# Linking Movement to Energy Channel Use in an Estuarine Predator

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**GEER**
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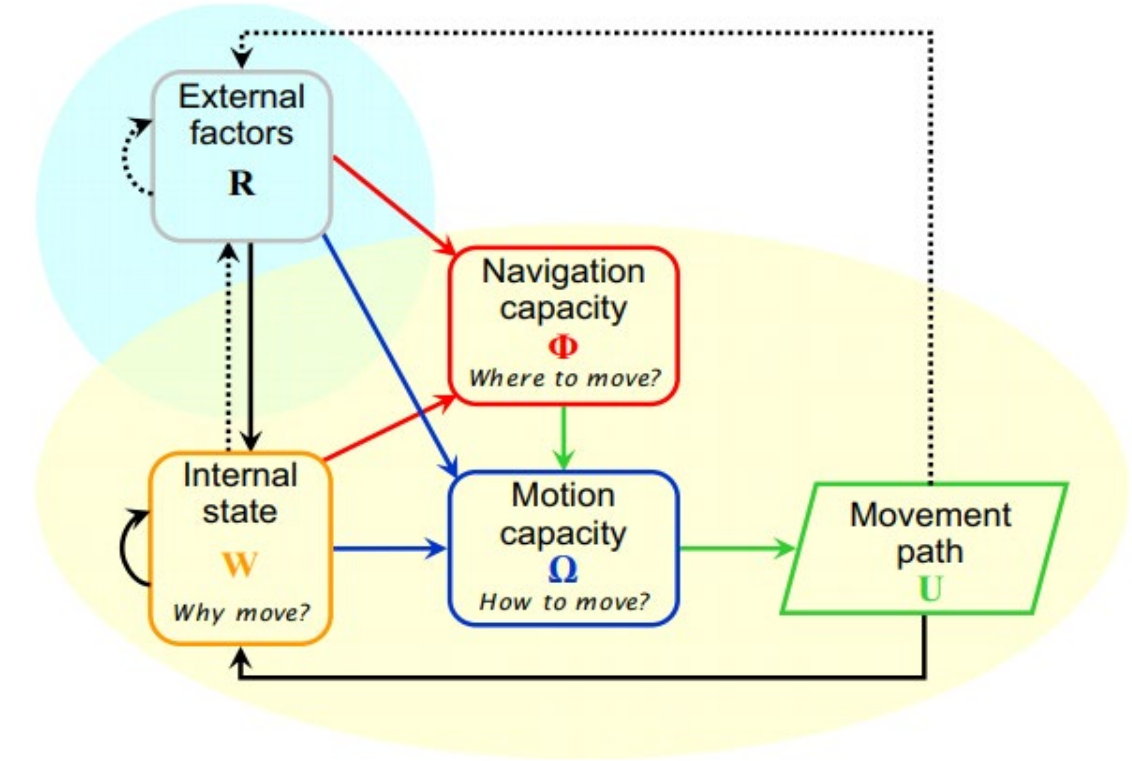
# Animal Movement Shapes Ecosystems

- Population Dynamics
- Habitat Connectivity
- Trophic Interactions
- Nutrient Dynamics

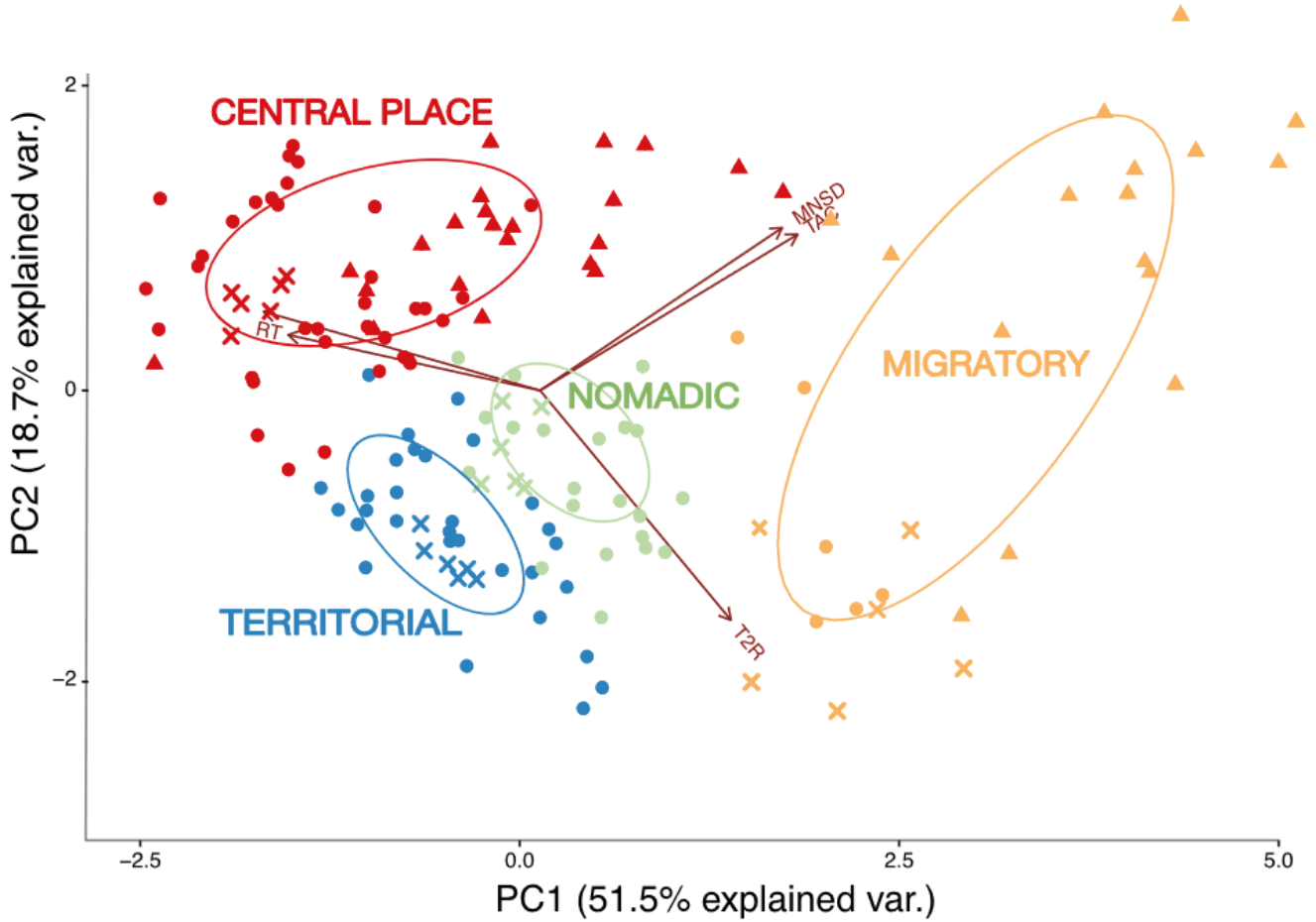
# What drives movement?




Nathan et al., 2008 (*PNAS*)

# Movement Strategies

- Correlated movement traits
- Function of:
  - Environmental cues
  - Cognition




Abrahms et al., 2017 (*Movement Ecology*)

# Movement Strategy Selection Research

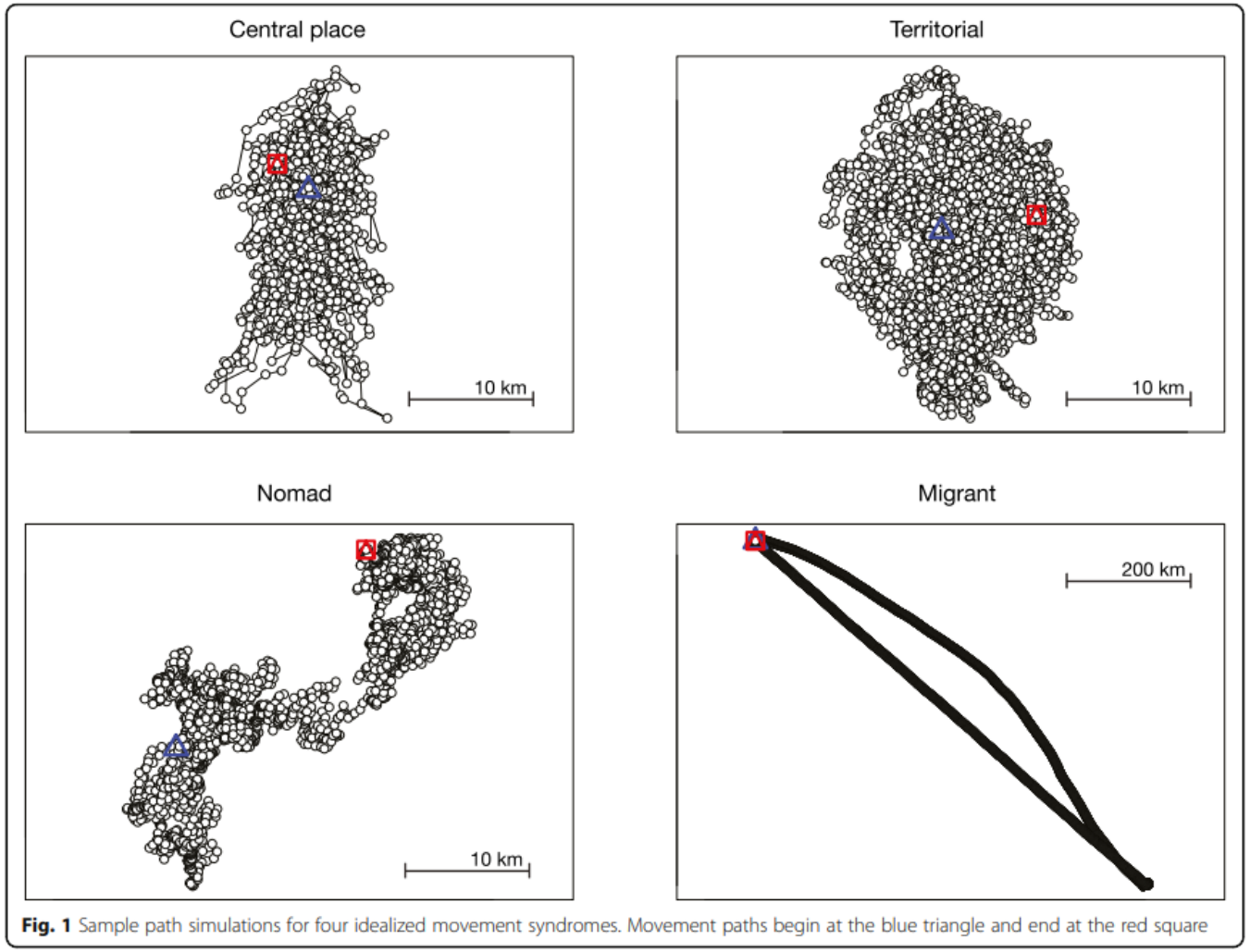
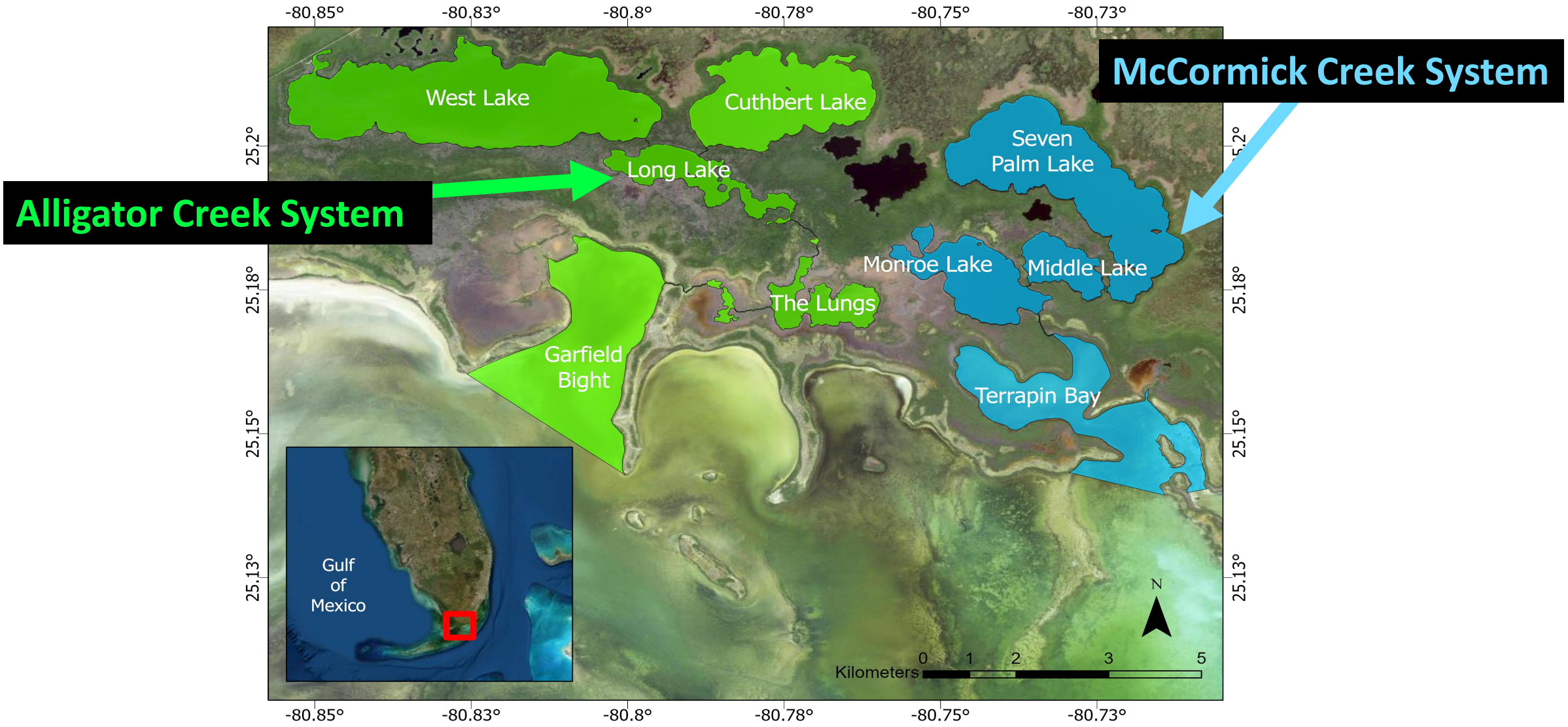



**Fig. 1** Sample path simulations for four idealized movement syndromes. Movement paths begin at the blue triangle and end at the red square

Abrahms et al., 2017 (*Movement Ecology)*

# Study Region



# Focal Species

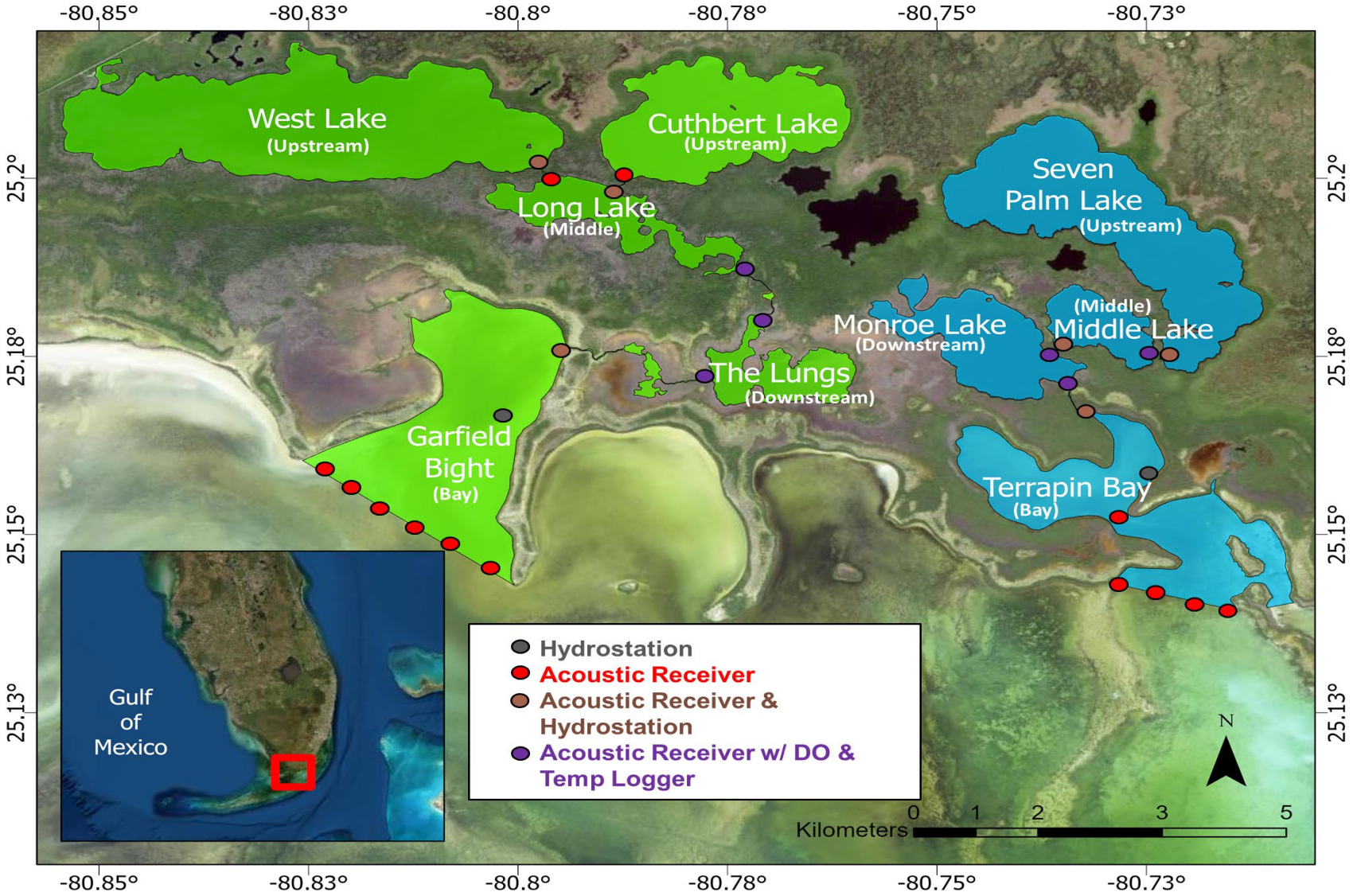
**Common Snook**
(***Centropomus undecimalis***)

**Atlantic Tarpon**
(***Megalops atlanticus***)

- **Estuarine dependent**
- **Euryhaline**
- **Gape limited opportunistic ambush predators**
- **Similar prey resources**

# Coastal Everglades Lakes Acoustic Array

## CELA$^2$



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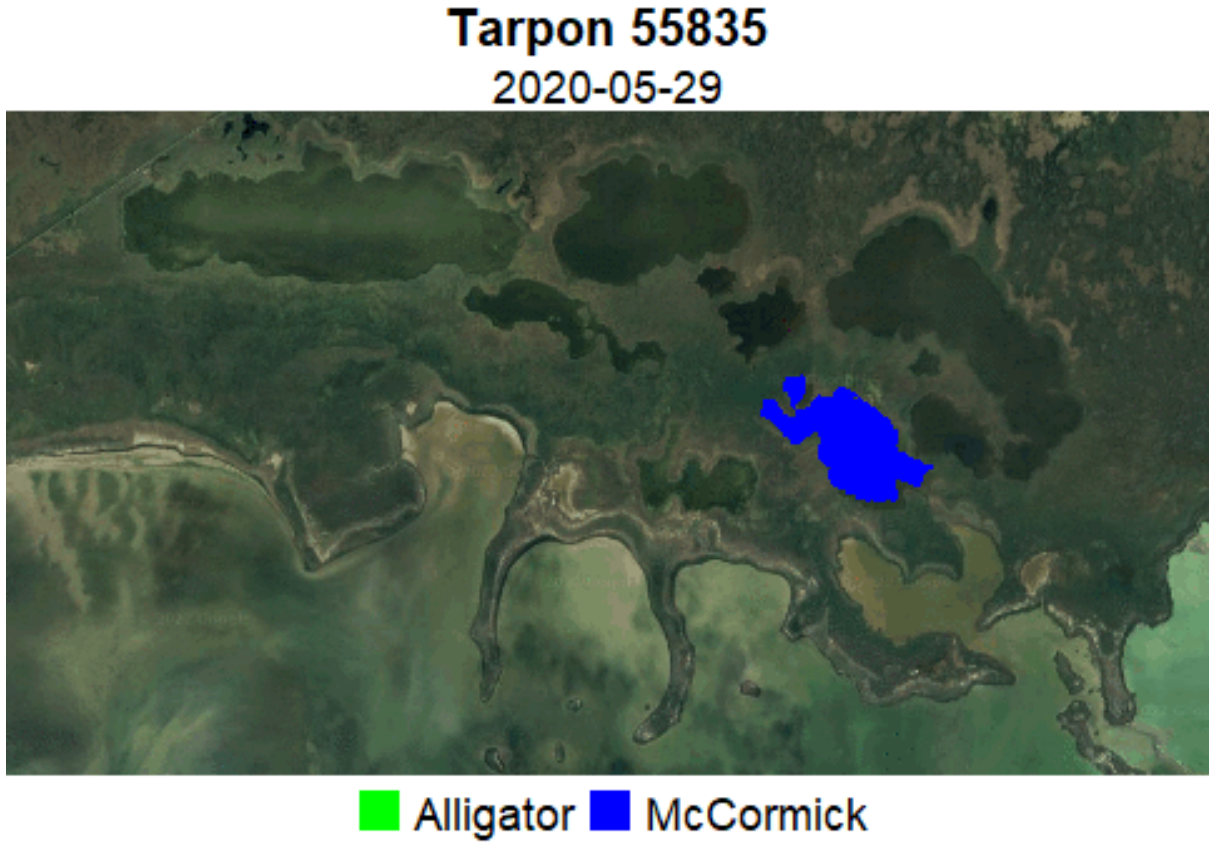
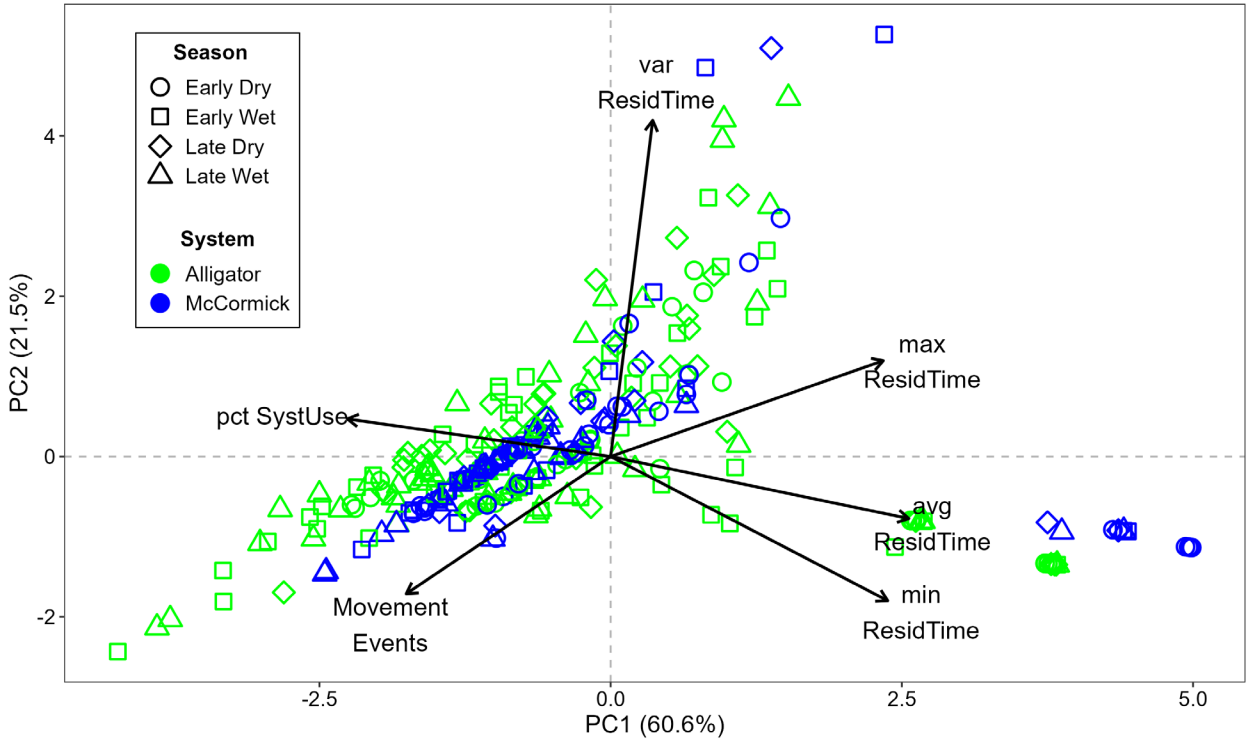


# Movement Strategy Classifications- 3 months




PCA to reduce dimensionality

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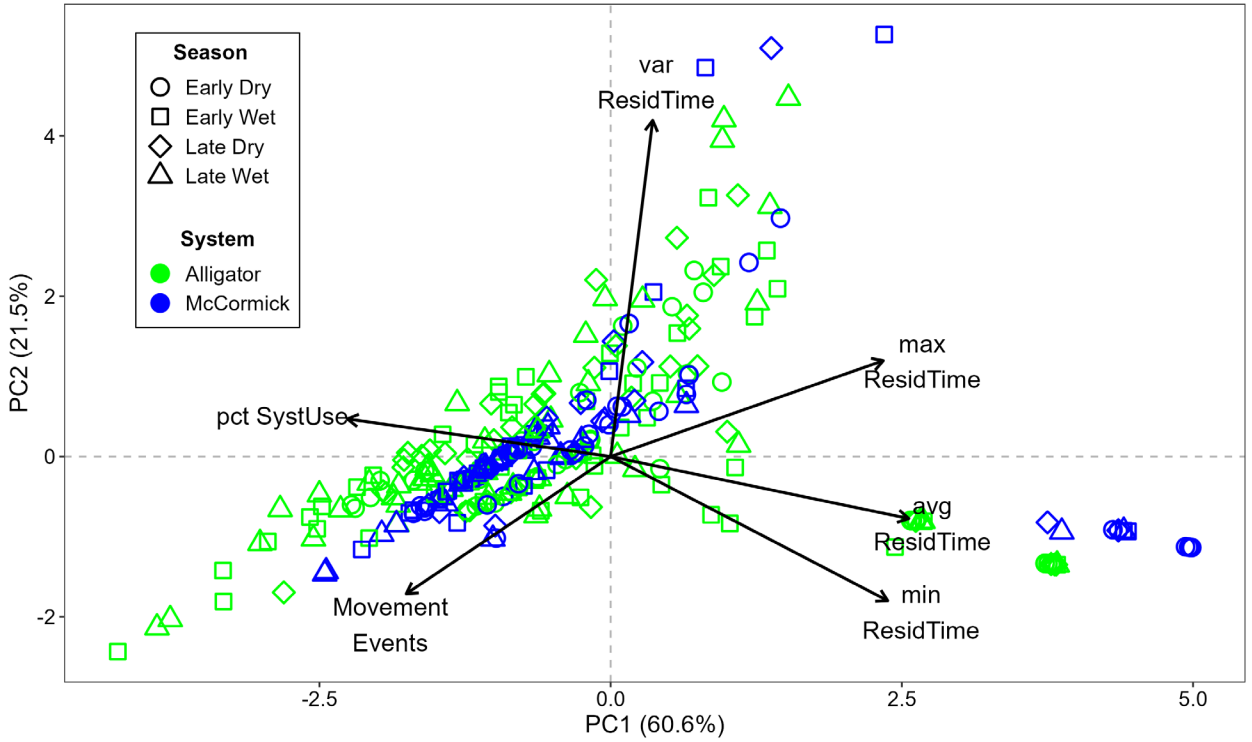


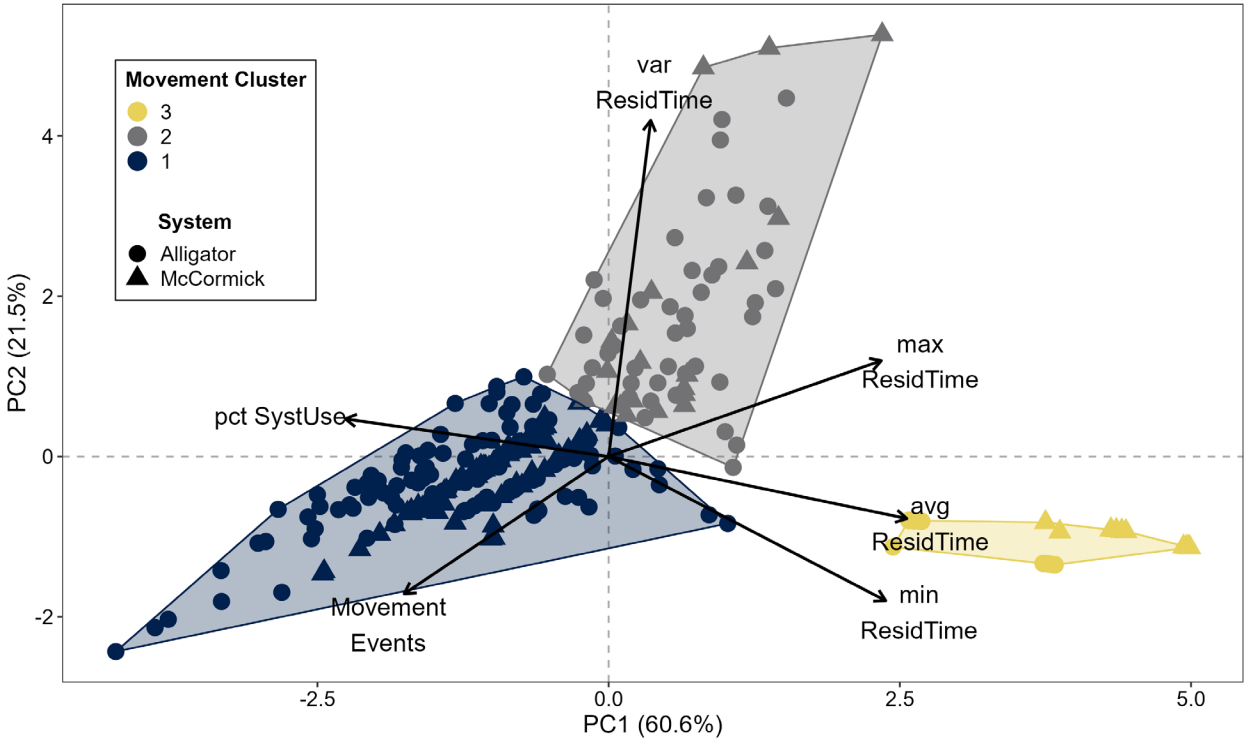


PCA to reduce dimensionality

K-means clustering

- Silhouette coefficients and gap statistics

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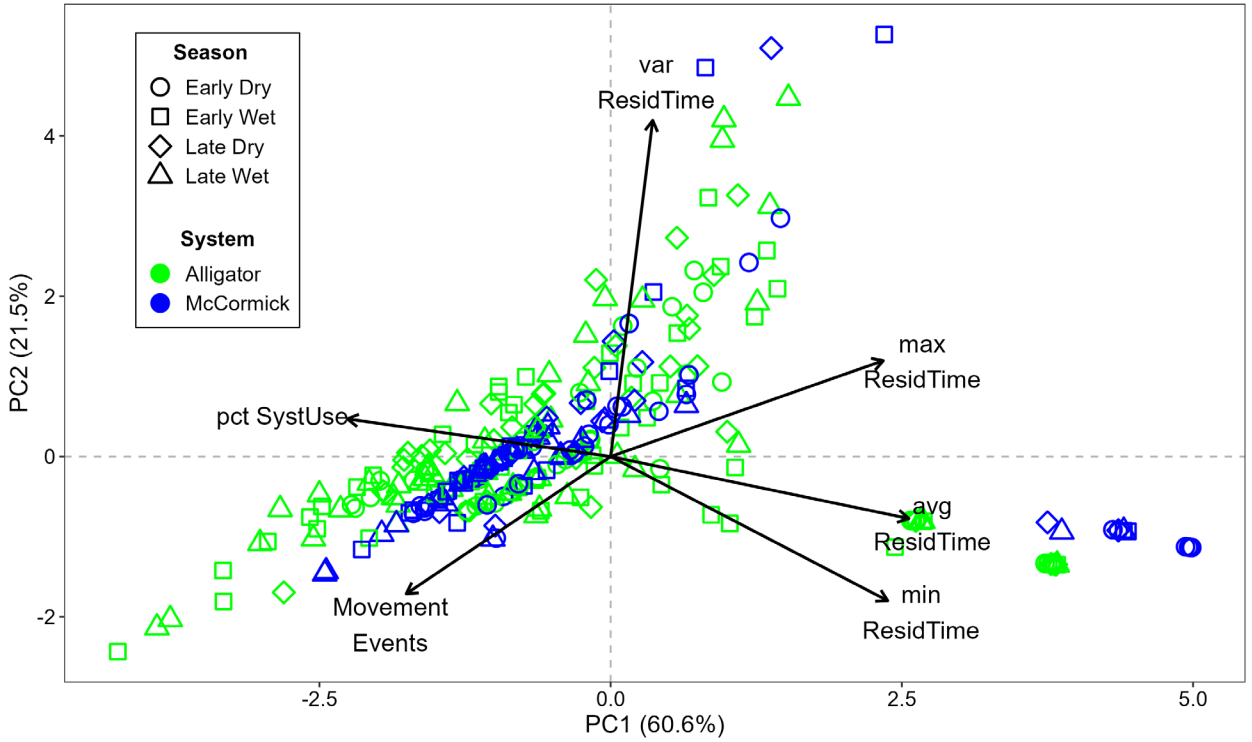


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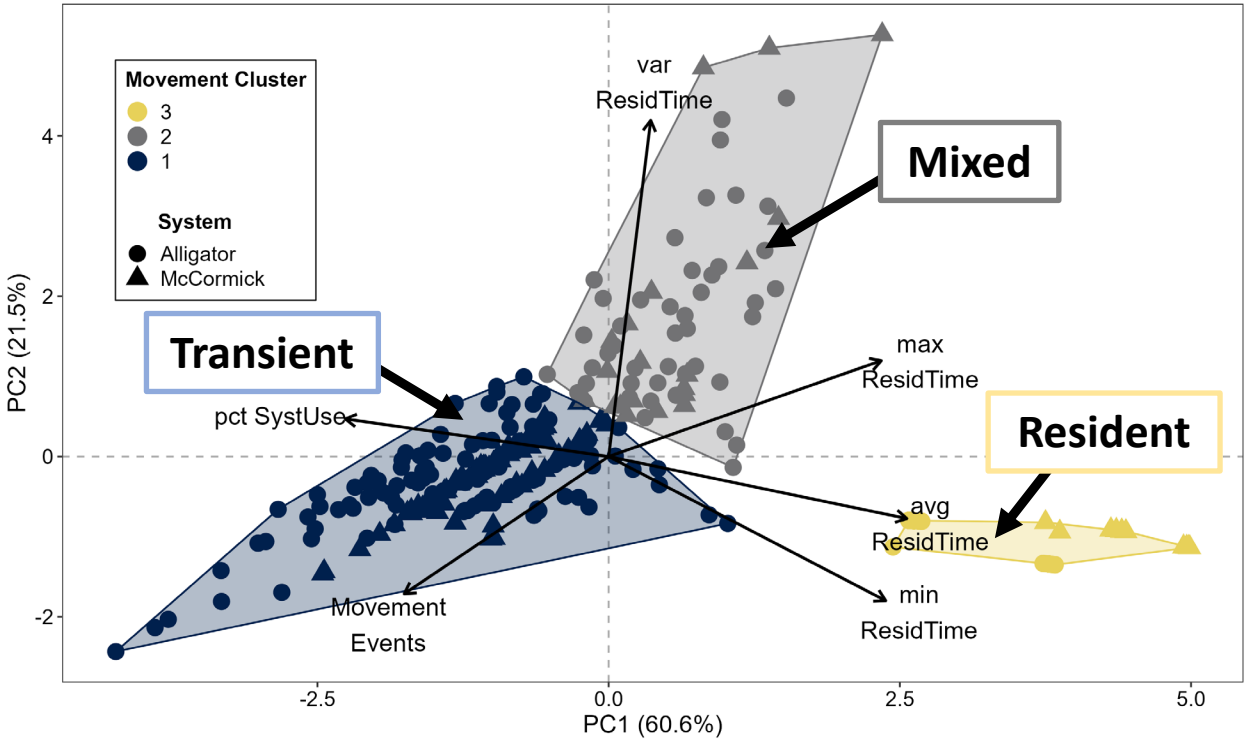


K-means clustering

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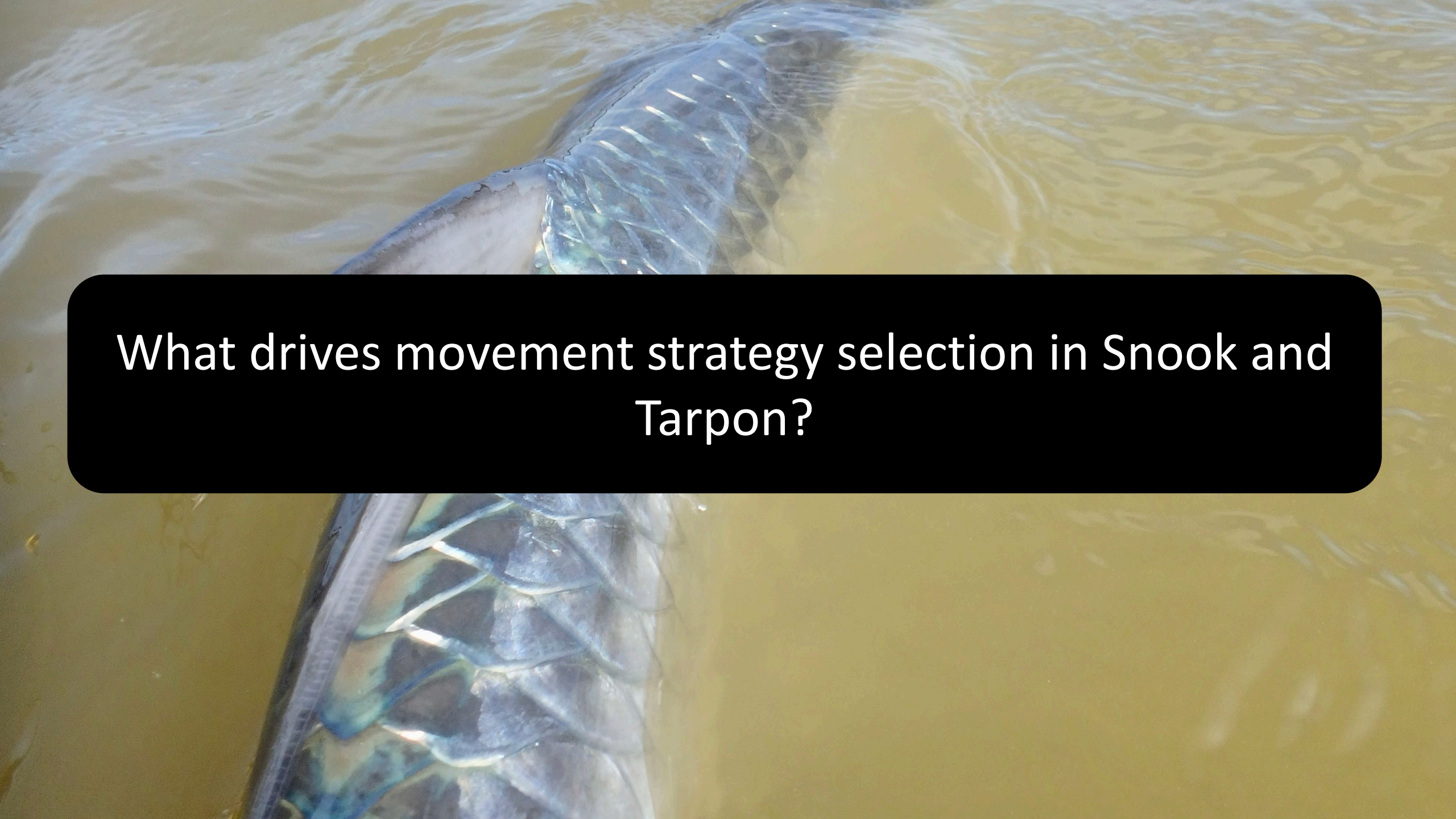


What drives movement strategy selection in Snook and Tarpon?

# Internal Drivers: Size or Sex-Specific Selection?

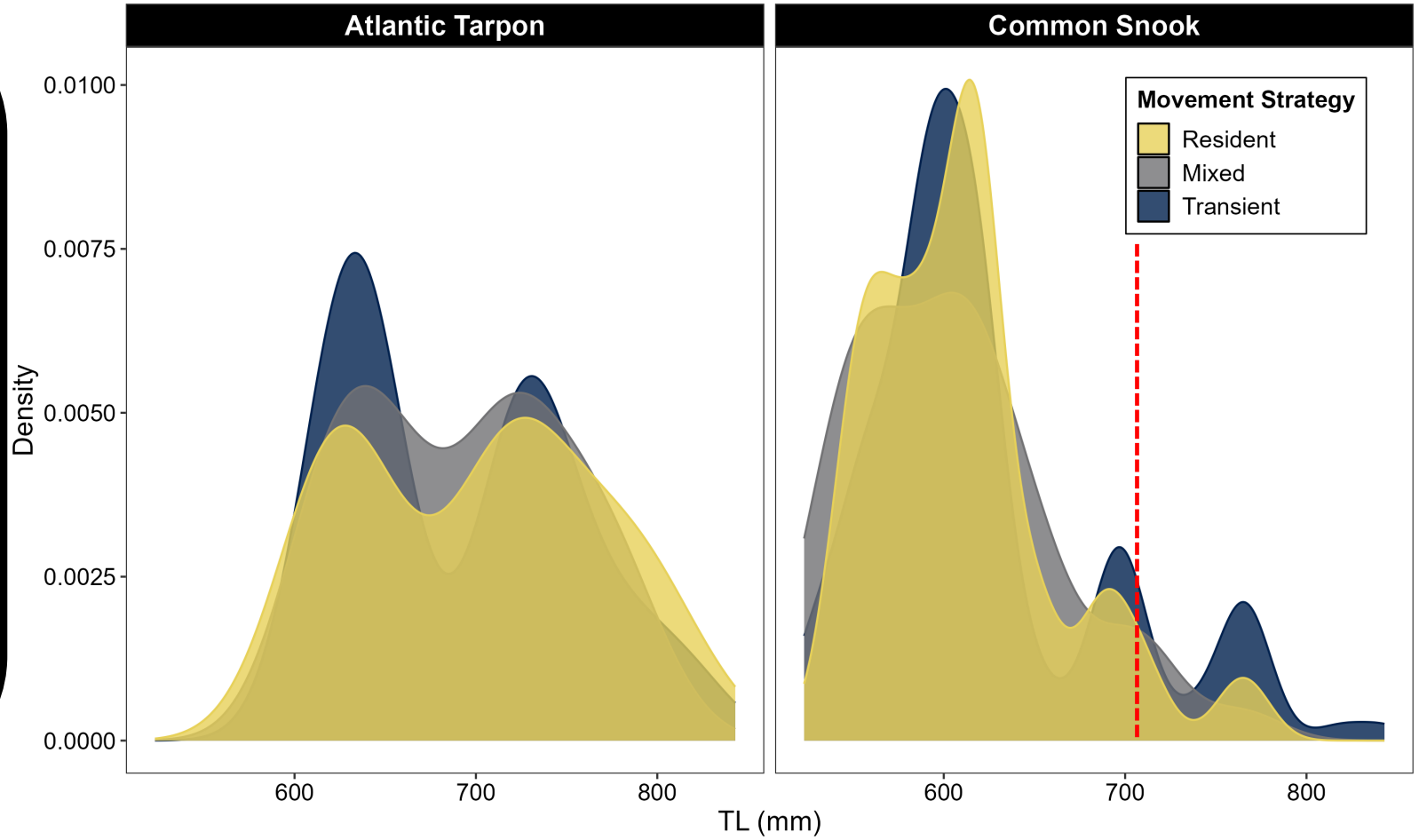
**Tarpon**

- Unable to estimate sex at these sizes

**Snook**

- Protandric hermaphrodites
- Red line = 50:50 male to female

**Size or sex not significant**



# External Drivers: Environmental

**Environment (External Factors) = Conditions + Resources + Risks**

**Condition = environmental variable that influences an organism's functioning (e.g., temperature, humidity, salinity)**

**Resource = environmental variable that always has a positive effect on fitness (e.g., food, object, or place)**

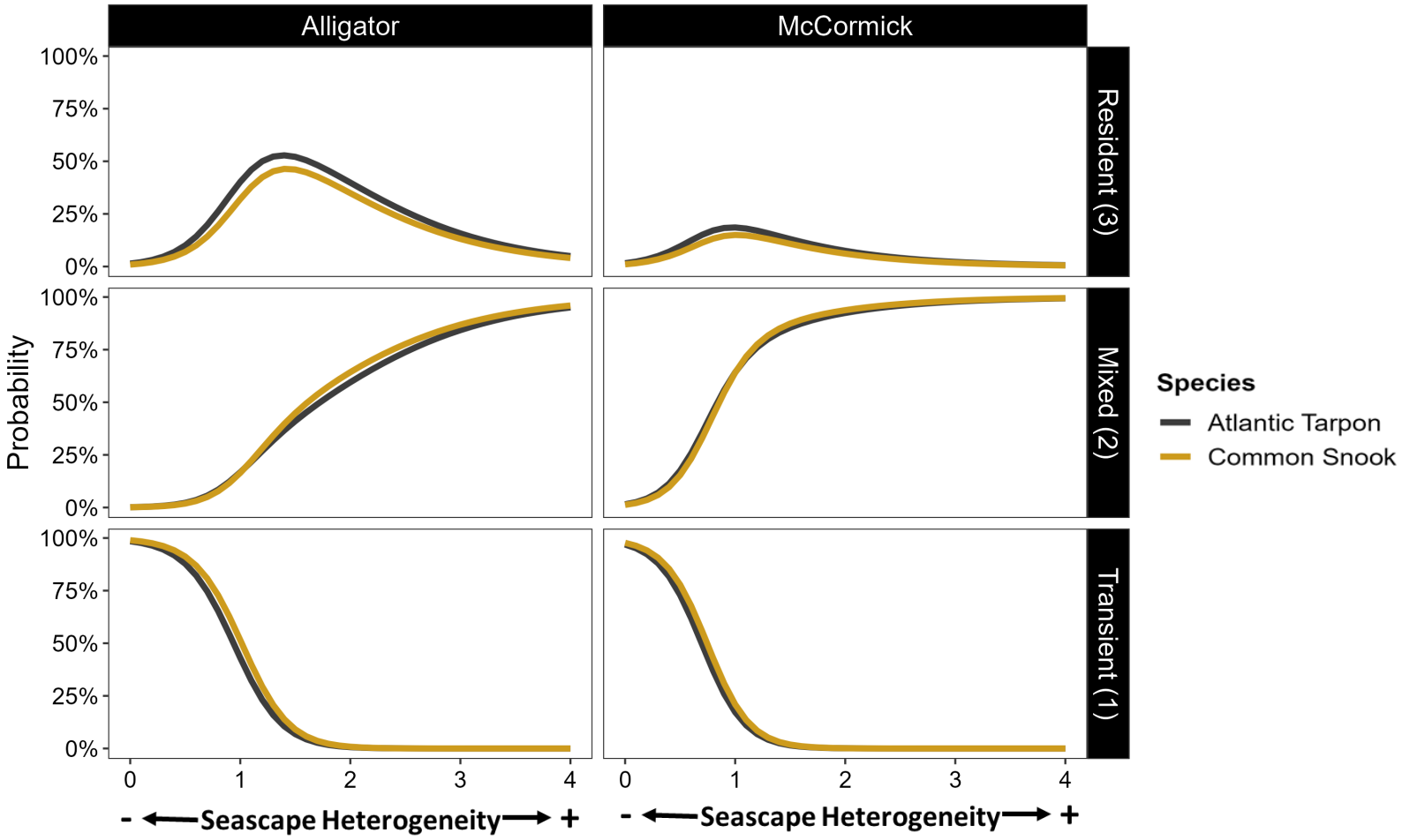
**Risk = environmental variable that has negative relationship with fitness (e.g., predation risk, competition)**

Matthiopoulos et al., 2020- "Species-Habitat Associations"

# Environmental Conditions as Movement Strategy Predictor

Multinomial Log-linear Regression

- Transient = Homogenous seascape
- Mixed = Heterogeneous seascape
- Resident = Intermediate heterogeneity



# Does Movement Strategy Selection Affect Consumer (Snook) Trophic Dynamics?

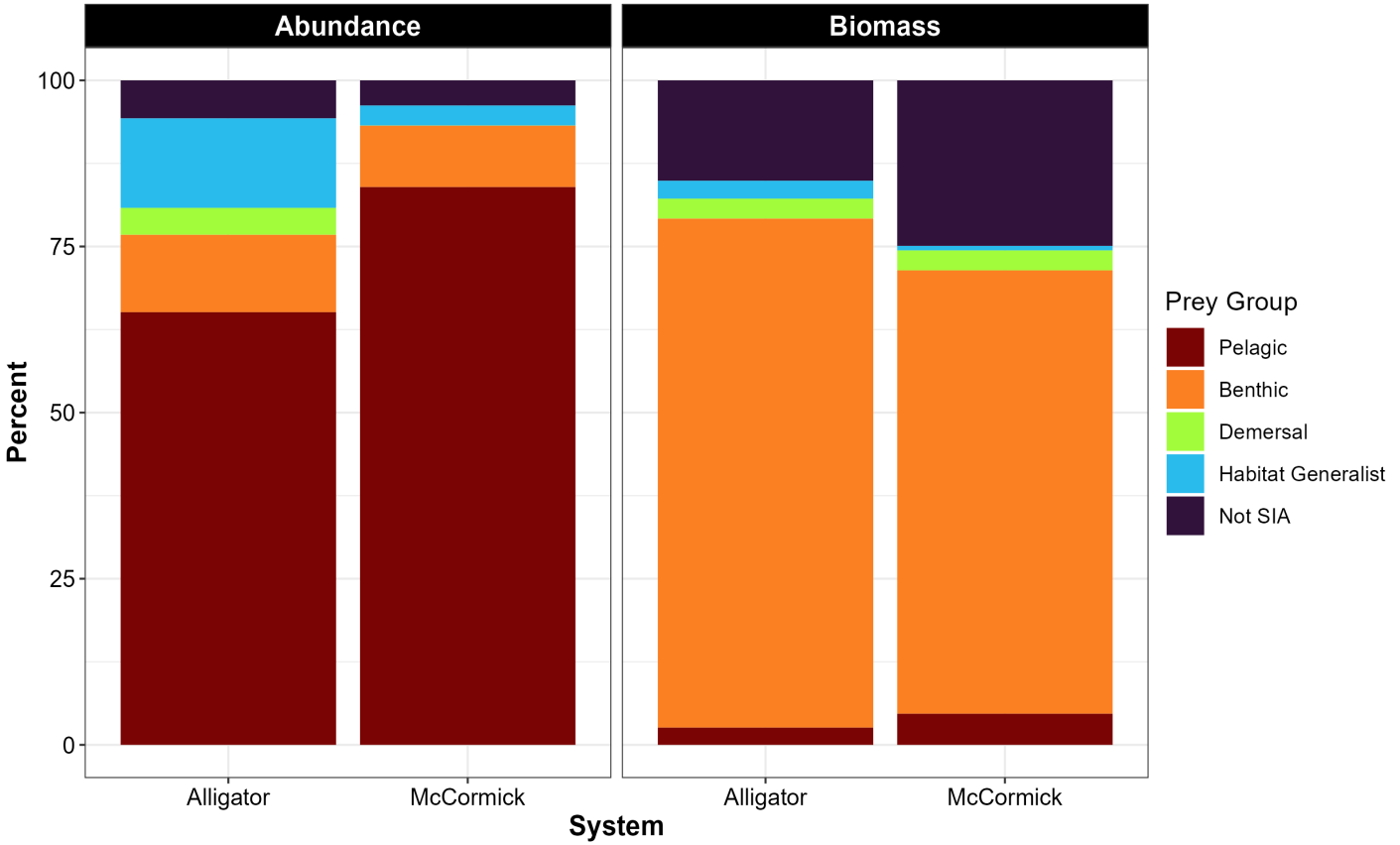
# Prey Resource Seascapes

**FIM 21.3m Seine Net Sampling**

- SRS Peak Wet & Dry Sampling
- 5 years (Wet 2016 to Dry 2021)
- 713 seine hauls
- Prey were counted and measured
- Subset run for stable isotope analysis
- Physiochemical conditions measured at each site

# Prey Resource Seascapes

| Common Name | Species | Prey Group | SIA Processing | System | n |
|---|---|---|---|---|---|
| Mojarra | *Eucinostomus harengulus* | Benthic | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Clown Goby | *Microgobius gulosus* | Benthic | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Hardhead Catfish | *Ariopsis felis* | Benthic | Muscle | Alligator | 6 |
| | | | | McCormick | 6 |
| Mullet | *Mugil spp.* | Demersal | Muscle | Alligator | 4 |
| | | | | McCormick | 6 |
| Pink Shrimp | *Farfantepenaeus duorarum* | Demersal | Composite | Alligator | 6 |
| | | | | McCormick | 3 |
| Needlefish | *Strongylura notata* | Pelagic | Muscle | Alligator | 6 |
| | | | | McCormick | 6 |
| Rainwater Killifish | *Lucania parva* | Pelagic | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Clupeid | *Clupeidae* | Pelagic | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Silverside | *Menidia spp.* | Pelagic | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Anchovy | *Anchoa spp.* | Pelagic | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Ladyfish | *Elops saurus* | Pelagic | Muscle | Alligator | 6 |
| | | | | McCormick | 6 |
| Mayan Cichlid | *Cichlasoma urophthalmus* | Habitat Generalist | Muscle | Alligator | 6 |
| | | | | McCormick | 6 |
| Sailfin Molly | *Poecilia latipinna* | Habitat Generalist | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Grass Shrimp | *Palaemonetes spp.* | Habitat Generalist | Composite | Alligator | 6 |
| | | | | McCormick | 6 |
| Mud Crab | *Panopeidae spp.* | Habitat Generalist | Composite | Alligator | 6 |
| | | | | McCormick | 6 |



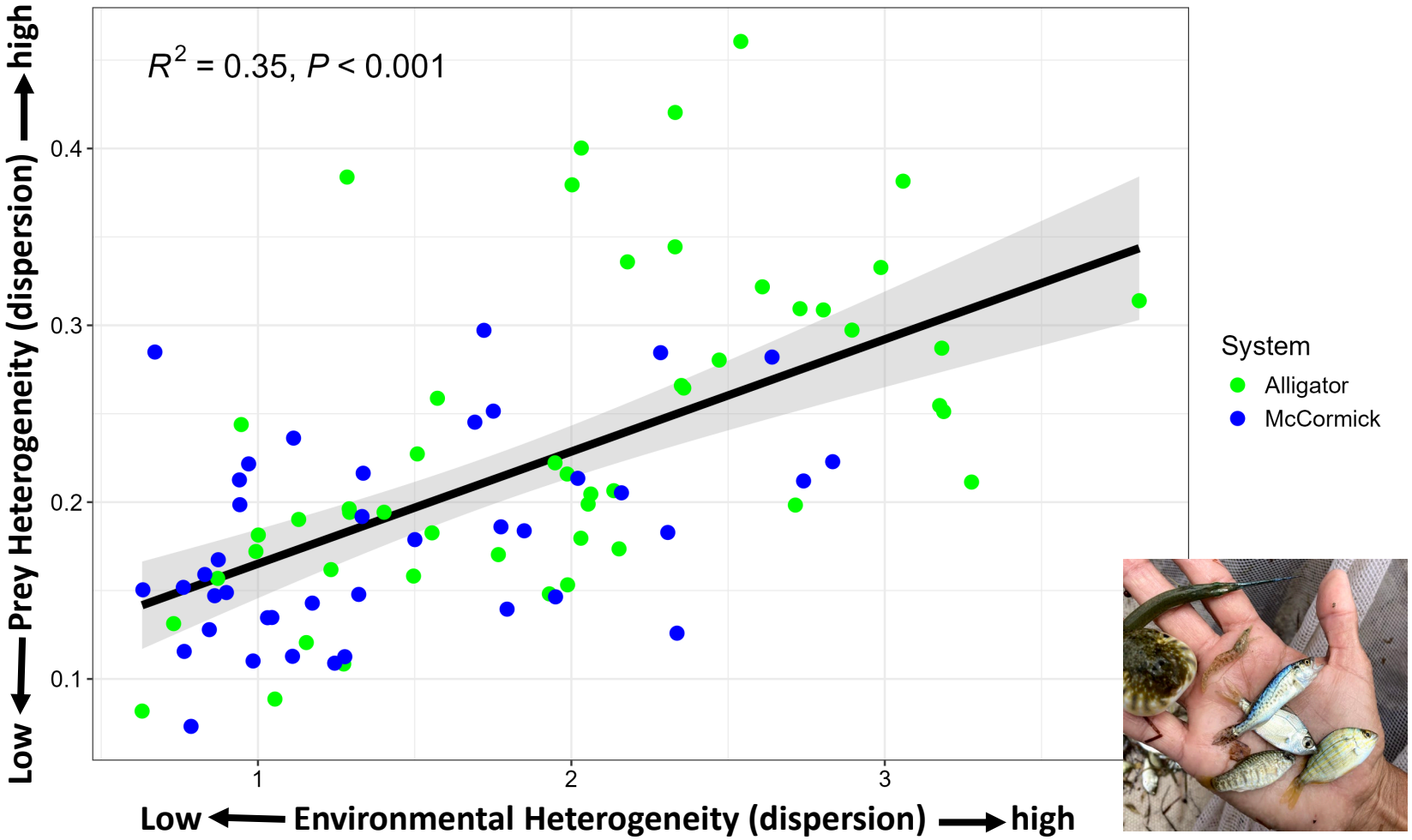

**~95% Abundance**

**~80% Biomass**

# Homogenous Env Conditions = Homogenous Prey Seascape

Snook & Tarpon:
Homogenous → profitable to increase movement

Heterogeneous → profitable to decrease movement



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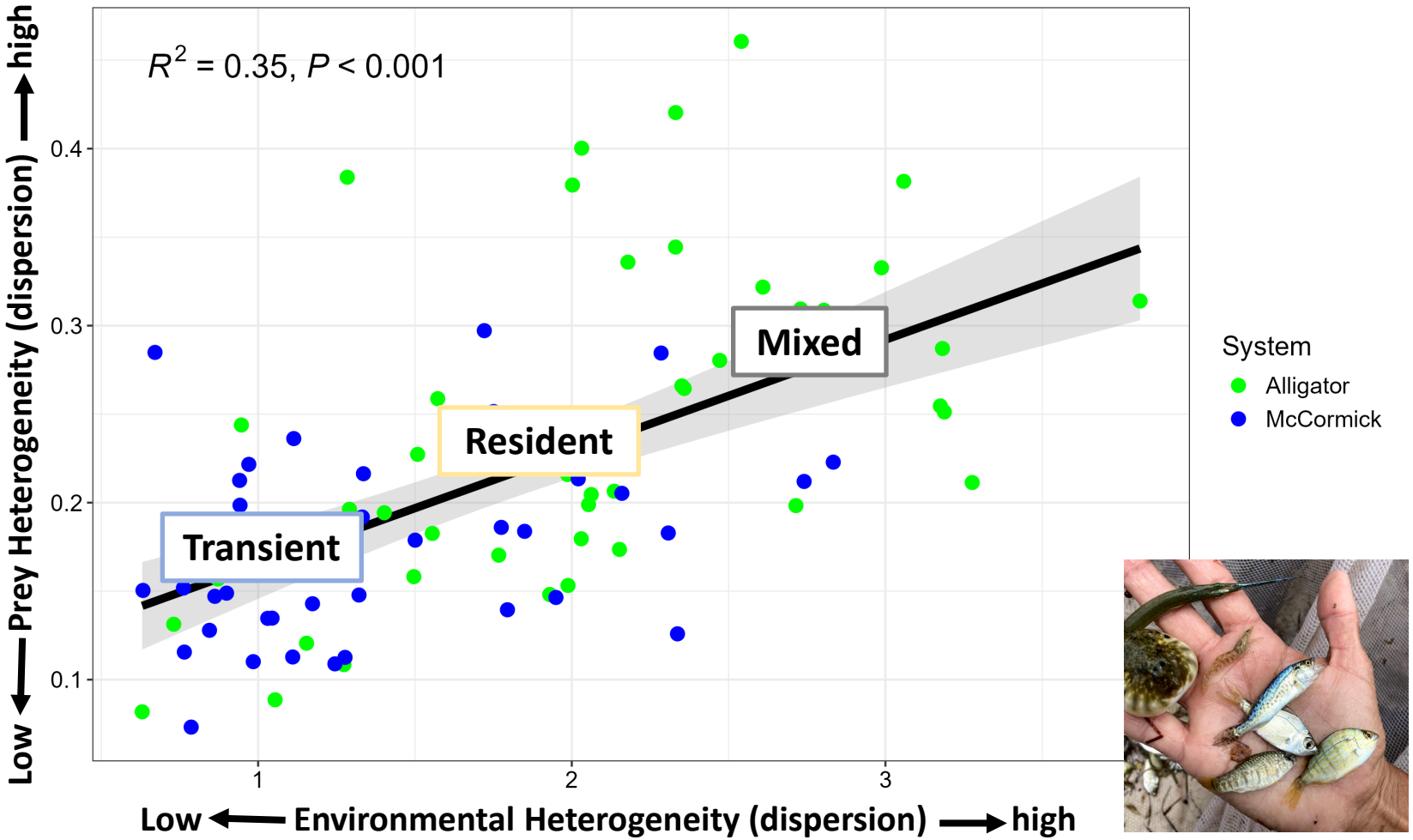


# Stable Isotope Functional Groups

$\delta^{15}N$ – identify trophic level

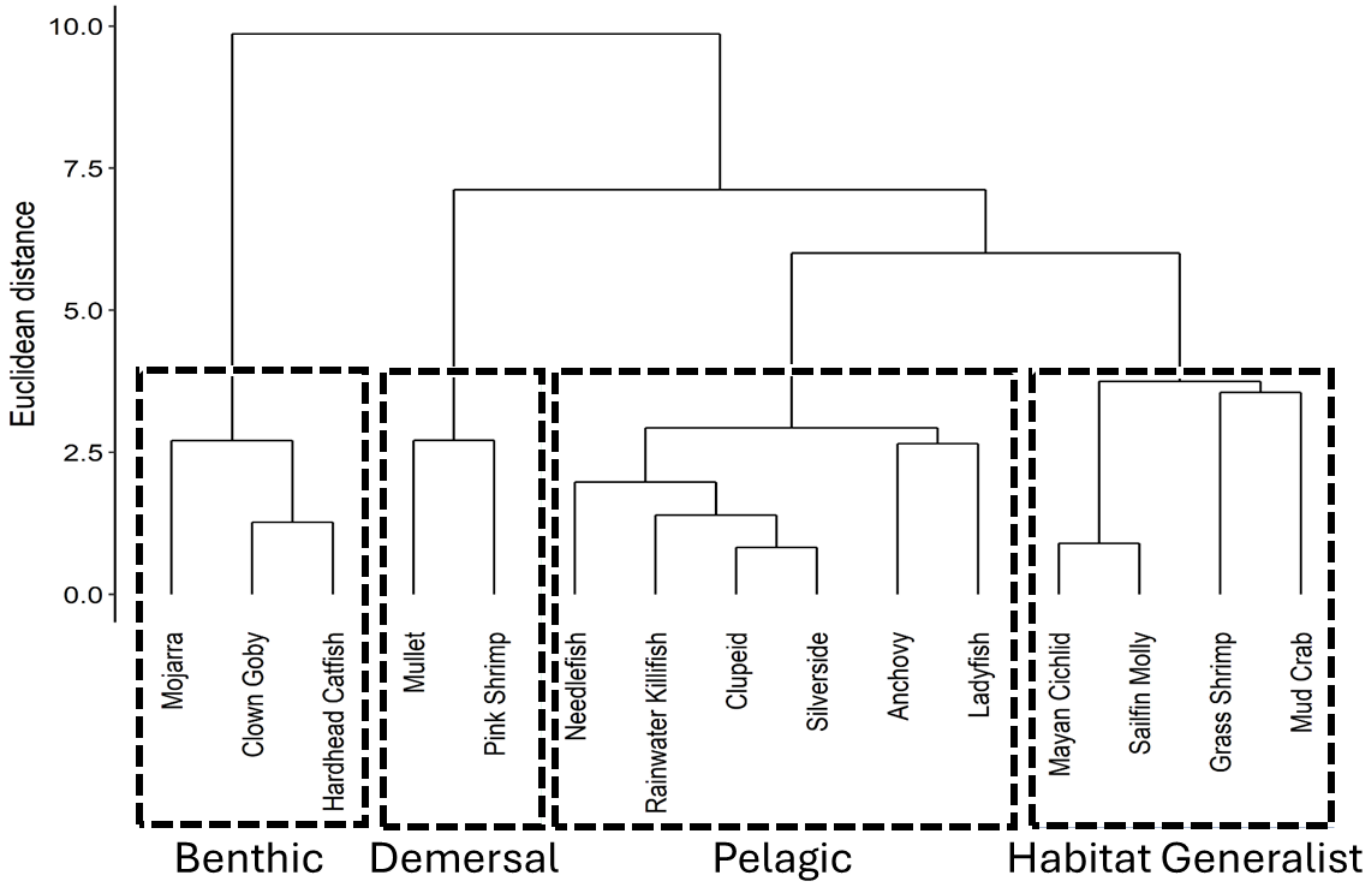
- Step-wise enrichment of 3.4‰ = 1 trophic level

$\delta^{13}C$ – identify origins of organic matter to consumers

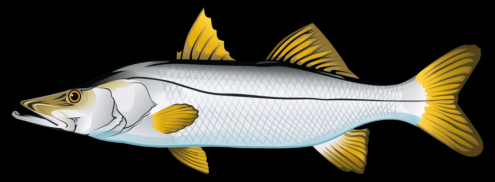
- Changes very little with trophic transfer (0-1‰)

$\delta^{15}S$ – Compliments $\delta^{13}C$ (Marine vs Freshwater, DO)

- Changes very little with trophic transfer (0-1‰)

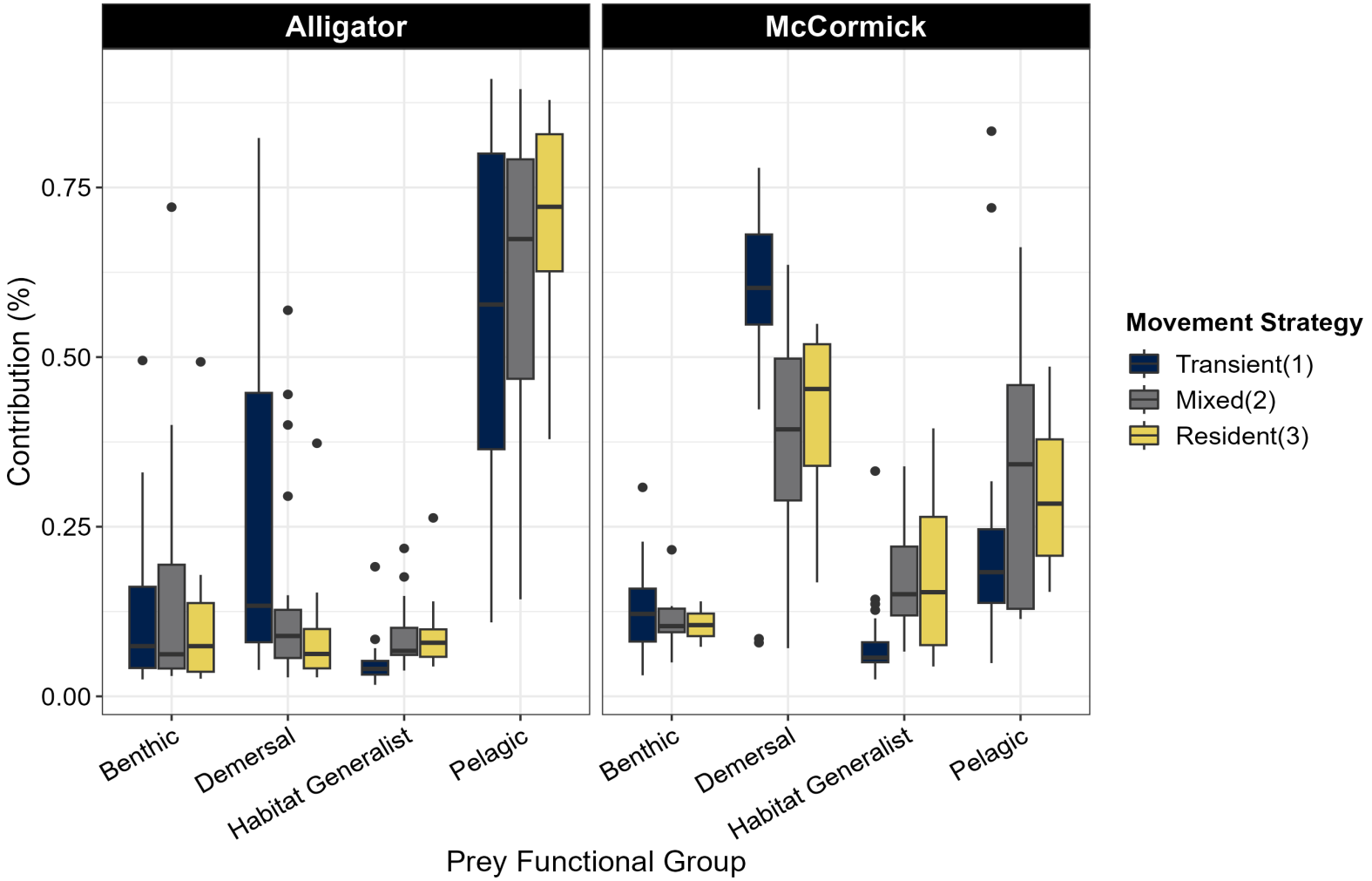


# Snook Resource Contributions

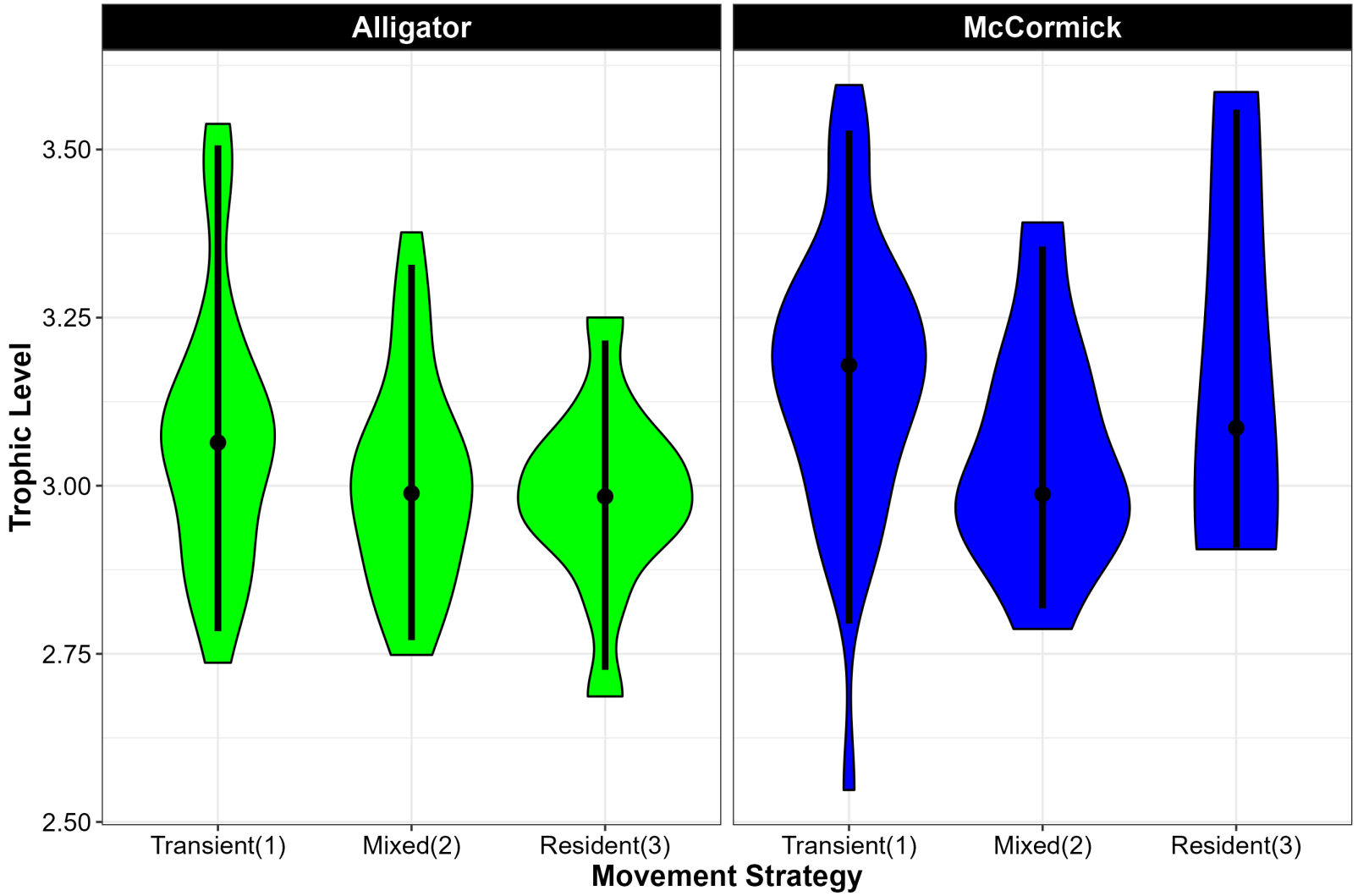


Bayesian mixing models

- Alligator = Pelagic dominated
- McCormick = Demersal dominated
- Greater variation in McCormick

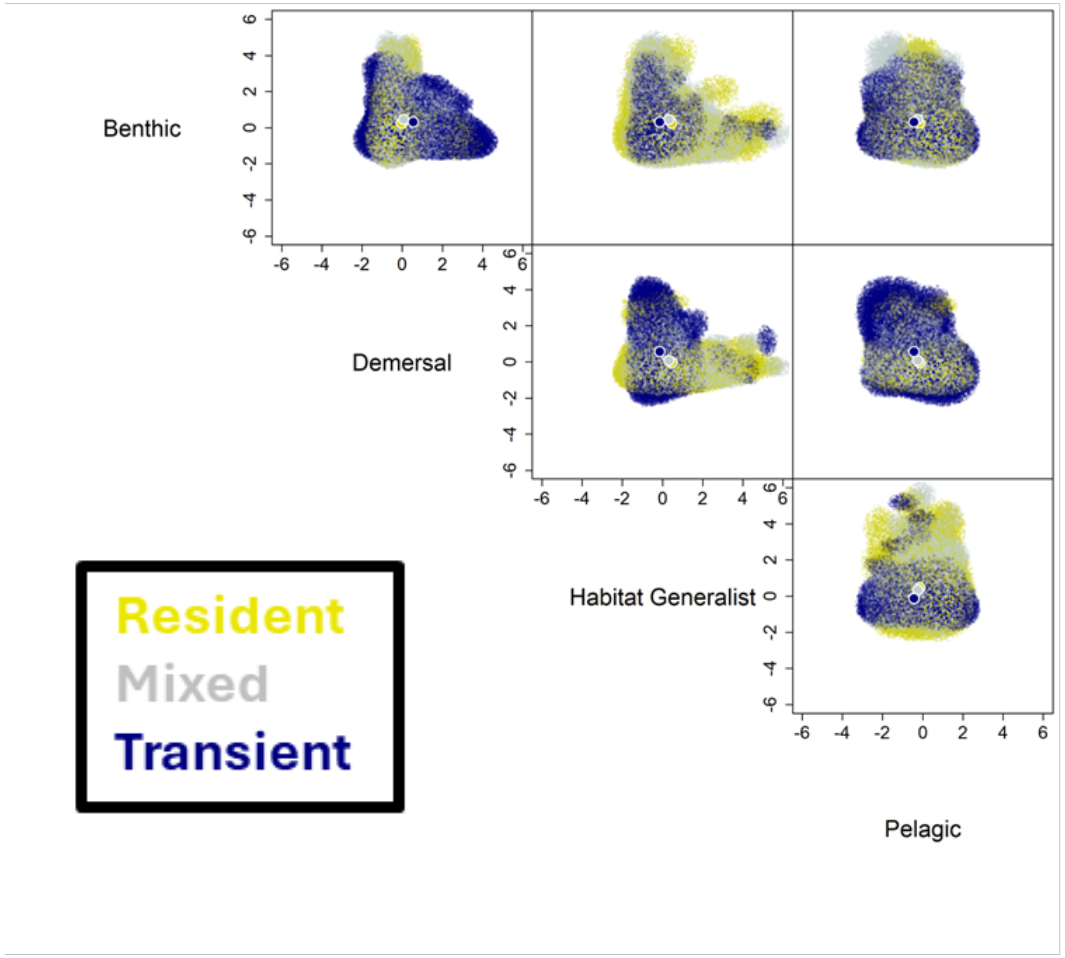


# No Difference in Snook Trophic Level

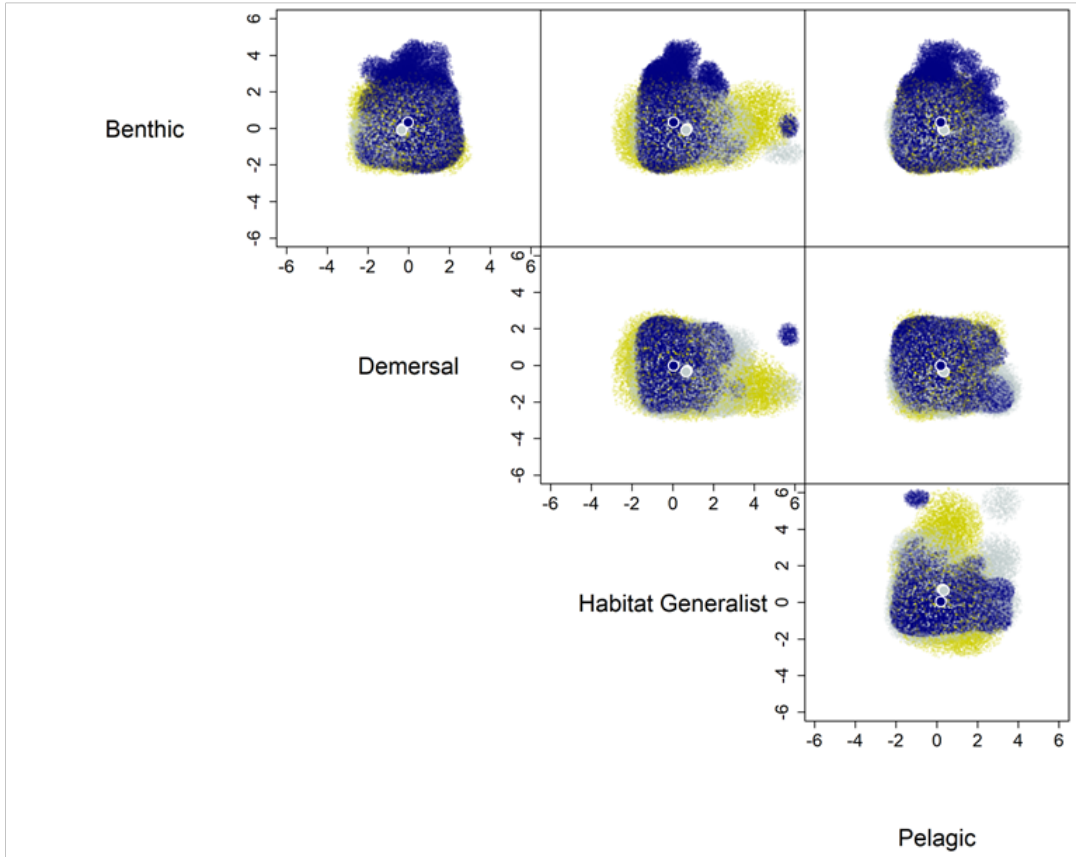


# Snook Trophic Niche Hypervolumes

## Alligator System



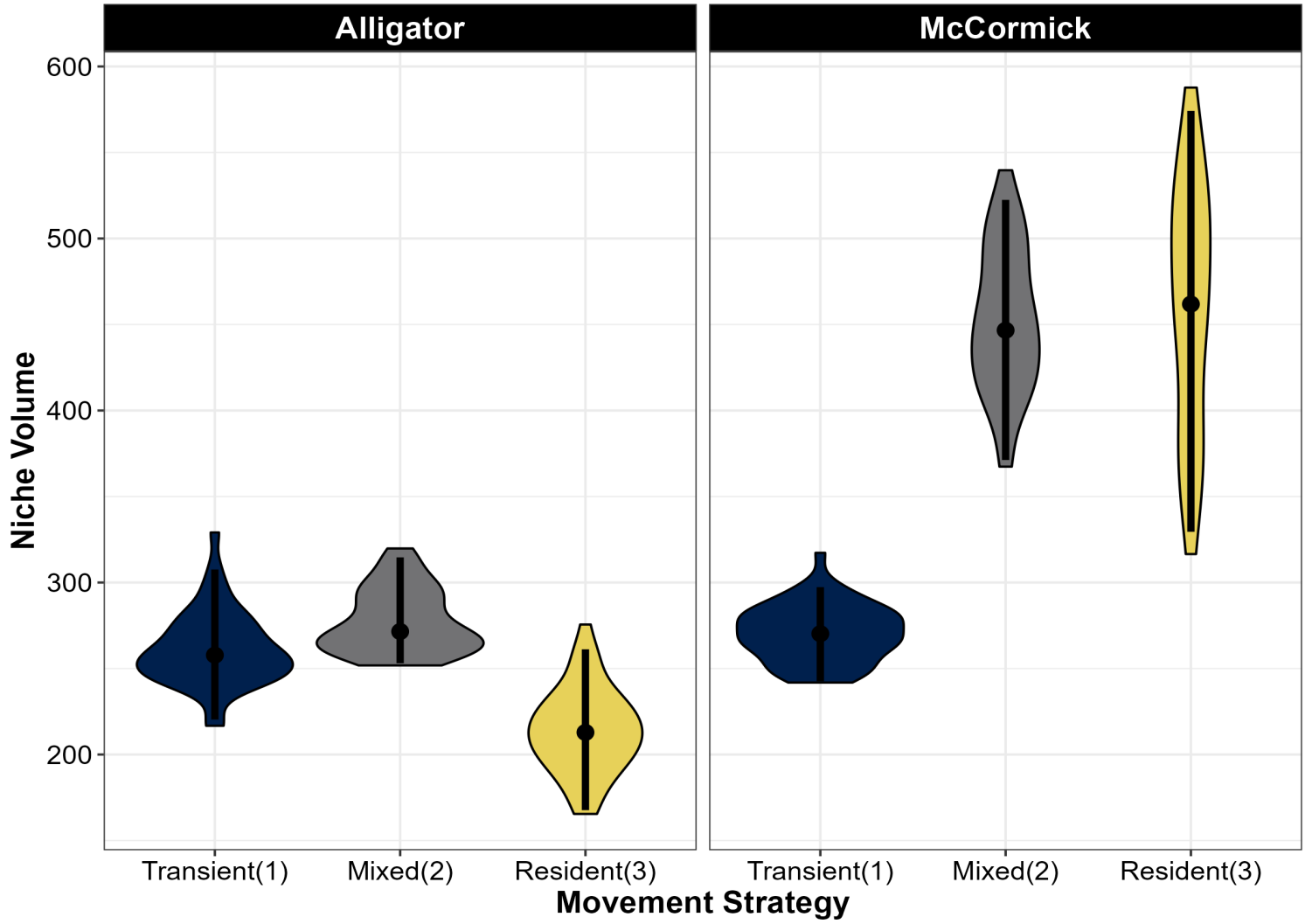

## McCormick System



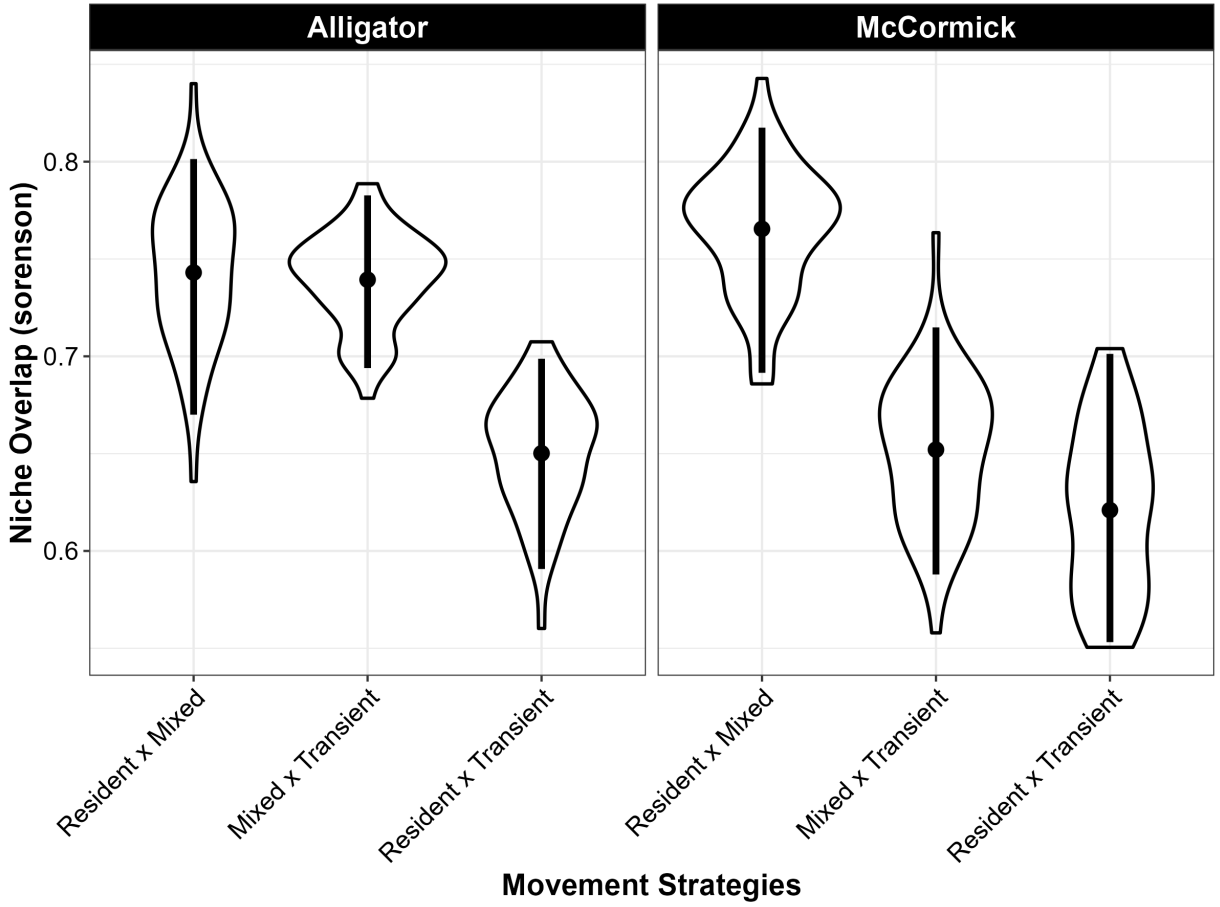
# Snook Trophic Niche Volumes

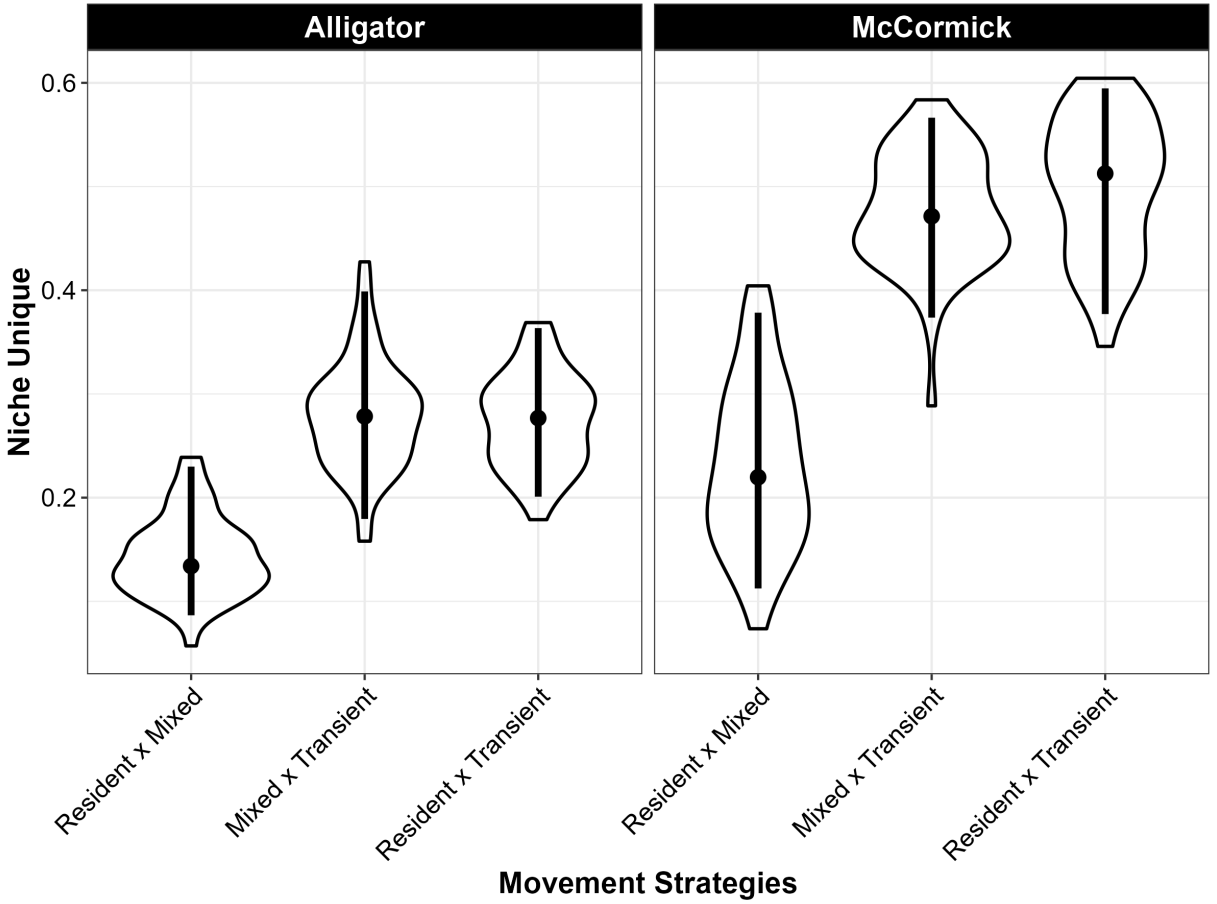
Niche volumes differ by:

1. Movement strategy
2. System



# Energy Channel Dependance Scales with Movement



# GEER Takeaways

- Capable of classifying movement strategies using acoustic telemetry
- Movement strategy selection → External drivers (e.g., environmental conditions, resources) outweigh internal traits
- Energy channel use and trophic niche shifts with movement strategy
- Water management, restoration, & climate change will likely drive these relationships


Thank You
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