Linking movement & trophic ecology to understand responses to hydroclimatic variation

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RECOVER assessment integration evaluation science

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In response to changing environments…

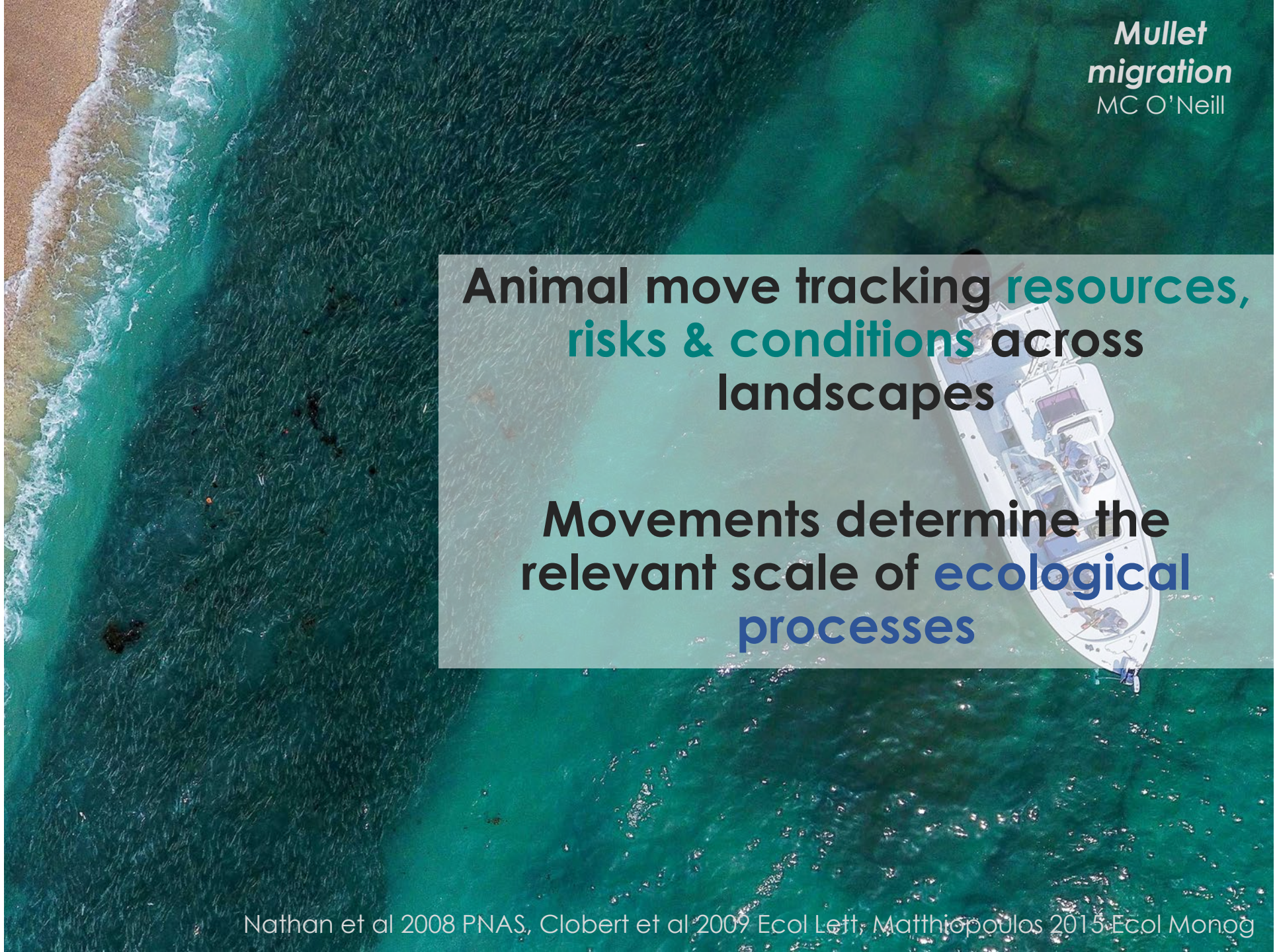
ADAPT

ADJUST

1920's Great Tits opening milk in England

MOVE

Wong & Candolin 2015 *Behavioral responses to changing environments*



Animal move tracking resources, risks & conditions across landscapes

Movements determine the relevant scale of ecological processes

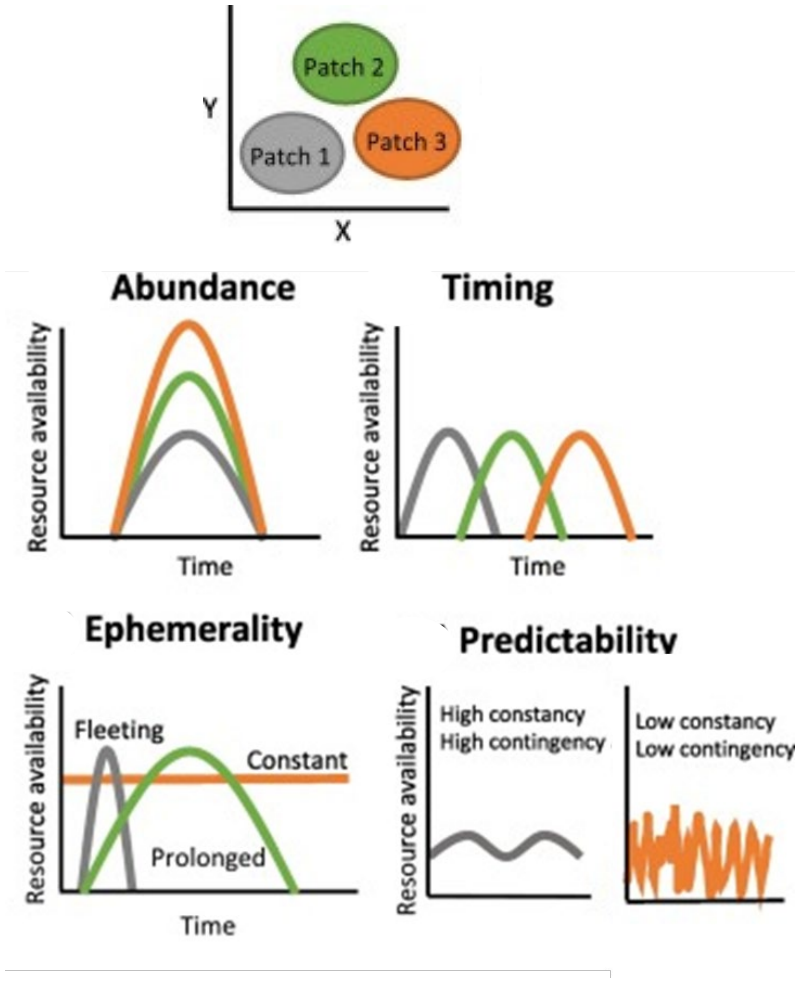
Nathan et al 2008 PNAS, Clobert et al 2009 Ecol Lett, Matthiopoulos 2015 Ecol Monog

Animal movements are highly responsive to environmental variation

Sentinels of ecosystem health & resilience & a consideration for restoration

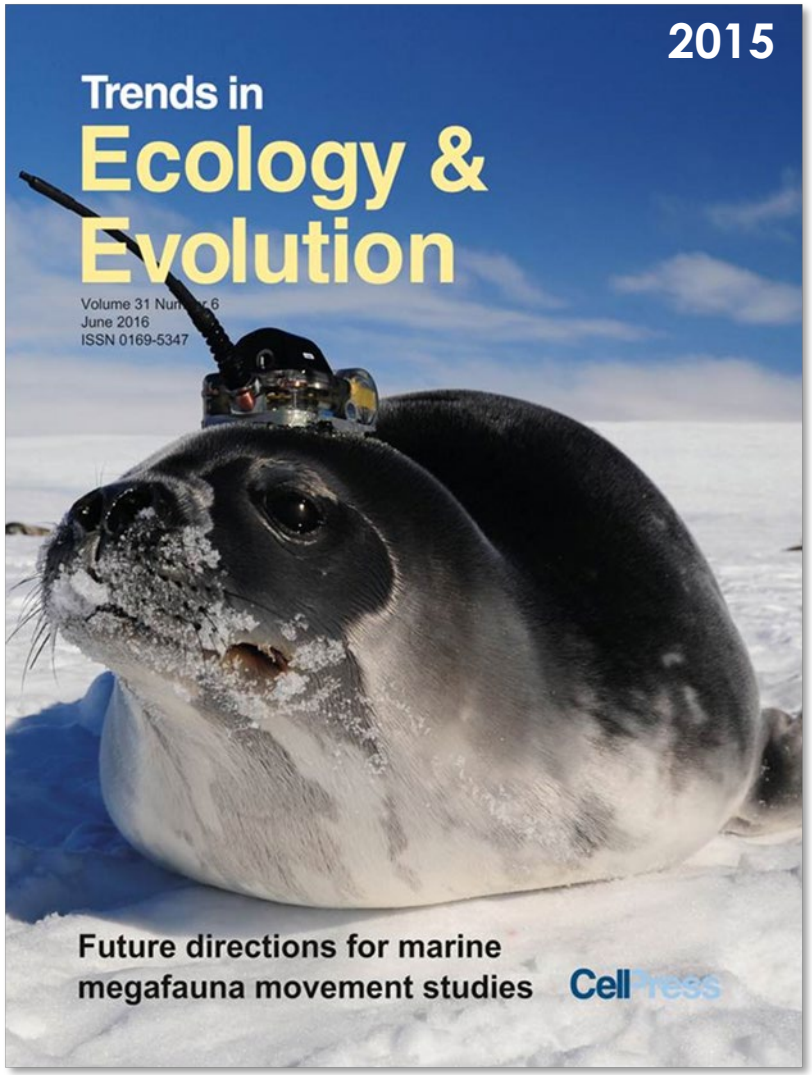
Mullet migration
MC O'Neill

Consumers move: Tracking heterogenous resource landscapes



Abrahms et al. 2021 TREE

Unprecedented ability to track animal movement across the landscape

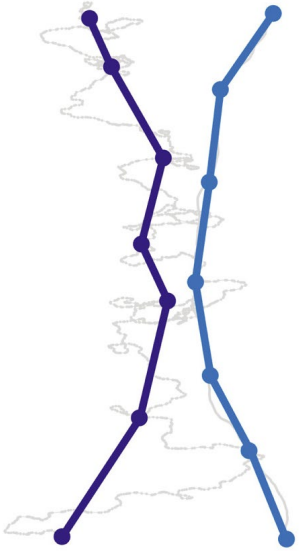


Lower resolution
(30 min intervals)

Exploration

Bold = Shy

No interactions

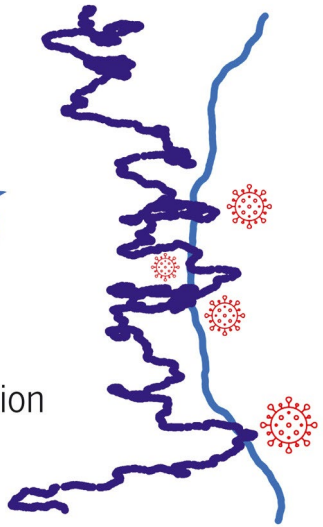


Higher resolution
(5 s intervals)

Exploration

Bold > Shy

Multiple interaction hotspots



Higher resolution allows for greater insight

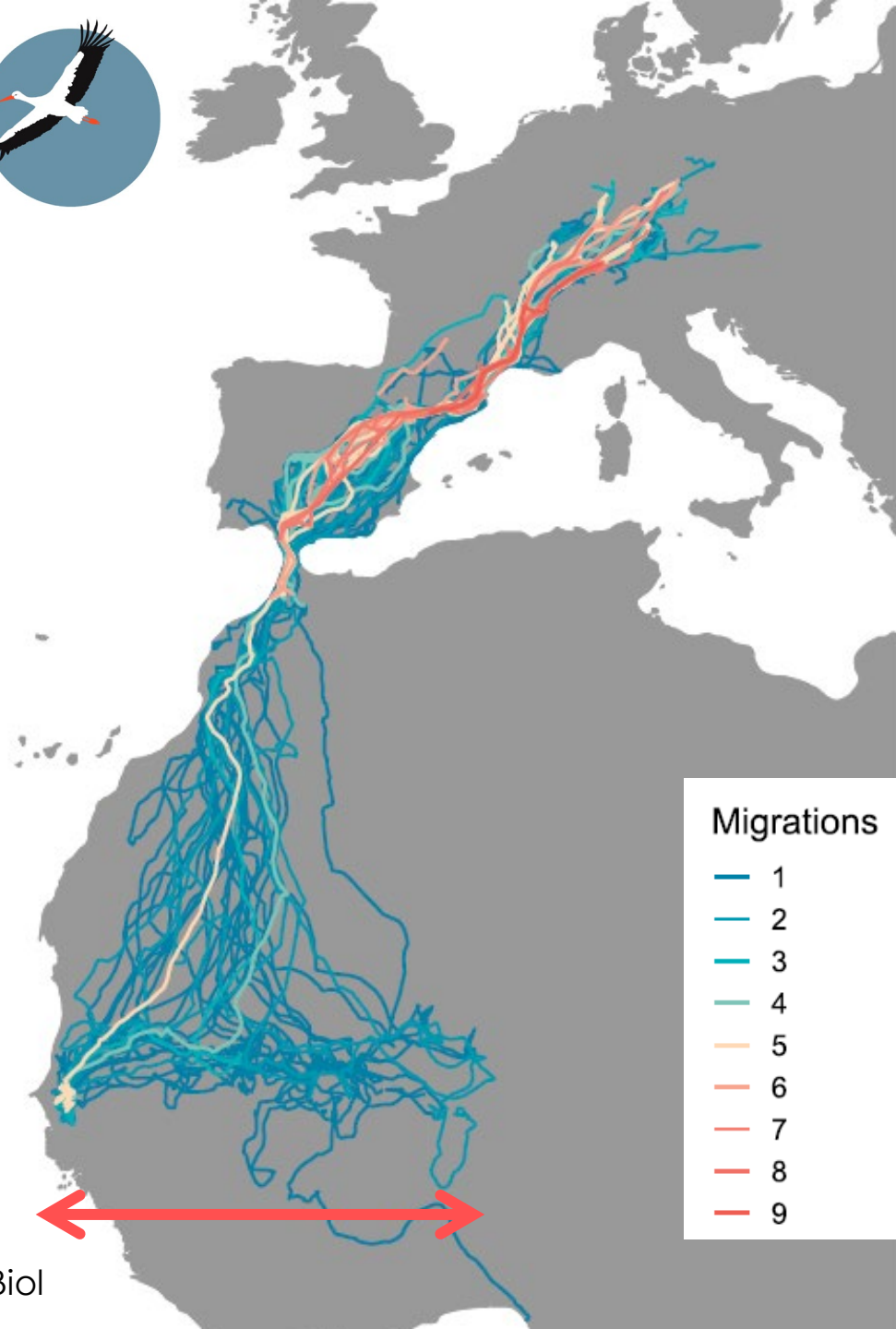
Nathan et al. 2022 Science

As consumers move: Similarity in routes to resources but inter-individual variation

White storks

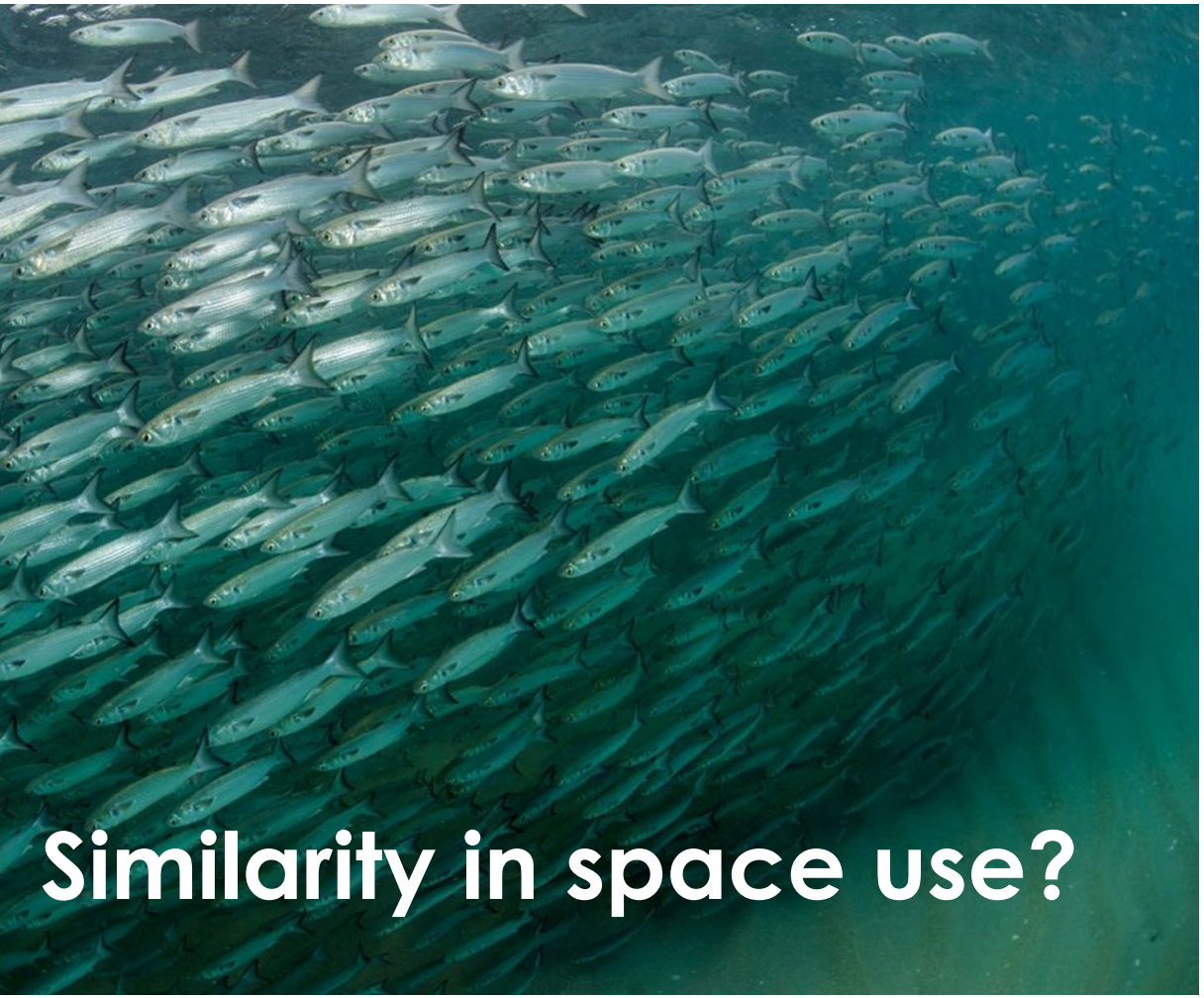
Juveniles: move with conspecifics

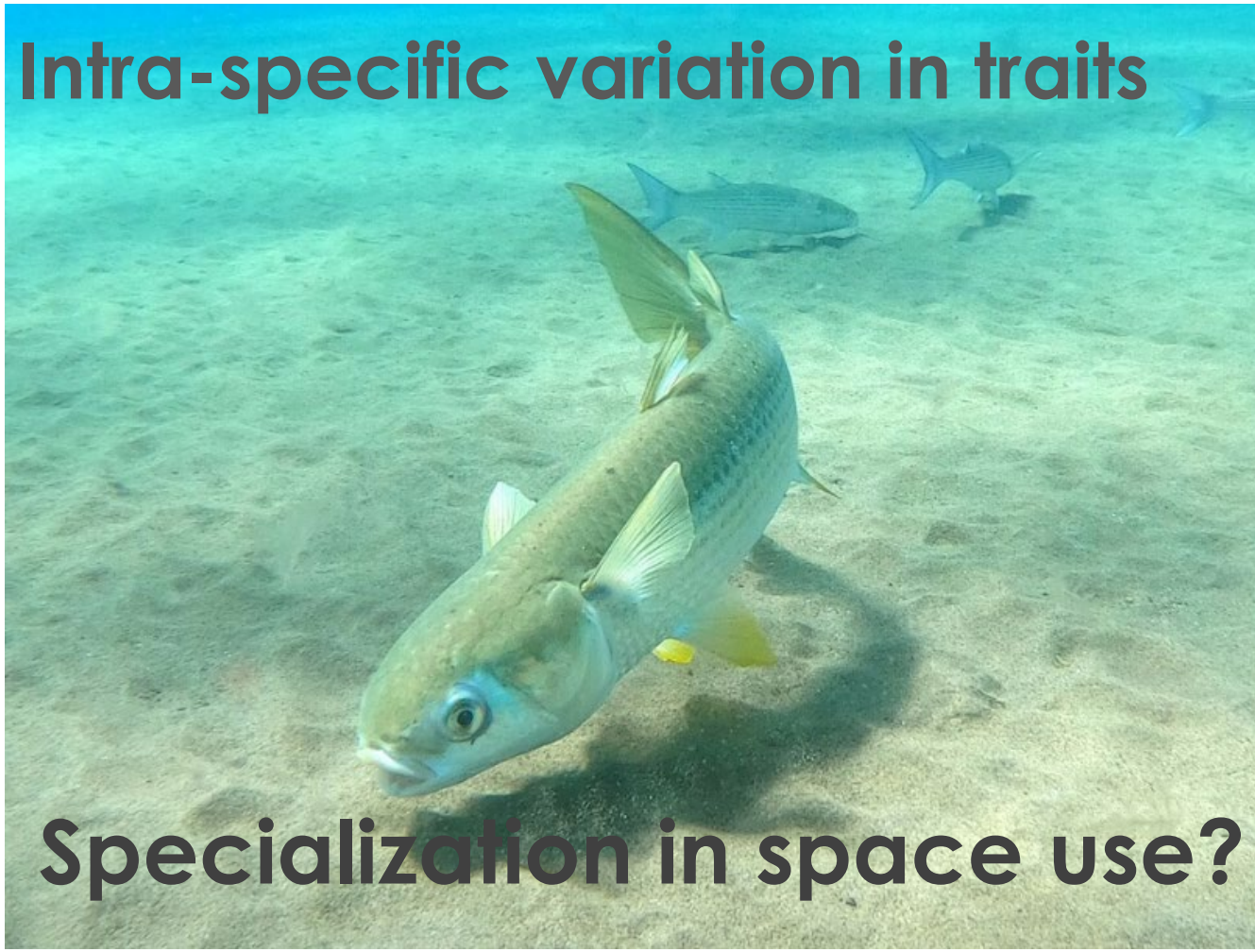
Experienced: Specialized in less traveled routes



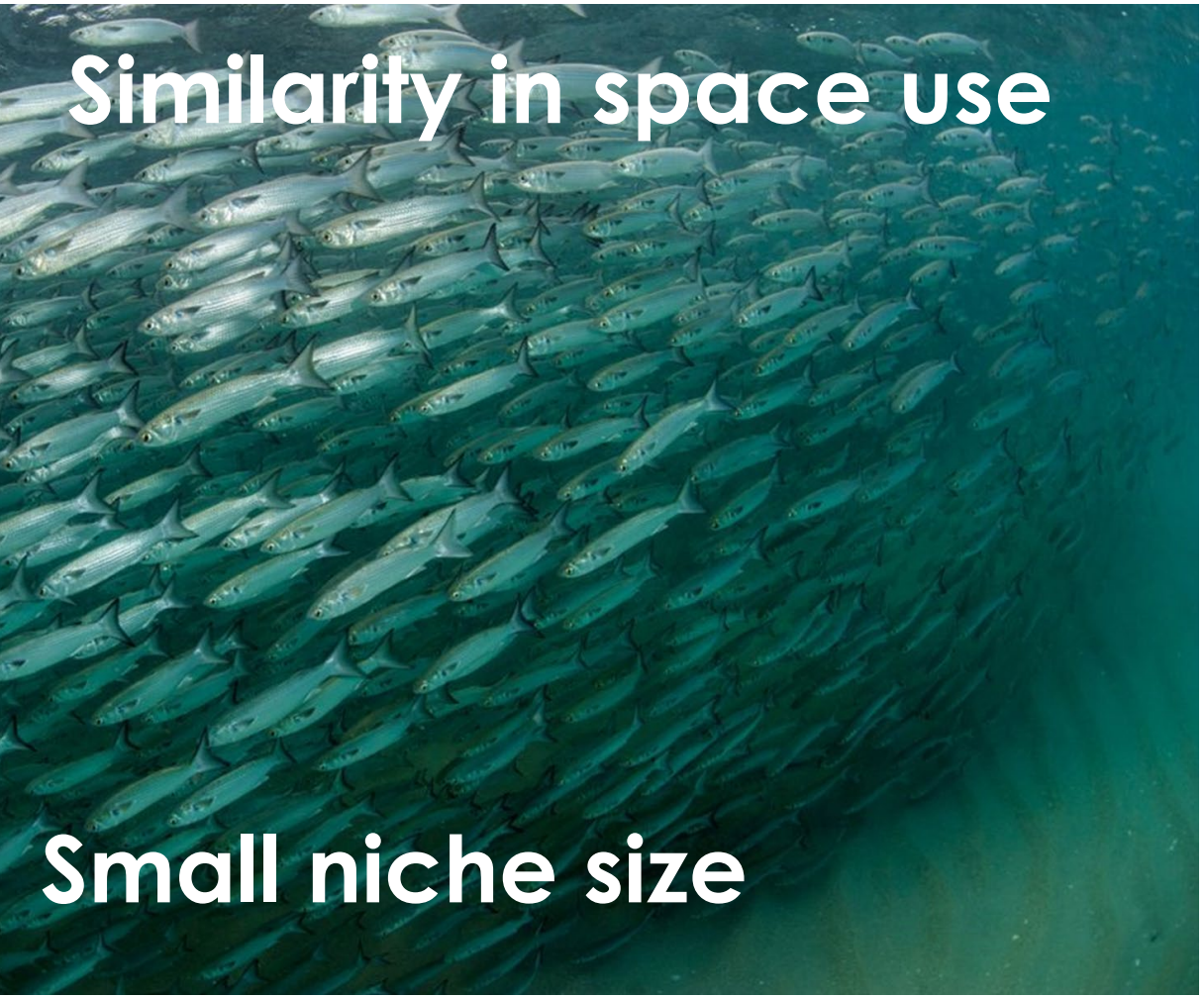
Brønnvik et al 2024 Current Biol

How does this work? Resource tracking lead to:

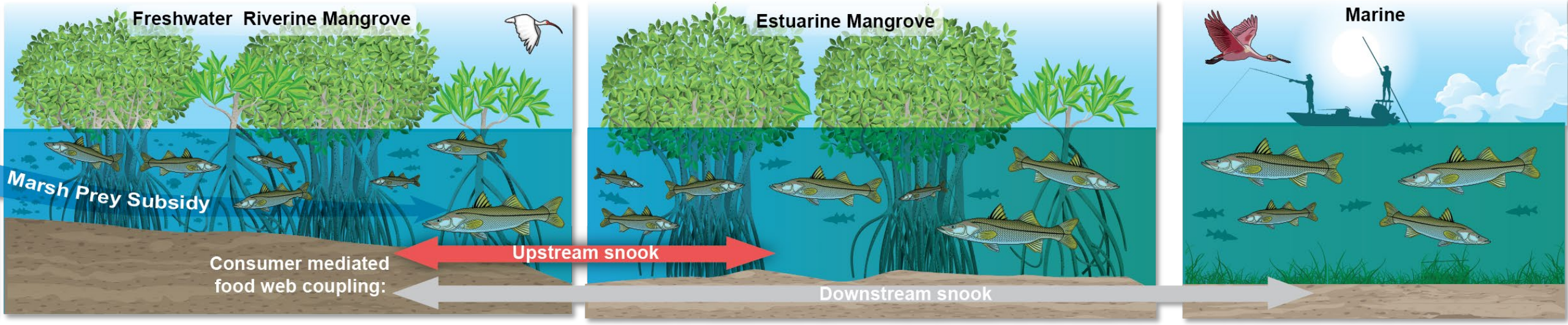




Implications for diet & resource use: Trophic niche



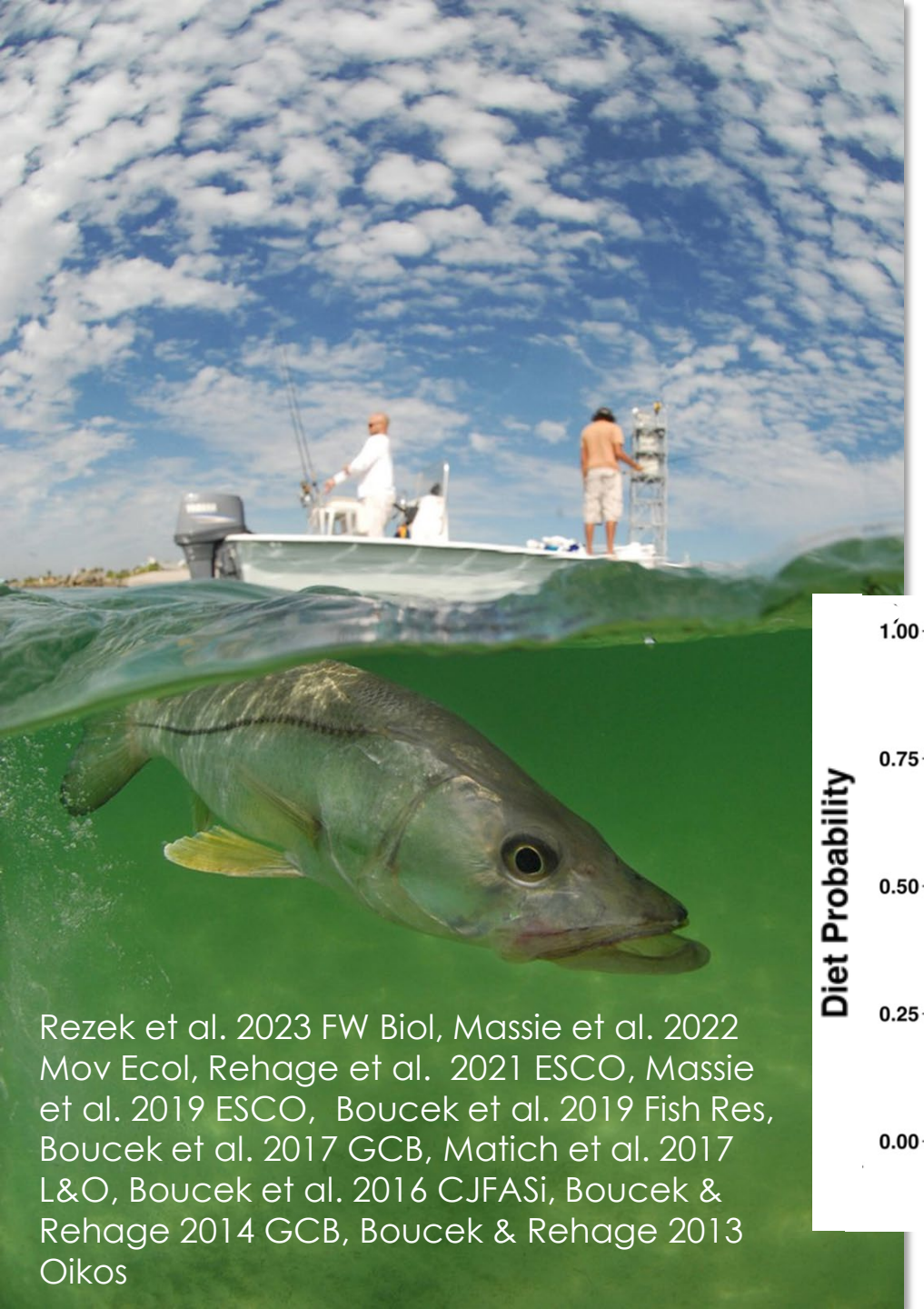
In coastal rivers: Does resource tracking lead to specialization or space use similarity?



Flow-ecology relationships in coastal rivers of SCS Module

Freshwater flows

Hydrological alteration/restoration

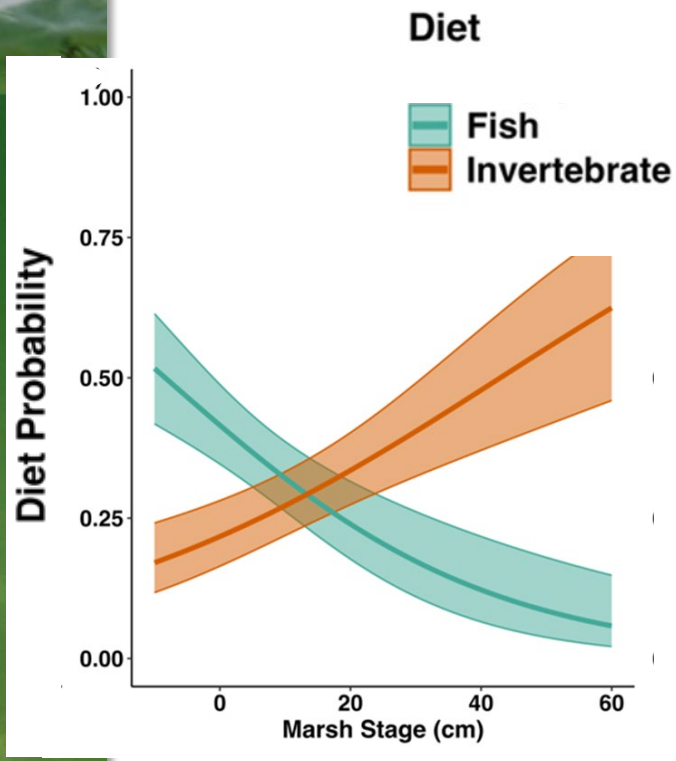


Rezek et al. 2023 FW Biol, Massie et al. 2022 Mov Ecol, Rehage et al. 2021 ESCO, Massie et al. 2019 ESCO, Boucek et al. 2019 Fish Res, Boucek et al. 2017 GCB, Matich et al. 2017 L&O, Boucek et al. 2016 CJFASi, Boucek & Rehage 2014 GCB, Boucek & Rehage 2013 Oikos

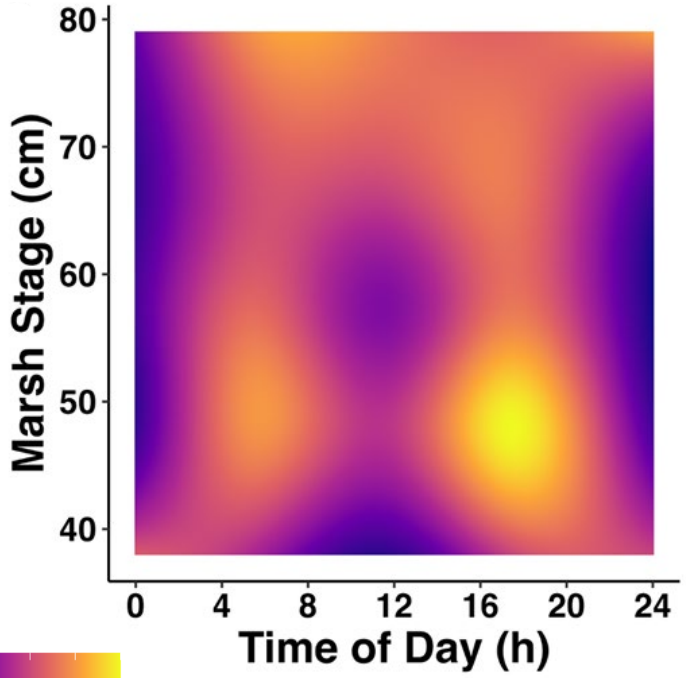
Many things…river lovers

Life history closely tied to **flows**

Tropical, protandric hermaphrodites support **recreational fishery** (10 M fish caught/yr)

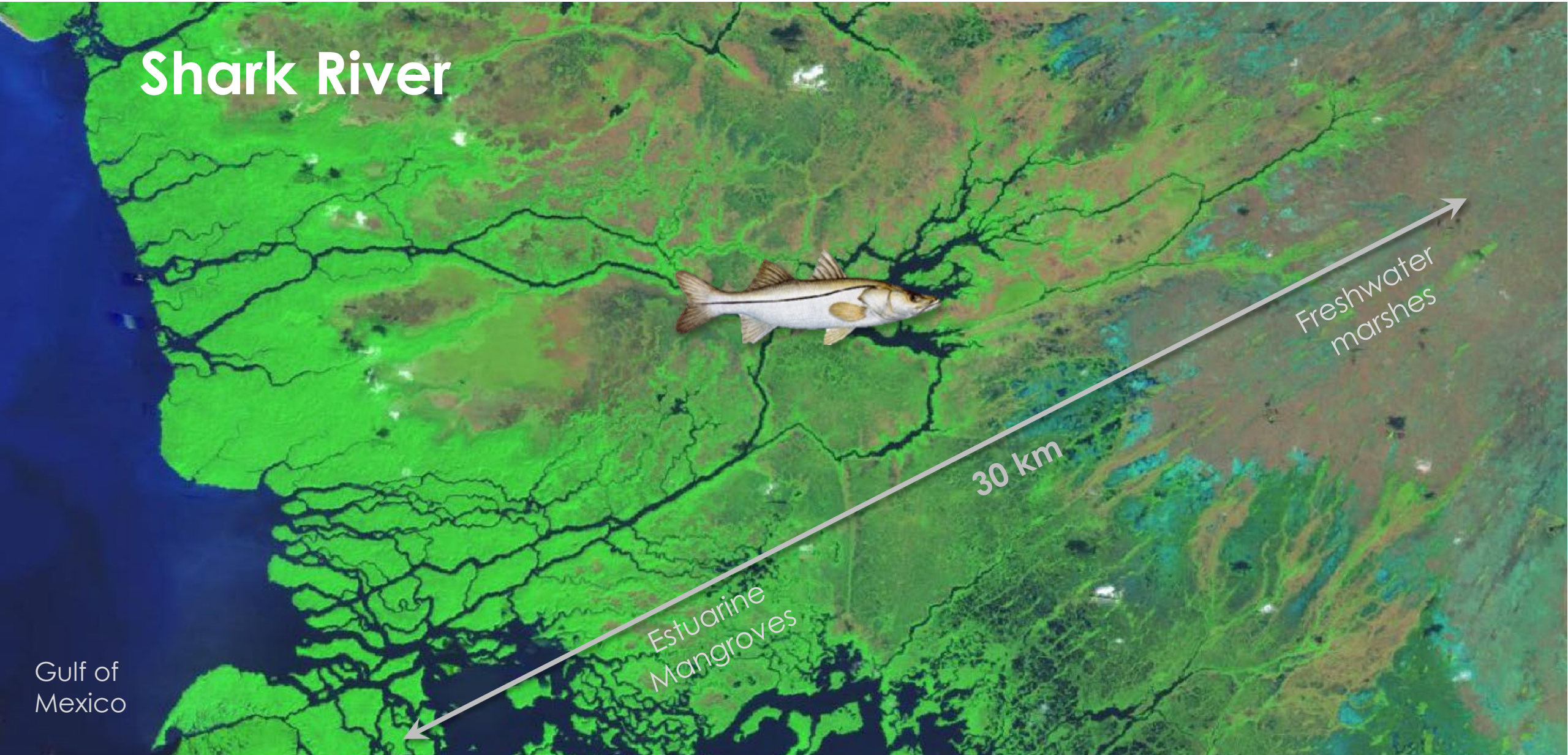


Crepuscular foraging

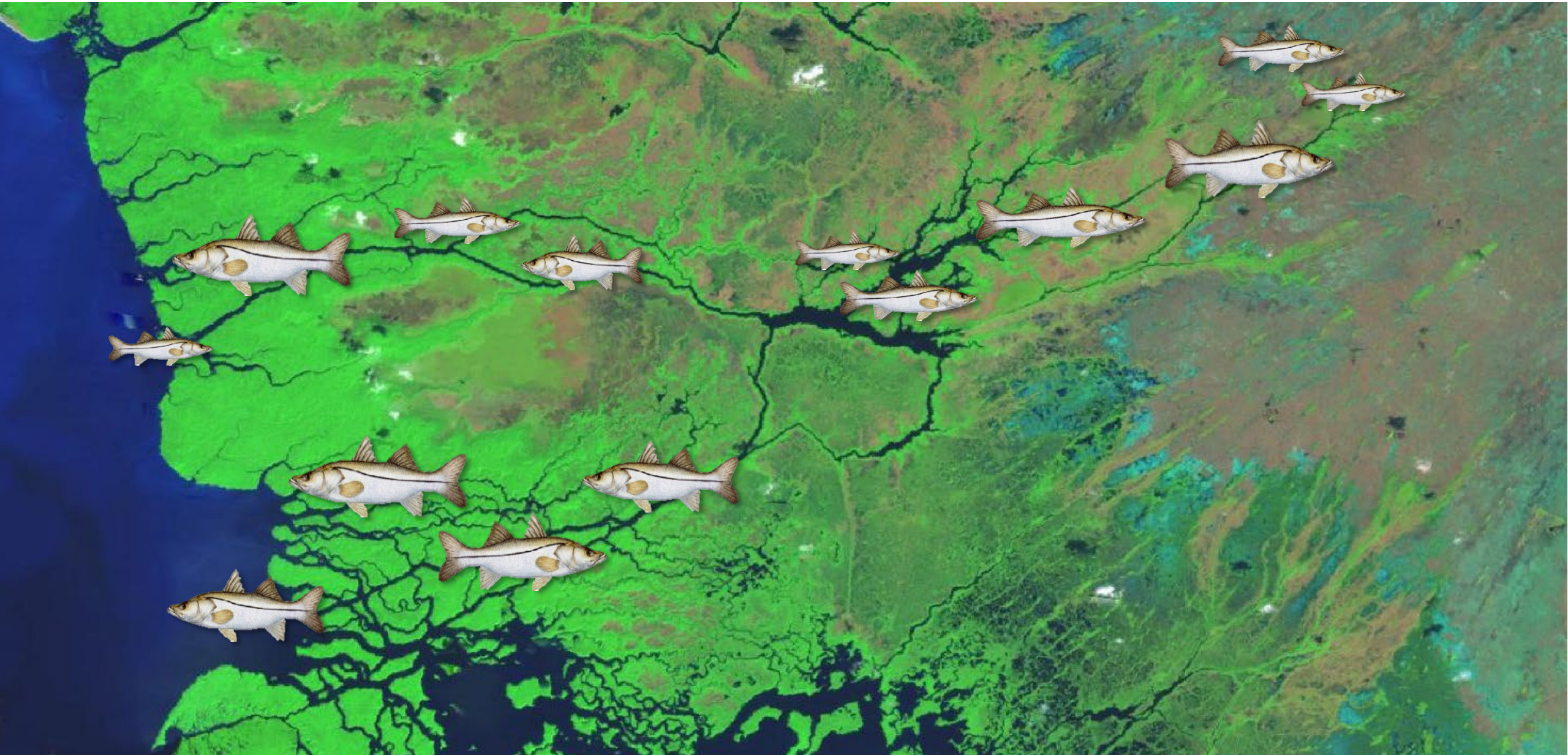


White et al. In review

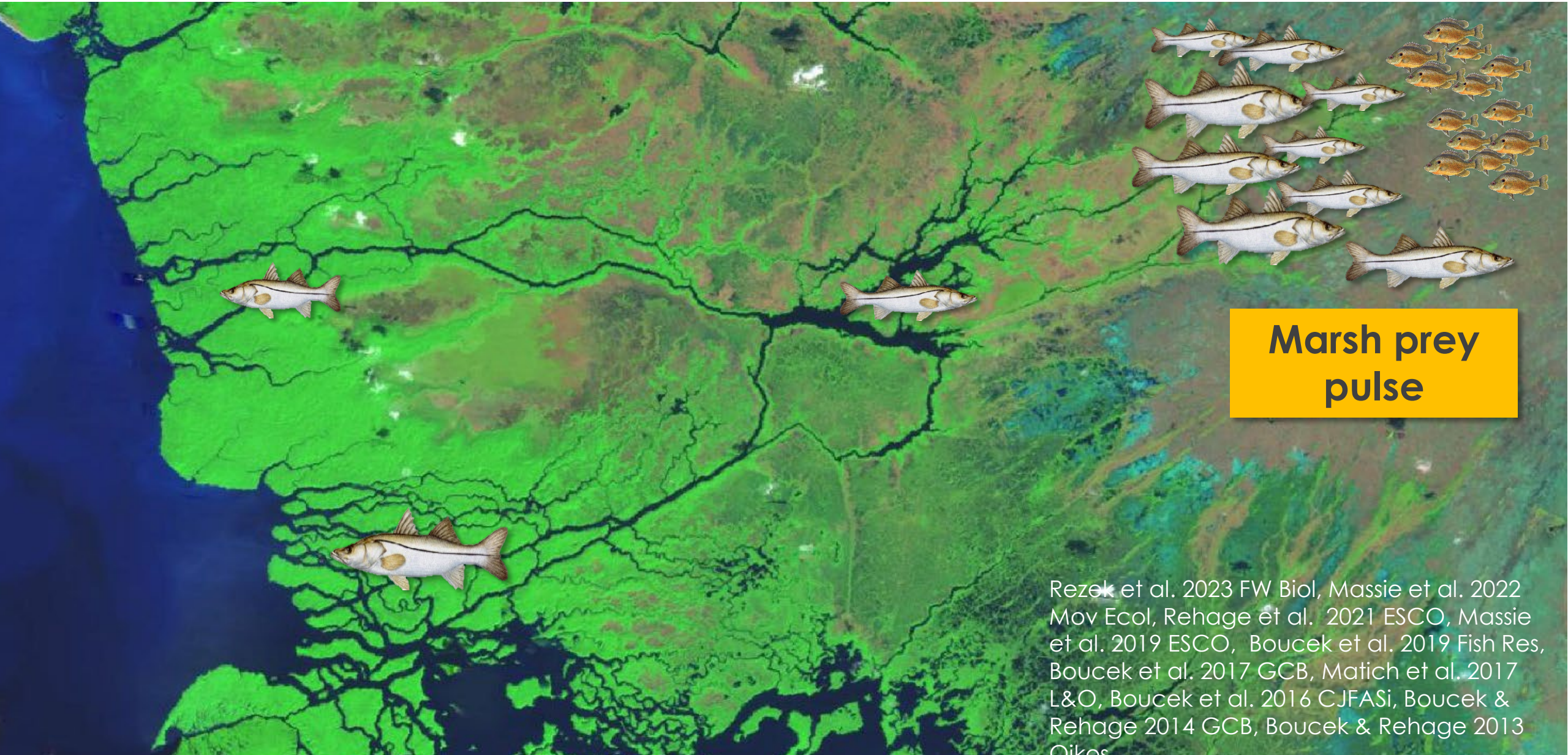
Specialization: hypothesize to be seasonal



Wet season



Dry season



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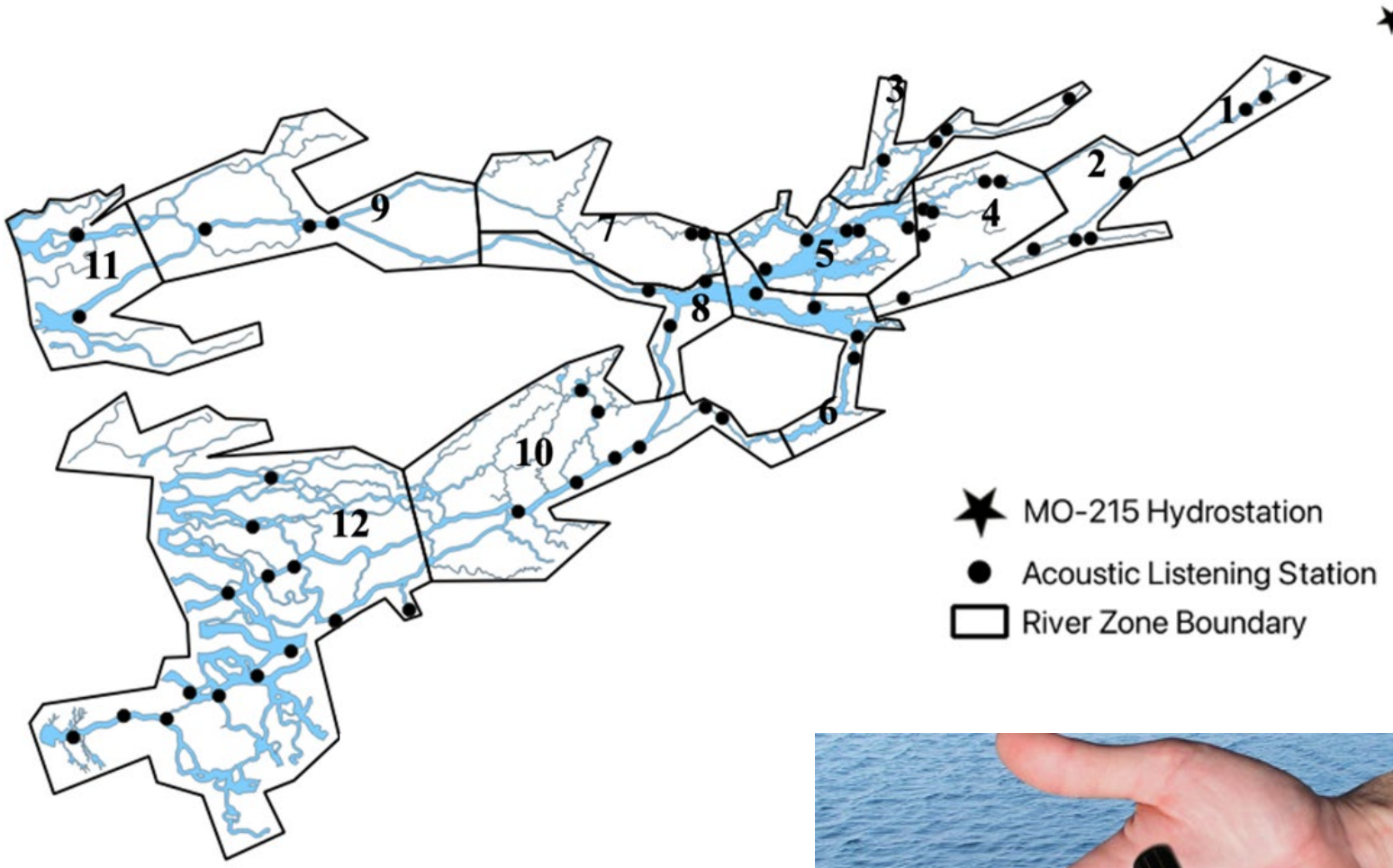
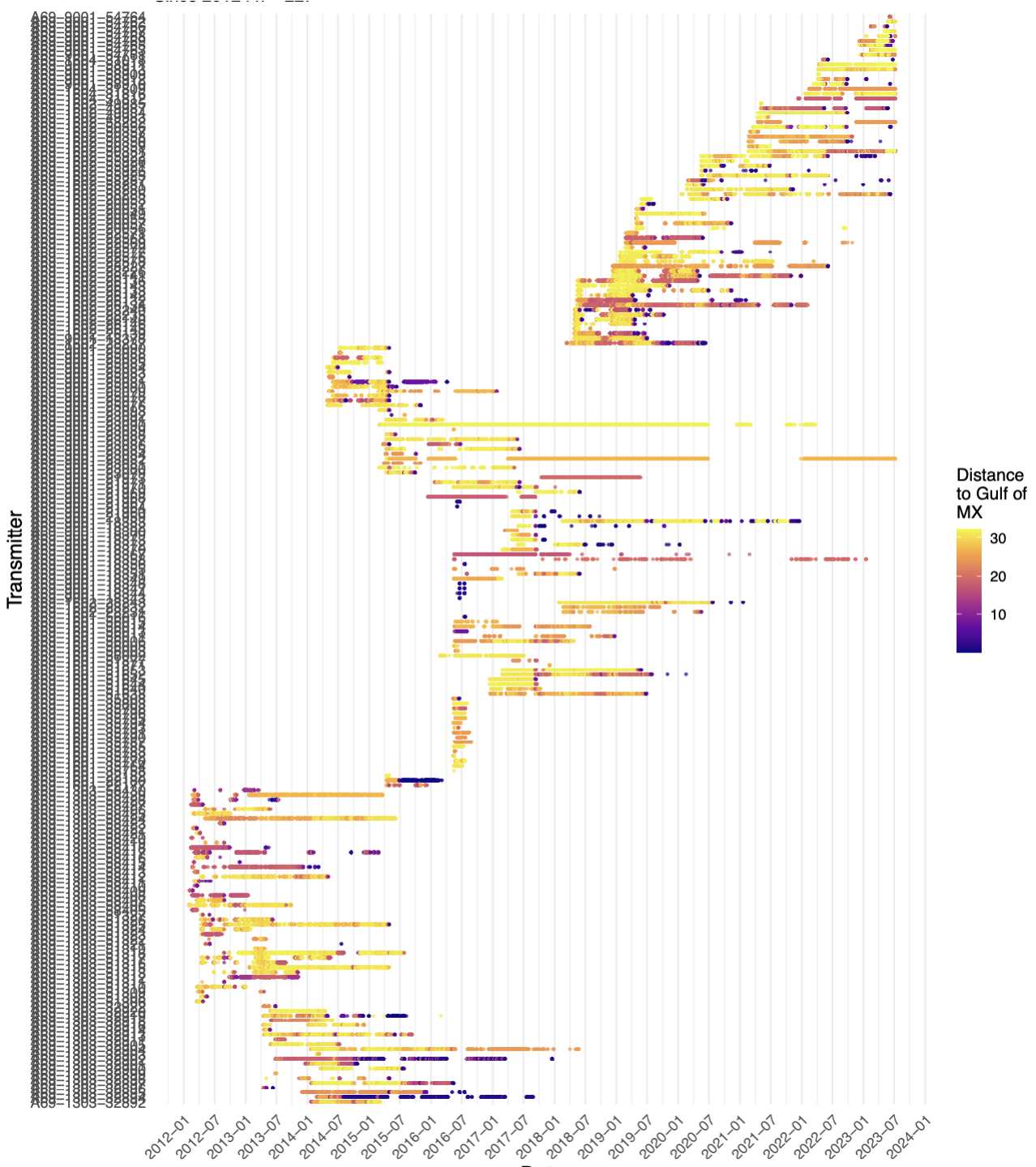
1) How much temporal variability in space use specialization?
2) How do hydrological conditions affect it?
3) Is trophic niche size associated with specialized space-use?

Approach: Acoustic telemetry

- **227 snook** tagged in 2012-2023
- 41 receivers that record movement across **12 zones**
- **Stable isotopes + mixing models** to describe resource use & niche size



227 tagged fish
90-2102 days

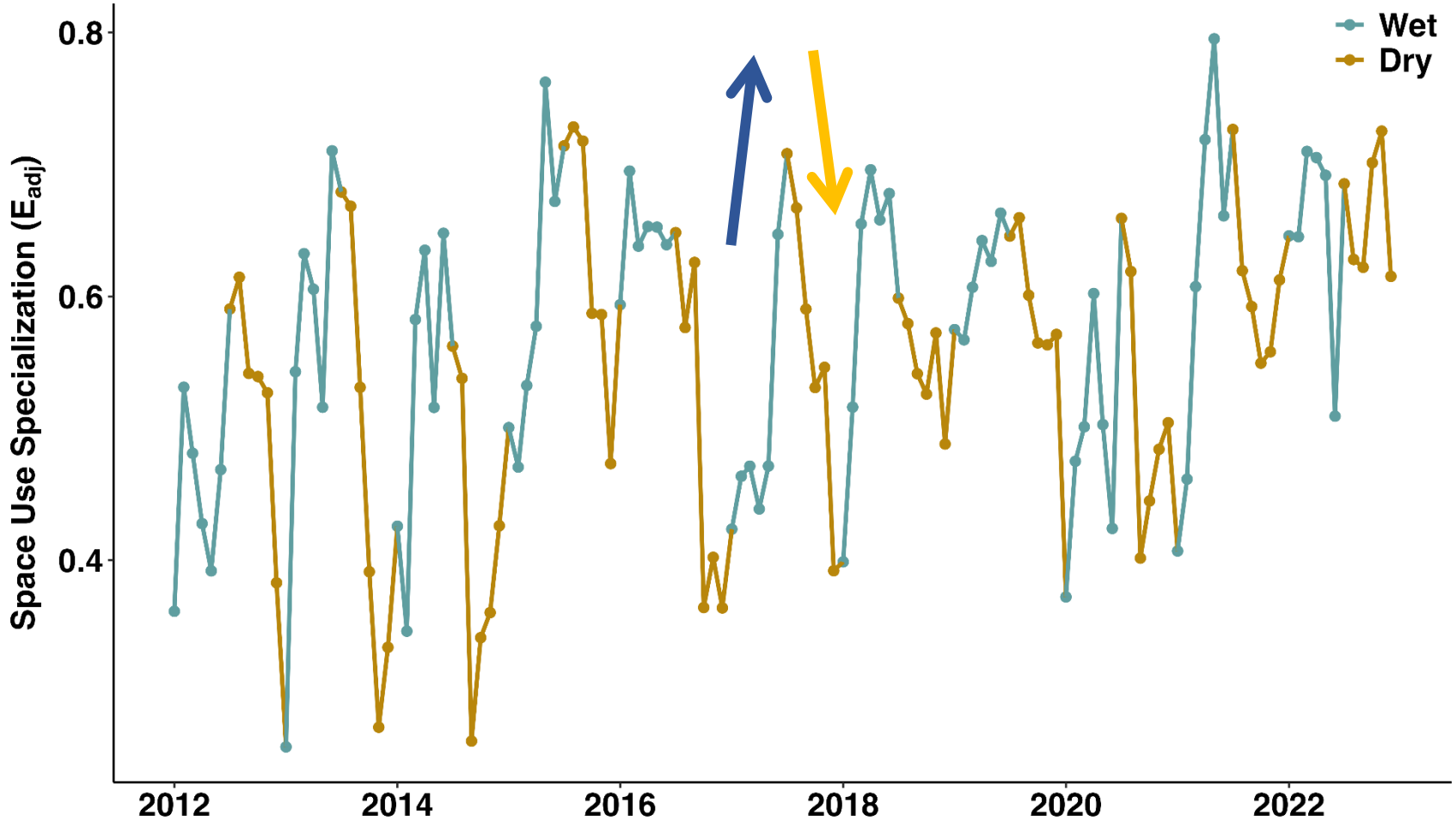


Approach: E Index

Overlap in resource use
Zaccarelli et al. 2014 Methods in Ecol & Evol

- Resources = detections across **12 zones** in monthly time steps
- Used GAMS to compared **monthly E's** over yr/seasons & related to **flows** (**marsh stage & # days below 30 cm)**
- Compared Es (dry season) to population **niche size** with Pearson correlation

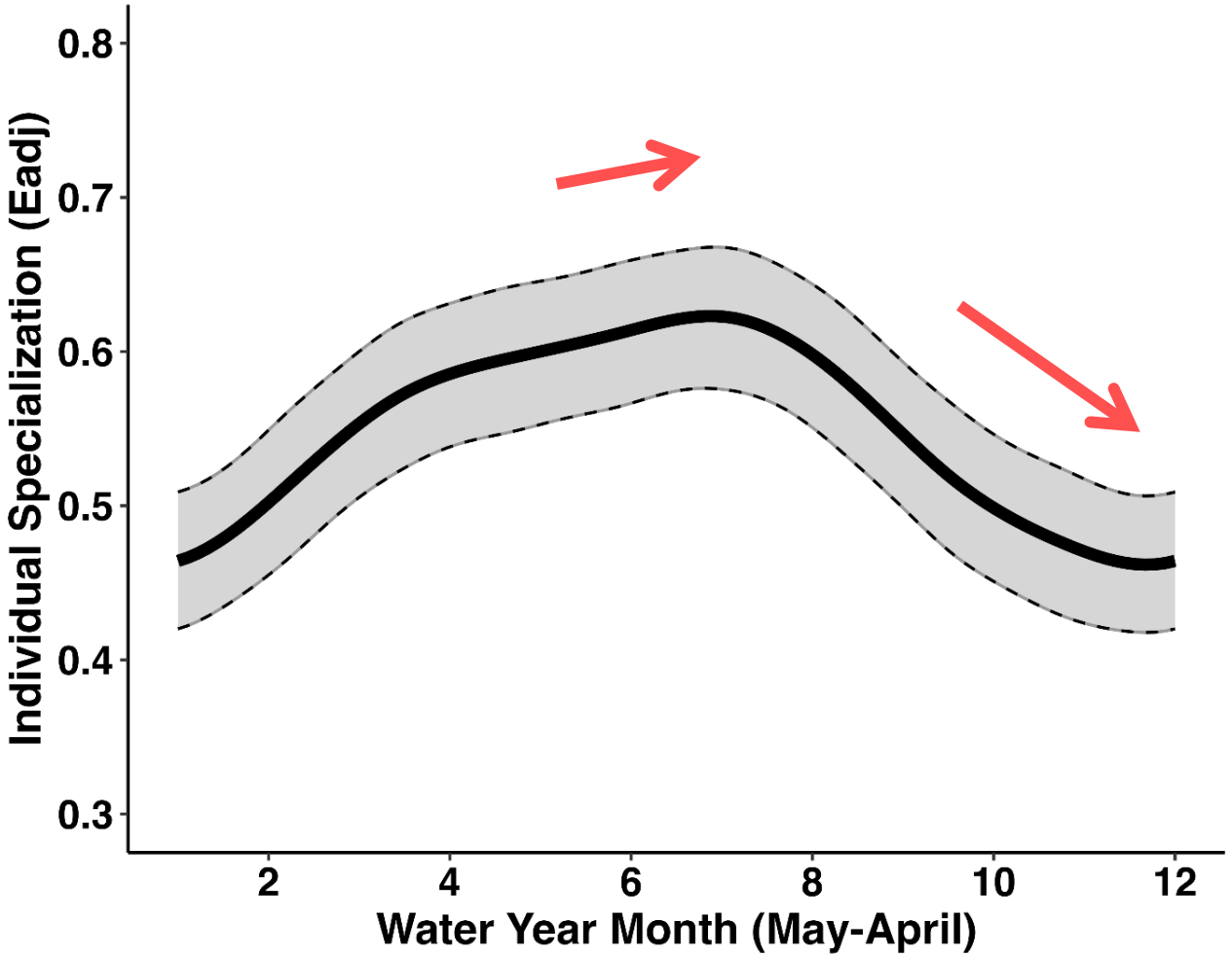
1) How much temporal variability in space use specialization?



Space use cycles:

Space use becomes specialized in wet season & then similar in dry season

1) How much temporal variability in space use specialization?

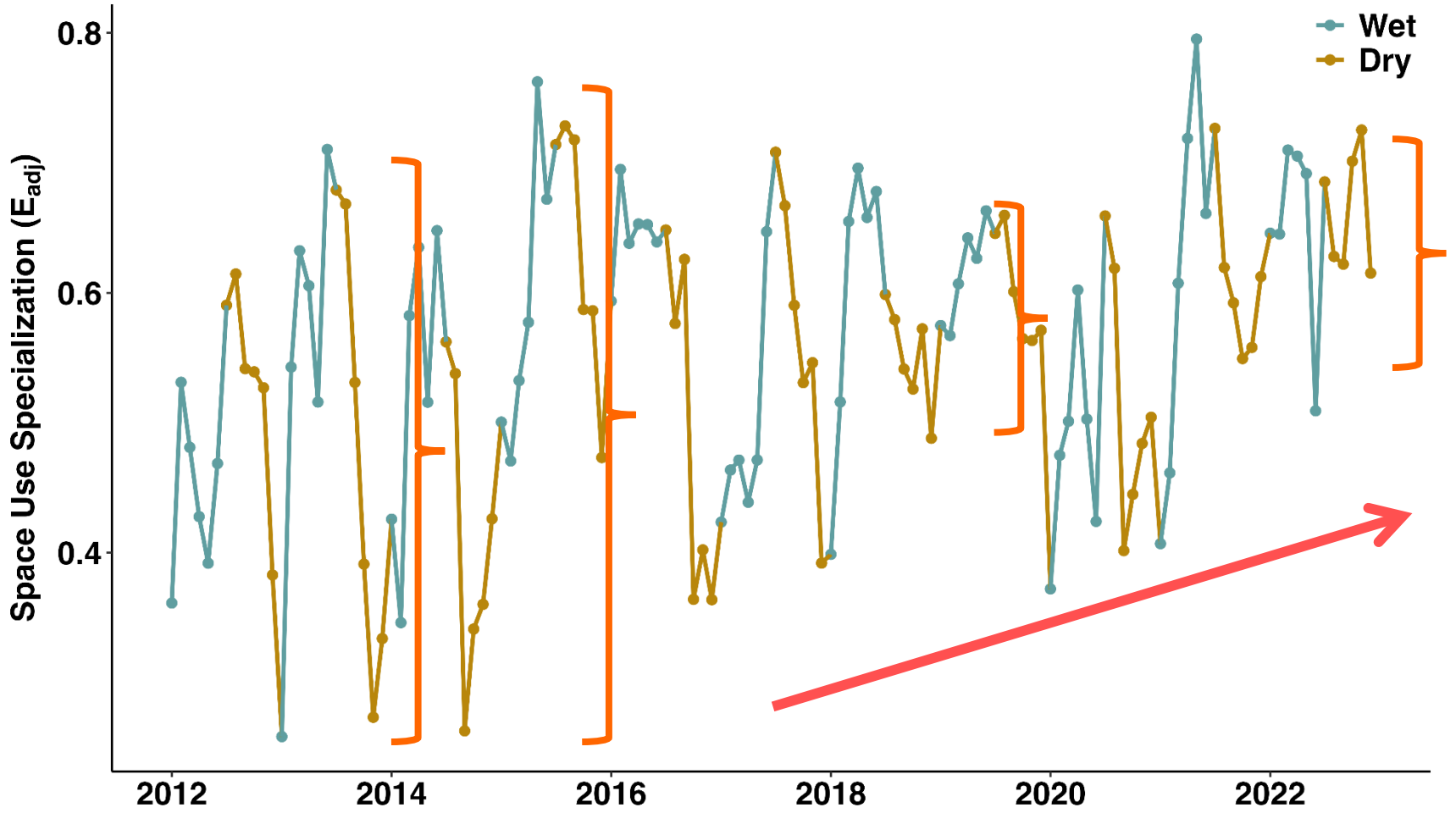


GAM: month + year smoother
- 50% of deviance

Specialization peaks in Nov-Dec

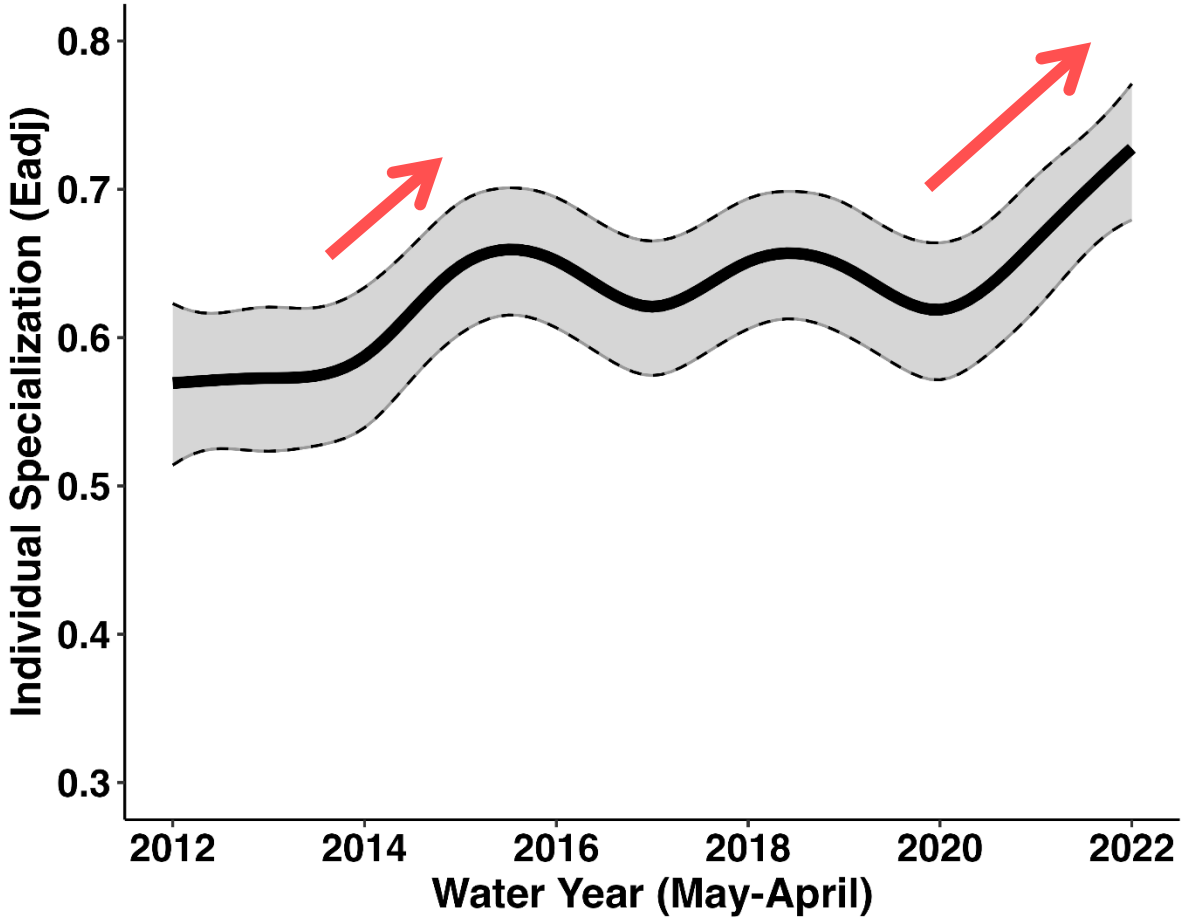
Similarity in space use is highest in Mar-Apr

1) How much temporal variability in space use specialization?



Degree of cycling between wet & dry varies across years

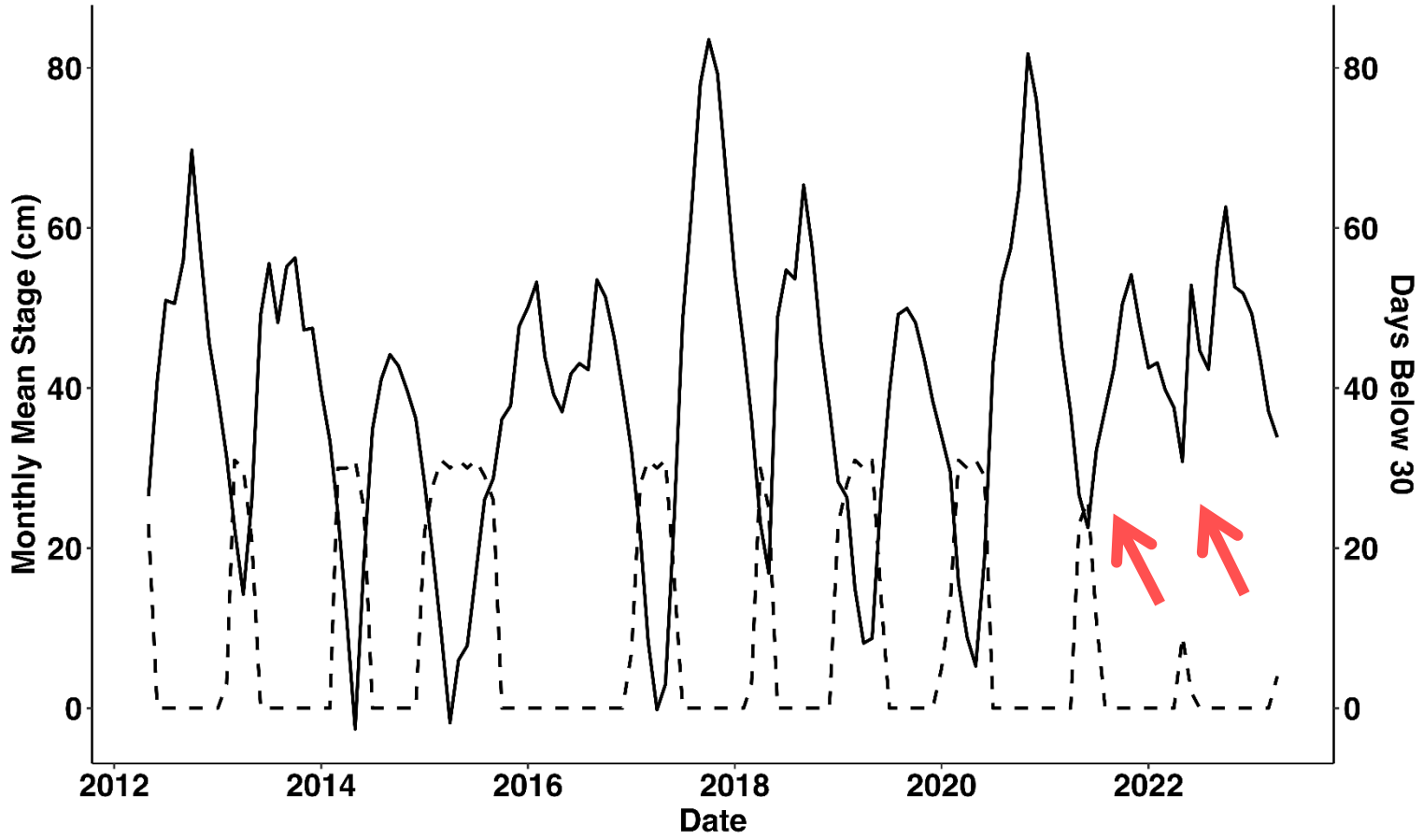
1) How much temporal variability in space use specialization?



Stability followed by increases

Recent years: highest specialization in 12 yrs

1) How much temporal variability in space use specialization?

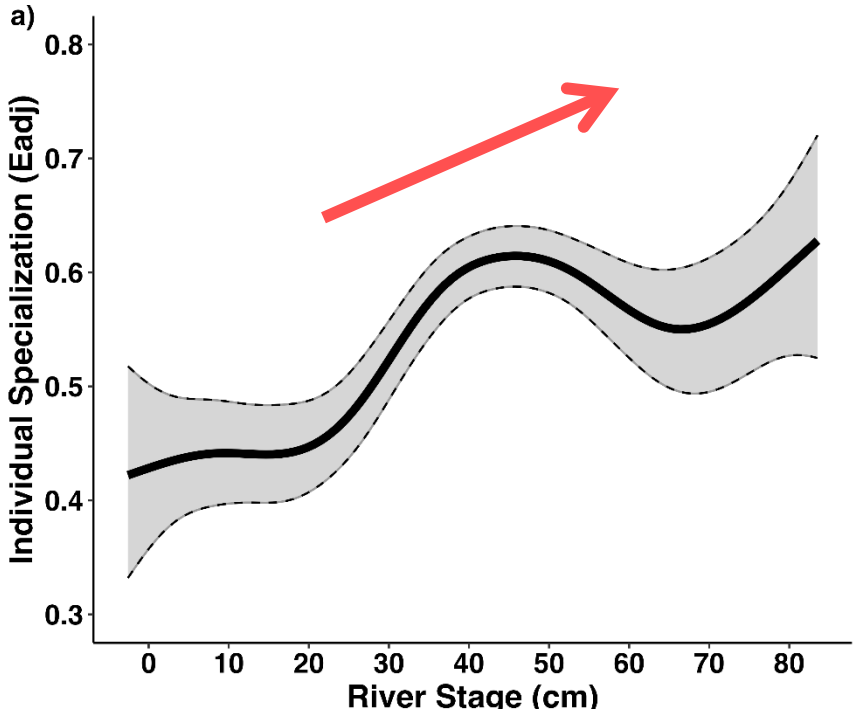


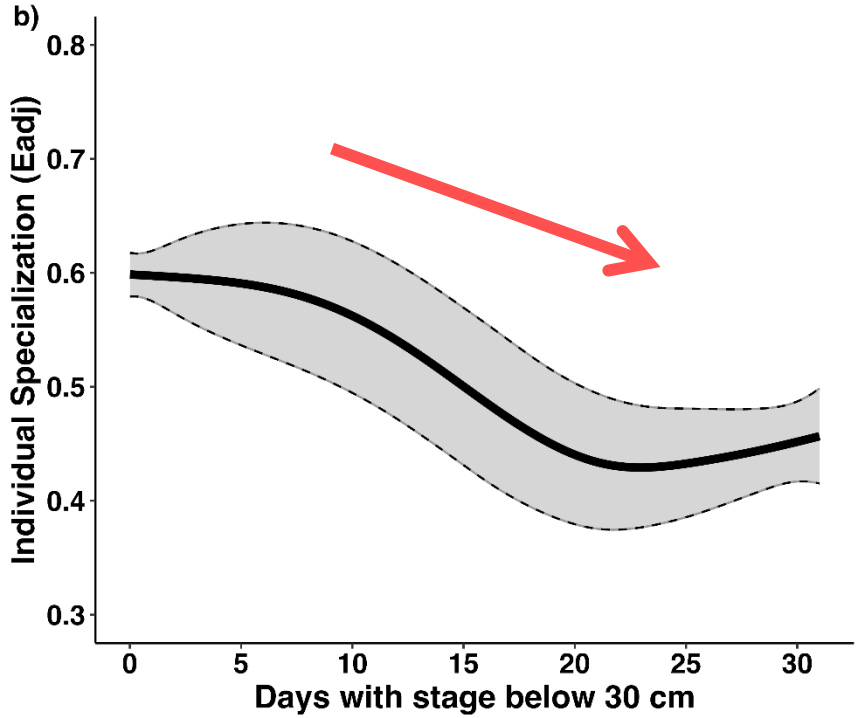
Recent years:
wettest dry seasons
in 12 yrs

➔ Lack of marsh dry down

➔ Low prey concentration

2) How does hydrology affect specialization?

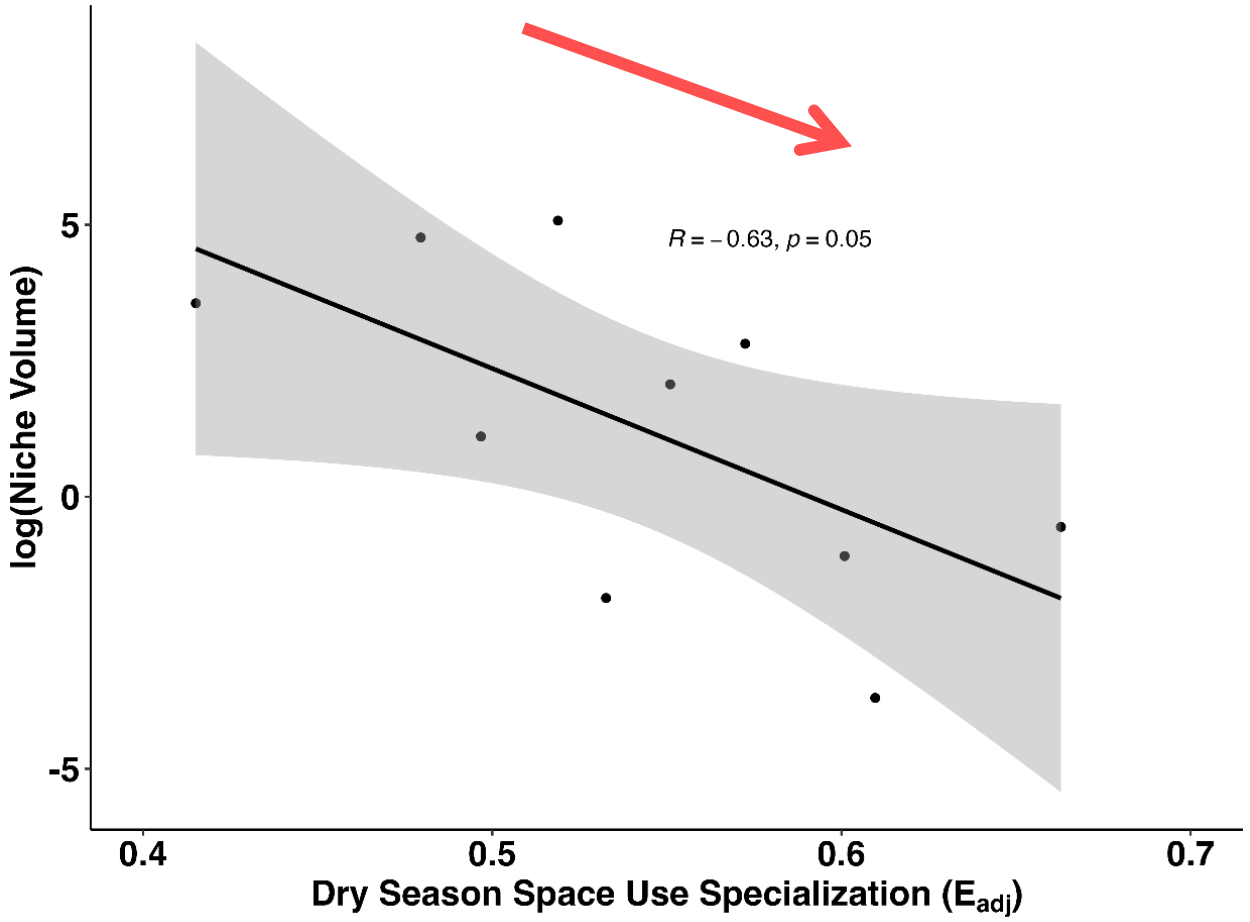




37.6% of deviance
Nonlinear increase:
Space use is more specialize at high stages

35.7% of deviance
Nonlinear decrease:
At 10-20 days, specialization decreases & similarity increases -> aggregation

3) Is trophic niche size associated with specialized space use?



In dry seasons when specialization is low & snook are aggregated
–> population trophic niches are large

Counter our hypothesis
-> Mix of resident vs migrant snook?

Competition?

As snook move….

Aggregate in dry season & disperse in riverscape in wet season

Wet years -> more dispersion & less aggregation

As they aggregate -> rely on more diverse food sources

As snook move….

Aggregate in dry season & disperse in riverscape in wet season

Wet years -> more dispersion & less aggregation

As they aggregate -> rely on more diverse food sources

Most often, we track populations ‘means’

But intraspecific variation (phenology in distribution) is also responsive to hydrology & restoration

We are hiring!

scientific reports

2025

OPEN

Cause and consequences of Common Snook (*Centropomus undecimalis*) space use specialization in a subtropical riverscape

Rolando O. Santos[1,2]✉, Mack White[3], W. Ryan James[1,2,3], Natasha M. Viadero[4], Jordan A. Massie[5], Ross E. Boucek[6] & Jennifer S. Rehage[2,3]

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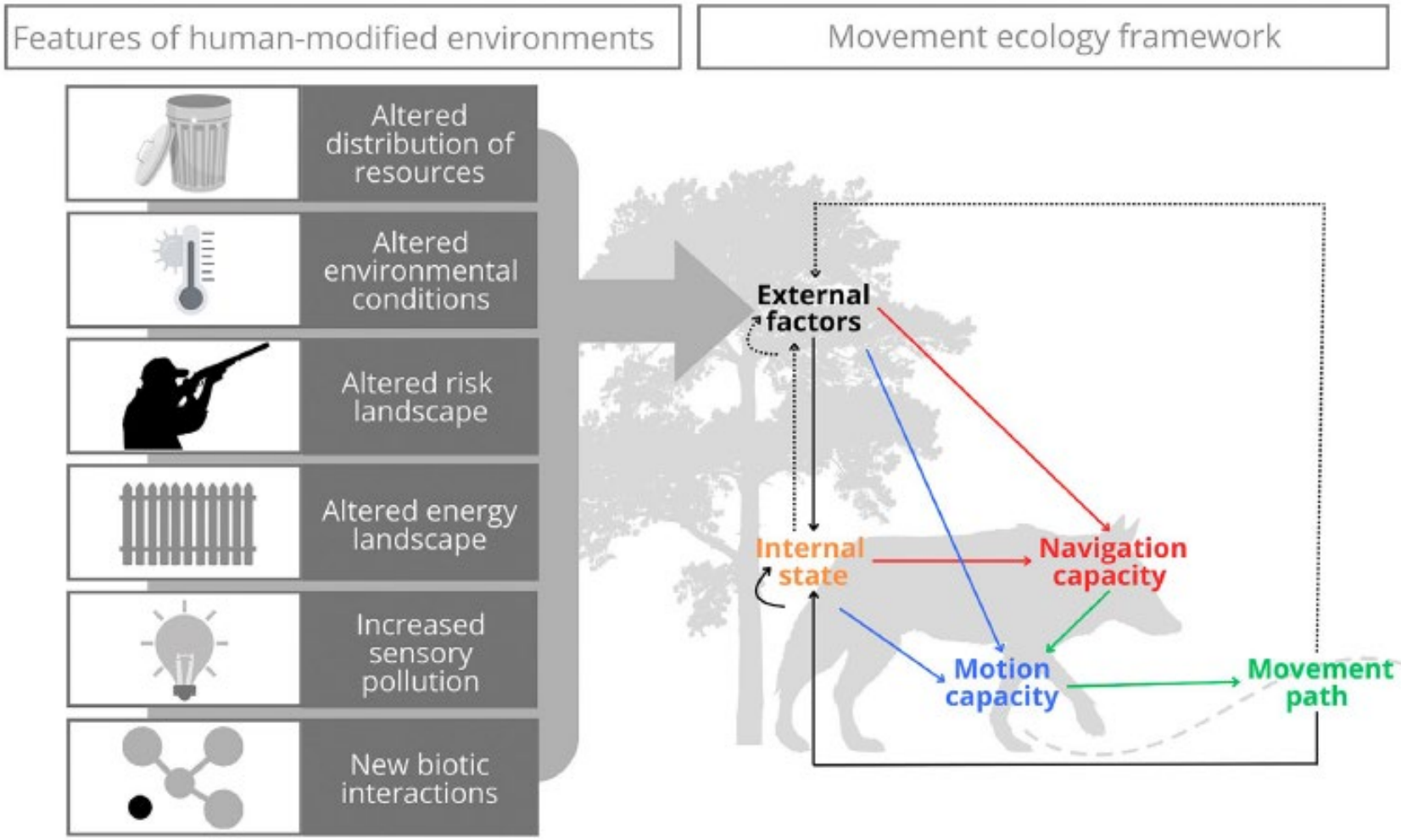
Availability & predictability of resources is changing..



Gomez et al. 2025 JAE