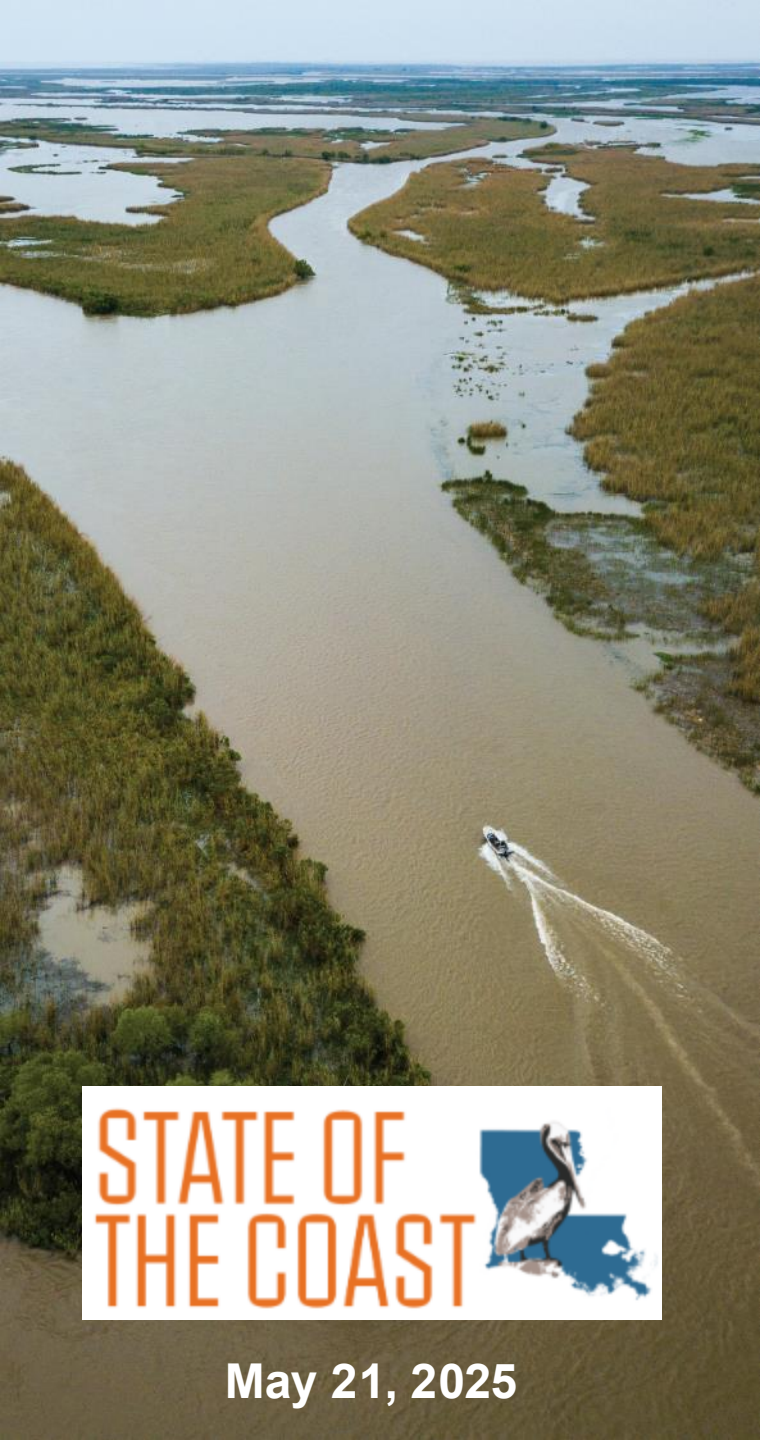

THE WATER INSTITUTE

ASSESSING THE LOCALIZED IMPACT OF COASTAL RESTORATION ON ESTUARINE NEKTON IN LOUISIANA

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5/14/2025

ACKNOWLEDGEMENTS

Thanks to many colleagues for their help with this project, including those from:

- **CPRA**: Darin Lee
- **USGS**: Brady Couvillion, Gregg Snedden
- **NOAA**: Ian Zink, Jennifer Doerr, Jennifer Leo, Melissa Carle, David Reeves, Steve Giordano, Craig Gothreaux, Dawn Davis, Donna Rogers, Patrick Williams
- **LDWF**: Brady Carter, Troy Sehlinger, Willie Cheramie, Roy Moffet, Konner Lockfield
- **Dynamic Solutions**: Shaye Sable
- **LSU**: Steve Midway
- **The Water Institute**: Erin Kiskaddon, Shawn Doyle, Harris Bienn, Jean Cowan, Tim Carruthers, Emelia Marshall

Funded by:

- Louisiana Trustee Implementation Group (LA TIG). DIVER Portal Project ID#: 299

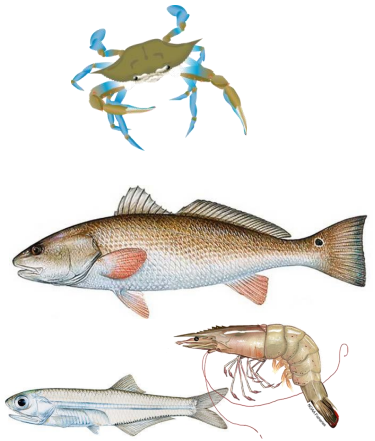
HOW WE GOT HERE

- The Louisiana Trustee Implementation Group (LA TIG) is looking for **quantitative targets and benchmarks** that will allow resource managers to better understand and evaluate how marsh habitat restoration provides **benefits** to local nekton

Example: NOAA's Large-Scale Upper Barataria Marsh Restoration Project

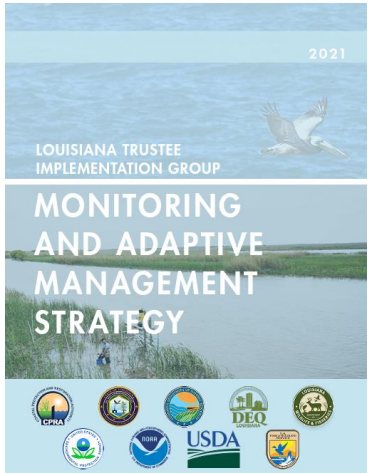
More nekton?

=



mobile fish and invertebrates that actively swim or utilize the water column

SMART objectives



Assist with creating, tracking, and assessing achievement of short- and long-term goals

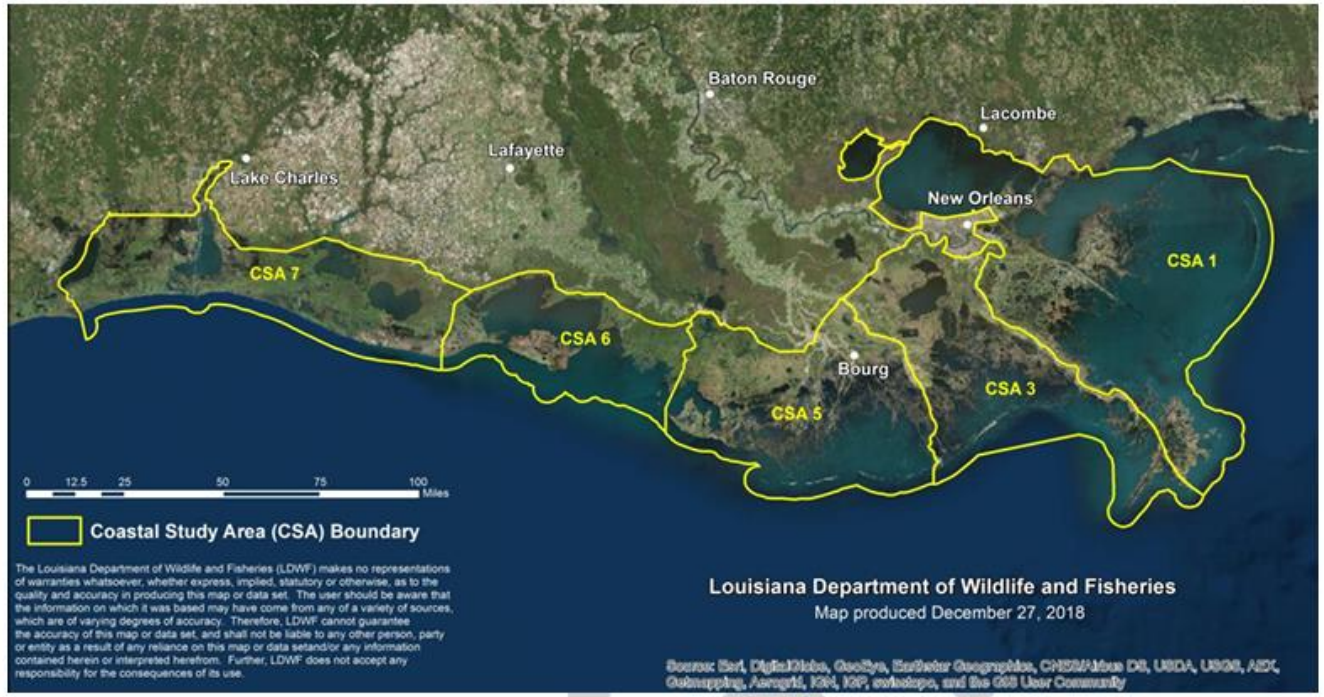
HOW WE GOT HERE

In 2023, Louisiana Trustees awarded a 6-year project to:

- **Support evaluation** of DWH restoration outcomes
- **Resolve critical information gaps** for better restoration planning and adaptive management
- Perform monitoring to **inform design and implementation** of future DWH restoration projects

- 2023-2024: Initial work to investigate the *potential* for using state fisheries independent monitoring data (FIMP – LDWF) to develop reference ranges and restoration targets in future project stages

https://gulfspillrestoration.noaa.gov/media/document/latig2023shellfishmaip1pdf



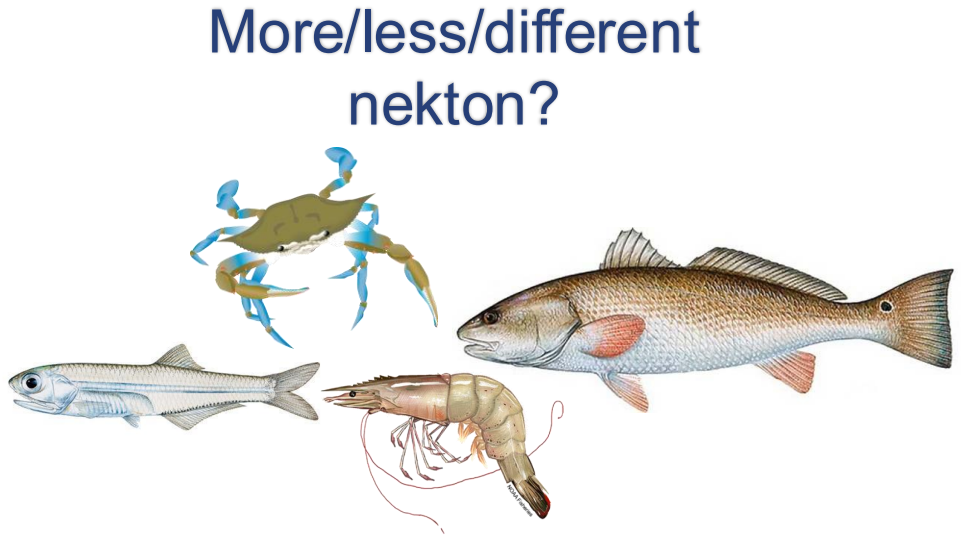
APPROACH

A team of 22 natural resource managers and scientists across federal and state government, academia, not-for-profit organizations, and private consultants tested the hypothesis:

Restoration projects have measurable effects on the relative abundance of estuarine nekton and community composition

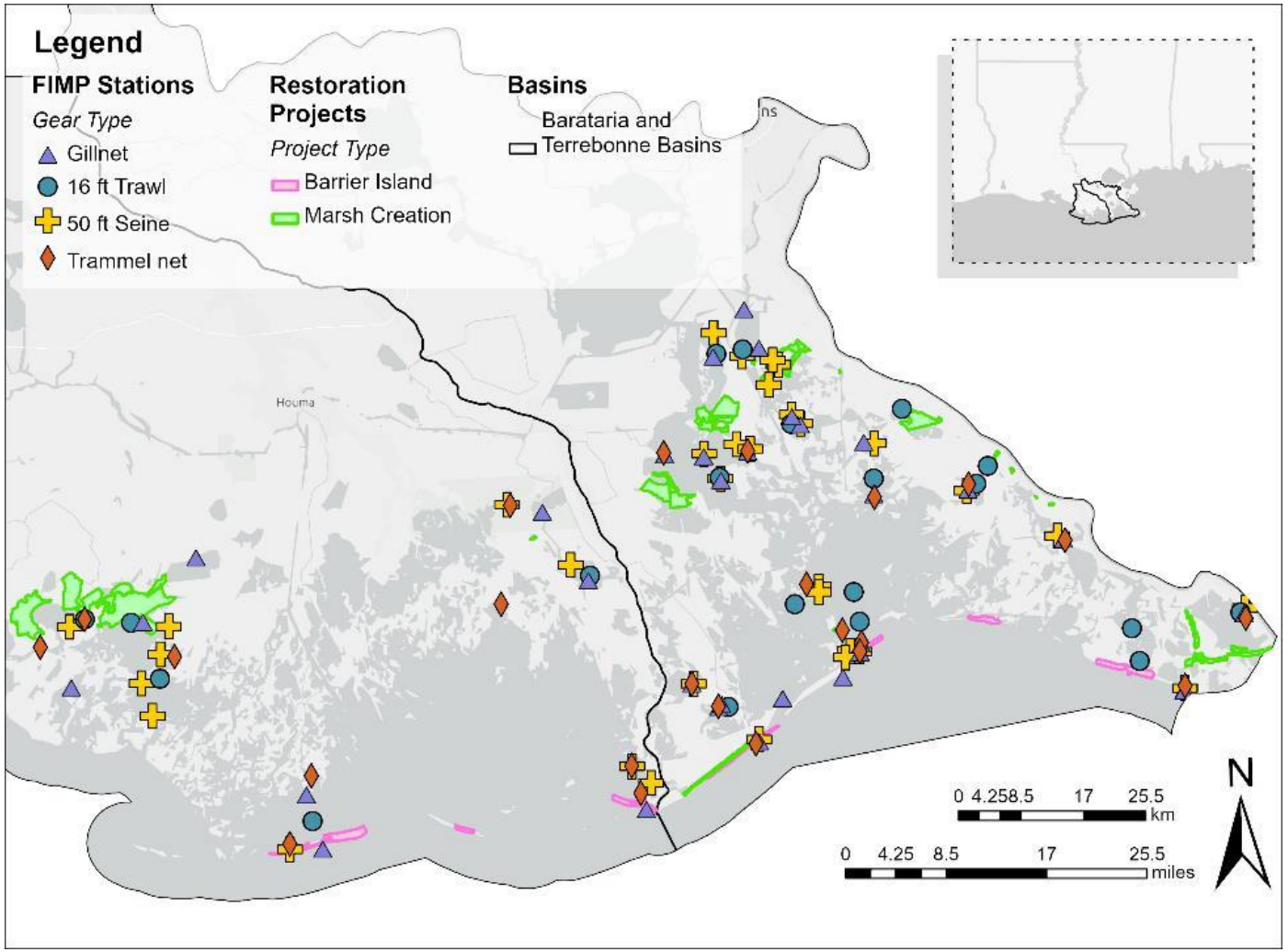
Example: NOAA's Large-Scale Upper Barataria Marsh Restoration Project

=



APPROACH

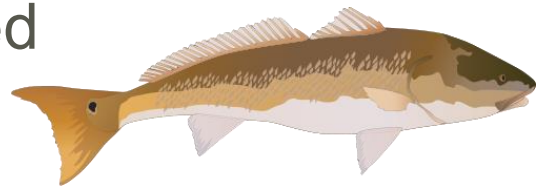
- **17 years of FIMP data** (2005-2022) from 144 stations
- FIMP stations were located **within 10 km** of select restoration projects
- **21 restoration projects** were used, ranging from 0 to over 15 years post-completion
- **Sites were in intermediate/brackish to saline wetlands** within Terrebonne and Barataria Basins



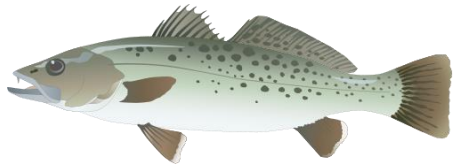
Kiskaddon et al., *in prep*

APPROACH

- Abundance of **18 nekton taxa** (catch per unit effort; CPUE) and two community composition indices (**Species Richness** and **Shannon-Weiner Diversity**) were evaluated



- FIMP **size data** were used to identify the most efficient gear types for different life stages, where appropriate



Target Taxa

- **Blue Crab** – seine, trawl
- **White Shrimp** – seine, trawl
- **Brown Shrimp** – seine, trawl
- **Grass Shrimp** – seine, trawl
- **Red Drum** – seine, gill, trammel
- **Black Drum** – seine, gill, trammel
- **Atlantic Croaker** – trawl, seine, gill
- **Spotted Seatrout** – seine, gill
- **Spot** – trawl, seine, gill
- **Sheepshead** – trammel
- **Largemouth Bass** – seine
- **Pinfish** – seine, trawl
- **Bay Whiff** – seine, trawl
- **Hogchoker** – seine, trawl
- **Blackcheek Tonguefish** – seine, trawl
- **Bay Anchovy** – seine, trawl
- **Gulf Menhaden** – seine, gill
- **Mullet** – seine, gill, trammel

- **Species Richness** – seine, trawl, trammel, gill
- **Shannon Diversity** – seine, trawl, trammel, gill

Kiskaddon et al., *in prep*

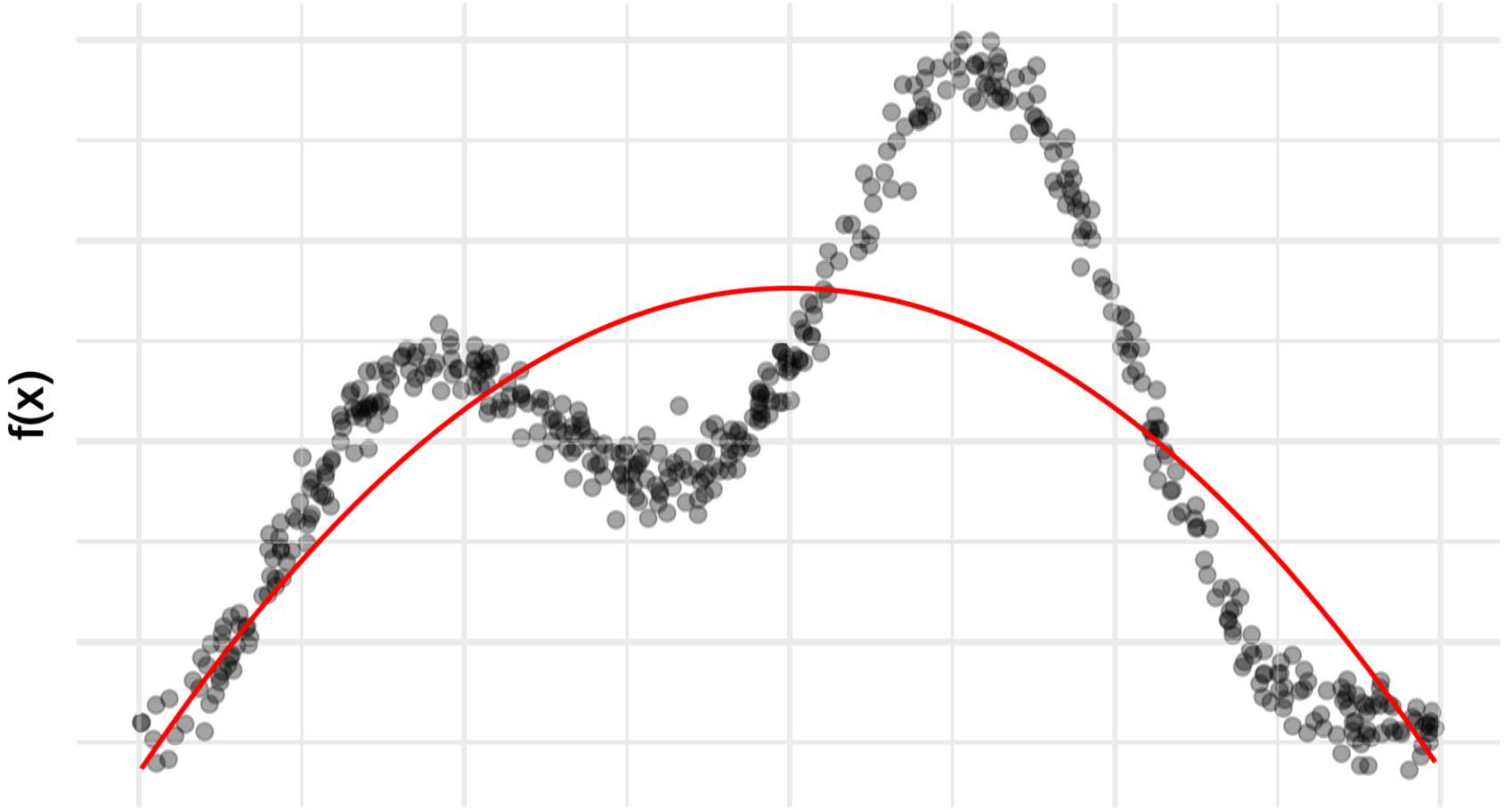
DATA ANALYSIS

- Nekton populations often exhibit **complex relationships** that traditional empirical modeling approaches may not adequately capture
  - Non-linear temperature and salinity associations
  - Periodic seasonal cycles
  - Spatial hotspots and/or gradients of nekton populations
  - Non-normal error distributions
- Generalized additive models (GAMs) allow nekton relationships to be modeled directly using smooth functions (splines) without requiring us to pre-specify the exact functional form
  - Smooth functions are constructed by adding up several little functions (basis functions)
  - The “wiggliness” is penalized to avoid overfitting

TRADE-OFFS IN MODEL BUILDING

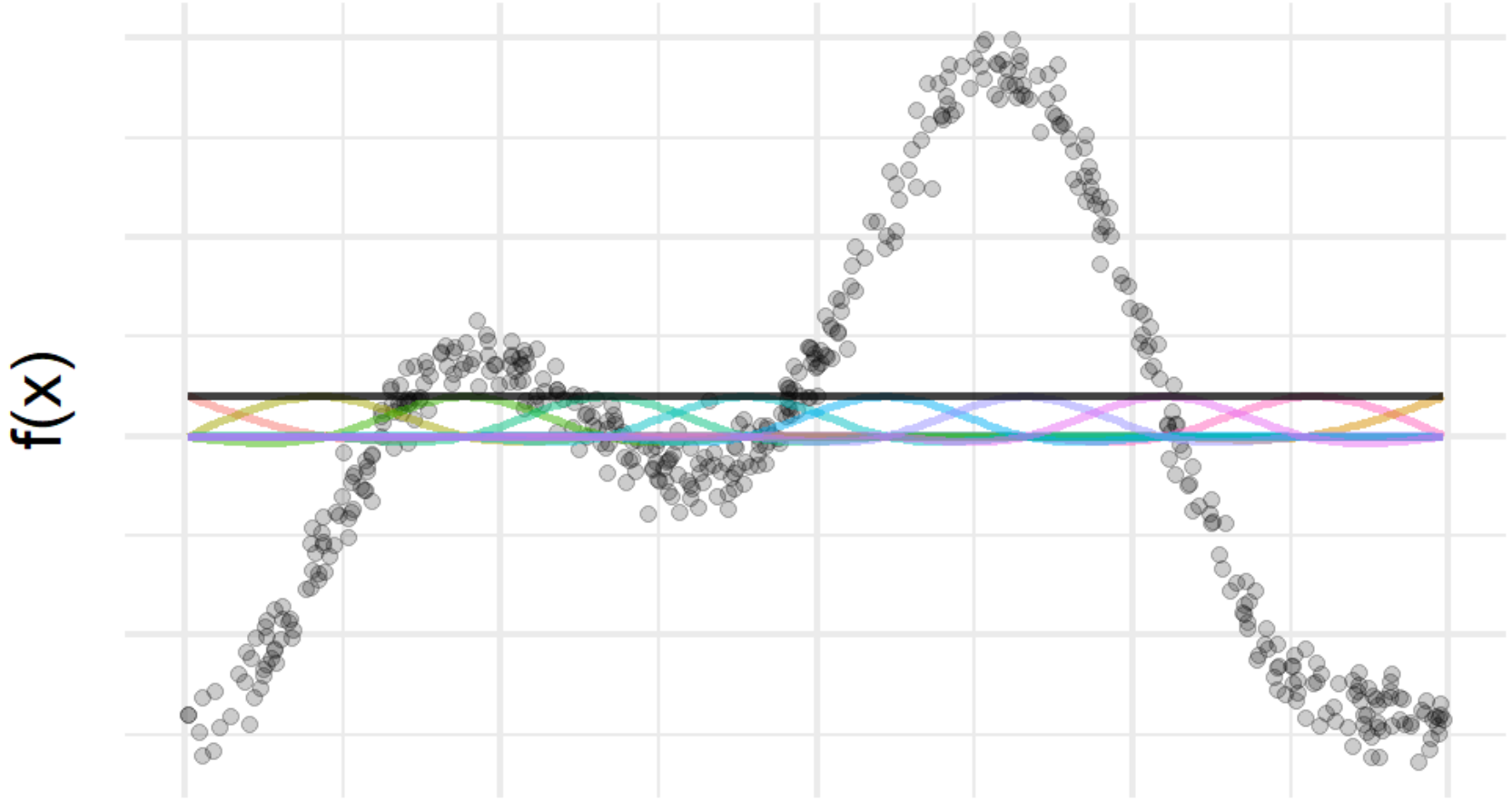
Graphic credit: Noam Ross

ORDINARY LEAST SQUARES REGRESSION



Linear models have high interpretability, but are not very flexible

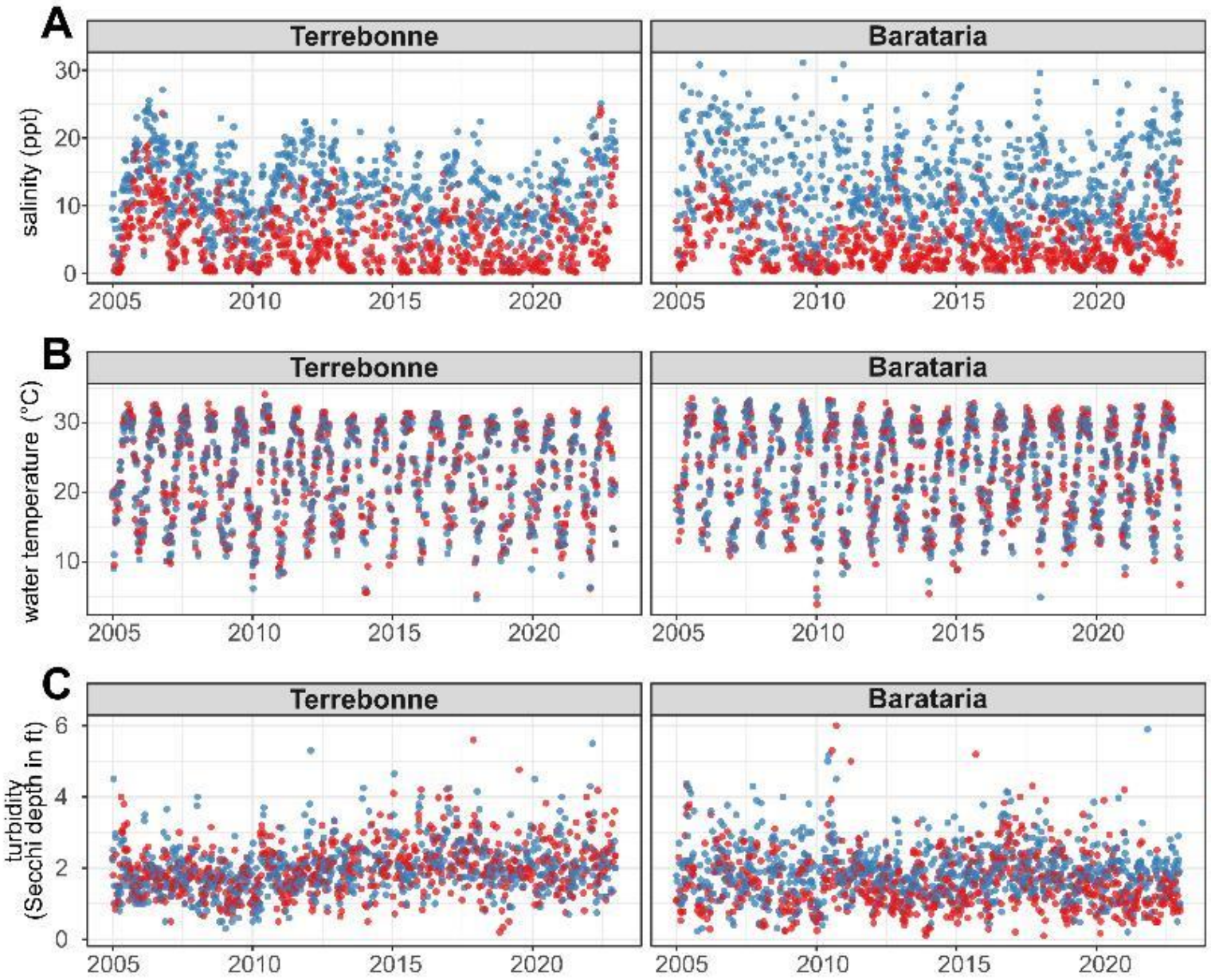
GENERALIZED ADDITIVE MODELS



GAMs create flexible smooth fits that are constructed from many smaller functions

MODEL INPUTS

- Nekton-habitat relationships explored with **water quality**:
  - Water temperature (°C)
  - Salinity (ppt)
  - Turbidity (ft)



Intermediate/Brackish Saline

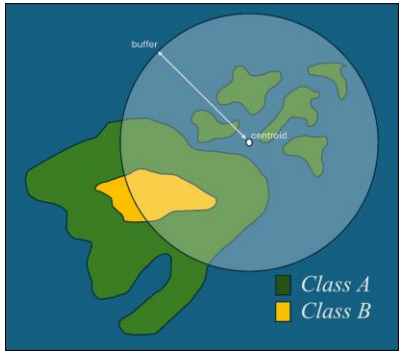
Kiskaddon et al., *in prep*

MODEL INPUTS

…and habitat fragmentation

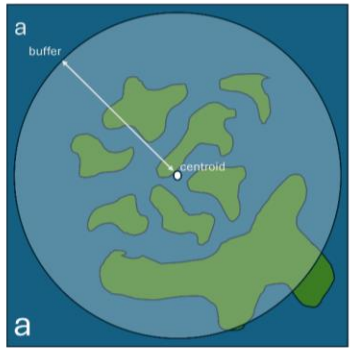
- Median patch area of wetland habitat
- Aggregation of wetland habitat
- Mean fractal dimension of wetland habitat
- Connectedness of water habitat

Wetland Patch Area

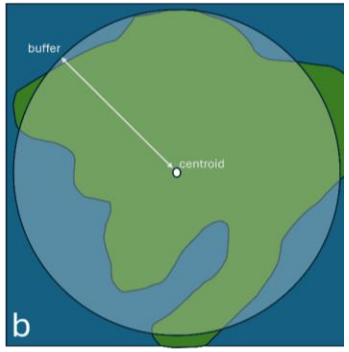


Wetland Patch Aggregation

Low

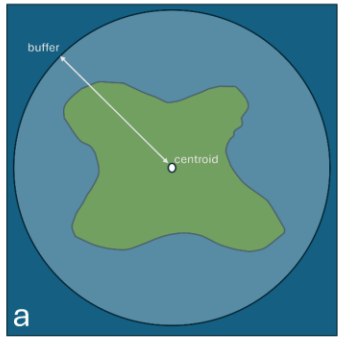


High



Wetland Fractal Dimension

Low



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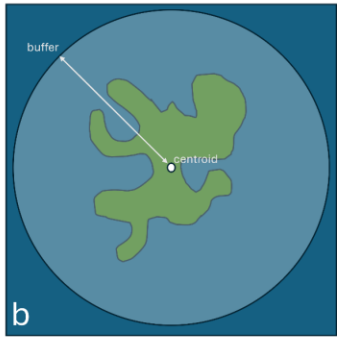
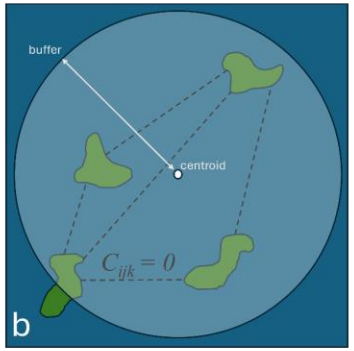


Connectedness

Low



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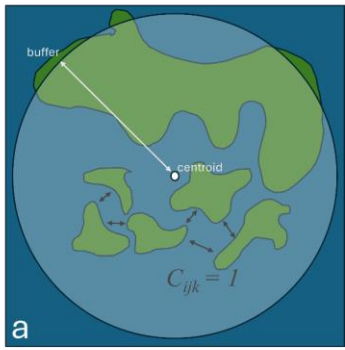


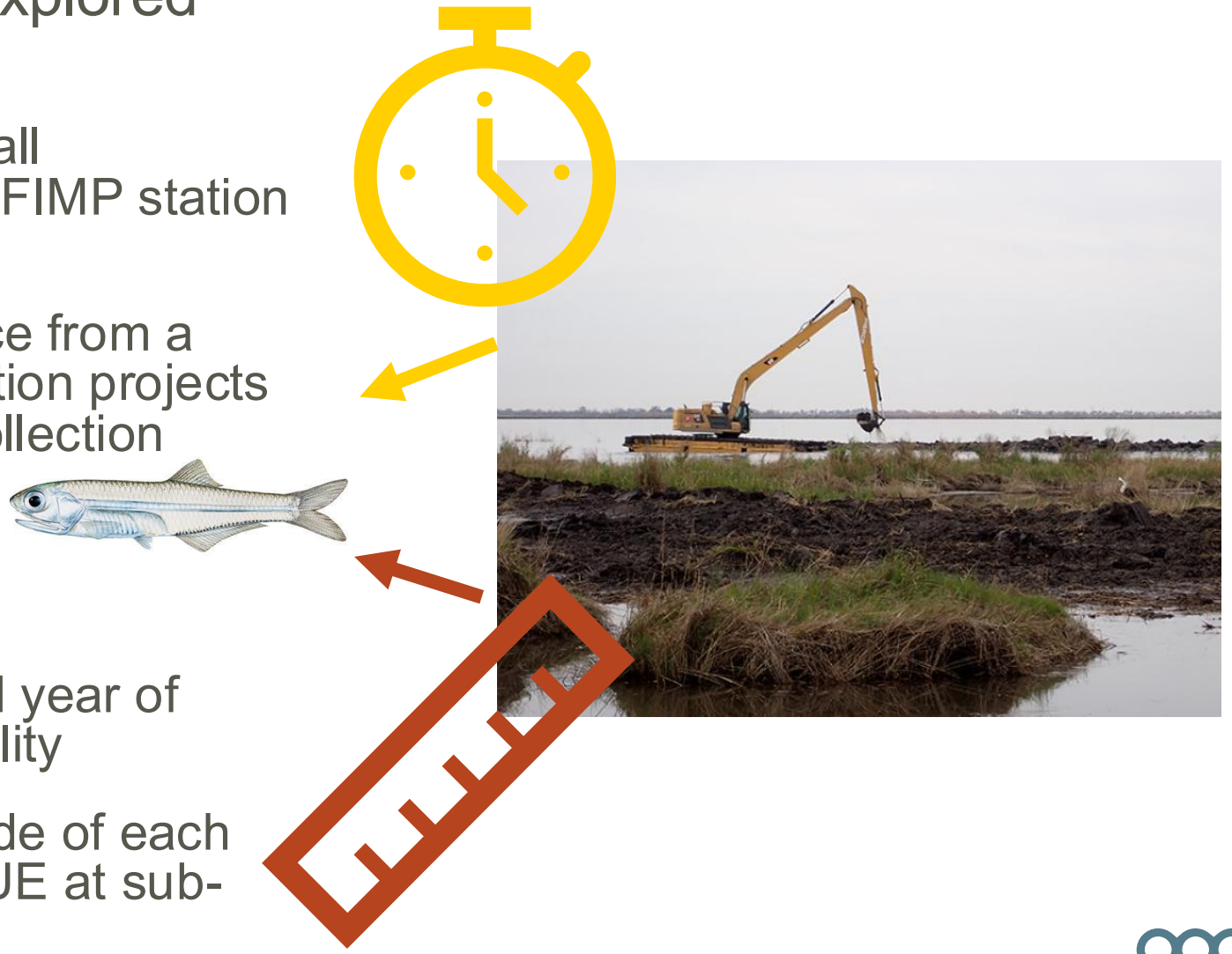
calculated annually in circles with 1km and 5km radiuses that were centered on each FIMP station

Kiskaddon et al., *in prep*

MODEL INPUTS

Restoration effects on nekton explored with:

- Time since restoration: mean age of all completed projects within 10 km of a FIMP station at the year of sample collection
- Distance to restoration: mean distance from a FIMP station to all completed restoration projects within 10 km at the year of sample collection



Additional predictors included…

- **Time** included as both the month and year of sample collection to capture seasonality
- **Location** included as latitude/longitude of each sample to account of variation in CPUE at sub-basin spatial scales

Kiskaddon et al., *in prep*

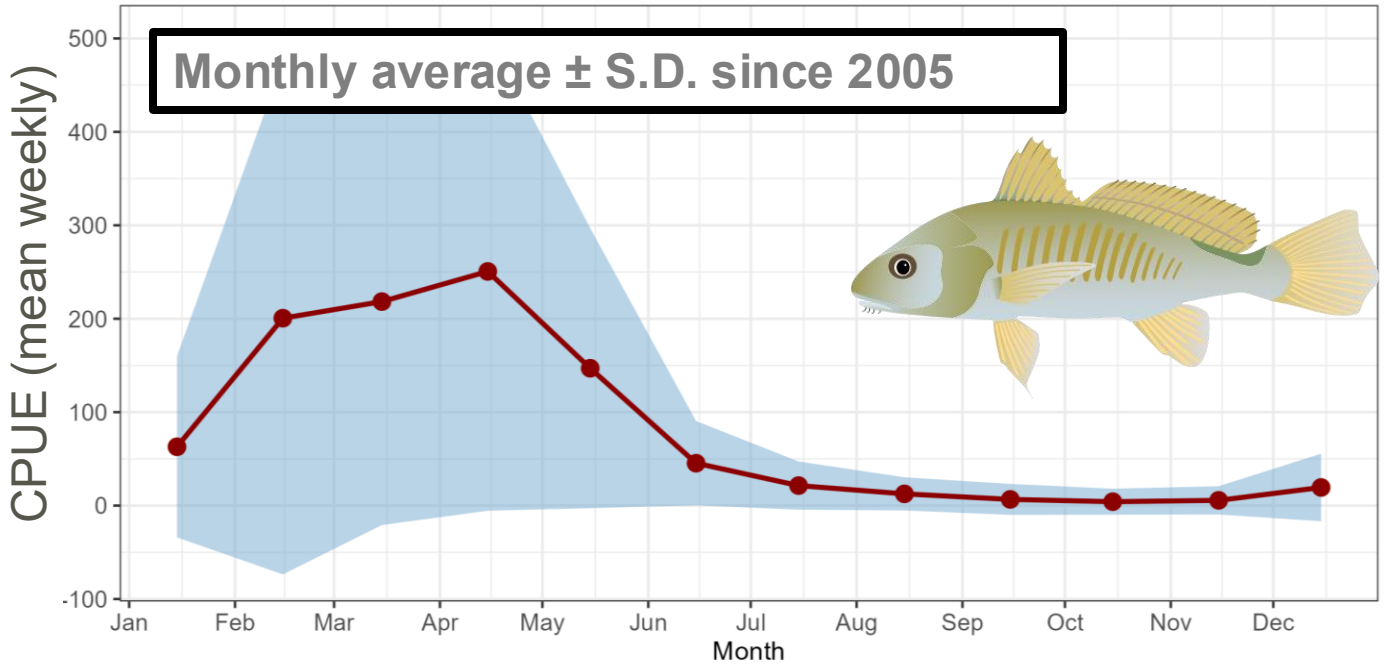
RESULTS: SEASONAL AND INTERANNUAL VARIATION EXPLAINED THE MAJORITY OF THE VARIATION IN CPUE

- 102 models were developed and evaluated on full datasets
- **40 models** explained >40% deviance and contained at least one significant restoration effect parameter

- For all models, **Time (month, year)** explained the greatest proportion of CPUE variance
- Variance explained by restoration and fragmentation ranged from 0-7%

Example of clear seasonal pulses in CPUE

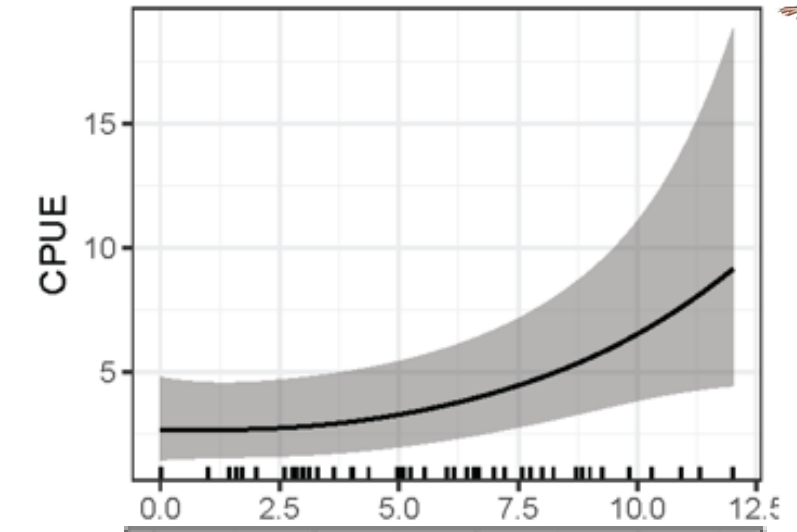
Juvenile Atlantic Croaker collected by 16 ft trawls in Terrebonne

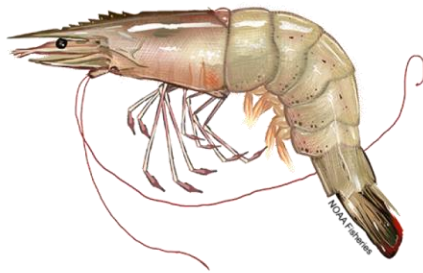


Kiskaddon et al., *in prep*

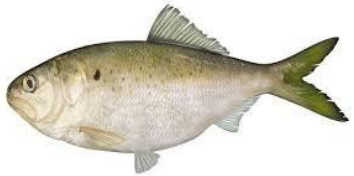
RESULTS: SIGNIFICANT EFFECT OF TIME SINCE RESTORATION

- 25 models contained significant **time since restoration** predictors
- 60% (mostly shrimp) indicated positive relationships between CPUE and increasing time post-restoration
- 36% (range of fish taxa) were characterized by the opposite trend, with lower abundances observed over time post-construction





Juvenile Brown Shrimp collected by 16 ft trawls in Barataria

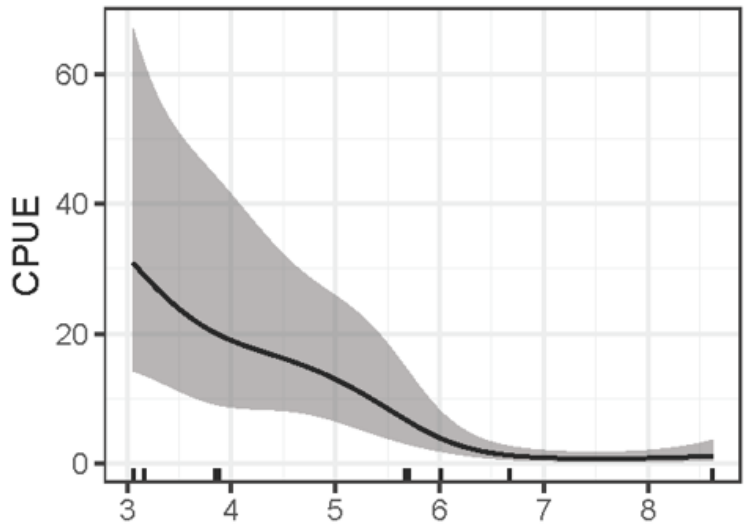


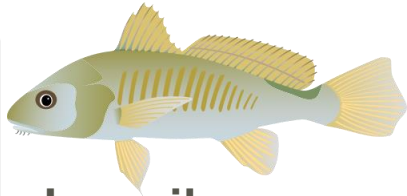
Juvenile Gulf Menhaden collected by seines in Terrebonne

Kiskaddon et al., *in prep*

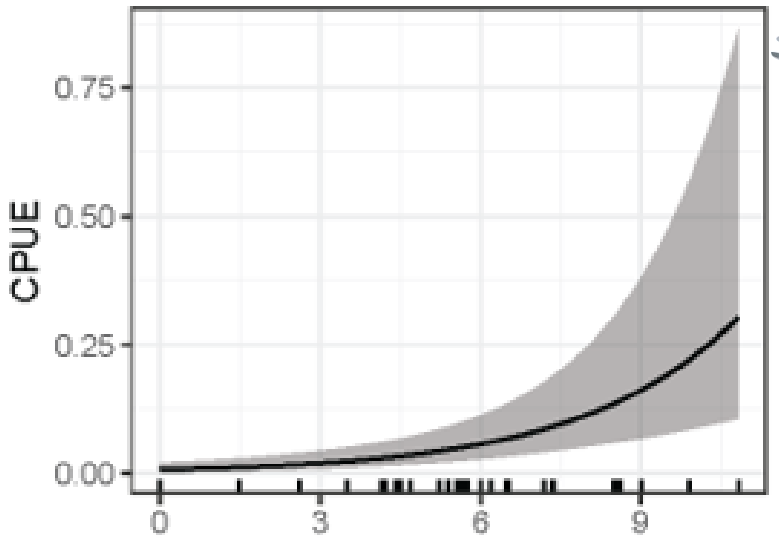
RESULTS: SIGNIFICANT EFFECT OF RESTORATION DISTANCE

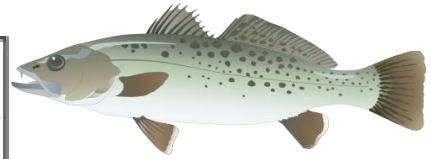
- 27 models contained significant **distance to restoration** predictors
- 44% of the models (range of fish taxa and species richness) exhibited increased CPUE when sampled closer to restoration projects
- 52% of the models (mostly shrimp and flatfish) were characterized by the opposite trend: populations were more abundant when sampling further from a restoration project.





Juvenile Atlantic Croaker collected by seines in Terrebonne





Juvenile Spotted Seatrout collected by seines in Barataria

Average Distance (km) from Restoration

CONCLUSIONS

H: Restoration projects have measurable effects on the relative abundance of estuarine nekton and community composition

- Yes, the effect of time since restoration and distance from restoration were detected using FIMP data; their effects were small relative to variation across years and seasons
- Relationships between nekton and abiotic variables varied widely by species, life stage, and geography; restoration effects on nekton are complex
- This analysis focused on main effects only, interactions between abiotic variables has potential to include deviance explained
- Potential indicator species including juvenile Brown Shrimp and Atlantic Croaker were identified from this analysis and may be appropriate for setting reference ranges and restoration targets

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THANK YOU

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