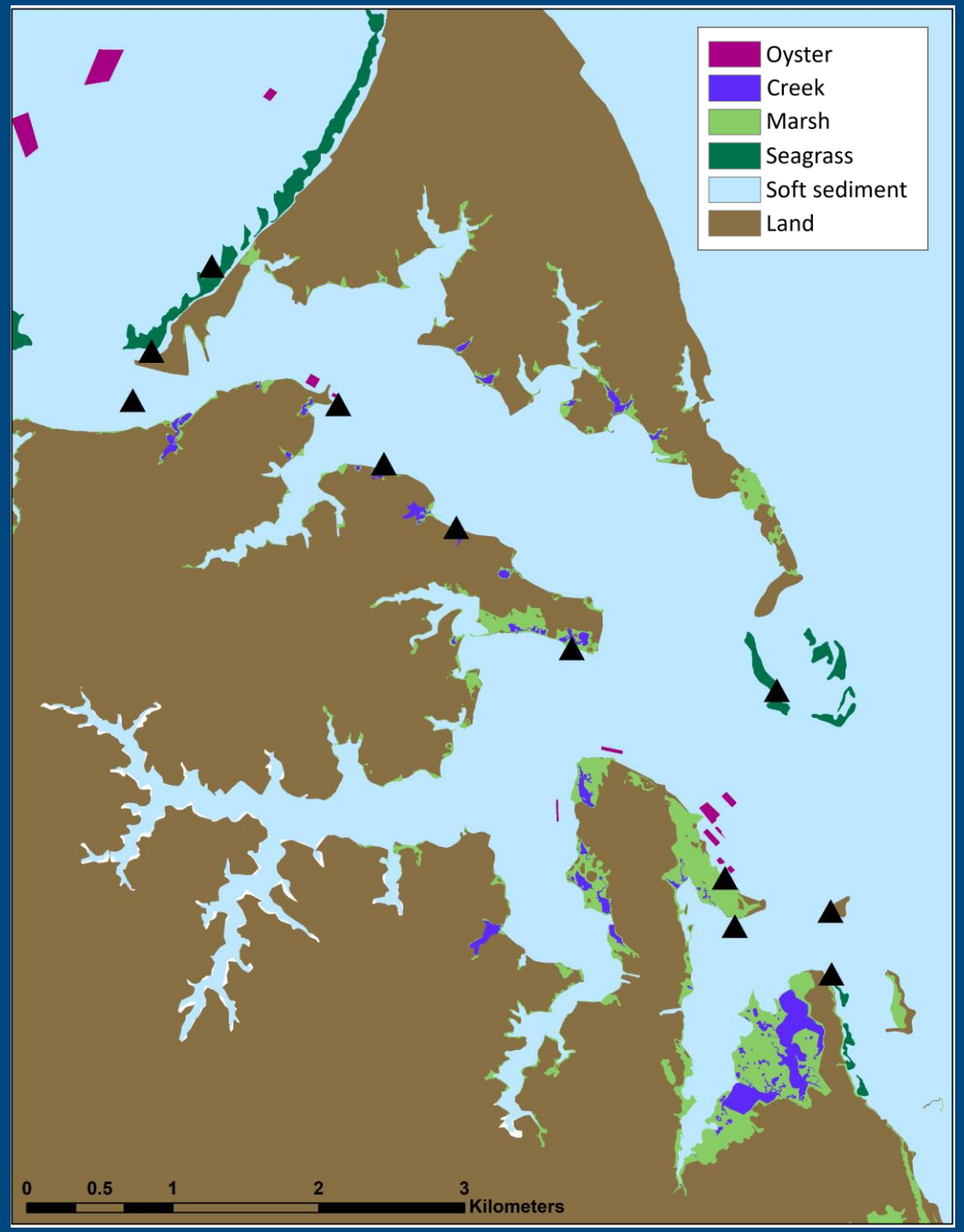
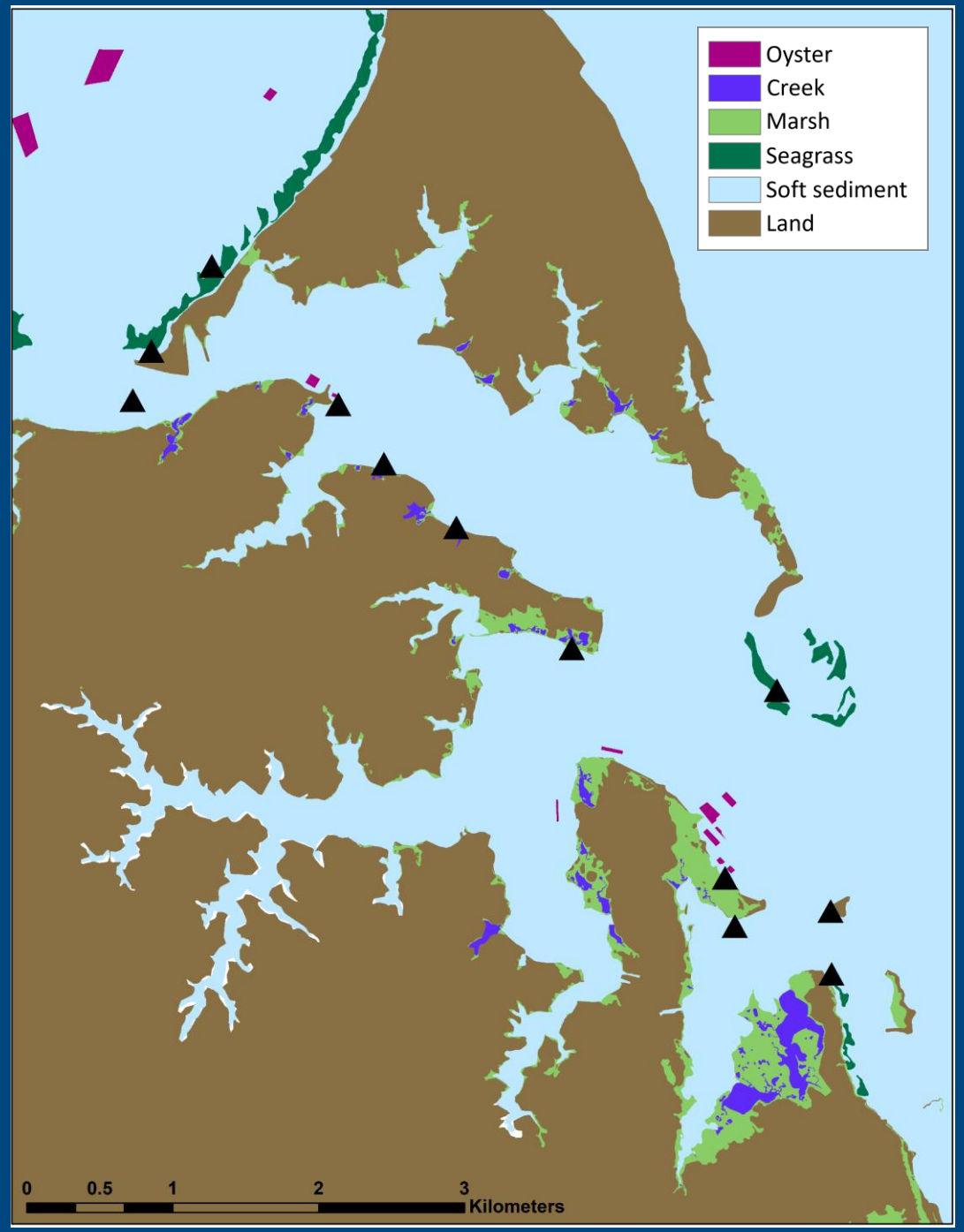
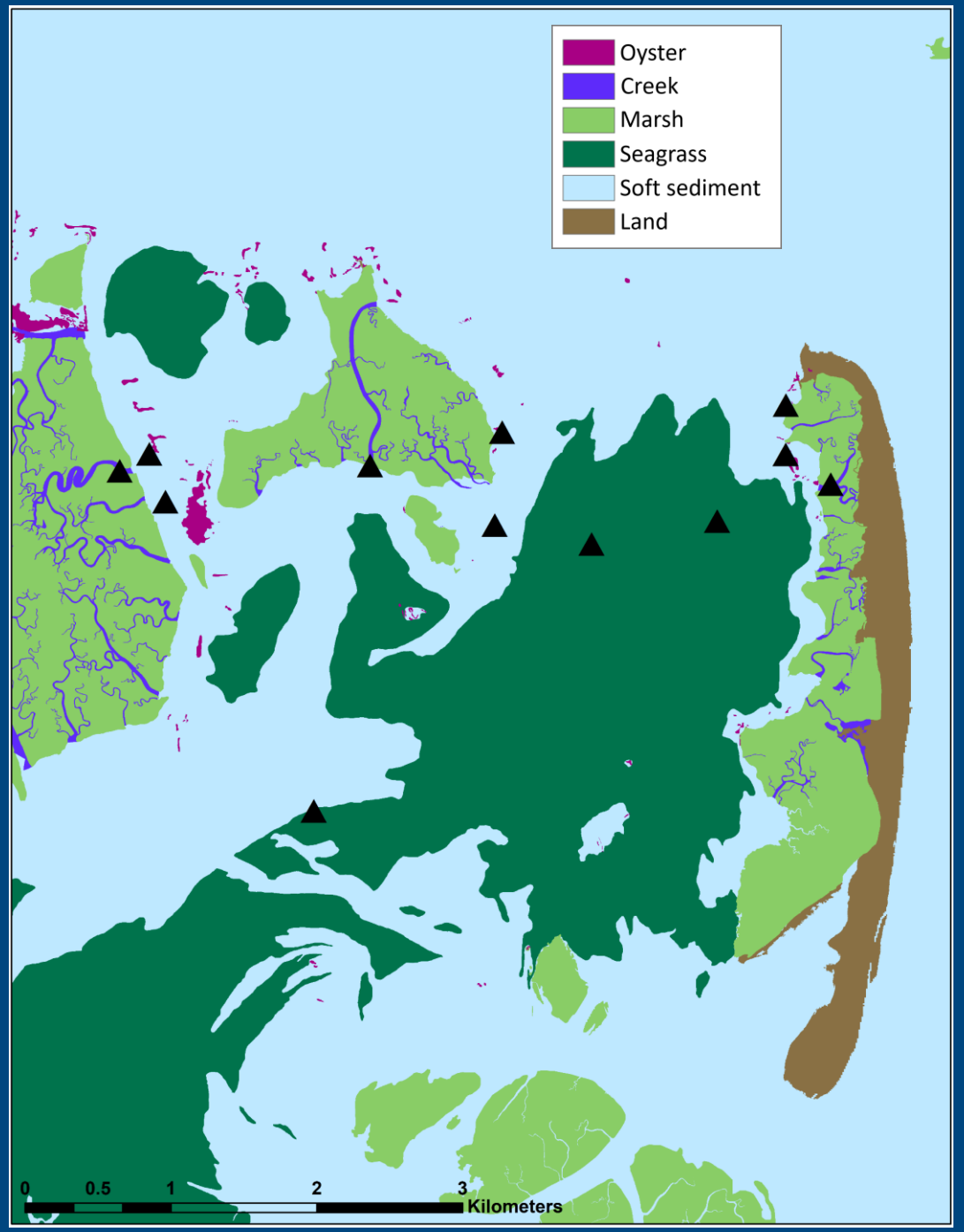
- Diversity
  - Simpson’s diversity
- Bathymetry & environmental conditions

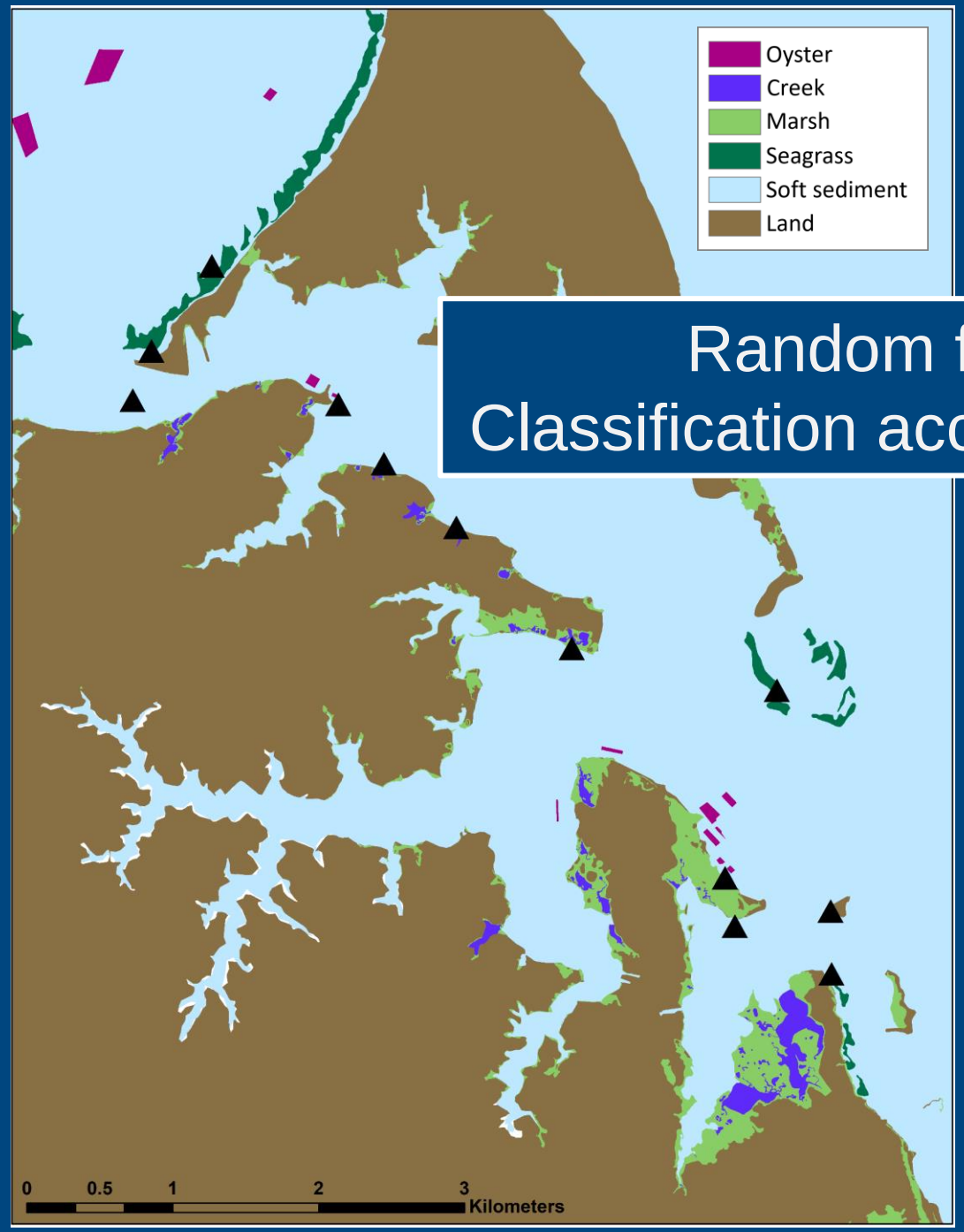


1 km for summer flounder

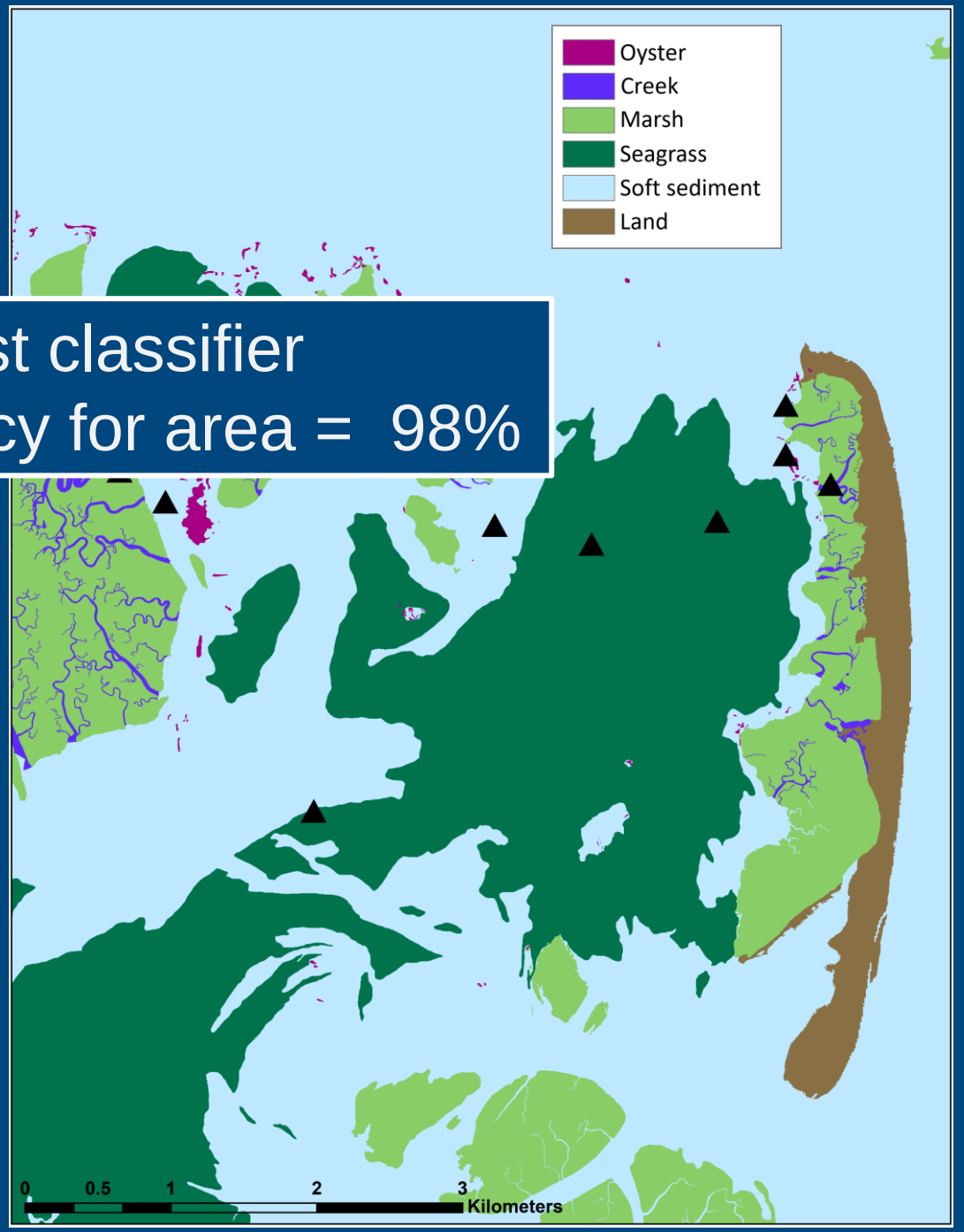

Oyster
Creek
Marsh
Seagrass
Soft sediment
Land
0
0.5
1
2
3
Kilometers

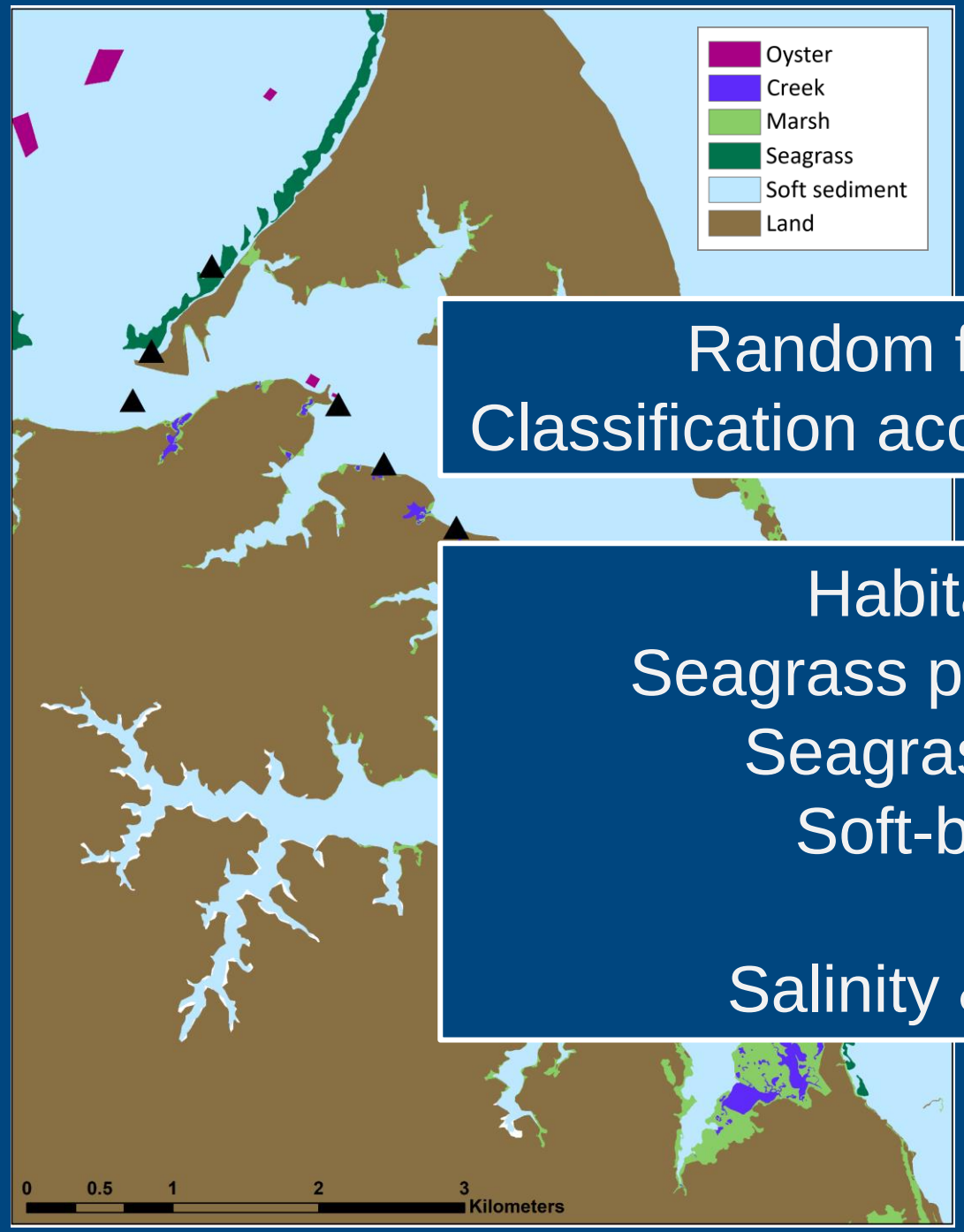

Oyster
Creek
Marsh
Seagrass
Soft sediment
Land
0
0.5
1
2
3
Kilometers

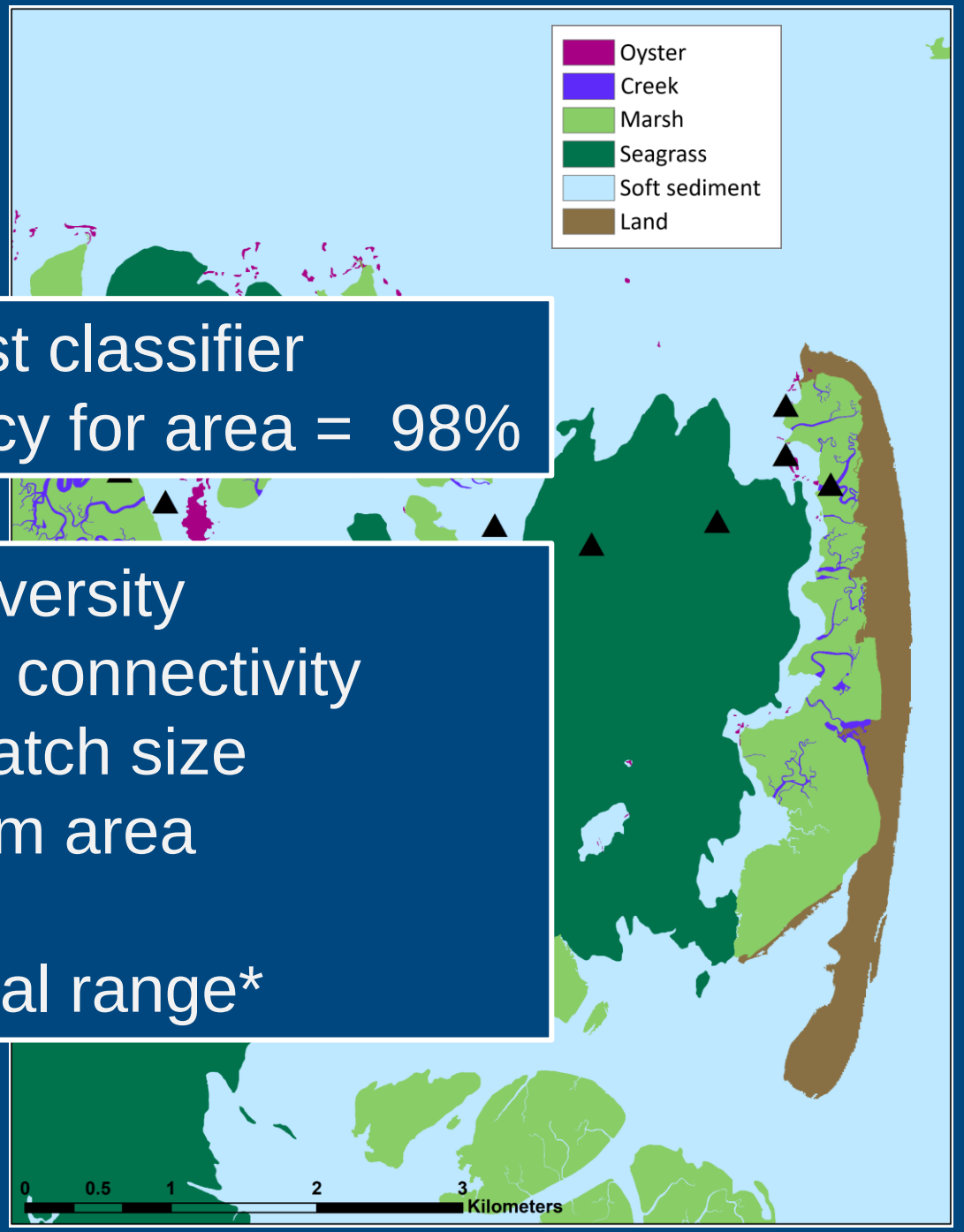

Oyster
Creek
Marsh
Seagrass
Soft sediment
Land
0
0.5
1
2
3
Kilometers



Random forest classifier
Classification accuracy for area = 98%



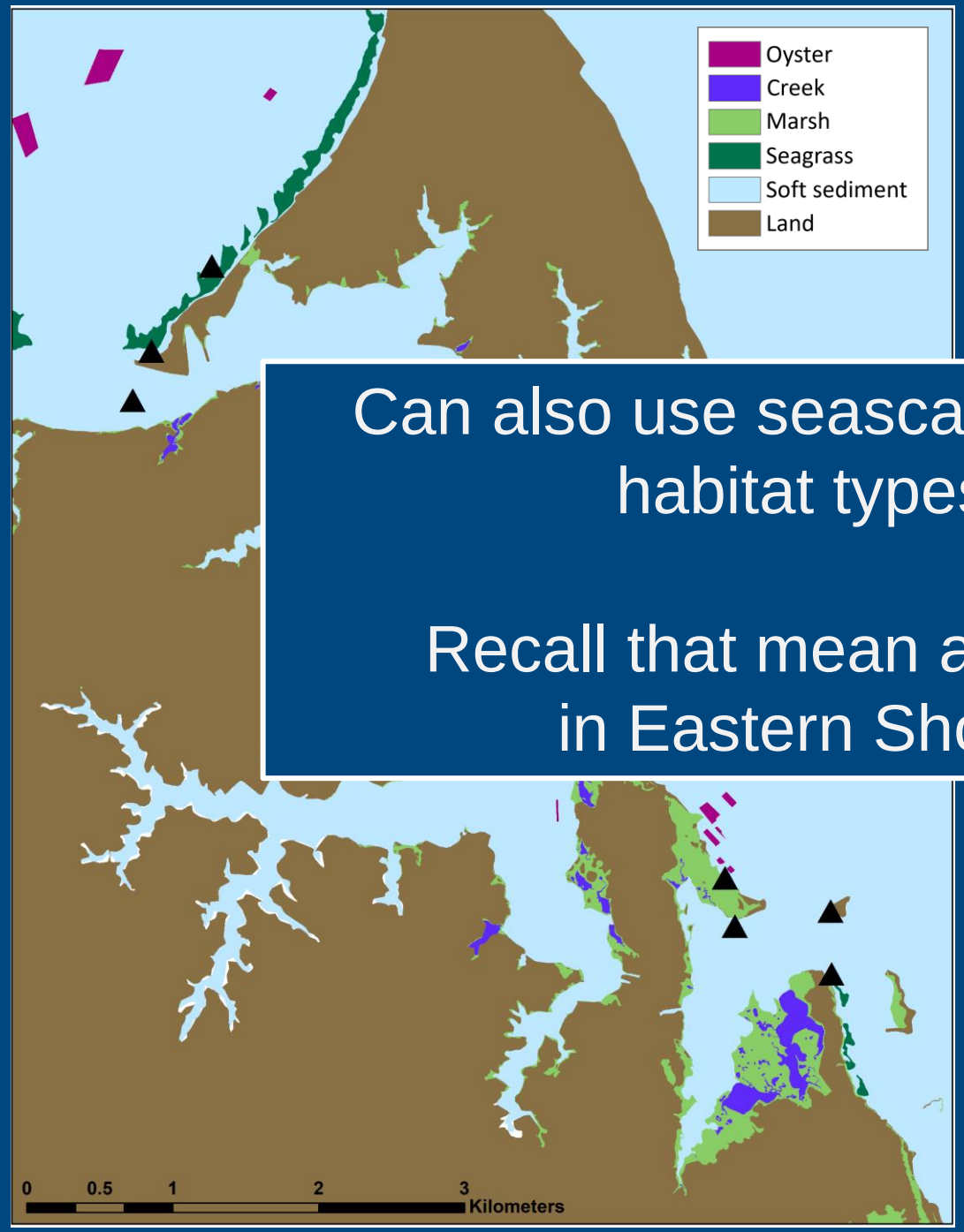


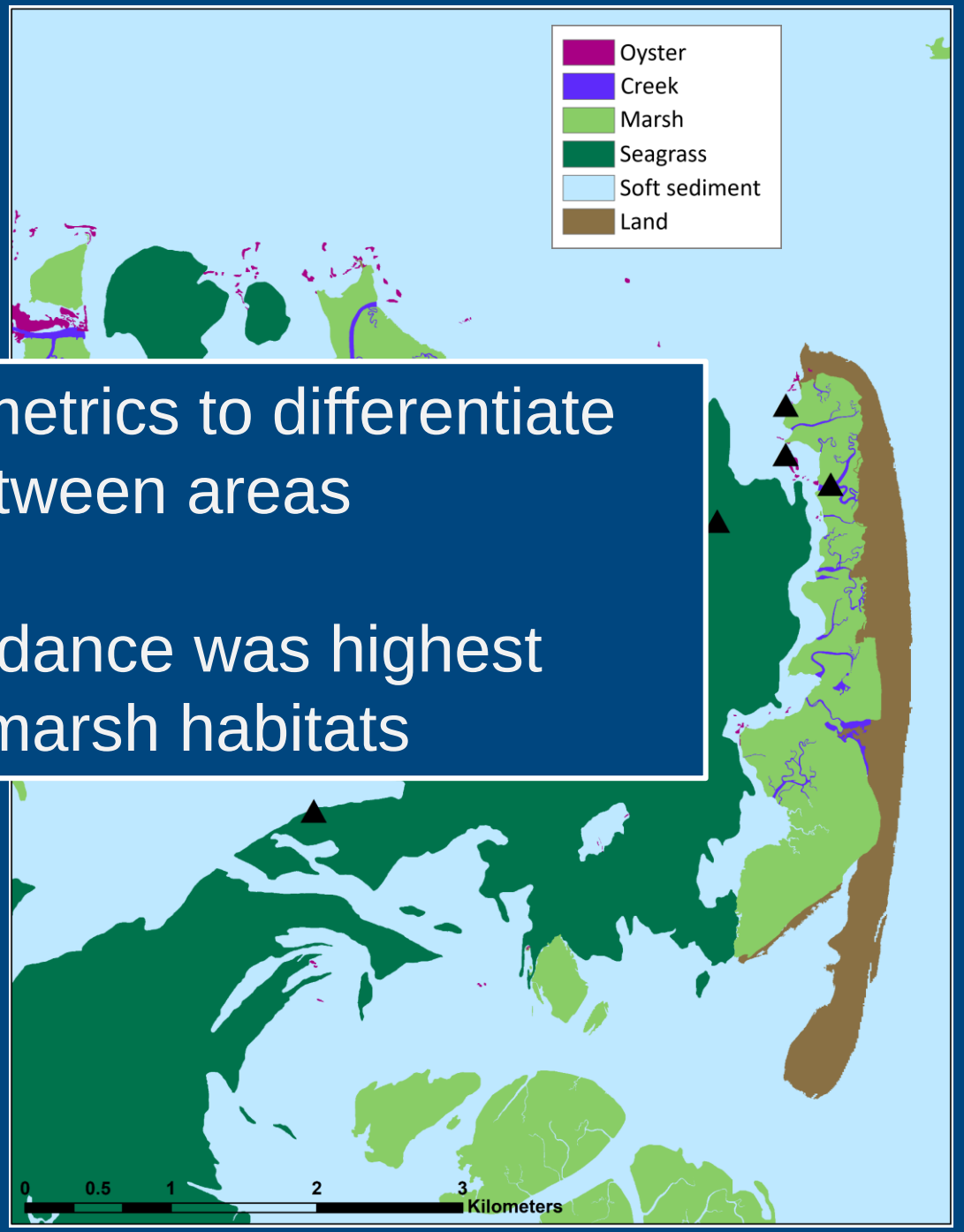


Random forest classifier
Classification accuracy for area = 98%

Habitat diversity
Seagrass patch connectivity
Seagrass patch size
Soft-bottom area

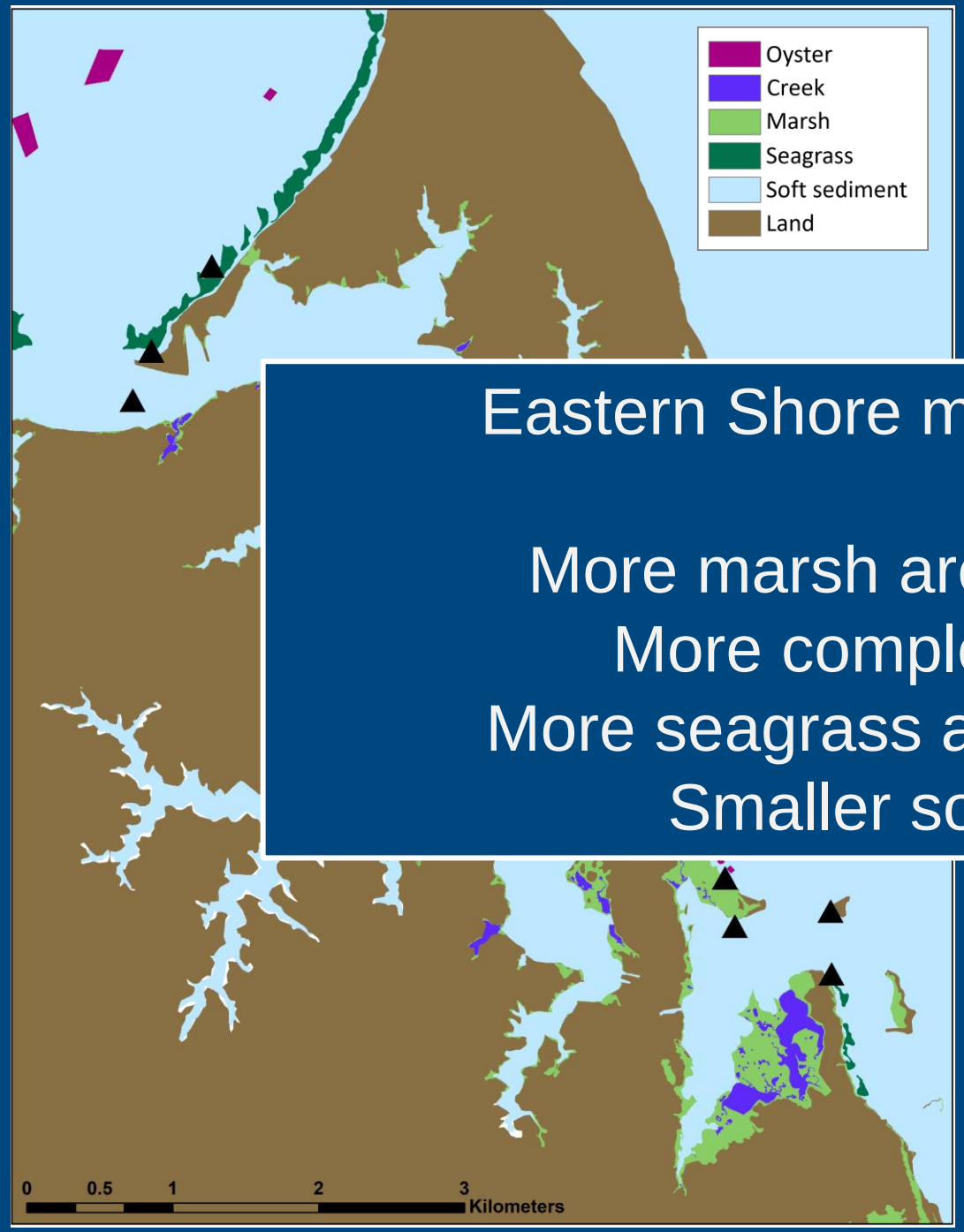
Salinity & tidal range*

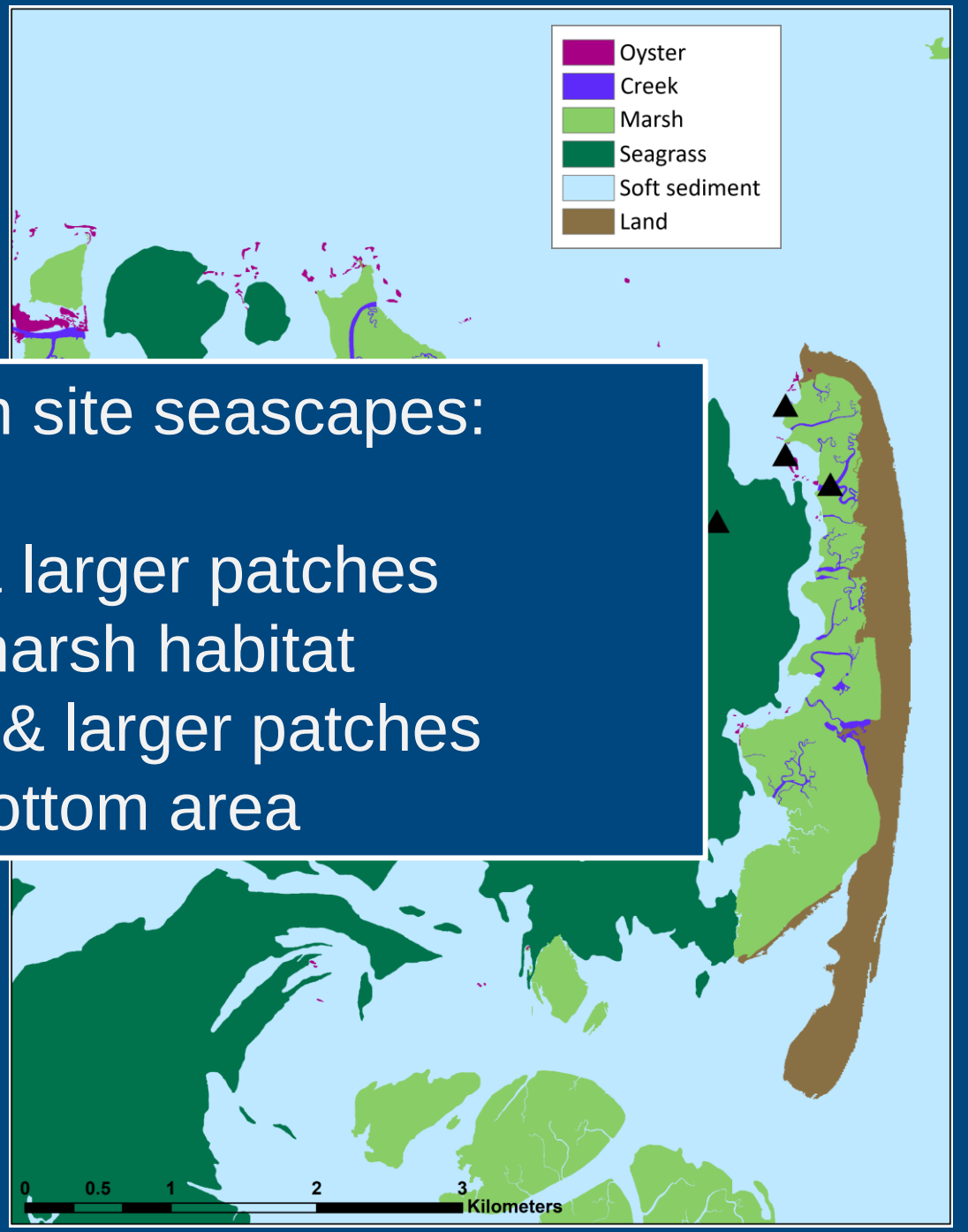




Can also use seascape metrics to differentiate habitat types between areas

Recall that mean abundance was highest in Eastern Shore marsh habitats





Eastern Shore marsh site seascapes:

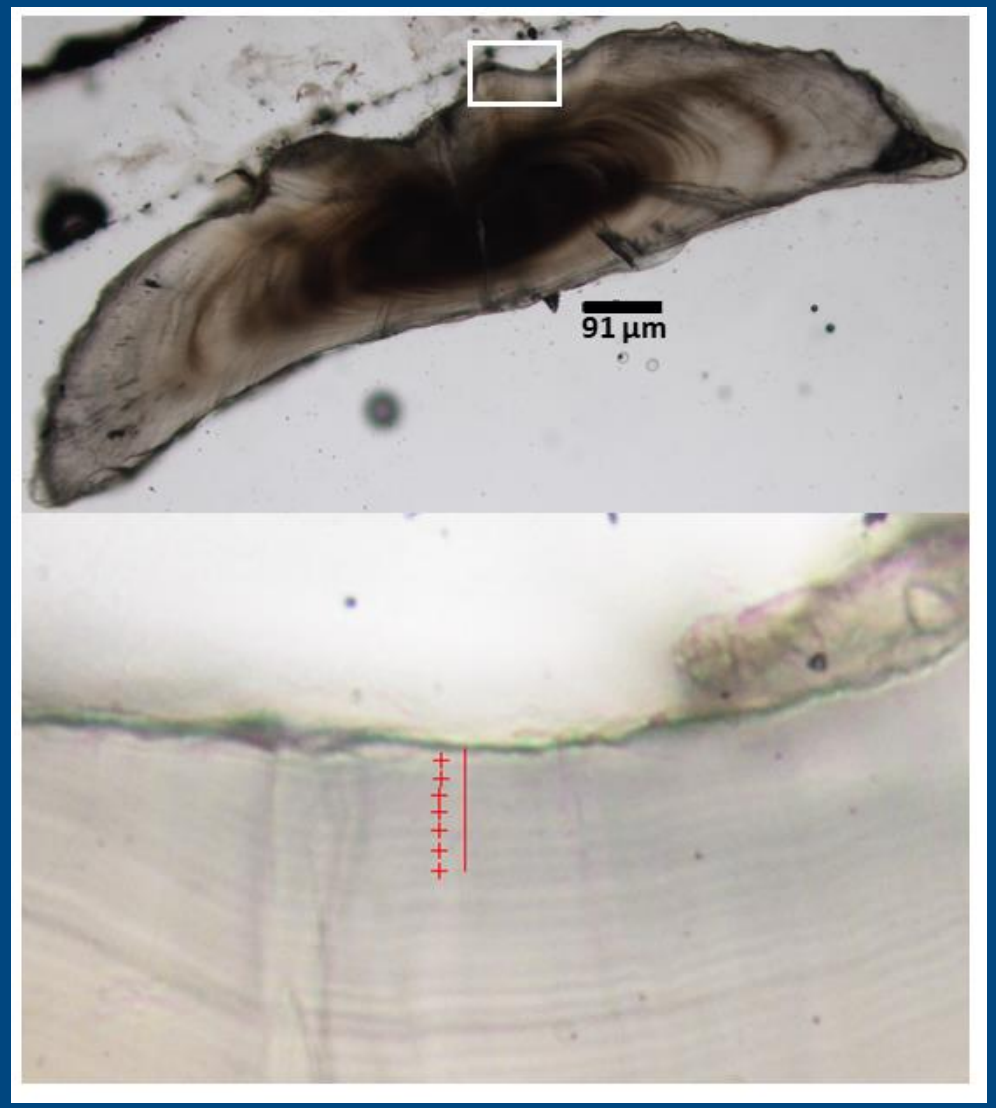
More marsh area & larger patches
More complex marsh habitat
More seagrass area & larger patches
Smaller soft-bottom area

Use of the seascape

- Higher abundance in Eastern Shore marshes may relate to seascape characteristics
- Despite seascape differences, no difference in mean body condition or recent growth in shallow waters
- Seascape characteristics may provide insight on how other species use these areas

Thank you!

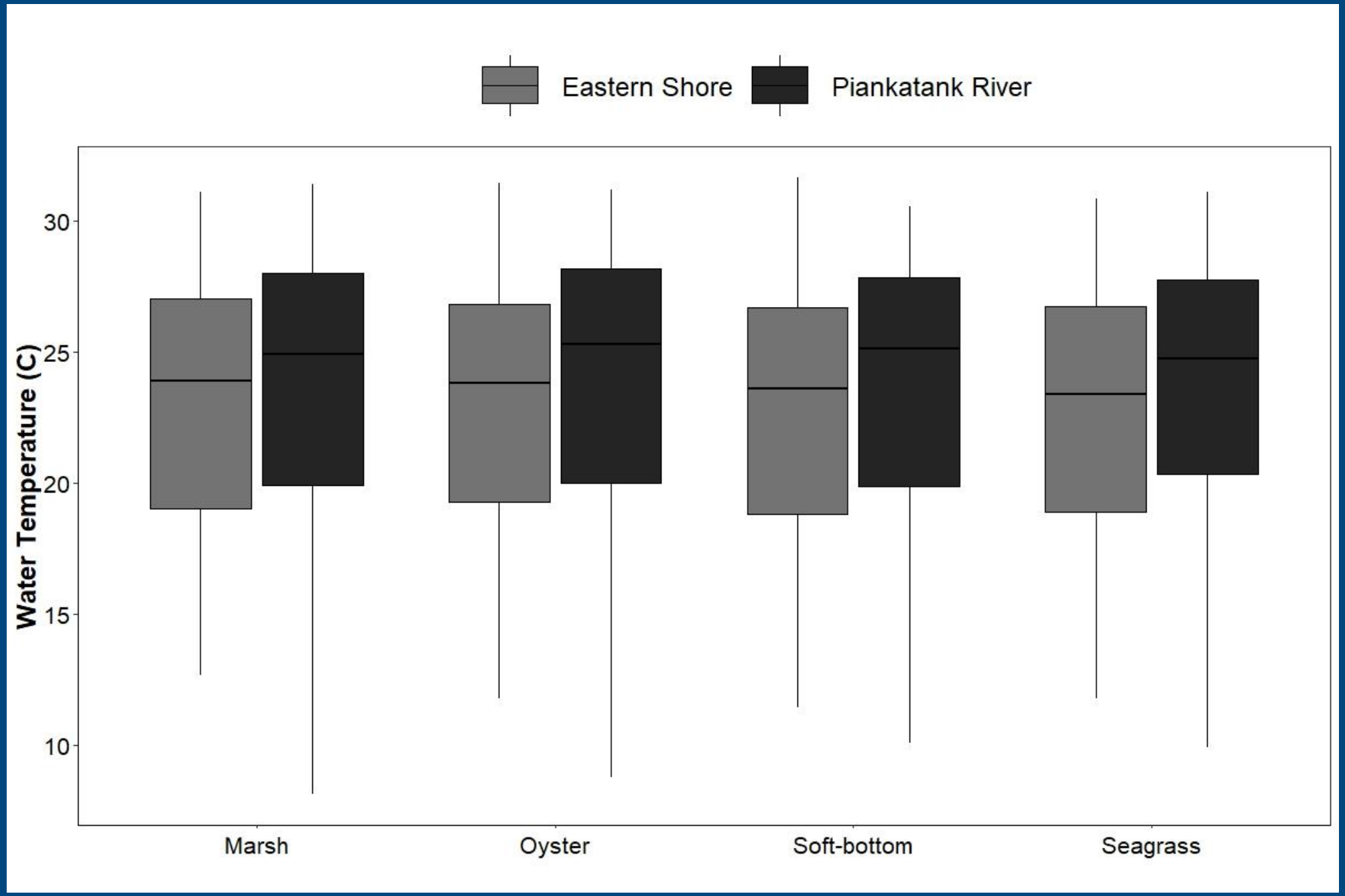
Shannon Smith
scsmith@vims.edu

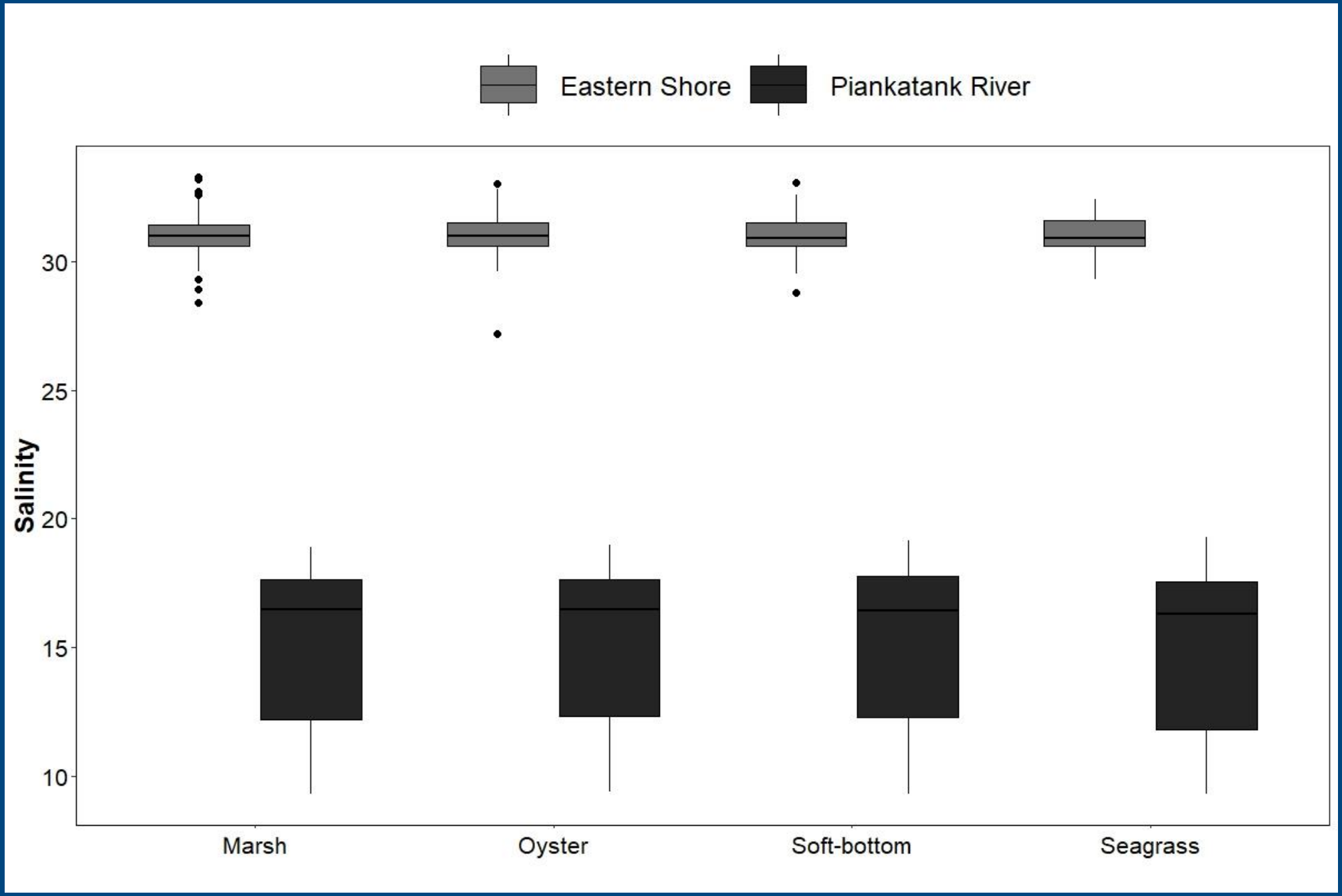


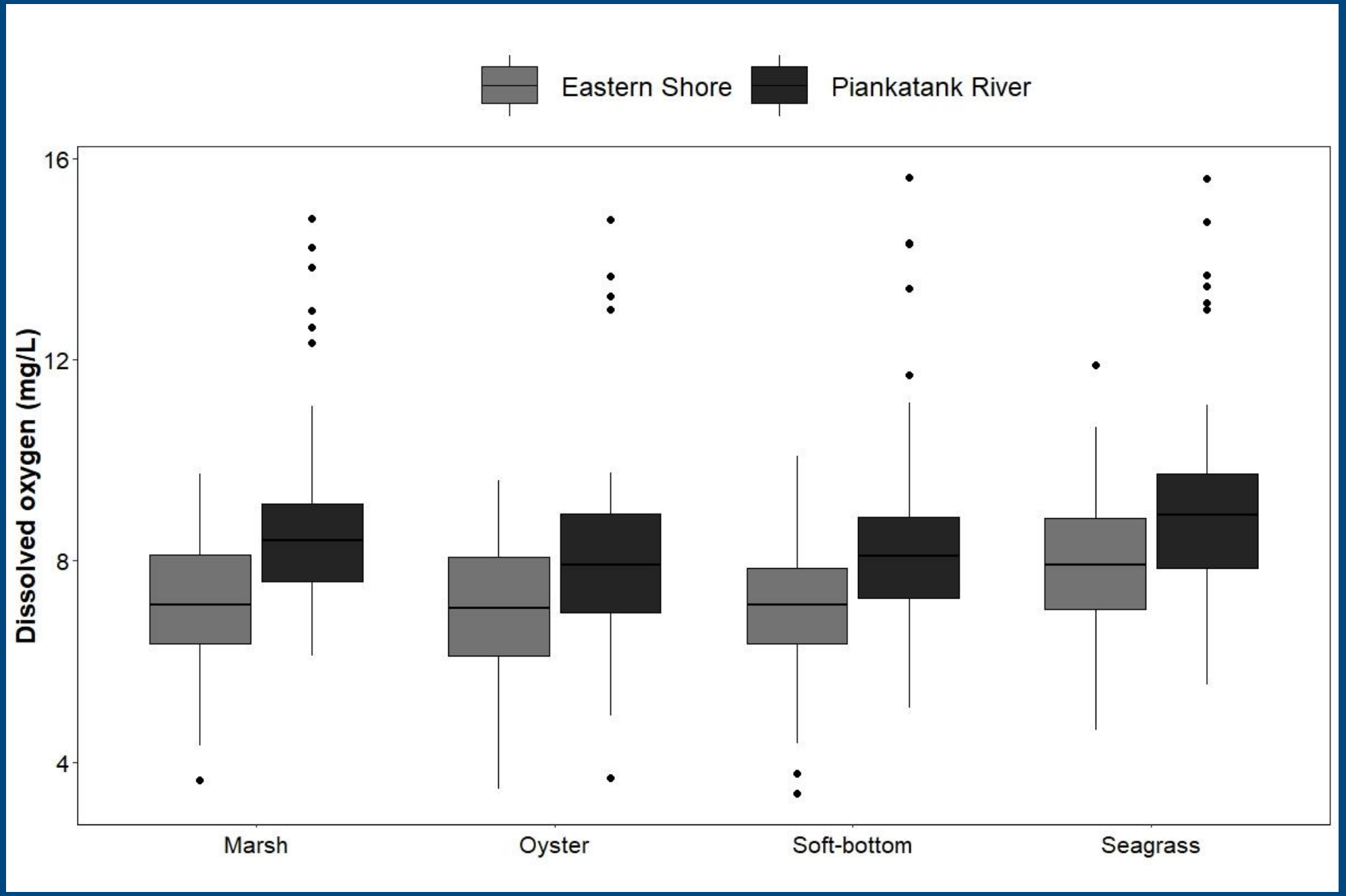
Models predicting fish size based on otolith radial distance took the general form L = a + bx, where L was fish size in mm, a and b were the intercept and slope in mm, and x was otolith radial distance in µm. We estimated recent growth of each fish in mm as:

$$recent\ growth = \frac{((b * 1000) * recent\ otolith\ growth)}{1000}$$

where the numerator is the product of otolith recent growth in µm and *b* is the slope in mm converted to µm. This product was converted to mm to yield recent growth of each fish in mm estimated from recent otolith growth in µm.


Eastern Shore
Piankatank River
Water Temperature (C)
30
25
20
15
10
Marsh
Oyster
Soft-bottom
Seagrass


Eastern Shore
Piankatank River
Salinity
30
25
20
15
10
Marsh
Oyster
Soft-bottom
Seagrass


Eastern Shore
Piankatank River
Dissolved oxygen (mg/L)
16
12
8
4
Marsh
Oyster
Soft-bottom
Seagrass

Habitat type	Distance to open water (m)	Distance to marsh creek (m)	Distance to oysters (m)	Distance to seagrass (m)	Habitat diversity within 500 m	Habitat diversity within 1 km	Depth (m)
	Eastern Shore						
Marsh	3599 (952.1)	0	265 (59.9)	445.3 (113.9)	0.39 (0.07)	0.43 (0.05)	0.97 (0.13)
Oyster	3121.4 (1019.7)	237 (37.8)	0	362.7 (79.5)	0.27 (0.08)	0.42 (0.03)	1.01 (0.16)
Soft-bottom	3648.1 (1037.7)	214.4 (27.9)	167 (46.3)	394.3 (154.3)	0.3 (0.05)	0.42 (0.04)	1.03 (0.14)
Seagrass	3145.6 (527.7)	997.8 (126.7)	840 (72.3)	0	0.18 (0.09)	0.38 (0.03)	1.53 (0.05)
	Piankatank River						
Marsh	2589.8 (312.3)	6.7 (1.0)	827.5 (124.7)	1200.6 (389.8)	0.12 (0.05)	0.07 (0.02)	0.14 (0.02)
Oyster	1947 (607.9)	418 (142.8)	0	1102.2 (256.3)	0.07 (0.03)	0.07 (0.02)	0.59 (0.05)
Soft-bottom	1477.2 (699.5)	638 (92.4)	906.2 (113.4)	699.3 (262.2)	0.04 (0.02)	0.08 (0.01)	0.52 (0.05)
Seagrass	2040.5 (563.8)	1222.5 (178.3)	1145.2 (120.4)	0	0.19 (0.04)	0.13 (0.02)	0.69 (0.23)