The use of eDNA in comparison to trawl and historical catch data for assessing marine finfish in Matagorda Bay, Texas

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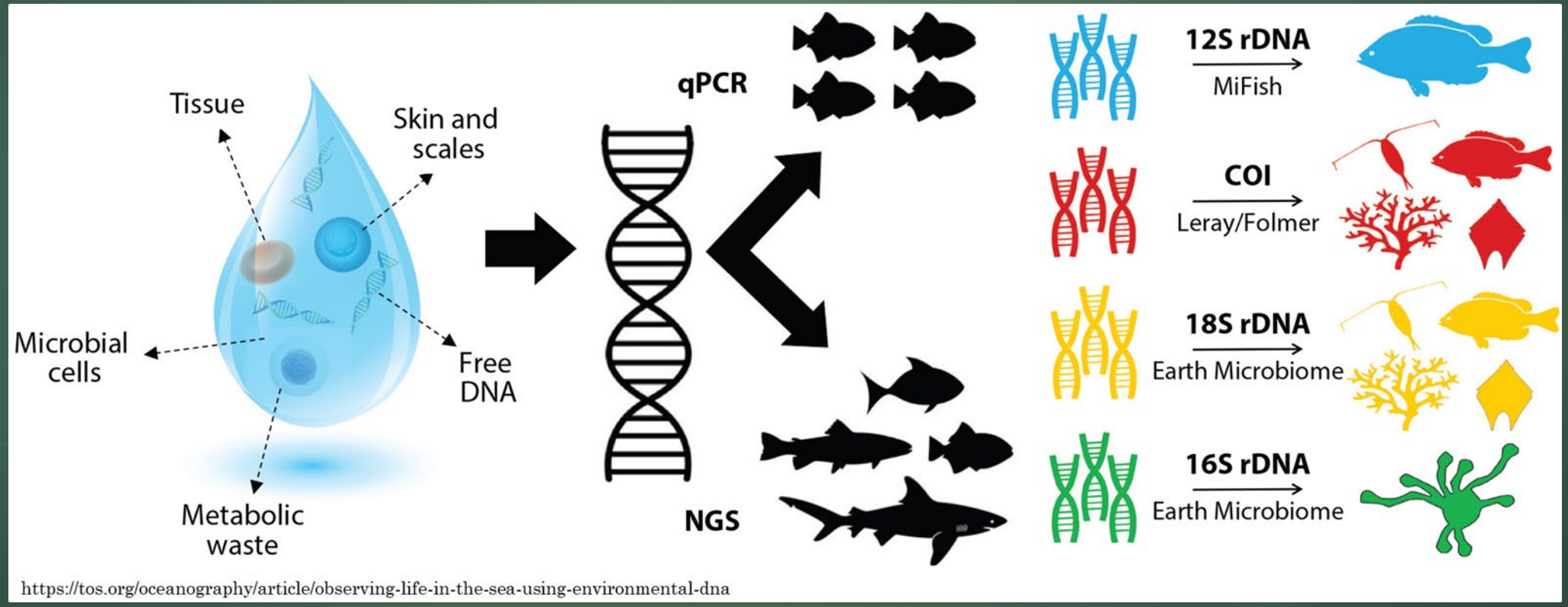
TEXAS PARKS & WILDLIFE

Environmental DNA (eDNA)

- An emerging tool for studies of presence and abundance of aquatic organisms
- minimally invasive methodology (water sampling)

Environmental DNA (eDNA)

- flexibility to accurately detect either
  - Single species specific
  - multi-species biodiversity in marine communities.
- Being deployed in the context of management worldwide



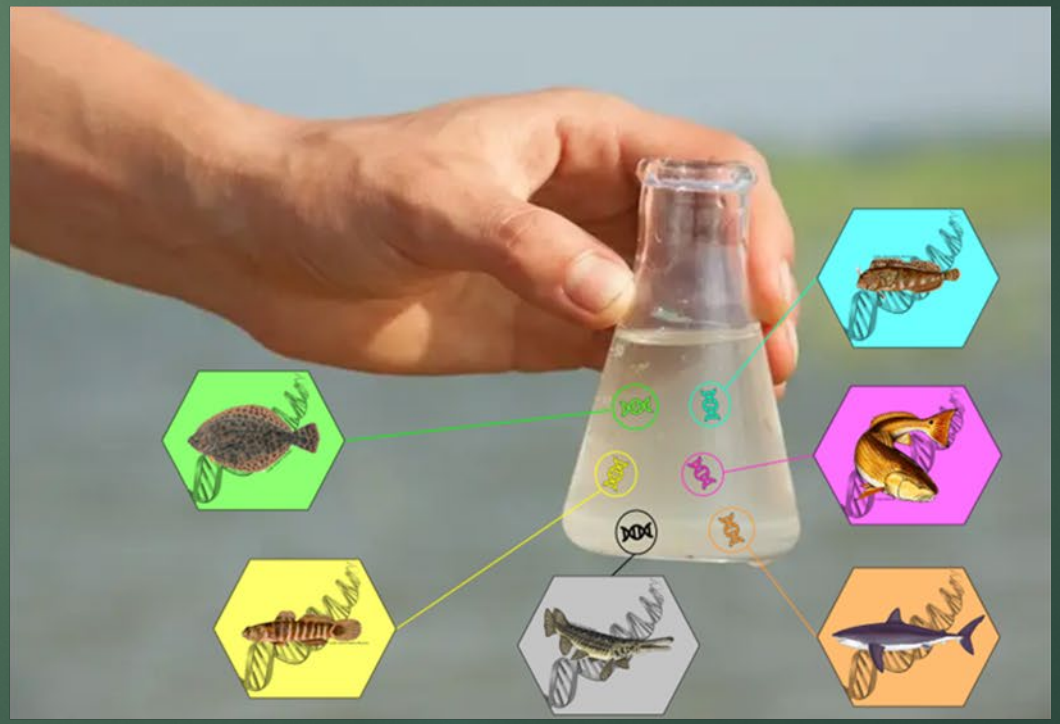
Texas Parks & Wildlife (TPWD)

- Texas Parks and Wildlife Department's (TPWD) extensive independent fisheries monitoring program
- Several sampling techniques that provides a comprehensive means of assessing finfish communities
  - Gill Nets
  - Bag Seines
  - Shrimp Trawls (Trawls)

Objective

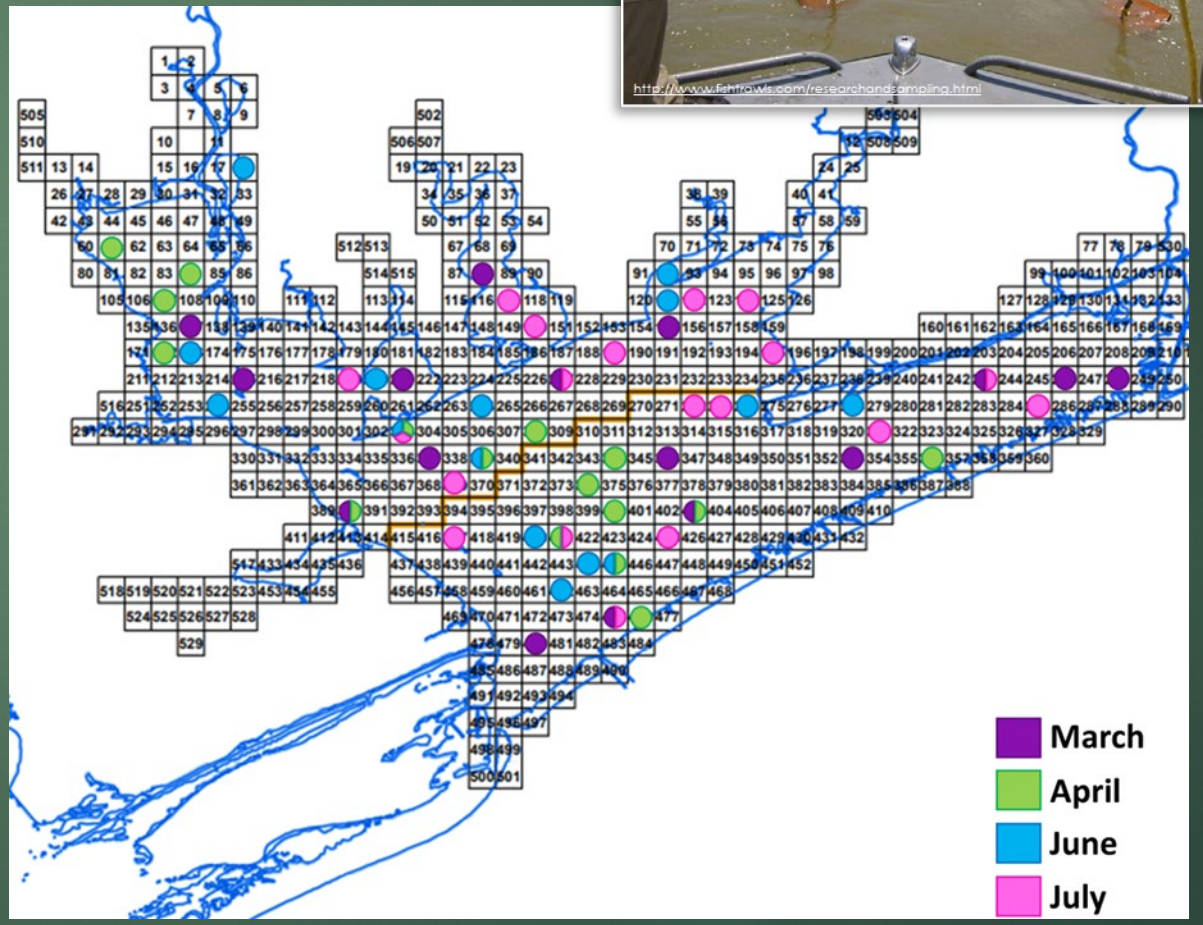
- Compare the fish community of Matagorda Bay as inferred by eDNA metabarcoding with a 47-year dataset of fishery-independent sampling conducted by TPWD in Matagorda Bay using bag seines, trawls, and gill nets.

TEXAS PARKS & WILDLIFE



Methods – Field Sampling 2023

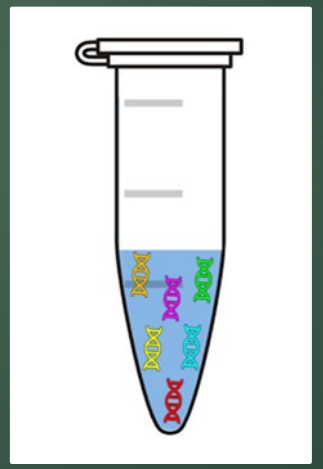
- Matagorda Bay
  - Randomized sampling
  - Aimed for 20 per month
- eDNA
  - 2 surface water samples per trawl
  - Taken before trawl was used
  - Placed on ice
- Trawls
  - Minimum depth of 1 meter
  - 10-minute tows
  - Towed in circular pattern
  - Worked up in field
- Historical data from TPWD's database
  - Gear – bag seines, trawls, and gill nets
  - Time – from 1975-2022 for the 4 months



Methods – Lab Processing

Filtration
Peristaltic Pump & Smith-Root eDNA glass filter pack

DNA Isolation
Qiagen PowerSoil Pro Kit &
Zymo PCR Inhibitor Removal Kit

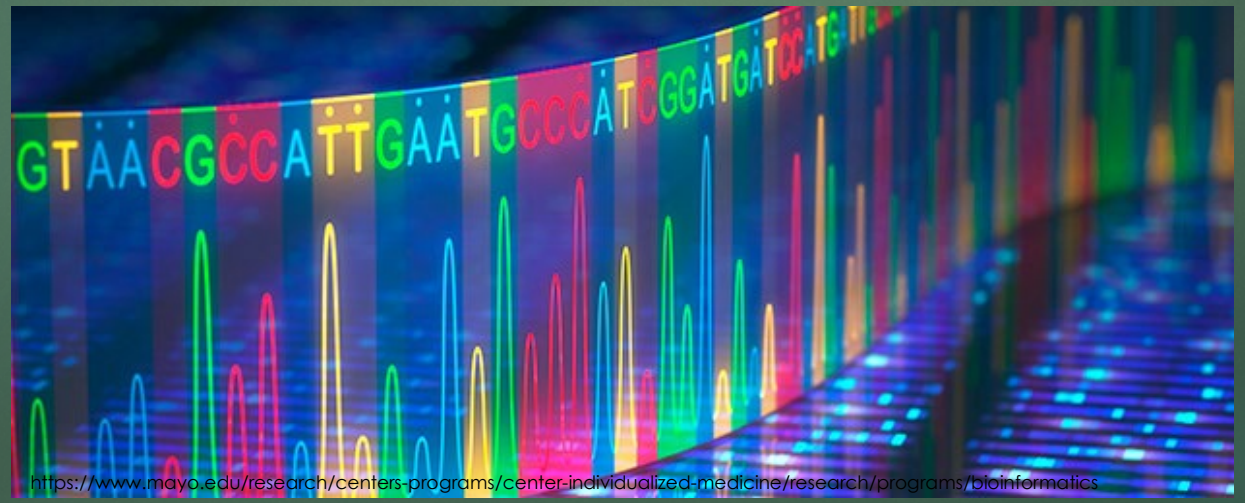


Library Prep
Metabarcoding (MiFish primers)

Illumina Sequencing
(Texas A&M Agrilife)

Methods – Analysis

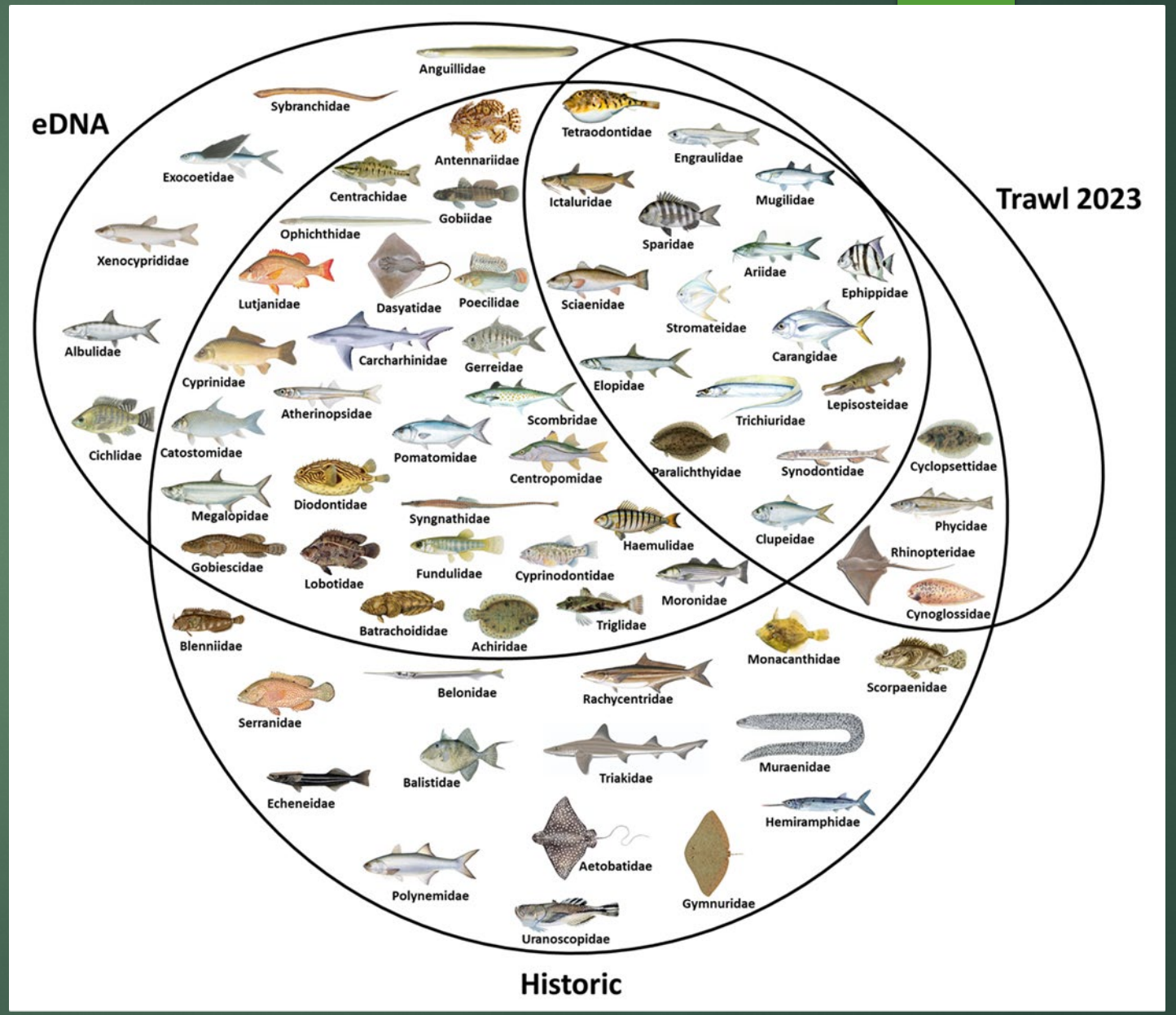
- Sequences were Demultiplexed, trimmed, and compared against reference library using DADA2 bioinformatics tools
- Compared presence/absence among traditional gears and eDNA
  - Comparisons made at family and species level
  - Comparisons gear relationships in the 2023 trawls and eDNA
    - Top 10 species caught and detected
    - Monthly species accumulation curves
- Compared species richness among traditional gears and eDNA using nonparametric Wilcoxon



https://www.mayo.edu/research/centers-programs/center-individualized-medicine/research/programs/bioinformatics

Results – Family Level Comparisons

- Historically, 62 families have been detected between 1975-2022
- Trawl 2023, detected 20 families
- eDNA
  - 16 (80%) of the 2023 trawl detected families
  - 49 (79%) of the historically detected families
  - eDNA detect 6 additional families not detected with traditional methods.



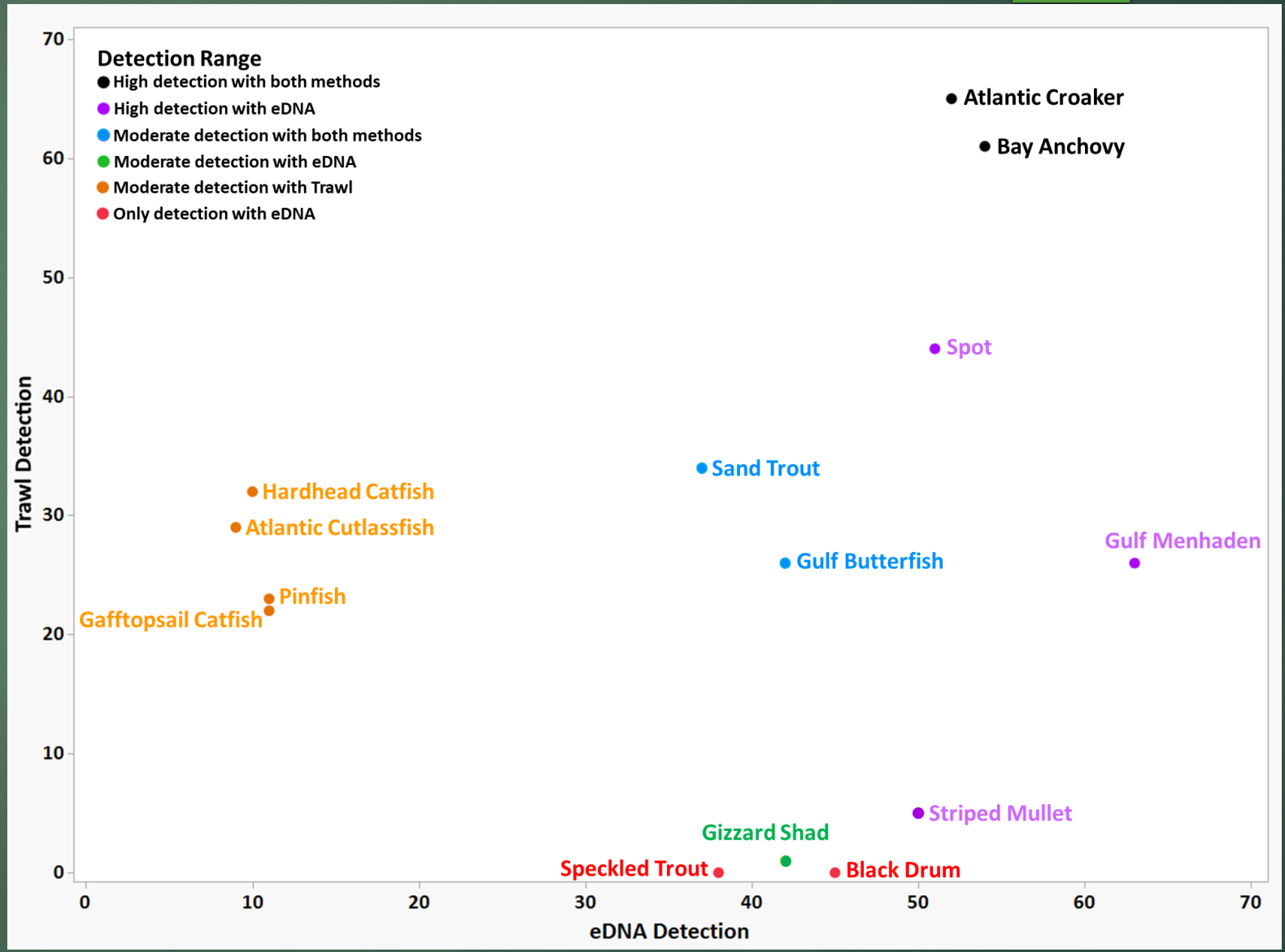
Results – Species Level Comparisons

- General
  - Historical = 168
  - Trawl = 36
  - eDNA = 105
- The top 3 species for the historical and trawl catch were present in the top 5 species detected in the eDNA

Gear	# 1	# 2	# 3	# 4	# 5
Historical Catch (1975-2022)	 Gulf Menhaden (32%)	 Atlantic Croaker (20%)	 Spot (11%)	 Hardhead Catfish (6%)	 Pinfish (3%)
Trawl Catch (2023)	 Atlantic Croaker (71%)	 Bay Anchovy (16%)	 Spot (5%)	 Sand Trout (3%)	 Pinfish (1%)
eDNA Detection (2023)	 Gulf Menhaden (94%)	 Bay Anchovy (81%)	 Atlantic Croaker (78%)	 Spot (76%)	 Striped Mullet (75%)

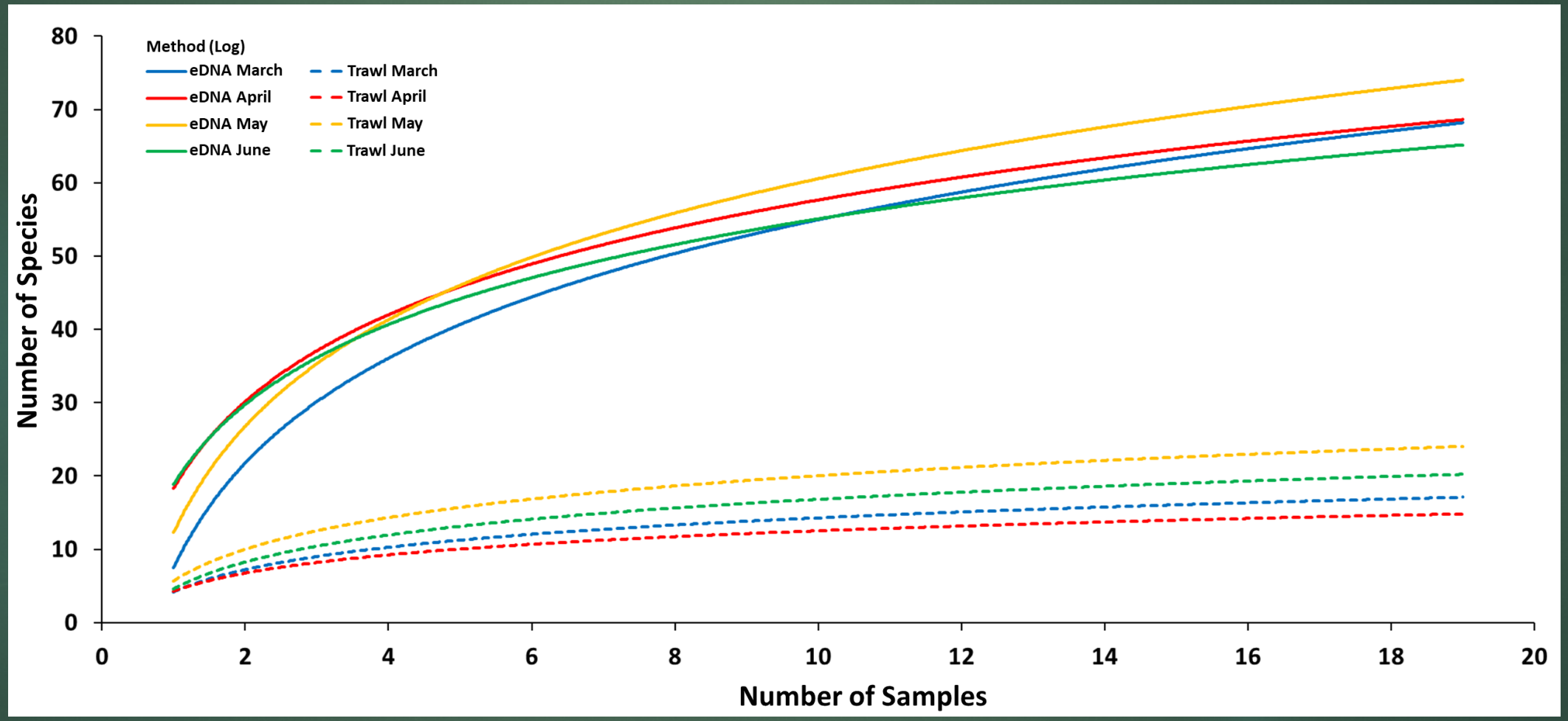
Results – Detection Range Comparisons

- Top 10 species detected in both methods
- Atlantic croaker and bay anchovy are highly detectable by both methods
- Other species like gulf menhaden or hardhead catfish were detected better by either trawls or eDNA
- Speckled trout and black drum were ONLY detected in eDNA



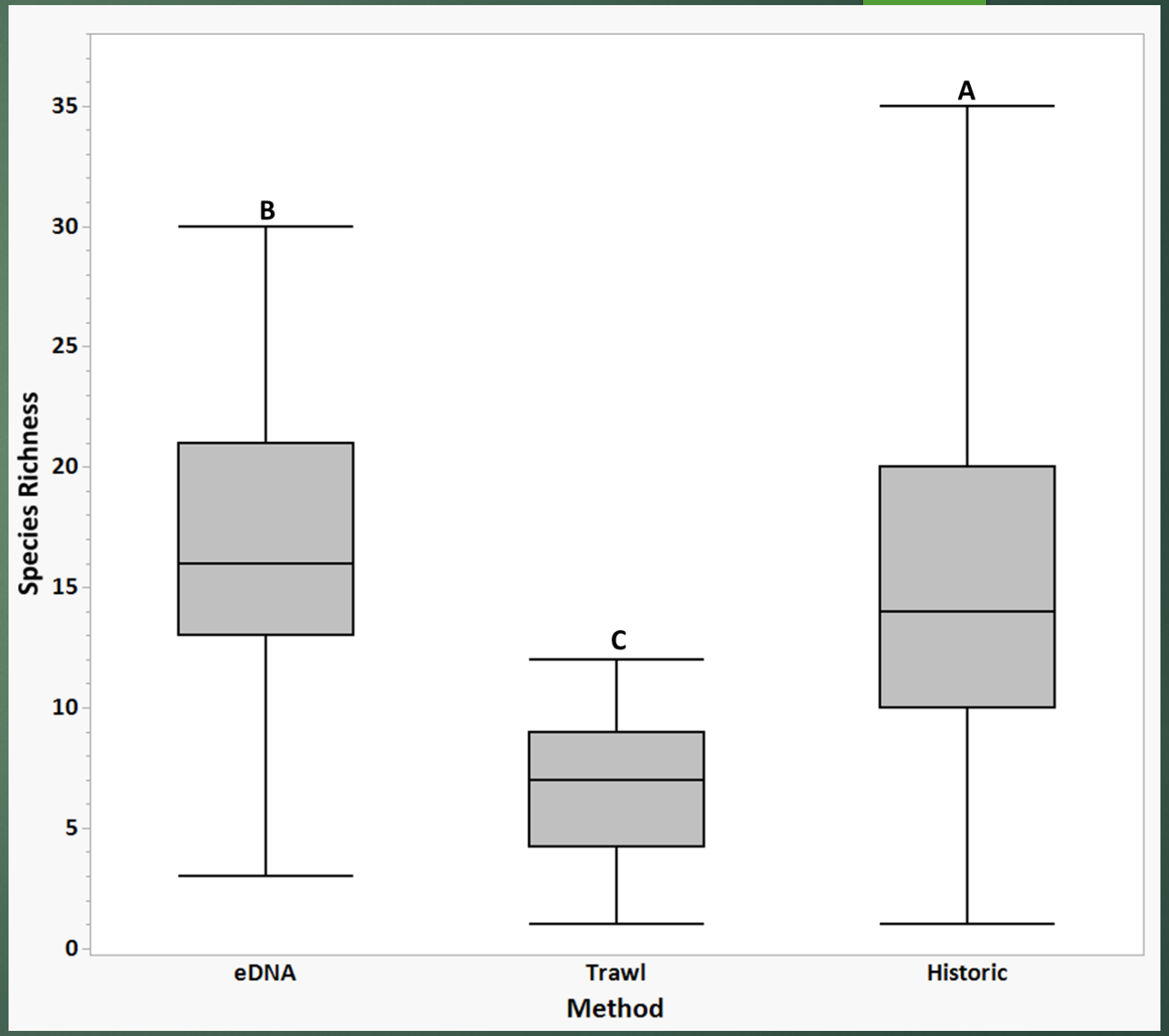
Results – Species Accumulation Curves

- Validated the finding that higher levels of species detection could be expected with eDNA than trawls



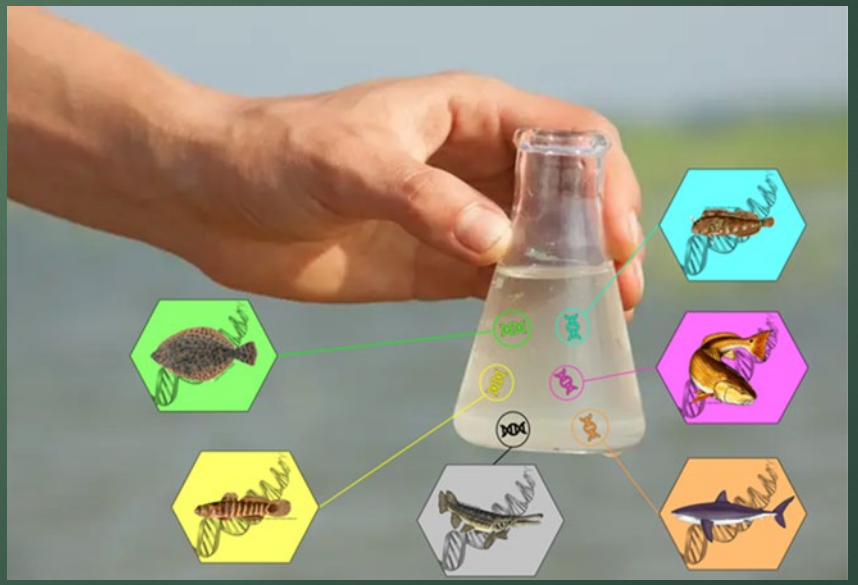
Results –Species Richness

- Kruskal – Wallis = <0.001
- Wilcoxon
  - Highly significantly (<0.001) between eDNA and 2023 trawls, and historical data and 2023 trawls
  - Slightly significant (0.033) between eDNA and historical



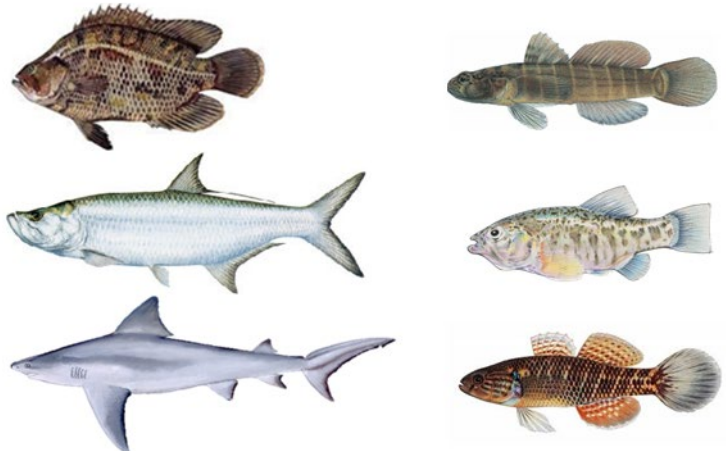
Discussion

- Overall eDNA detected over 79% of the families present in the historical record
- Top 4 present species in eDNA were in the top 3 species for both the trawl and historical catches
- Side-by-side sampling (eDNA vs trawl) showed that eDNA could detect a greater diversity of fish species than trawls. This could be caused by…

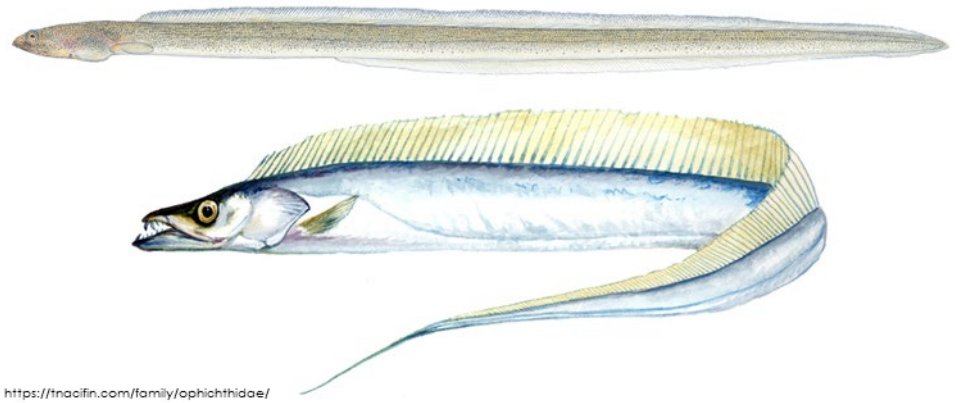


Discussion

- Gear bias – size-selection of the trawls, may prevent the detection of small- and large-bodied species
- Trawl deployment occurs in deeper water away from structures (e.g. reefs and jetties) preventing sampling shallow-water and structure-associated species
- TPWD trawl sampling occurs during daylight hours, decreasing the chances of detecting nocturnal species that spend the day resting in burrows or dens.



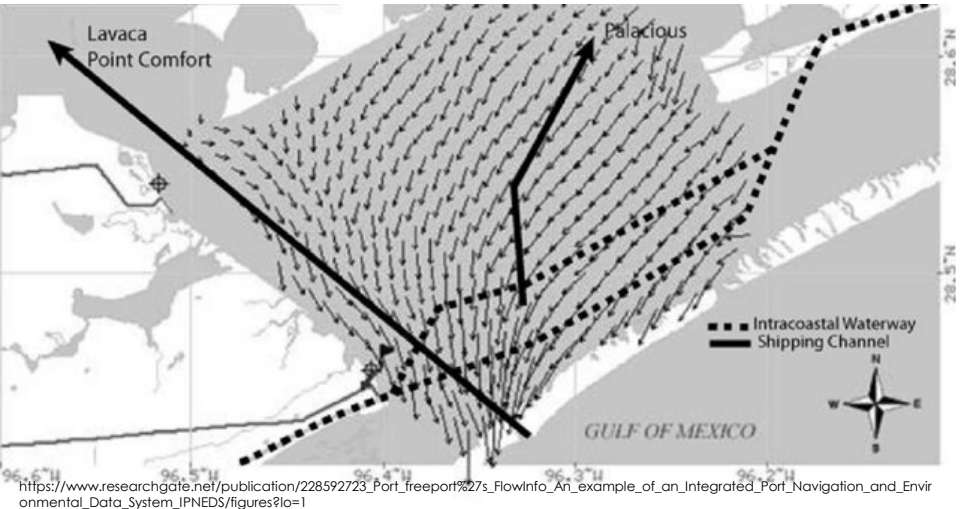
https://www.natureaustralia.org.au/what-we-do/our-priorities/oceans/oceanstories/shellfishreef-history-botany-bay/



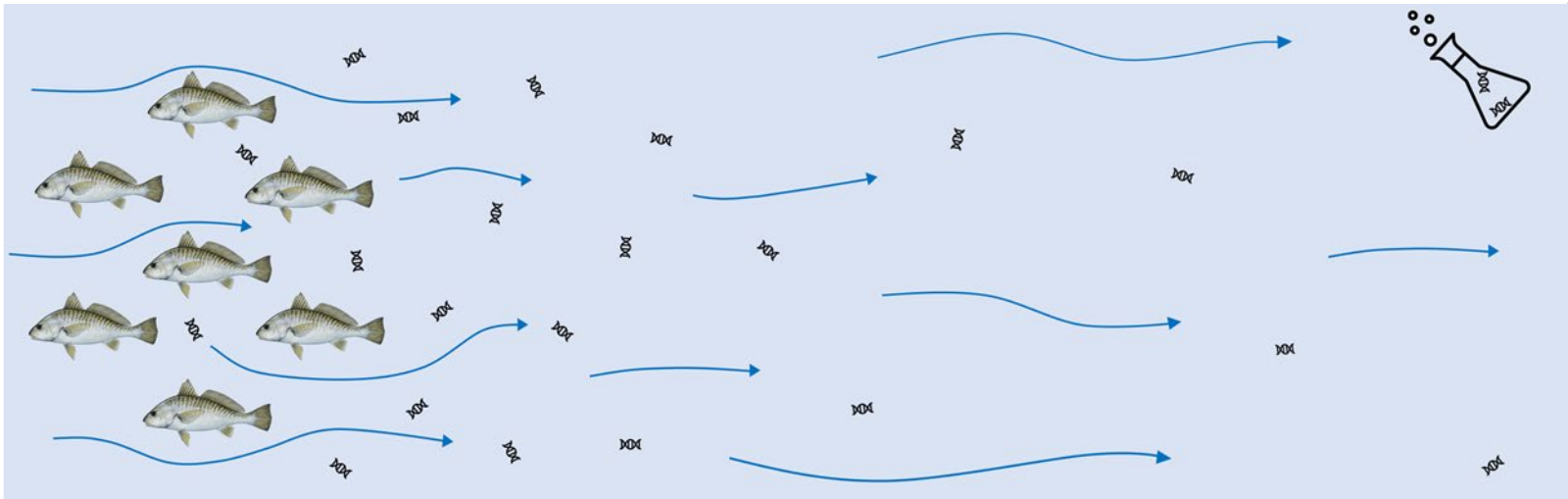
https://tnacifin.com/family/ophichthidae/
https://fishspecies.dnrec.delaware.gov/FishSpecies.aspx?habitat=2&species=208

Discussion

- eDNA drifts in the water column
- Influenced by currents and tidal direction
- May not have been in the immediate vicinity of the trawl when the water sample was taken

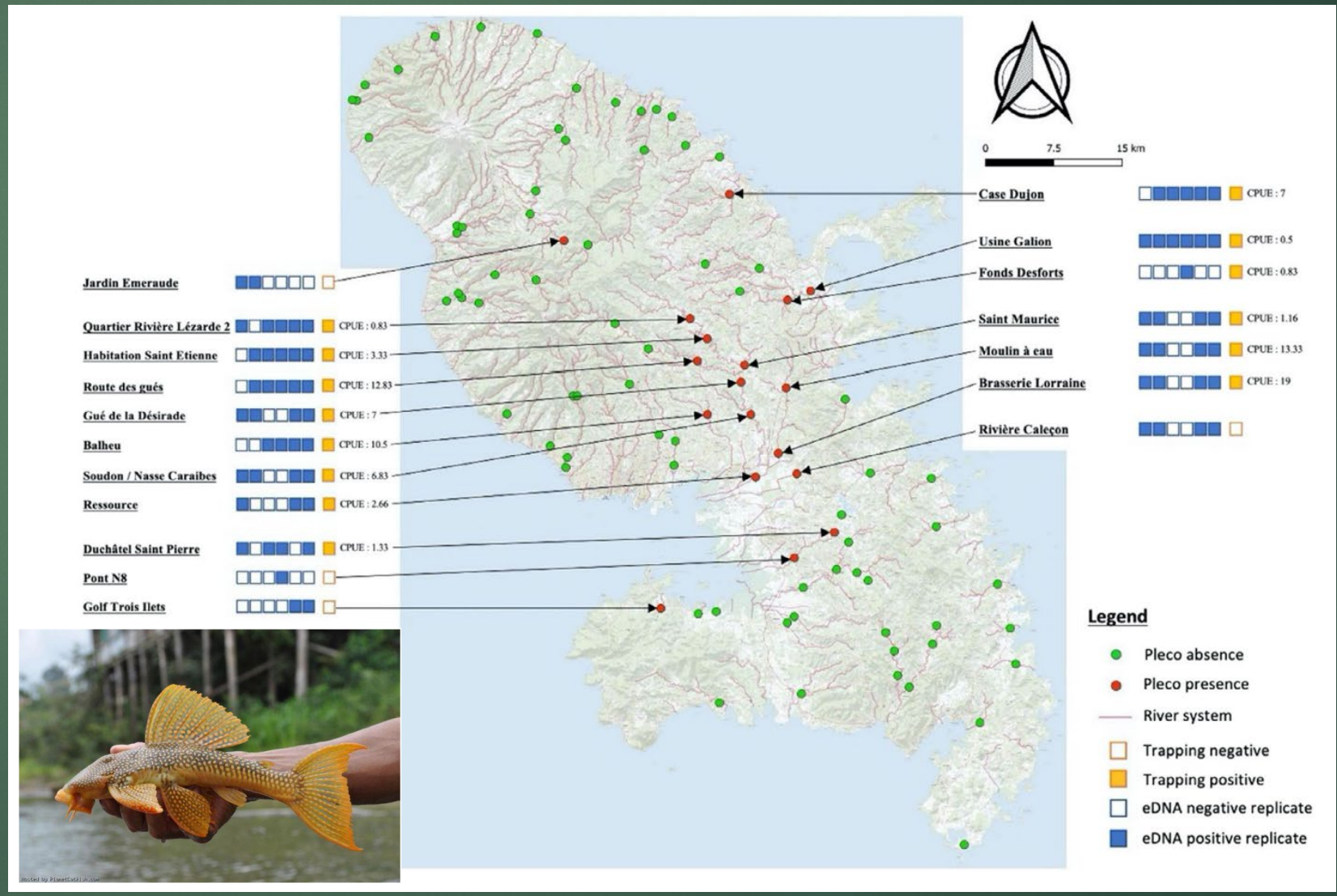


https://www.researchgate.net/publication/228592723_Port_freeport%27s_FlowInfo_An_example_of_an_Integrated_Port_Navigation_and_Environmental_Data_System_IPNEDS/figures?lo=1



Species Specific (qPCR) Example

- Teta catfish
  - Armored catfish
  - Native to Trinidad and Tobago Island
- eDNA and traps set at 83 sites in Martinique Island
  - eDNA detected in 18 sites
    - Red dots = + eDNA
    - Green dots = - eDNA
  - Traps detected in 14 site and the sites were detected by eDNA
- https://onlinelibrary.wiley.com/doi/pdf/10.1002/edn3.260



Acknowledgements

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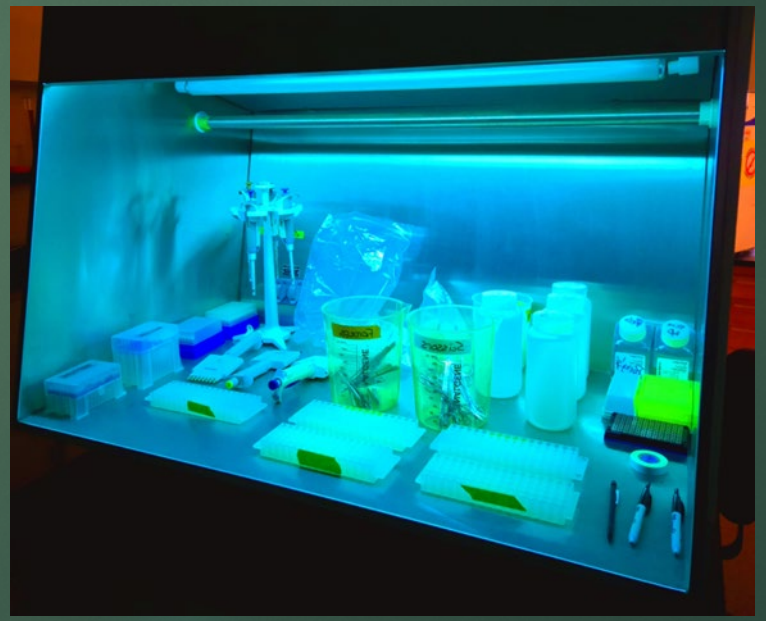
- Contact info
  - Polly Hajovsky
  - Email: polly.hajovsky@tpwd.texas.gov

Contamination Prevention

- Out in the Field
  - Designated eDNA
    - Ice chest
    - Spot on the boat
  - Nalgene bottles in Ziplock bags
  - Hand sanitizer
- In Lab
  - Sterilized filter packs
  - Clean work bench and water pump with10% bleach
  - Autoclave (Nalgene bottles, forceps, etc.)
  - Set all lab materials (pipettes, tips, etc.) under a UV light
  - Designated eDNA equipment
  - Filter pipette tips



Library Preparation Controls

- \+ Fin clip DNA controls (n = 2)
- − Milliq water controls (n = 10)
- − Plain filter control (n = 1)