# Environmental DNA surveys of fish community composition across the mid-Atlantic region: One method, many habitats

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# Communities

- The representative assemblage of organisms at a given space / time

- Emergent ecological property
  - Complex systems with many interaction
    - Resilience

Community composition is a good ecological indicator, but measurement across different habitats can be challenging.

eDNA metabarcoding can help with that.

# What is eDNA?

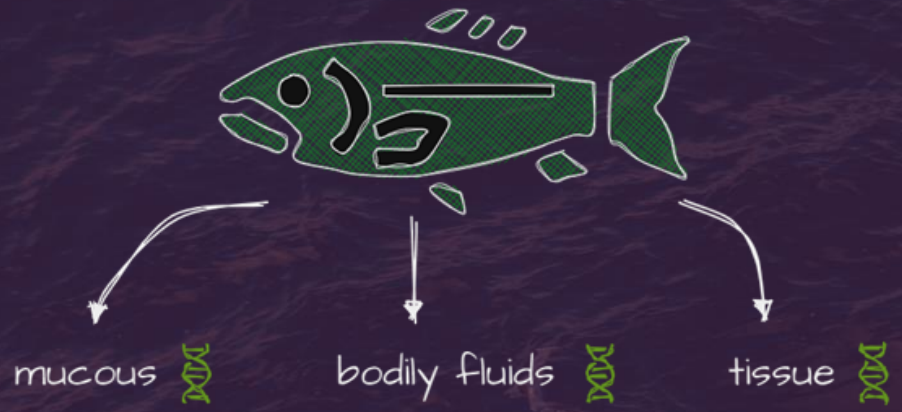
DNA is shed as cellular or extracellular material into the surrounding water

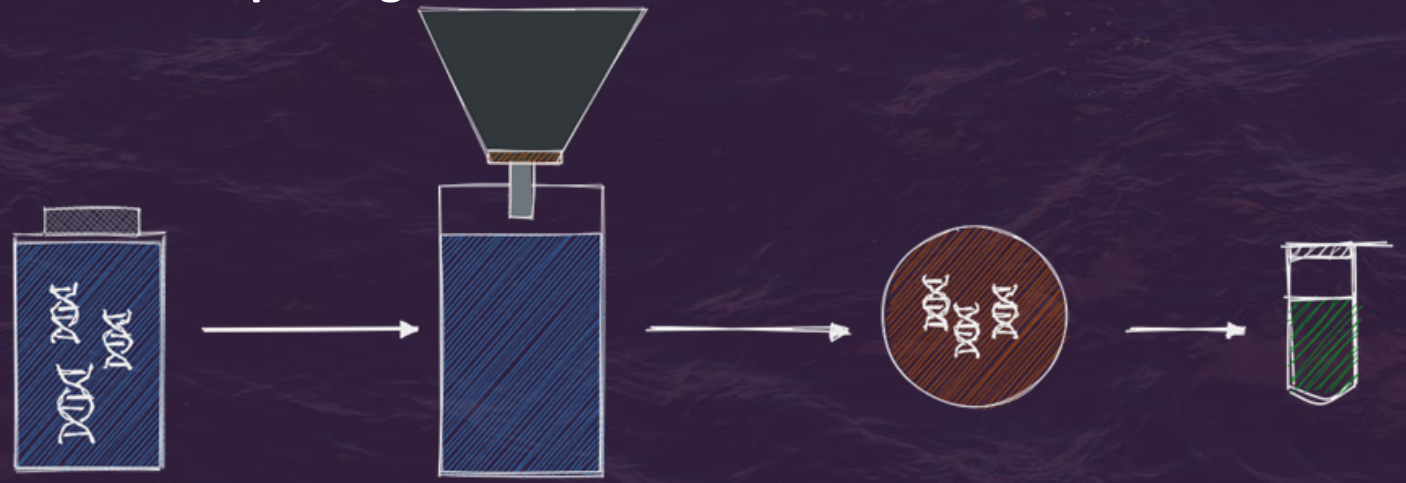
collect & filter water from aquatic systems

extract DNA from filters

**Marine eDNA has ~ 1 d half-life**

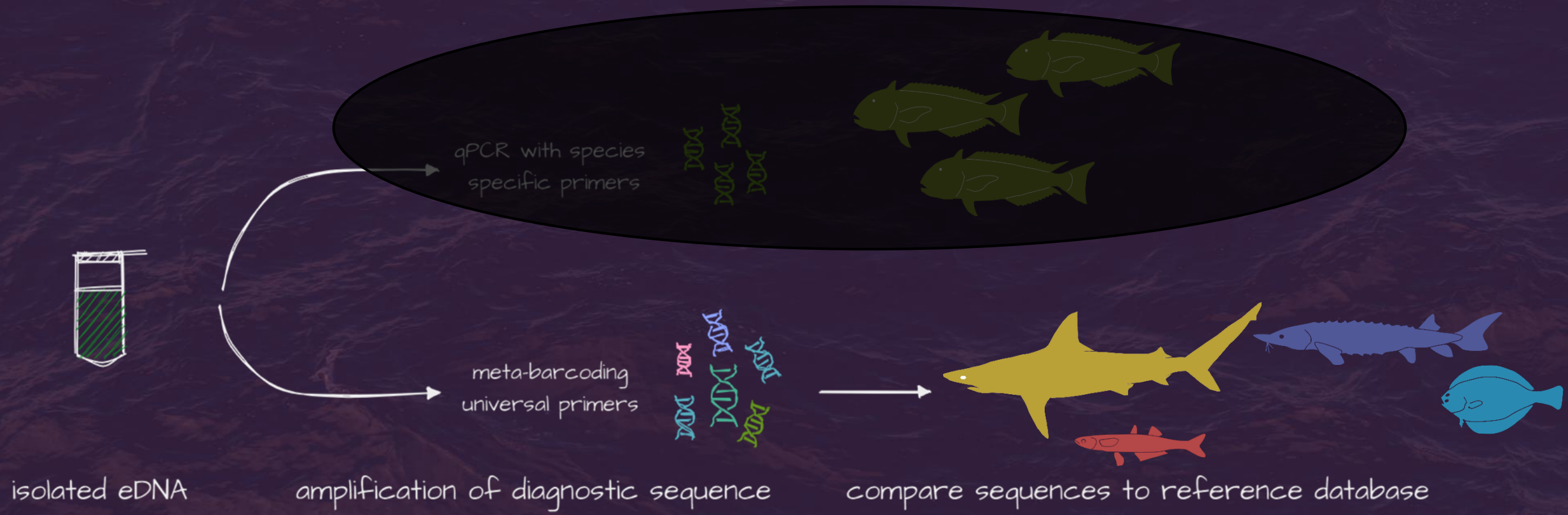
**Bottom waters sampled with some surface pairing**

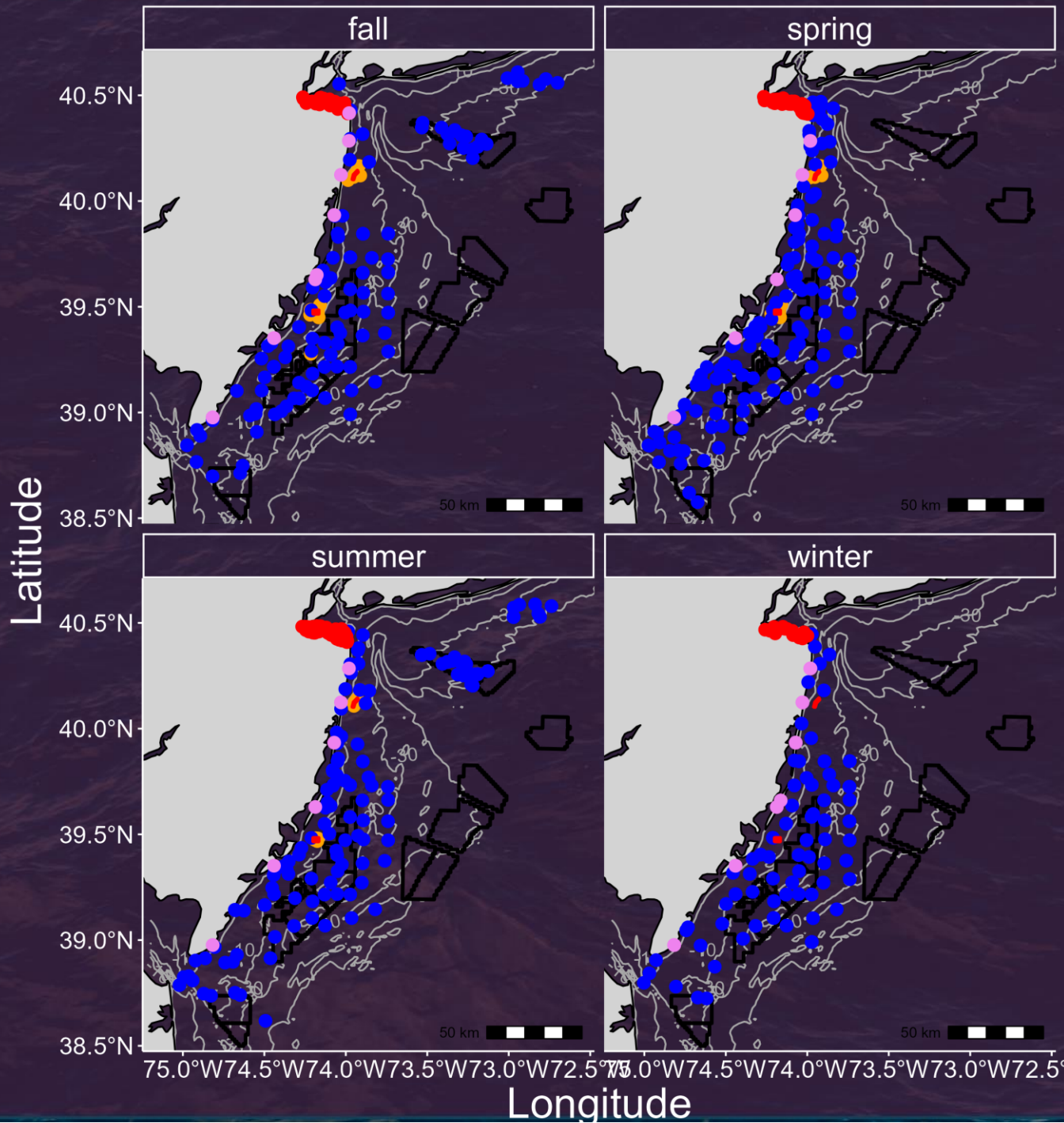


**Environmental DNA = DNA isolated from an environmental sample**

# eDNA metabarcoding = robust community data






# The Dataset and habitat designations:

**736** total samples analyzed

**143** amplicon sequence variants identified

habitat
- estuary
- reef
- shelf
- surf zone

## Sample sizes by season

| habitat | fall | spring | summer | winter |
|---|---|---|---|---|
| estuary | 24 | 30 | 94 | 14 |
| reef | 16 | 14 | 12 | |
| shelf | 129 | 126 | 135 | 107 |
| surf zone | 11 | 6 | 6 | 12 |

## Habitats by Campaigns

**Estuary** – Raritan Inventory Project (RIP)
(Stacy van Morter)

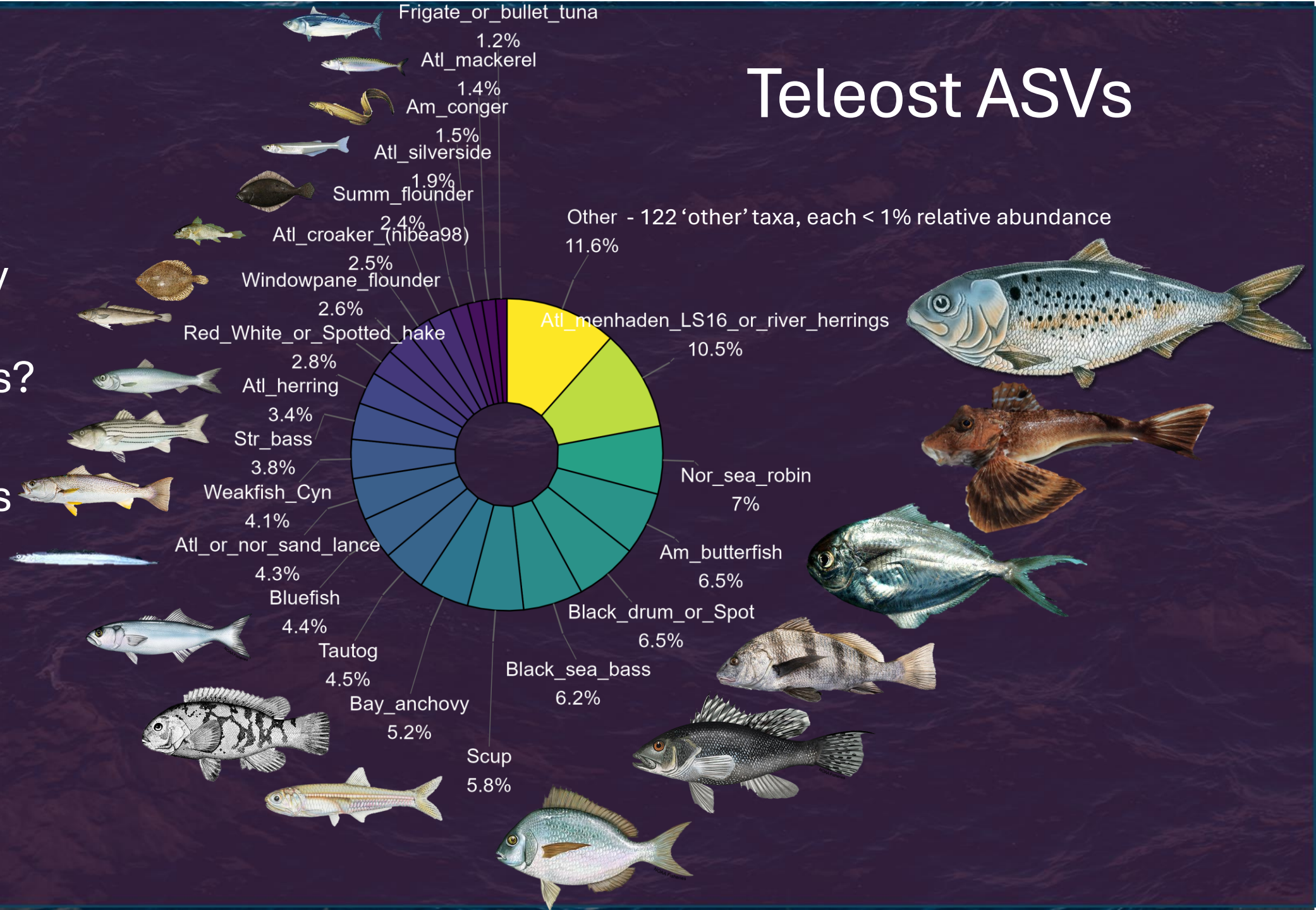
**Reef** – NJ Artificial Reefs program
(Peter Clarke)

**Shelf** – NJ Ocean Trawl, Monmouth University 'RMIO', & Inspire Environmental surveys
(Gregory Hinks (DEP); Brian Gervelis and Dara Wilber (Inspire Environmental))

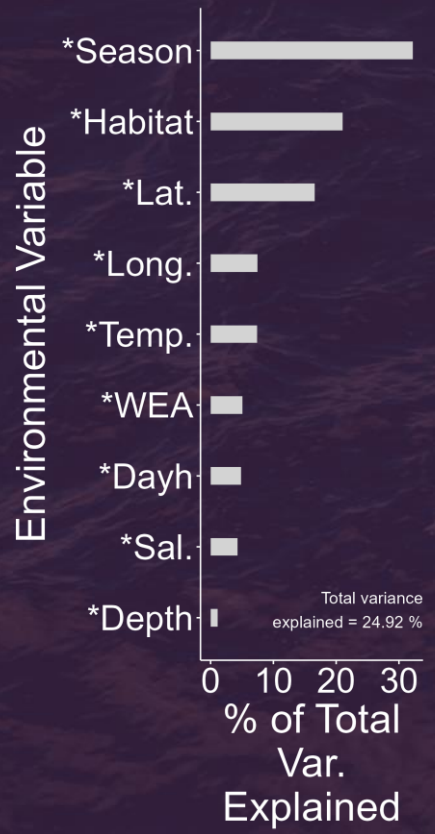
**Surf zone** – Monmouth University and community scientists

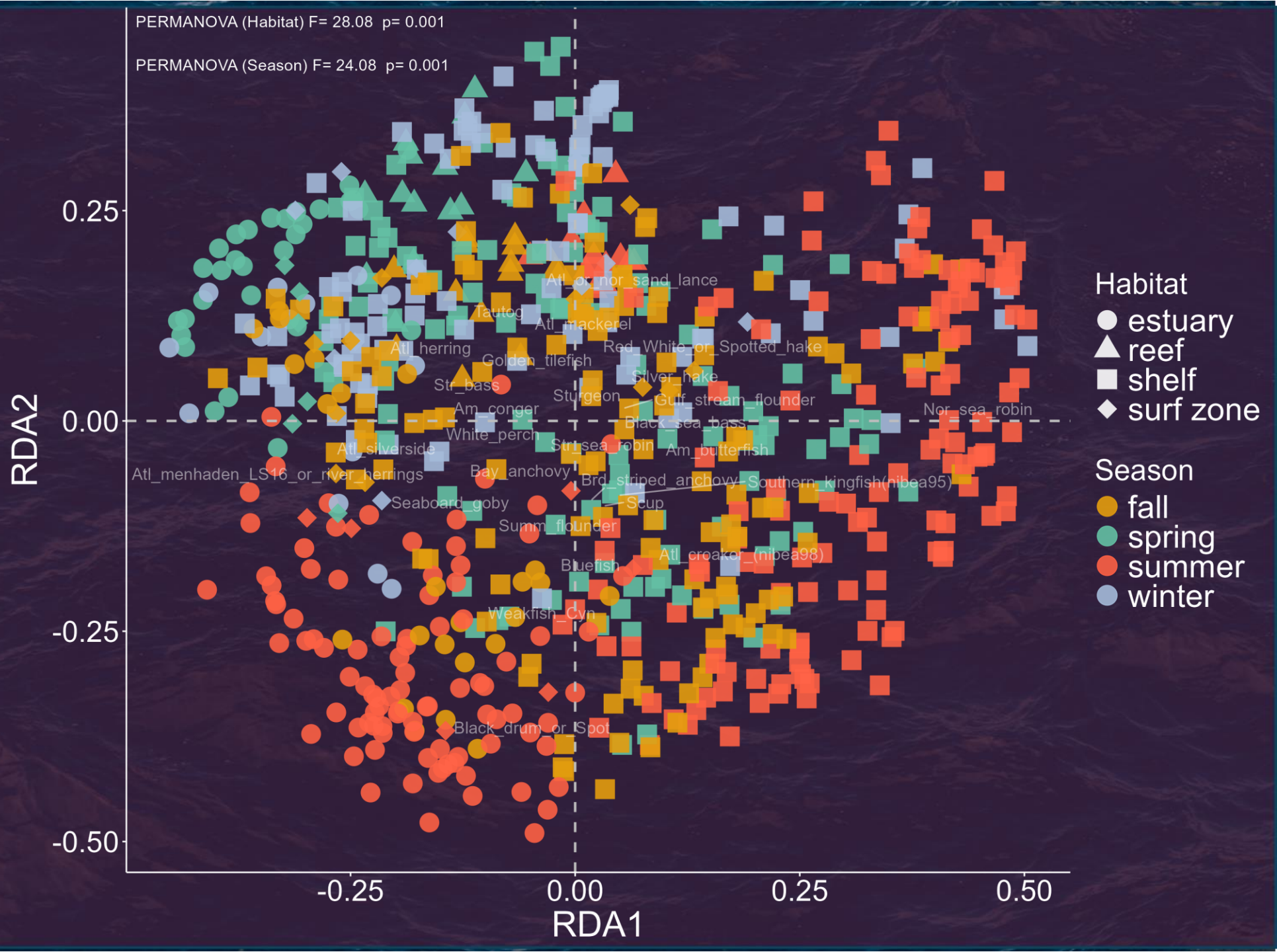
# Teleost ASVs

- How are they organized in communities?
- How are communities related to habitat?

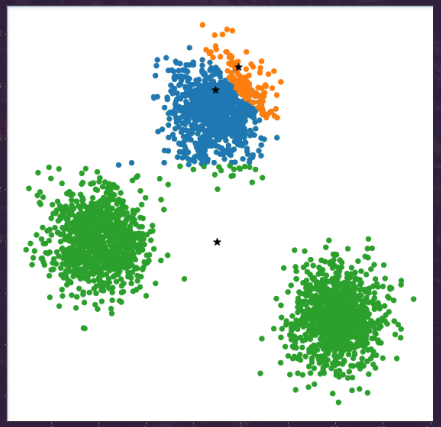


# Ordination of community data



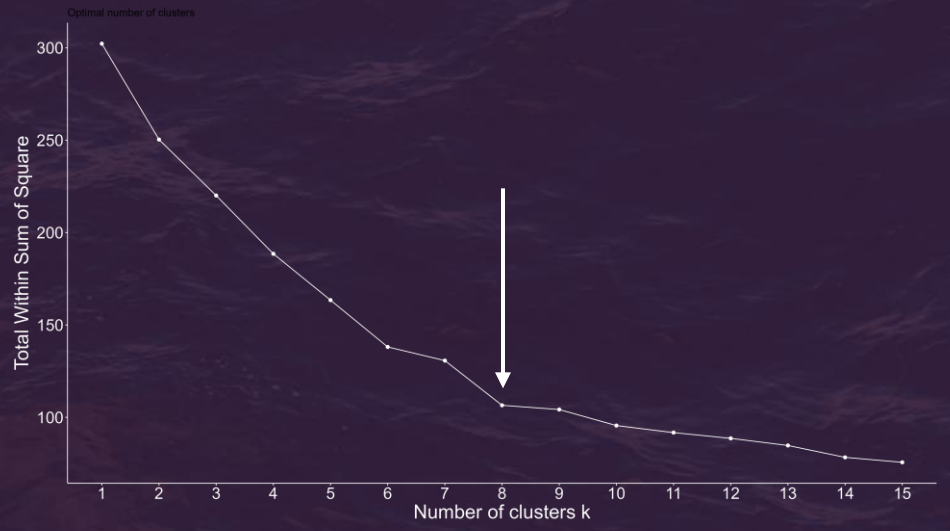



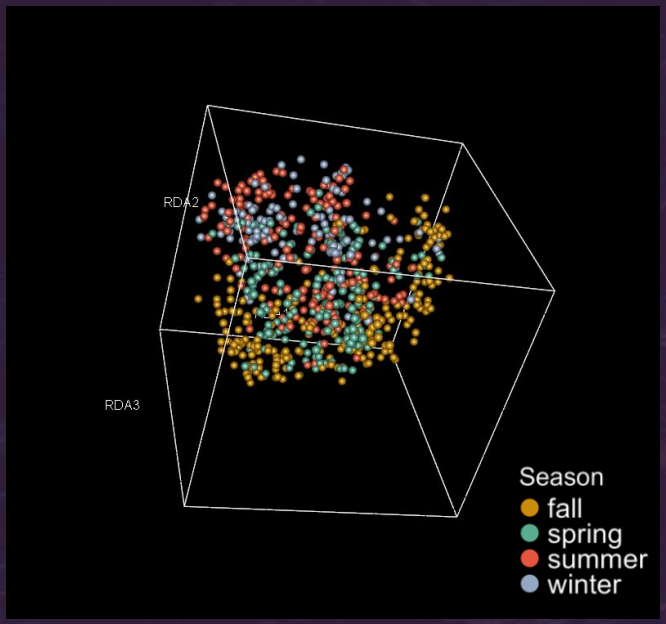
# K-means clustering to label communities



https://towardsdatascience.com/unsupervised-learning-k-means-clustering-6fd72393573c/

- Cluster results for RDA scores
  - Clusters in 6D data space from RDA scores
  - How many ‘named’ communities are there and how well does clustering work?
    - Elbow plot for choosing k-clusters: 8 clusters
    - Avg silhouette width: 0.28 (‘meh’)
    - PERMANOVA % variance in original fish community matrix explained – 35%



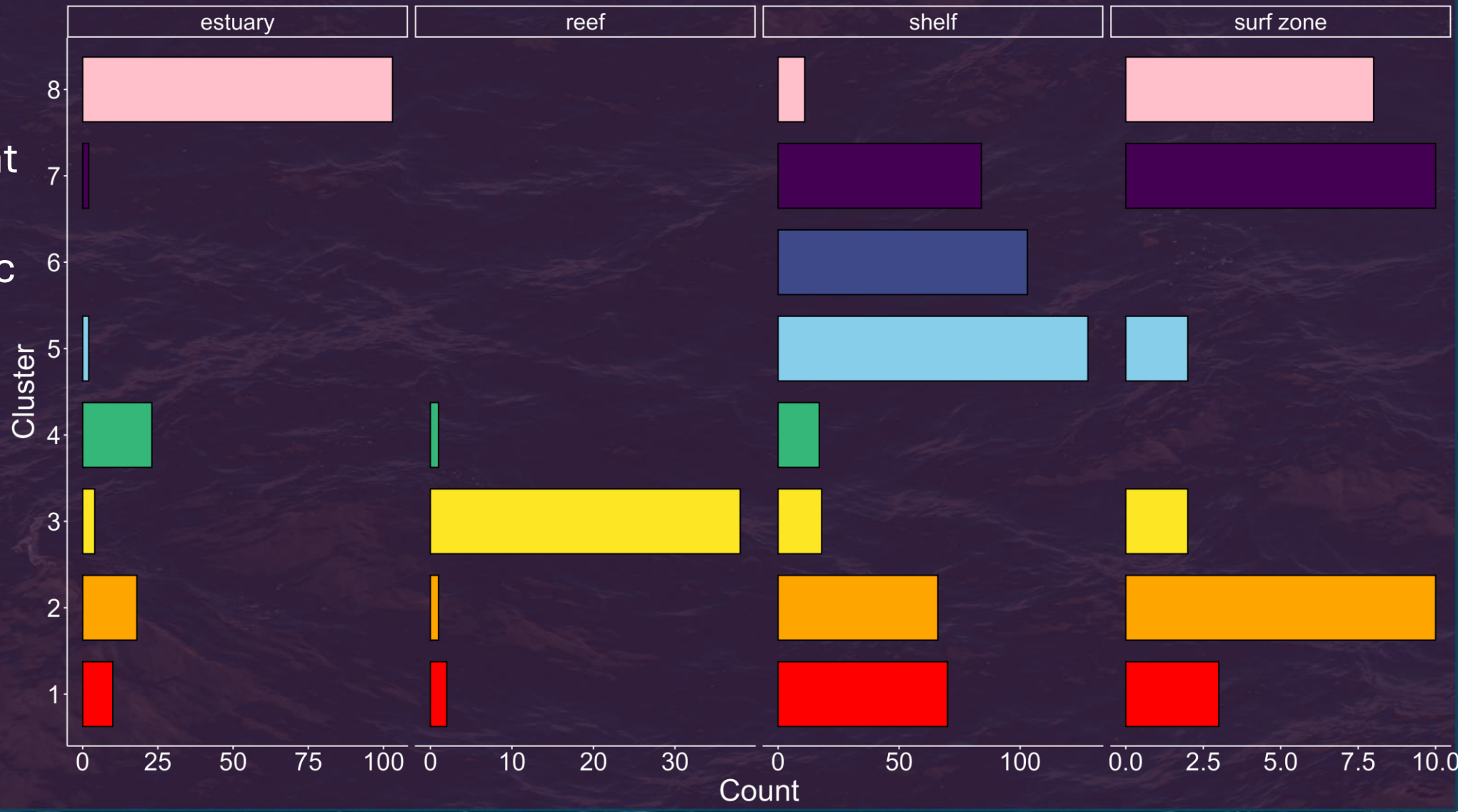




What our data actually looks like, in 3 out of 6 dimensions after RDA

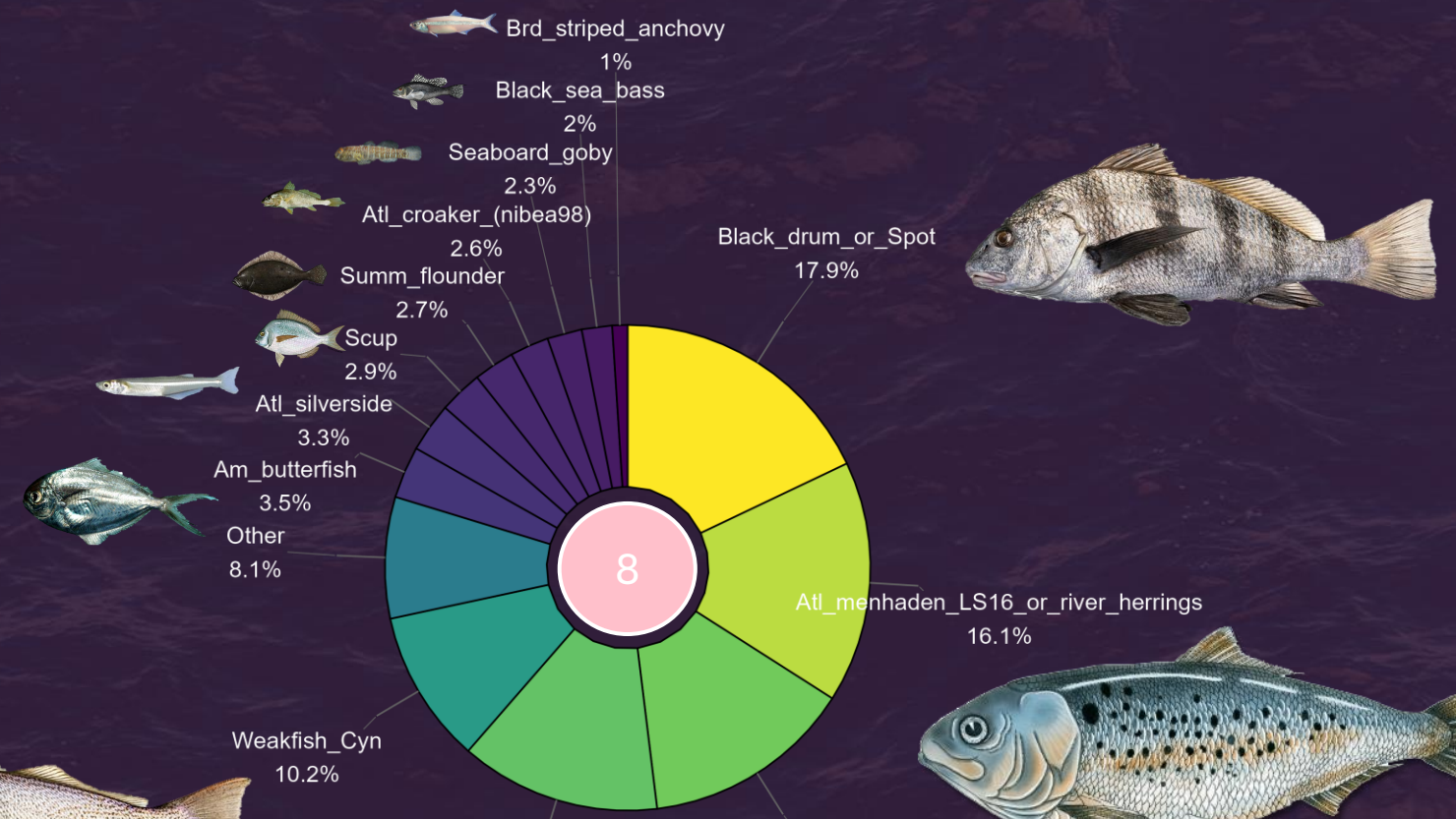
These data are complex beyond 8 clusters, but this is still a useful approach to understanding the data better

# Certain clusters were dominant in certain habitats

This indicates that habitats sampled had characteristic fish community composition as determined by eDNA metabarcoding



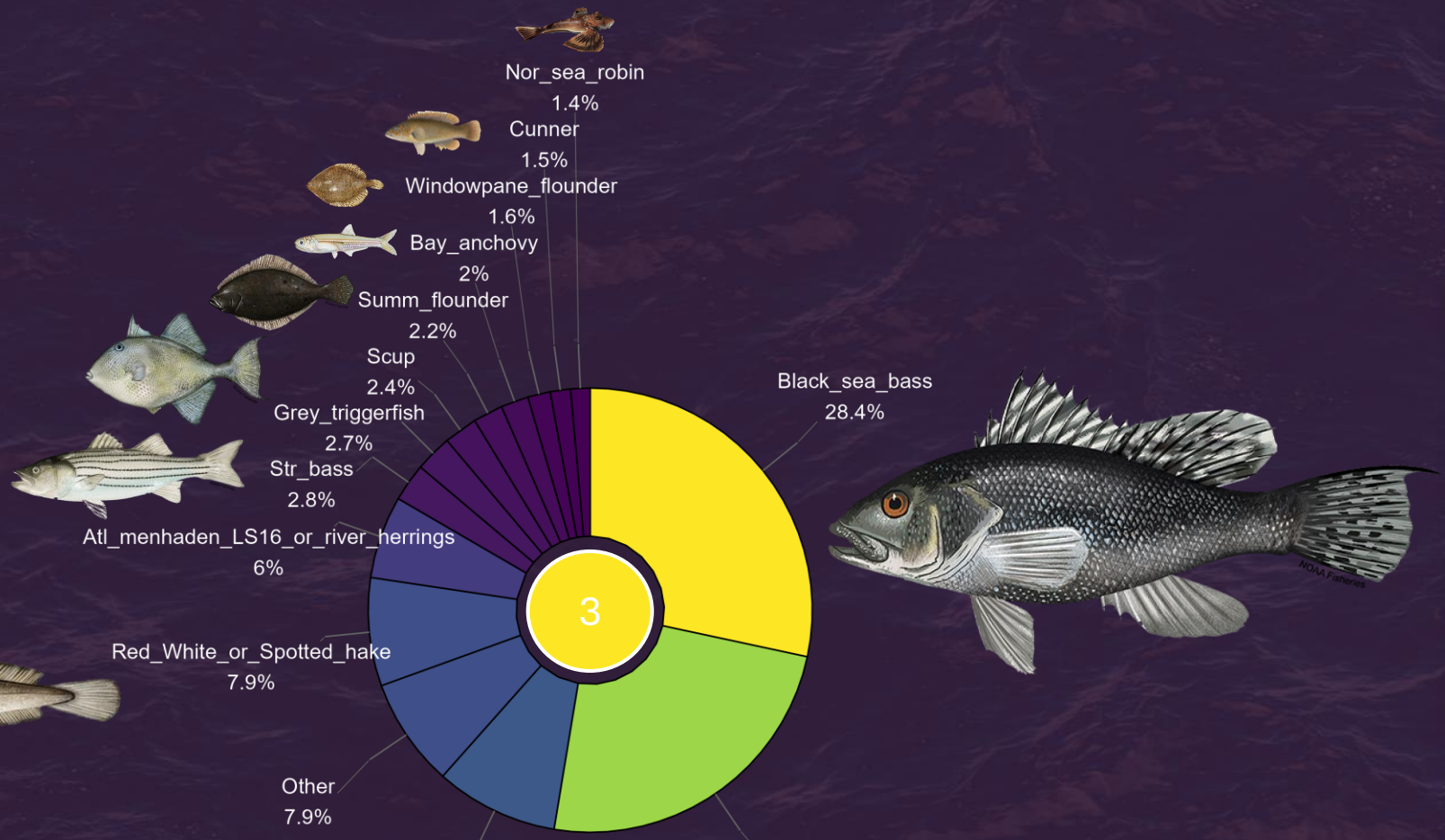
# ESTUARY

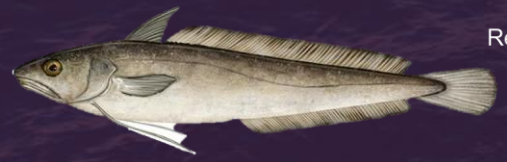




*You're turn to guess:*

SURF ZONE?
SHELF?
ARTIFICIAL REEF?
Or
ESTUARY?

# REEF

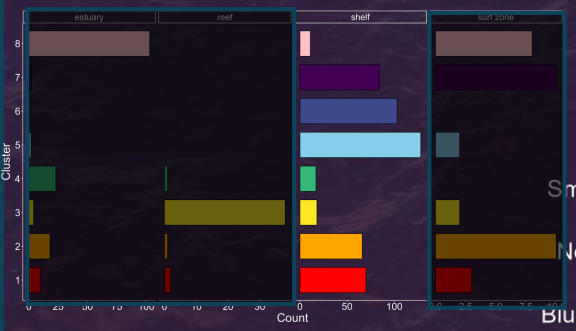



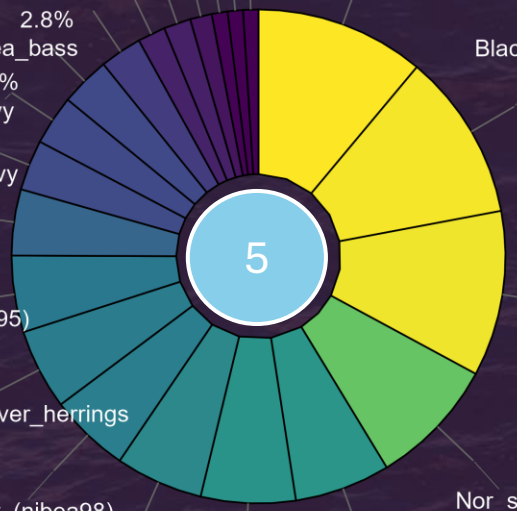
*You're turn to guess:*

SURF ZONE?
SHELF?
ARTIFICIAL REEF?
Or
ESTUARY?

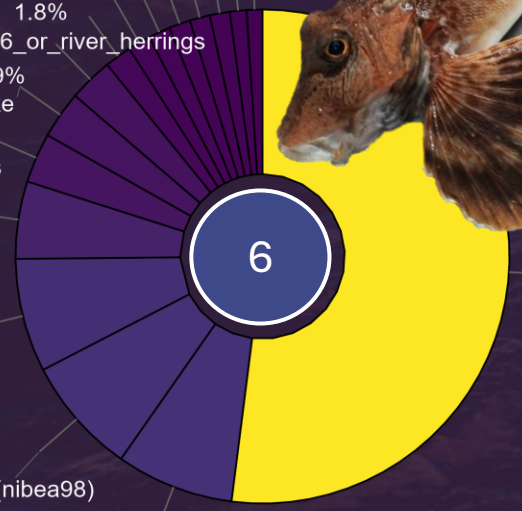
# SHELF




Sturgeon 1%
Tautog 1%
Str_bass 1%
Smallmouth_flounder 1.4%
Nor_kingfish 1.8%
Bluefish 1.8%
Red_White_or_Spotted_hake 2.8%
Black_sea_bass 3.3%
Bay_anchovy 3.3%
Brd_striped_anchovy 3.3%
Scup 4.3%
Southern_kingfish(nibea95) 5%
Atl_menhaden_LS16_or_river_herrings 5.3%
Atl_croaker_(nibea98) 5.3%
Summ_flounder 5.7%
Windowpane_flounder 6.2%
Weakfish_Cyn 6.3%
Nor_sea_robin 8.4%
Other 10.8%
Black_drum_or_Spot 11%
Am_butterfish 11.1%




Atl_or_nor_sand_lance 1.1%
Black_drum_or_Spot 1.3%
Red_White_or_Spotted_hake 1.3%
Gulf_stream_flounder 1.4%
Smallmouth_flounder 1.4%
Summ_flounder 1.5%
Windowpane_flounder 1.8%
Atl_menhaden_LS16_or_river_herrings 2.9%
Silver_hake 3.1%
Black_sea_bass 3.3%
Am_butterfish 5.1%
Bluefish 7.4%
Atl_croaker_(nibea98) 7.7%
Other 7.7%
Nor_sea_robin 52%
Bay_anchovy 1%



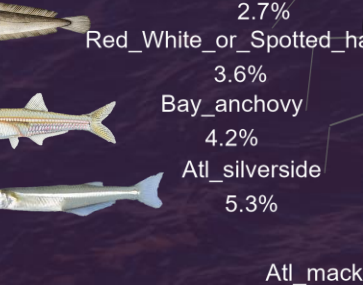

*You're turn to guess:*

SURF ZONE?
SHELF?
ARTIFICIAL REEF?
Or
ESTUARY?

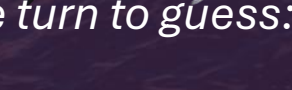
# SURF ZONE

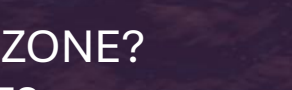

Black_sea_bass
1%
Black_drum_or_Spot
1.6%
Nor_sea_robin
1.6%
Atl_herring
1.6%
Nor_pipefish
1.8%
Am_butterfish
2.3%
Str_bass
2.3%
Atl_croaker_(nibea98)
2.3%
Smallmouth_flounder
2.4%
Summ_flounder
2.7%
Red_White_or_Spotted_hake
3.6%
Bay_anchovy
4.2%
Atl_silverside
5.3%
Atl_mackerel
8.3%
Windowpane_flounder
9%
Other
9.8%

Atl_menhaden_LS16_or_river_herrings
40.1%







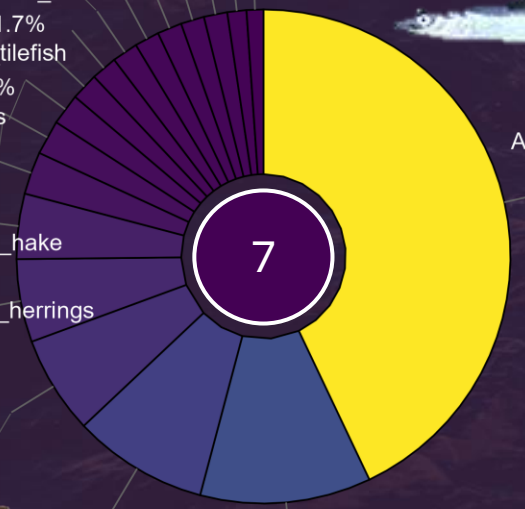
*You're turn to guess:*

SURF ZONE?
SHELF?
ARTIFICIAL REEF?
Or
ESTUARY?

Atl_mackerel
1.1%
Tautog
1.2%
Weakfish_Cyn
1.5%
Black_drum_or_Spot
1.5%
Nor_sea_robin
1.6%
Am_butterfish
1.6%
Scup
1.7%
Windowpane_flounder
1.7%
Golden_tilefish
1.8%
Str_bass
2%
Atl_salmon
2.3%
Red_White_or_Spotted_hake
2.8%
Atl_menhaden_LS16_or_river_herrings
4.3%
Atl_silverside
5.4%
Sturgeon
6.4%
Other
8.8%

Atl_or_nor_sand_lance
42.9%



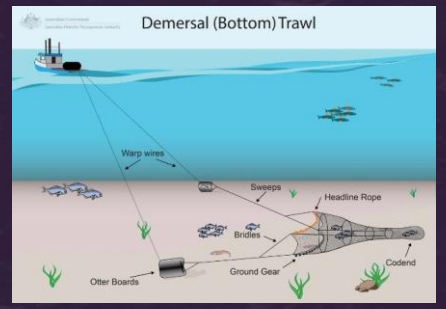


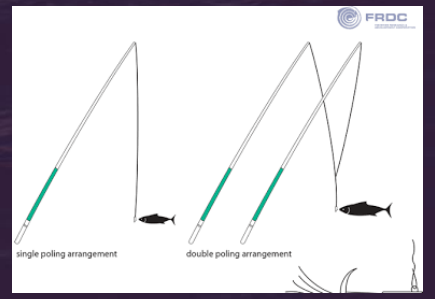

Frigate_or_bullet_tuna
11.2%

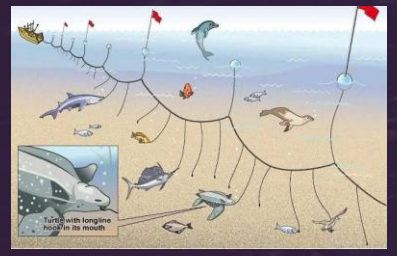
# What's it look like if we do this analysis on capture data?

- You can't… that's *kinda* the point

- eDNA allows sampling across habitats and taxa with consistent bias
  - Clark et al. - River Center Conference Rm 18, 10:30 AM (TODAY!)
- There's more than fish that may be useful in 12S metabarcoding data
  - O'Leary et al. River Center Conference Rm 18, 9:30 AM (TODAY! NEXT!)



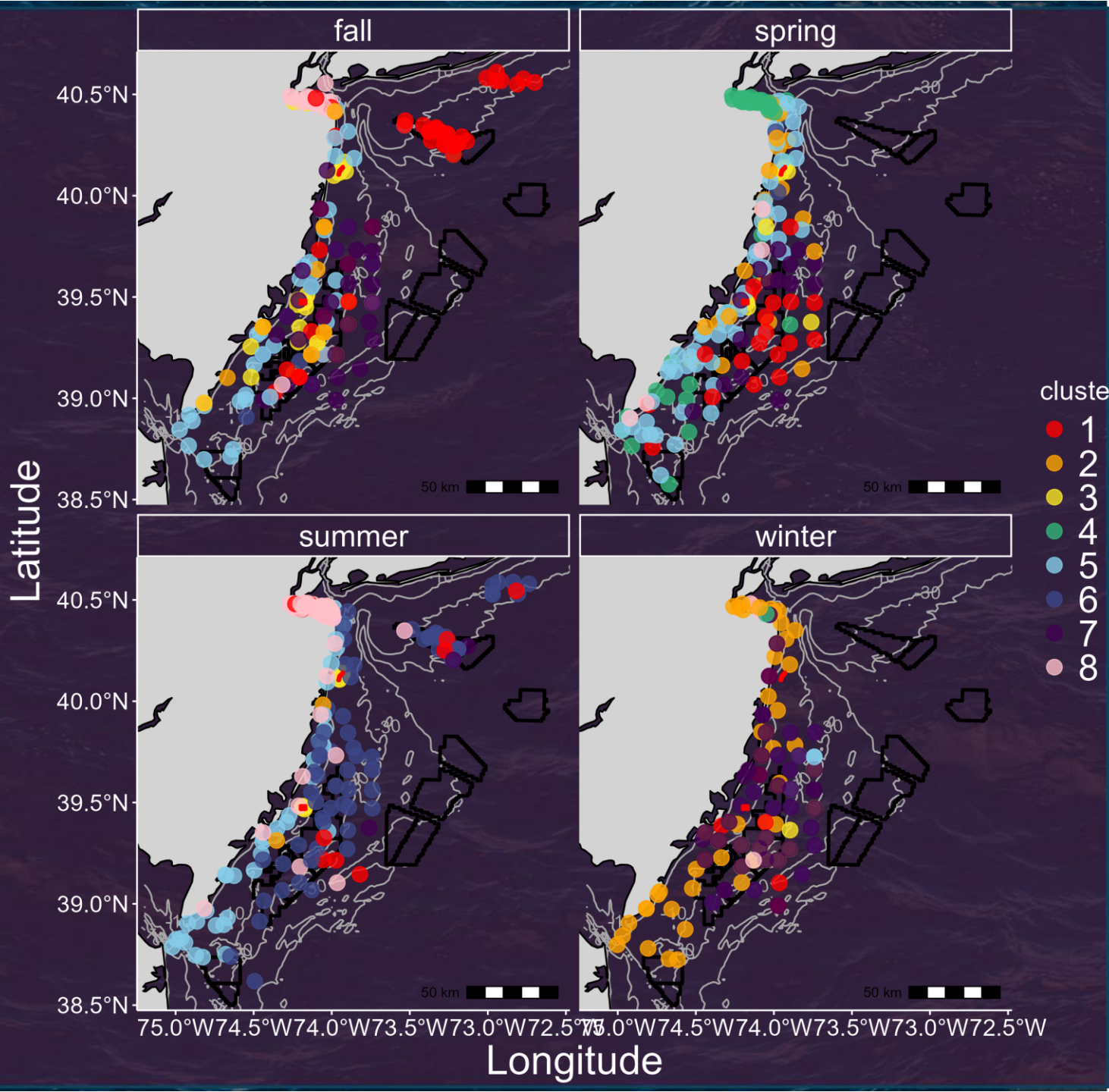
# Why is this useful?

Community composition is a good and resilient ecological indicator, but can be complex, hard to measure and difficult to visualize / summarize

We have far better methods for analyzing community data than for collecting it broadly

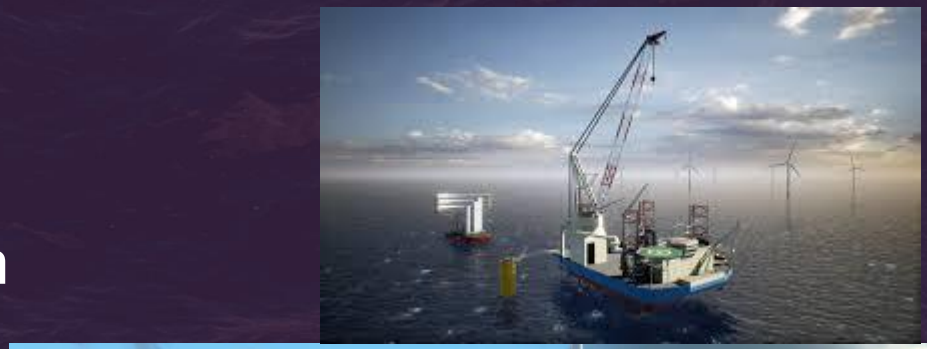
eDNA alleviates the collection issue, allowing us to focus more on the analyses!

- Leaflet interactive map



# Conclusion

- eDNA metabarcoding provides robust community composition data that is is a logical ‘response variable’ for impact-type studies
  - Community composition is a robust index based on a lot of data that integrates biological – biological and biological – physical interactions
    - Offshore wind development BACI / BAG
    - Restoration
      - Oyster reefs
      - Seagrasses
    - Climate research
      - ‘events’ causing community shifts



Equinor is beginning installation of turbines at the Empire wind site.

Funding:

Colleen Brust & Caitlin McGarigal (NJDEP Project Managers)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Library Prep & Sequencing: Sabeena Nazar (BASLab)