Gulf – Fishery Independent Survey of Habitat and Ecosystem Resources (G-FISHER):

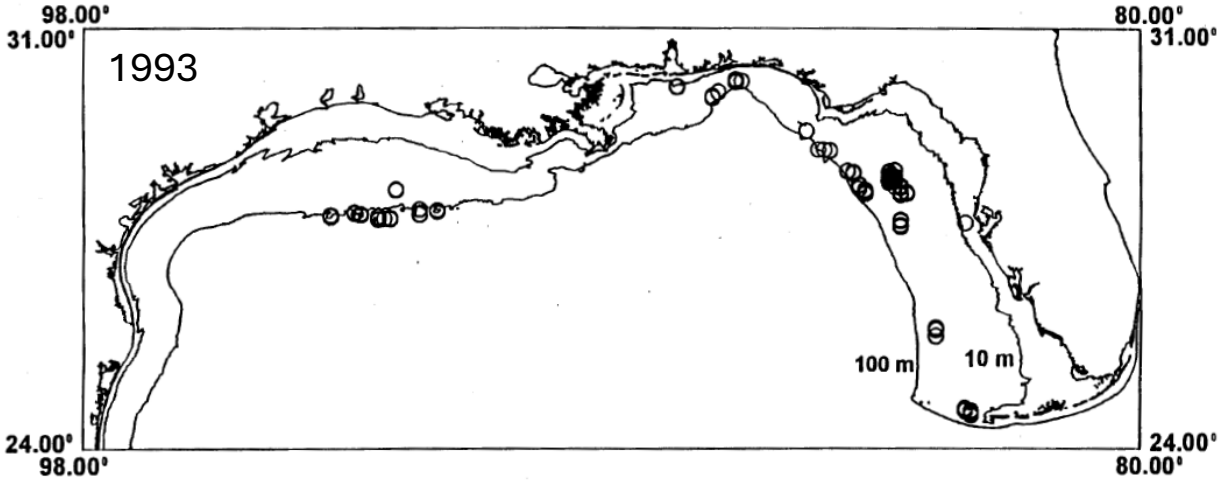
Development, Application, Adaptation

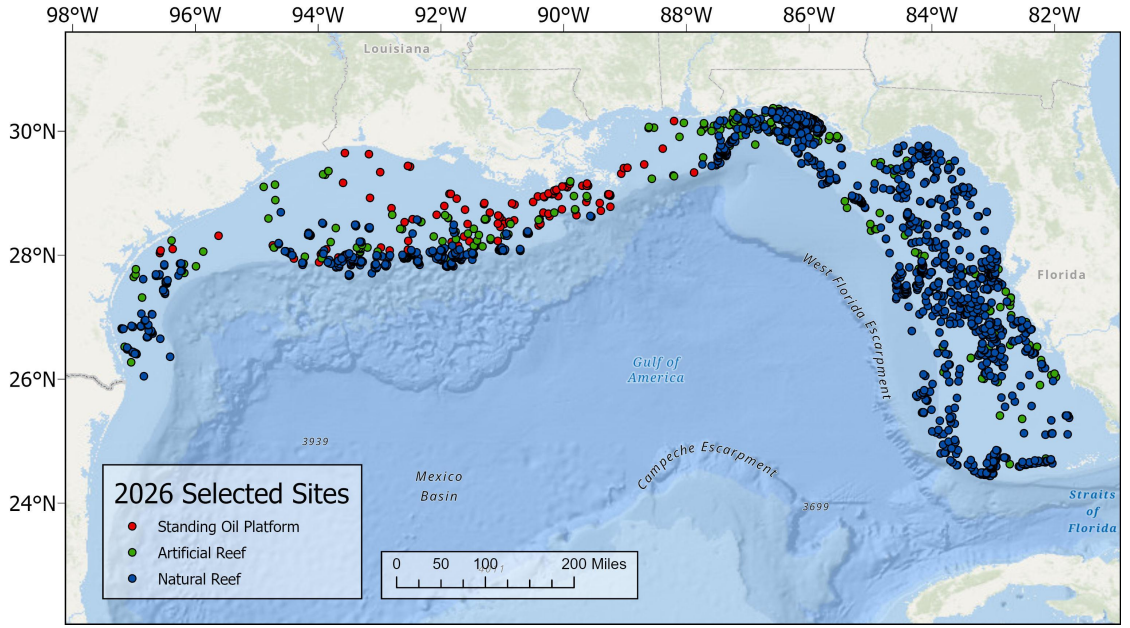
Ted Switzer, Matt Campbell, Kate Overly, Kelsey Martin, Justin Lewis, Heather Christiansen, Mandy Tyler-Jedlund, Taj Knapp, Sean Keenan

Gulf Council SSC Meeting, May 5, 2026

Presentation Overview

- Development
  - Initiation, expansion, and evolution of Gulf reef fish surveys
- Application
  - Data products for assessment, management, other uses
- Adaptation
  - Approaches to address survey limitations and emerging needs

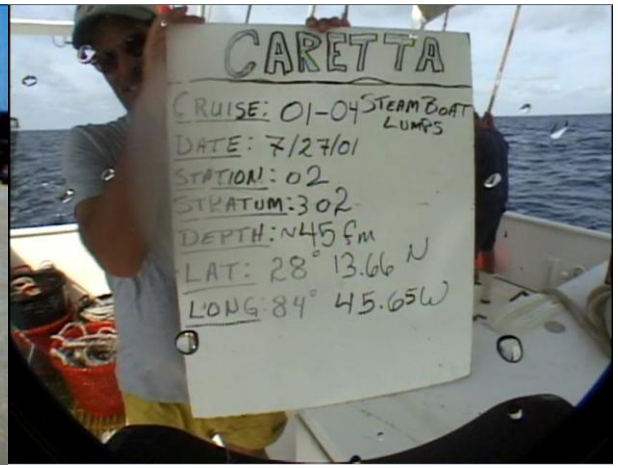




Part I. Development

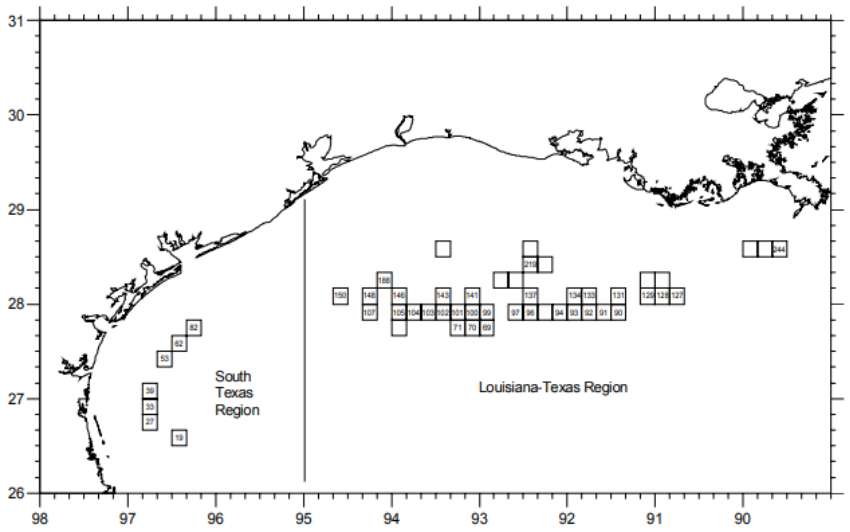
In the Beginning…

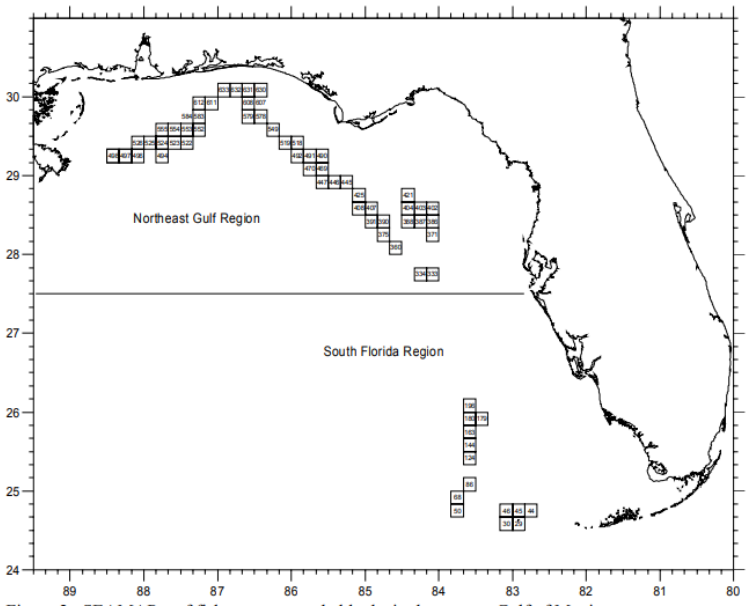
- Trap survey from late 1980s – cameras to assess fish behavior



- Led to transition to camera survey (1992)

- Initial focus on shelf break / well-known reef features





Gledhill and Ingram 2004

In the Beginning…

- SEDAR 7 – first use for assessment (Red Snapper)

- Recognized utility, but also limitations

Gledhill and Ingram 2004

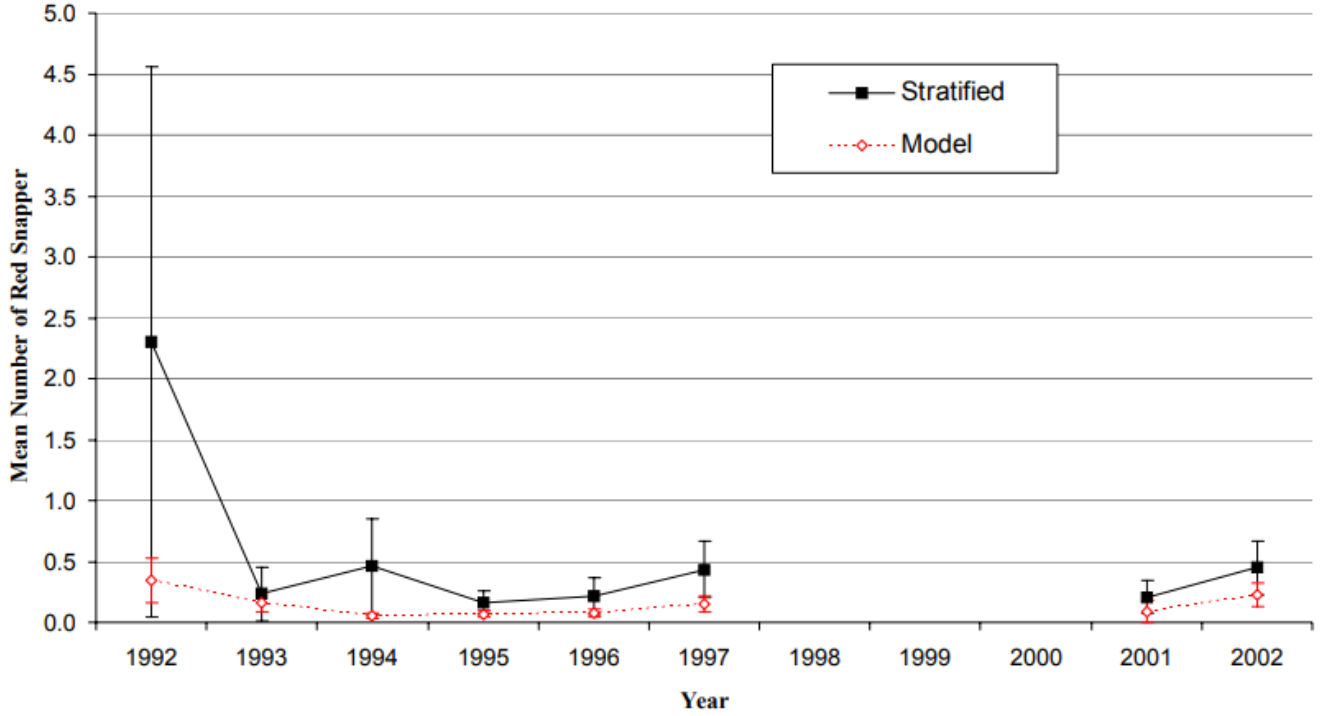
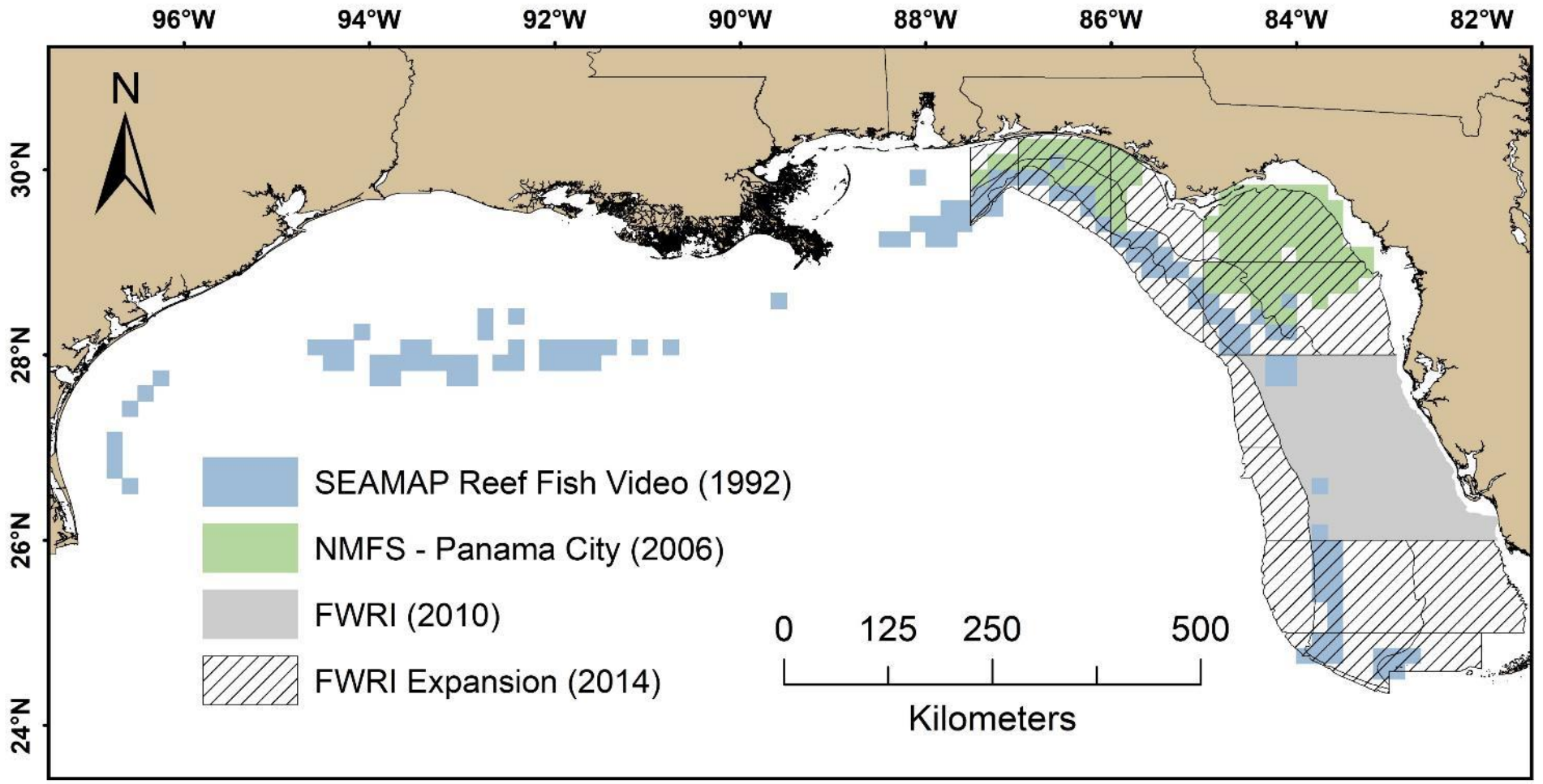


Figure 4. Model-based and design-based estimated mean number of red snapper with standard error for the entire Gulf of Mexico observed during SEAMAP reef fish survey.

'*The survey (i.e. SEAMAP RFV) could be considerably improved by increasing the sampling frame, especially along the Florida shelf. This would require more detailed bathymetric information on reef structure than is currently available.*'

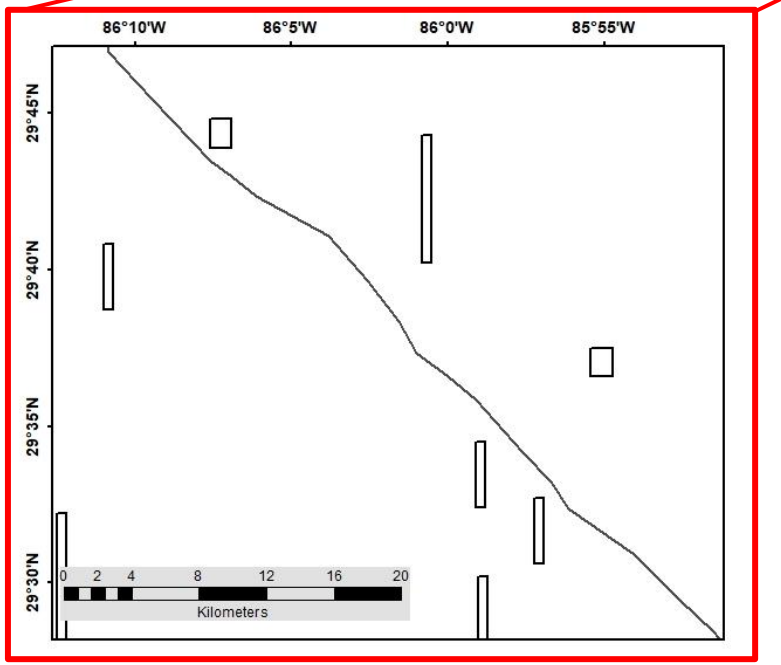
2008 - SEFSC Program Review

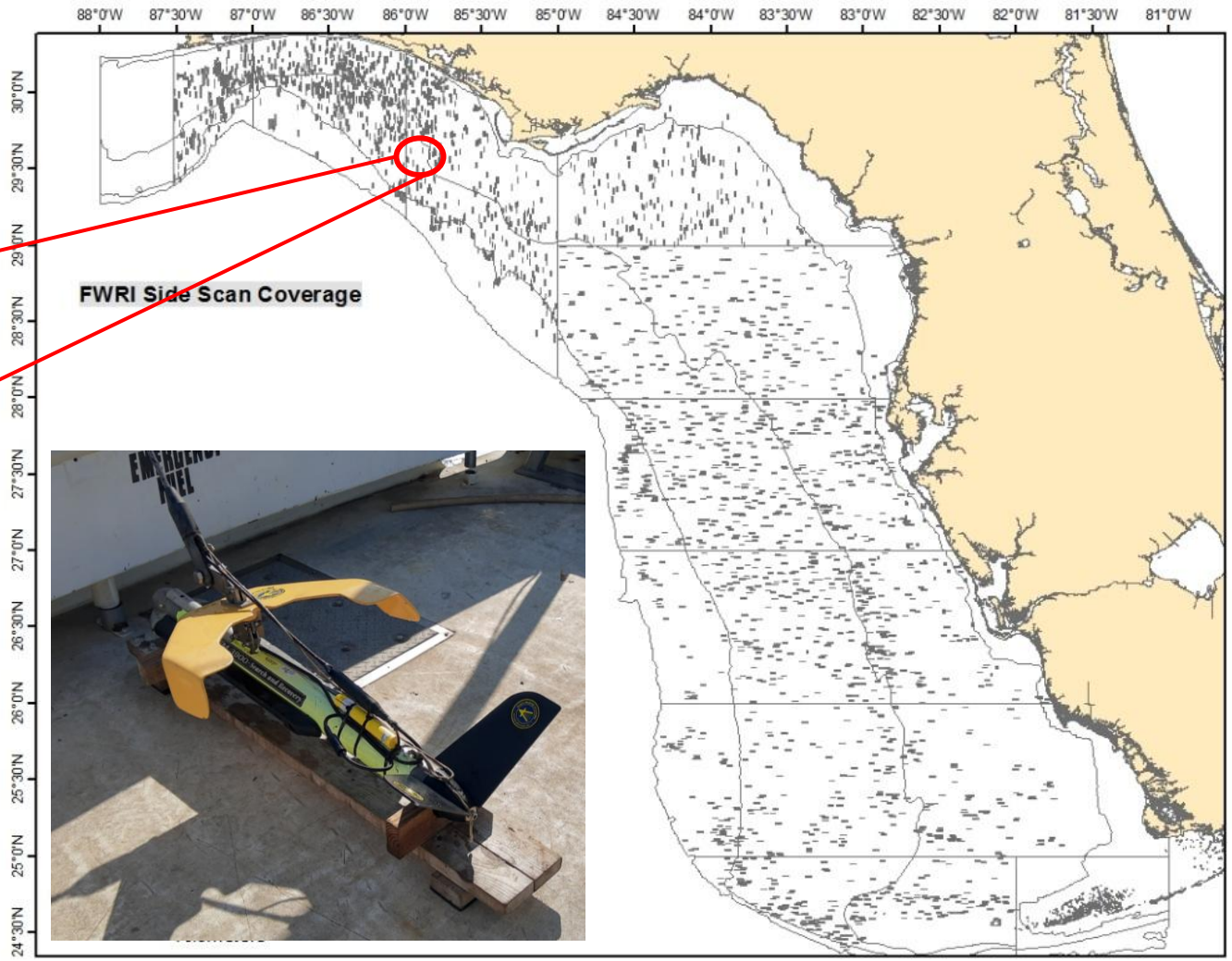
Expansion of Gulf Reef Fish Survey Efforts



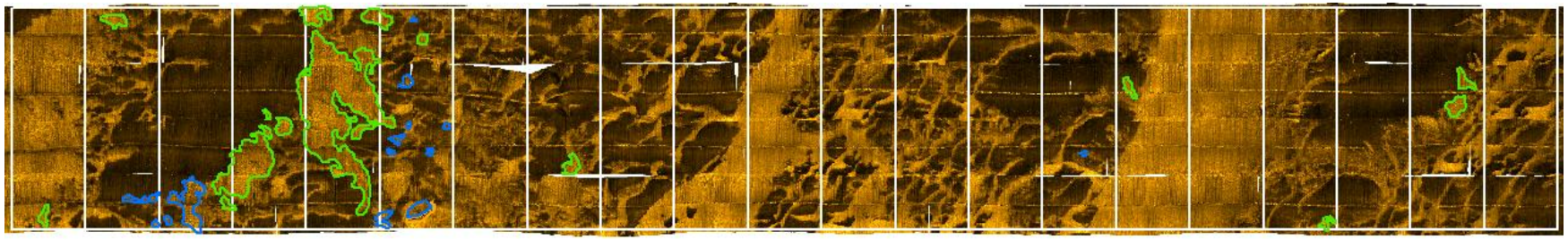
Habitat Mapping

- Eastern Gulf – side scan sonar
- Random surveys – primarily new areas (some rescans)





Habitat Mapping

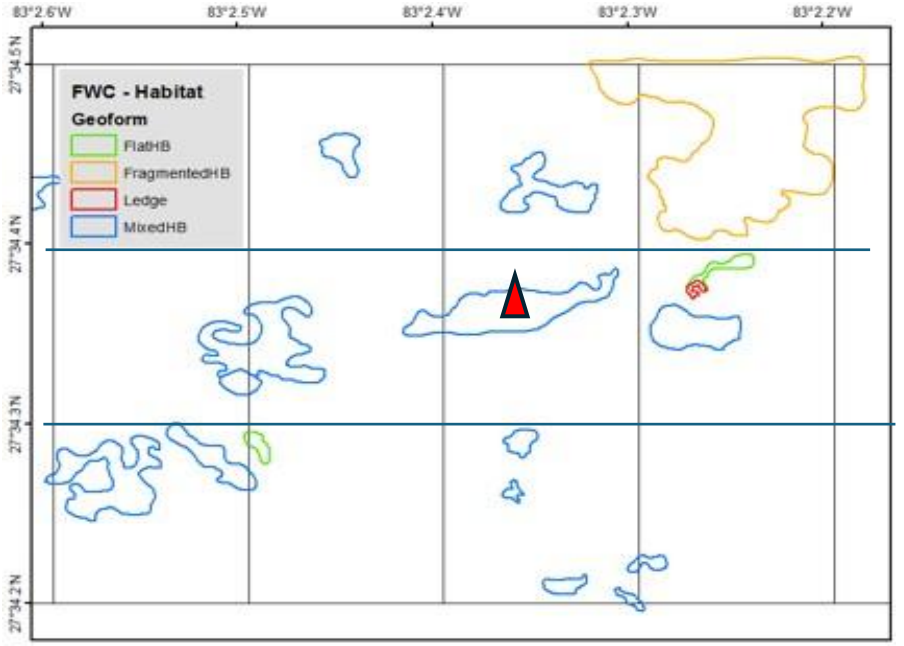


ORIGIN	HABITAT CLASS
Geologic	Boulder/Boulder Field
	Escarpment
	Fragmented Hard Bottom
	Fracture
	Flat Hard Bottom
	Ledge
	Mixed Hard Bottom
	Potholes
	Pinnacle
	Pavement
	Rubble Field
	Spring/Sink Hole
Unknown	Unknown Natural

ORIGIN	HABITAT CLASS
Biogenic	Aggregate Coral Reef
	Aggregation of Patch Reefs
	Individual Patch Reef
	Reef Rubble
	Spur and Groove

ORIGIN	HABITAT CLASS
Anthropogenic	Aircraft
	Cable
	Construction Materials
	Dredged Channel
	Chicken Coop
	Dredge Deposit
	Military Tanks
	Marine Wreckage
	Oil Platform Materials
	Pipeline Area
	Reef Modules
	Rock Piles
	Tires
	Unknown Reef material
	Other Vehicles
	Large vessel/barge
	Small Vessel

- Delineate and classify all reef habitats
- Quantify reef area / composition



Examples of Habitats and Ground Truth Imagery

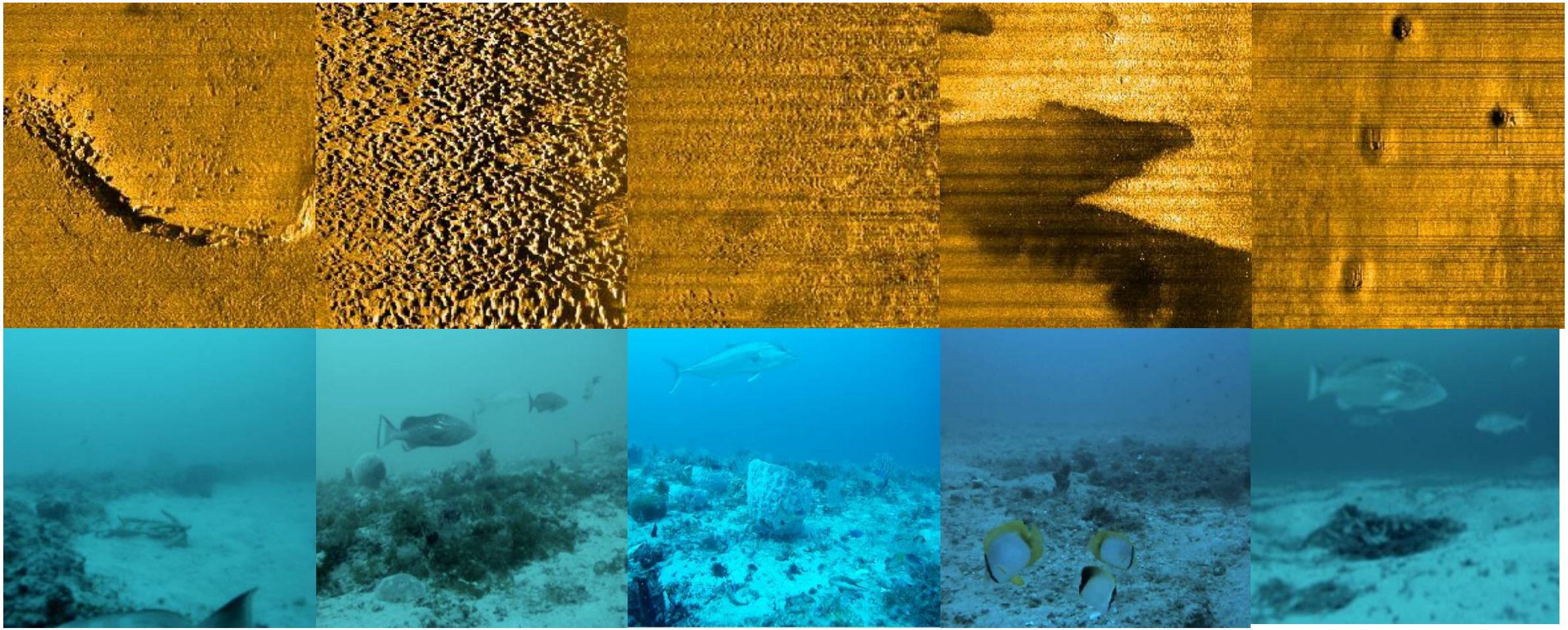
Ledge

Fragmented Hard Bottom

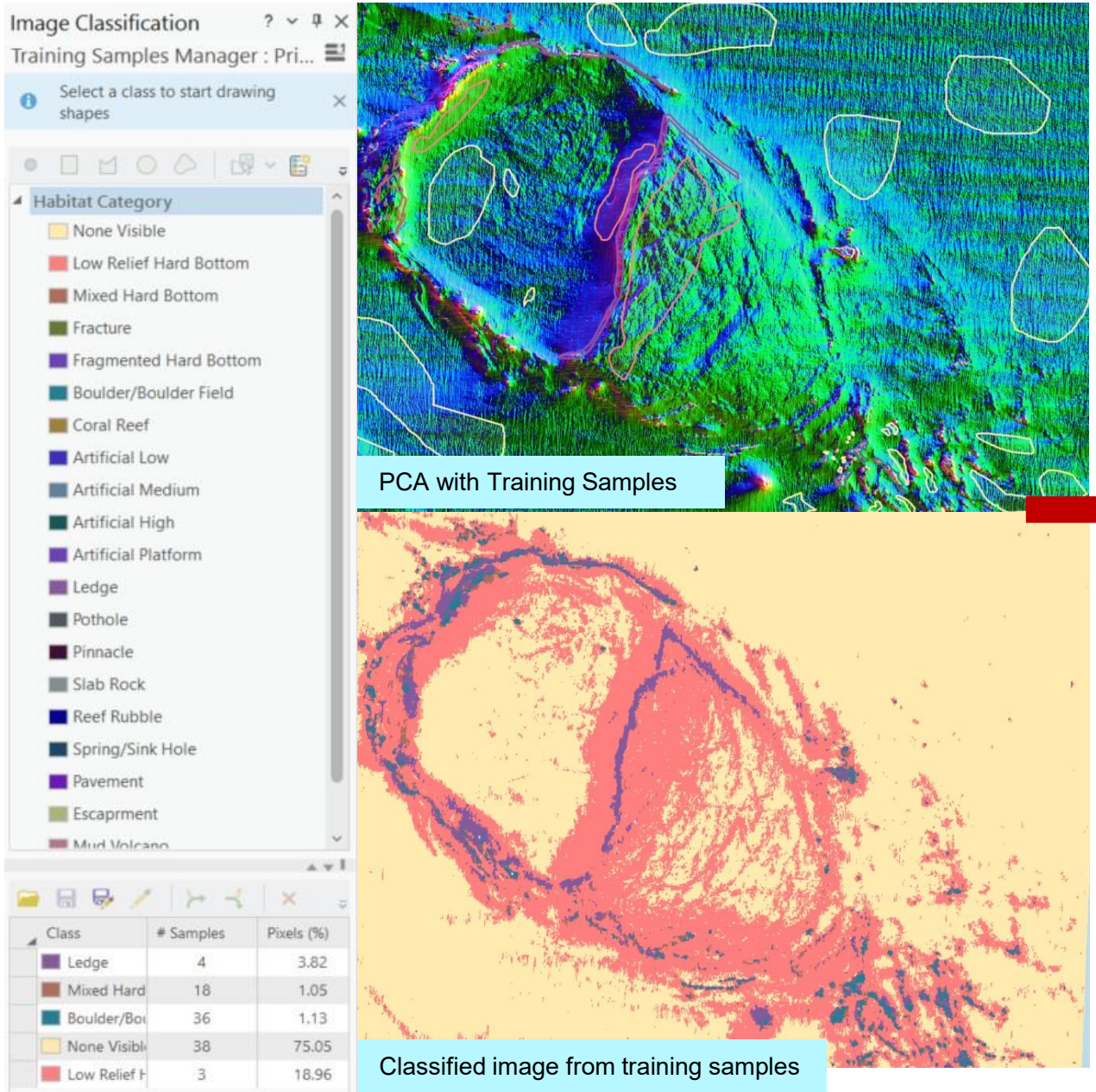
Mixed Hard Bottom

Flat (low-relief) Hard Bottom

Pothole

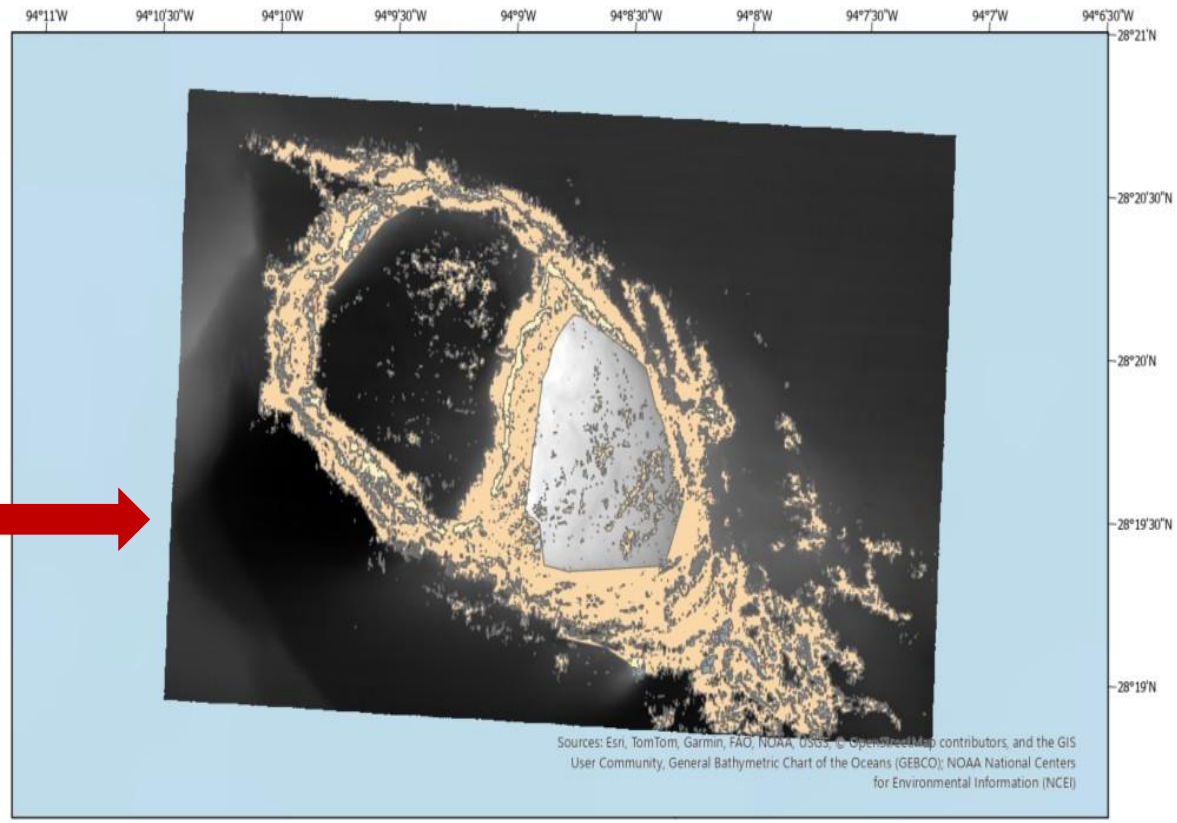


Habitat Mapping



PCA with Training Samples

Classified image from training samples



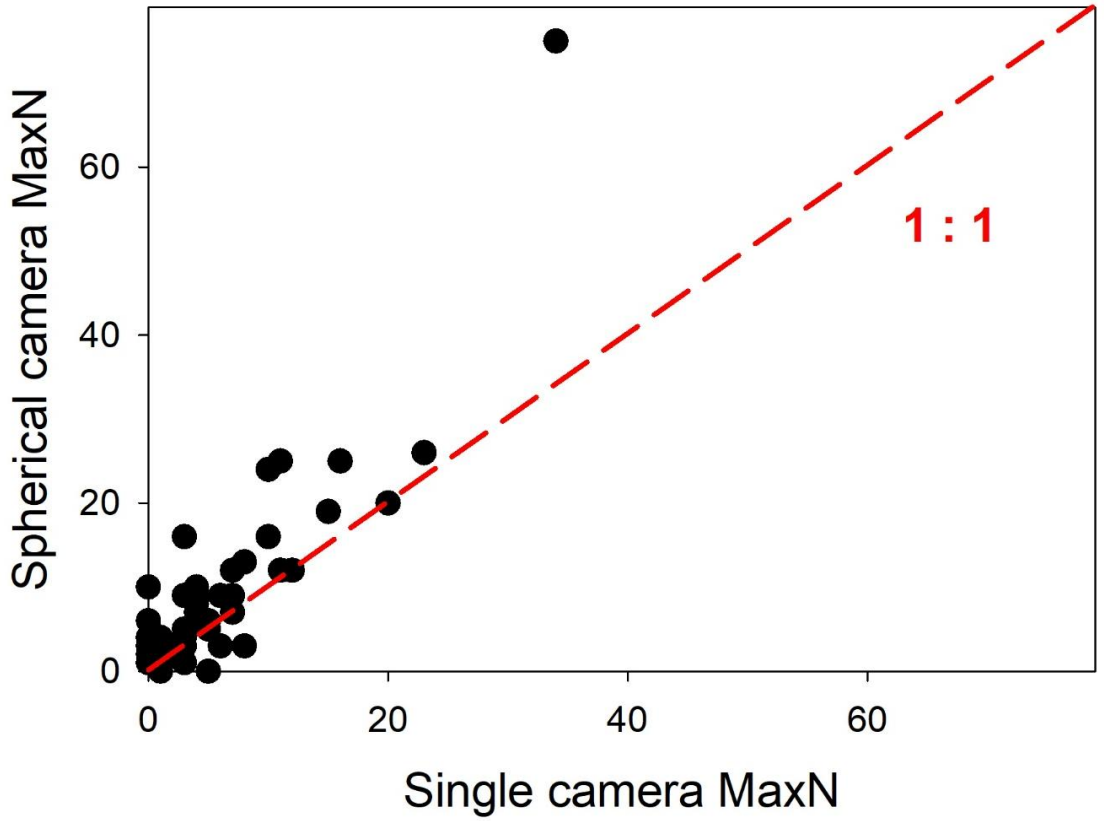
- Western Gulf – side scan / multibeam sonar
- Automated classification – same classes as SSS

Video Collection Methods

- Stereo-baited remote underwater video (S-BRUV) arrays:
  - Deployed for 30+ minutes
  - Baited with Atlantic mackerel / squid
  - Historically, orthogonal cameras (below)
  - More recently, spherical cameras (right)

Video Annotation Methods

- Twenty minutes of single camera video processed for abundance (all taxa)
- MaxN – maximum count on single screen shot
- Habitat metrics (type and composition of substrate and attached biota) quantified

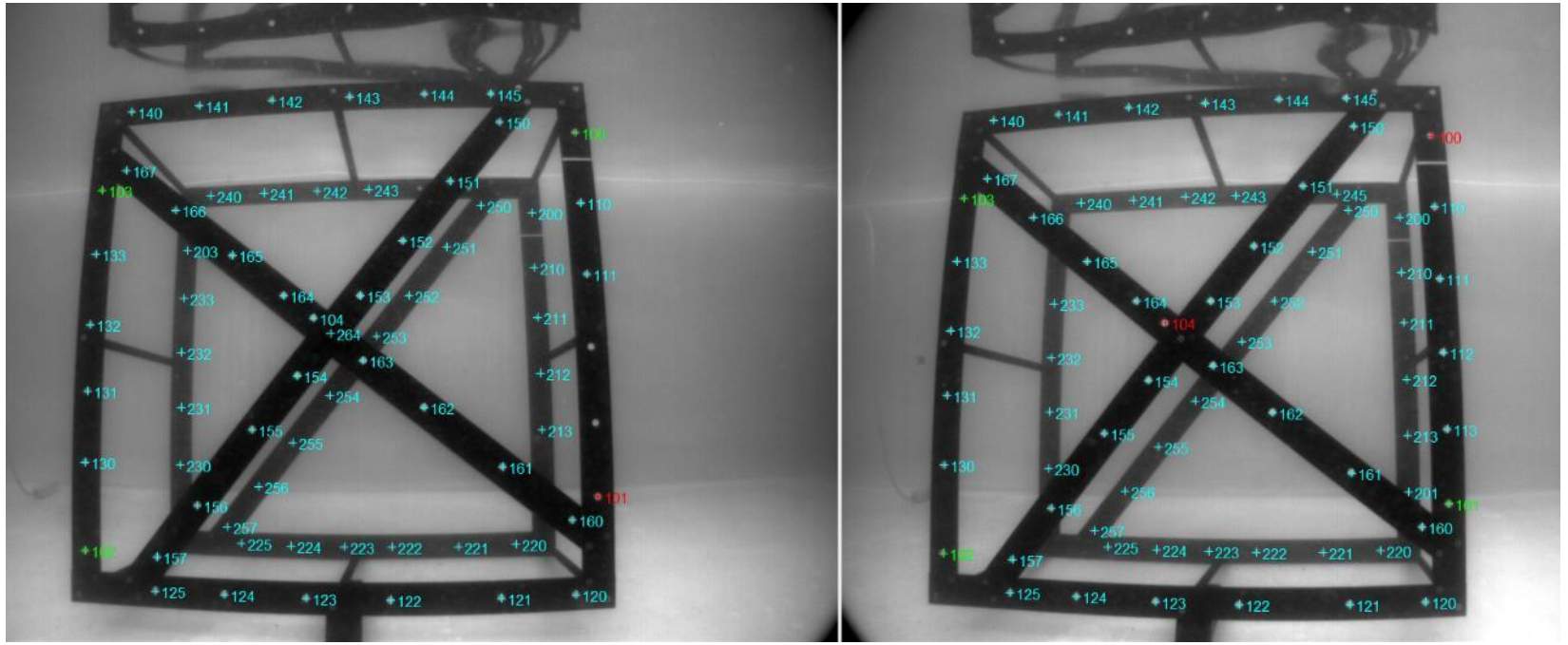


Video Annotation Methods

- Subset of full camera reads – potential biases of single-camera MaxN
- Important for ‘abundance-type’ studies – relative indices not impacted

Video Measurement Methods

- SeaGIS Software
- Quality assurance:
  - Pre- and post-season calibrations
  - Measurement diagnostics
- Measurements ~ fork length



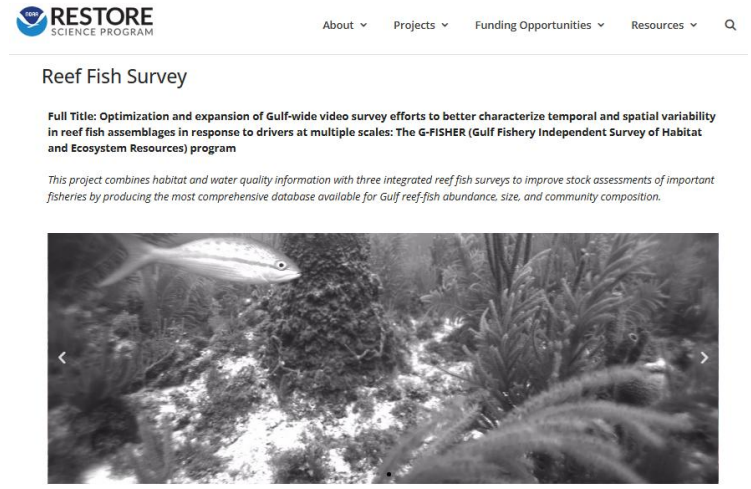
Survey Integration Under Unified Design

NMFS SEAMAP

NMFS Panama City

FWRI

2020



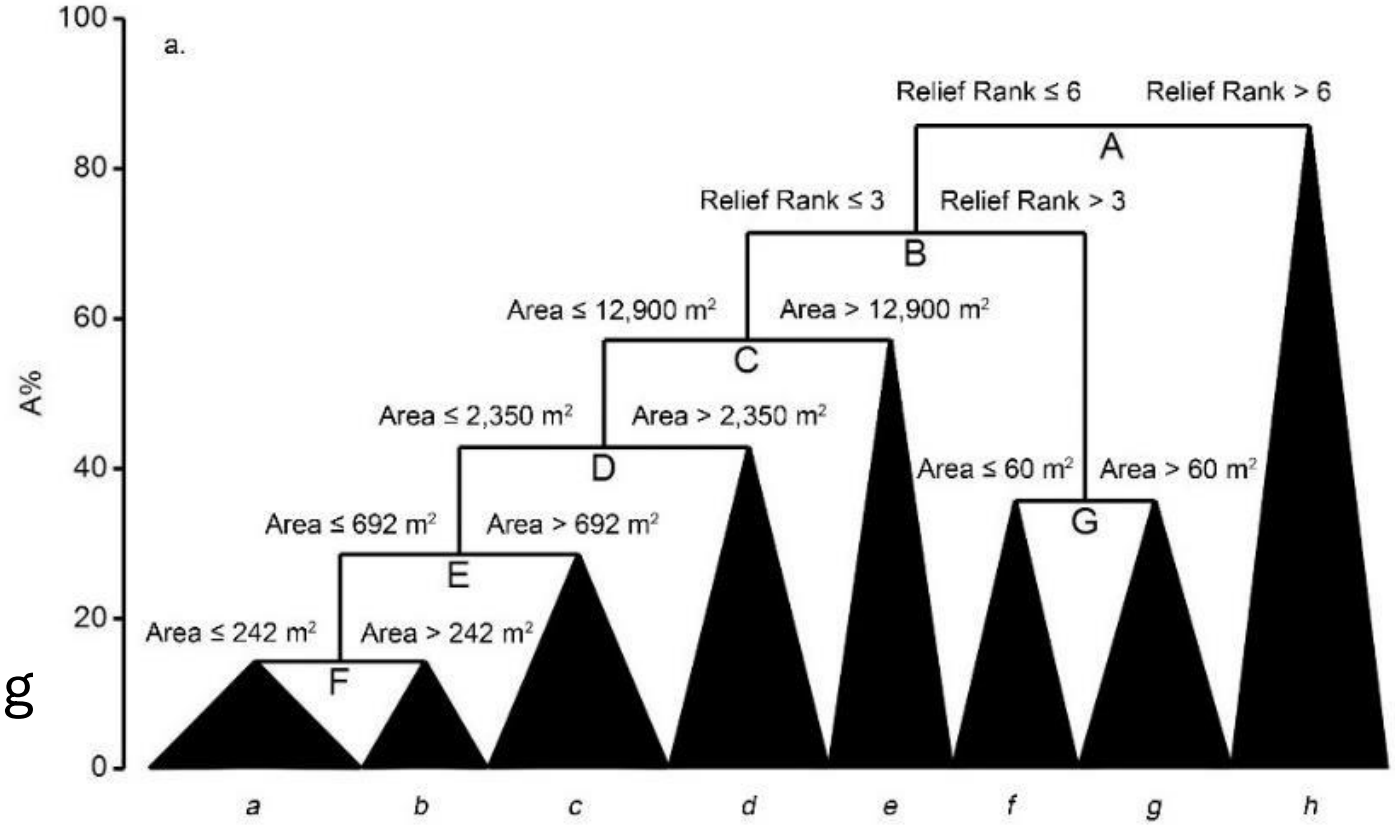
G-FISHER

Gulf Fishery-Independent Survey of Habitat and Ecosystem Resources

G-FISHER Survey Design (Eastern Gulf)

- Assemblage-level analyses (FMP)

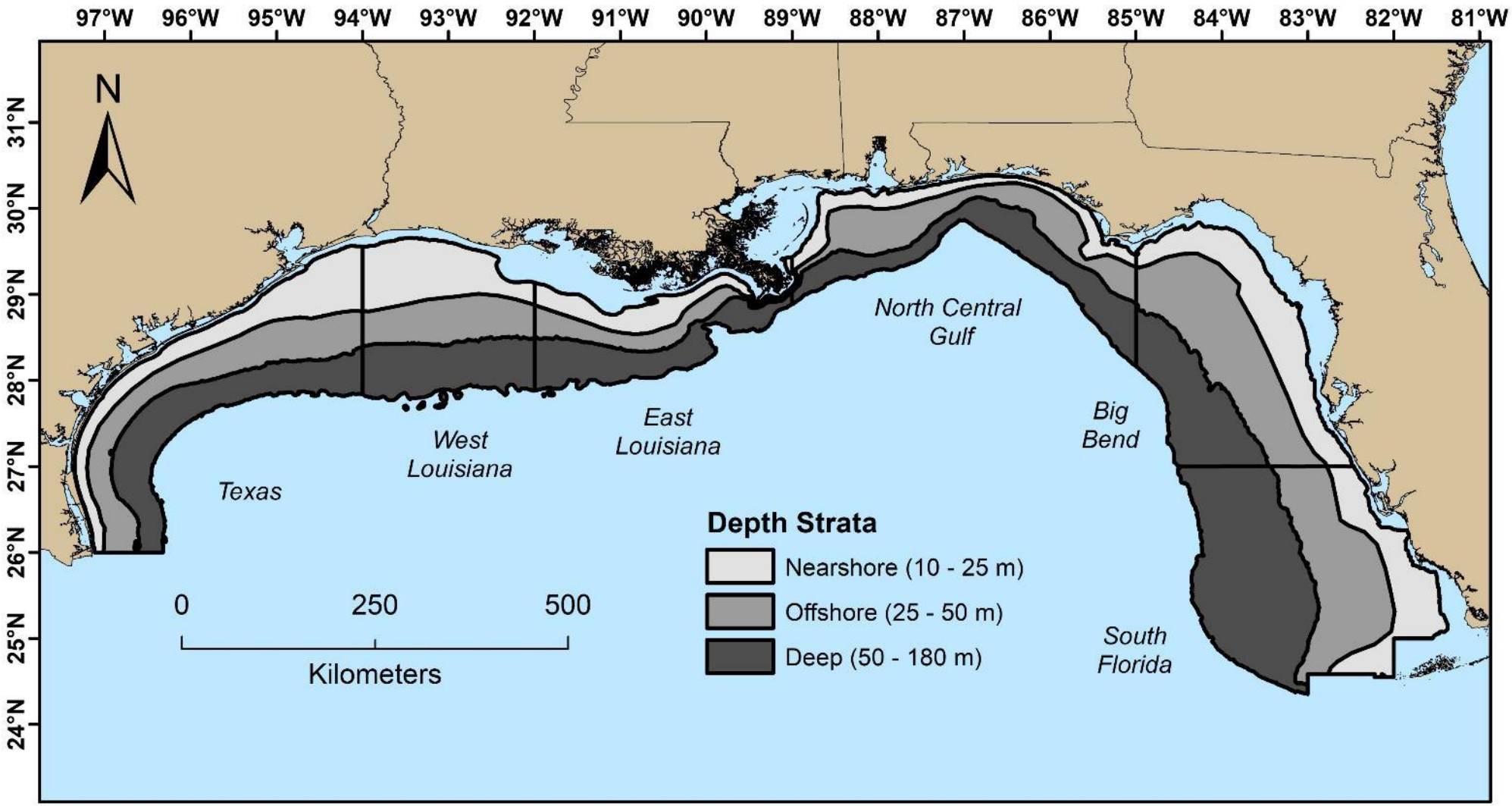
- Analyses to:
  - Define spatial strata → latitude, longitude, depth
  - Define habitat strata → relative relief, areal extent (SSS mapping data)
  - Effort allocation → function of habitat availability, managed species richness



Integrating assemblage structure and habitat mapping data into the design of a multispecies reef fish survey

Theodore S. Switzer[1] | Sean F. Keenan[1] | Kevin A. Thompson[1] | Colin P. Shea[1] | Anthony R. Knapp[2] | Matthew D. Campbell[3] | Brandi Noble[3] | Chris Gardner[4] | Mary C. Christman[5]

G-FISHER Spatial Stratification



Natural Reef Habitat Stratification

Increasing Size of Feature

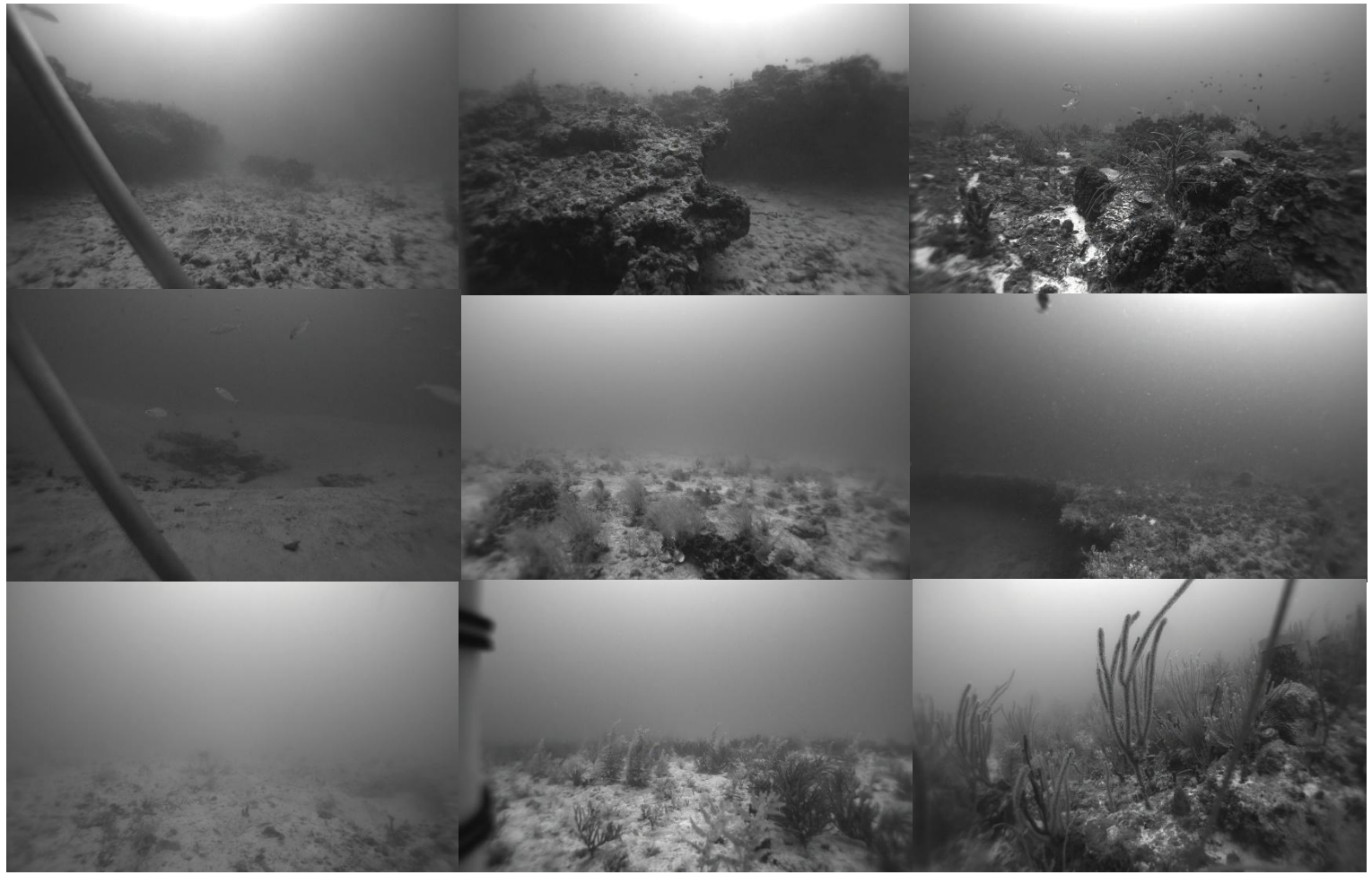
Small | Medium | Large

Increasing Relief

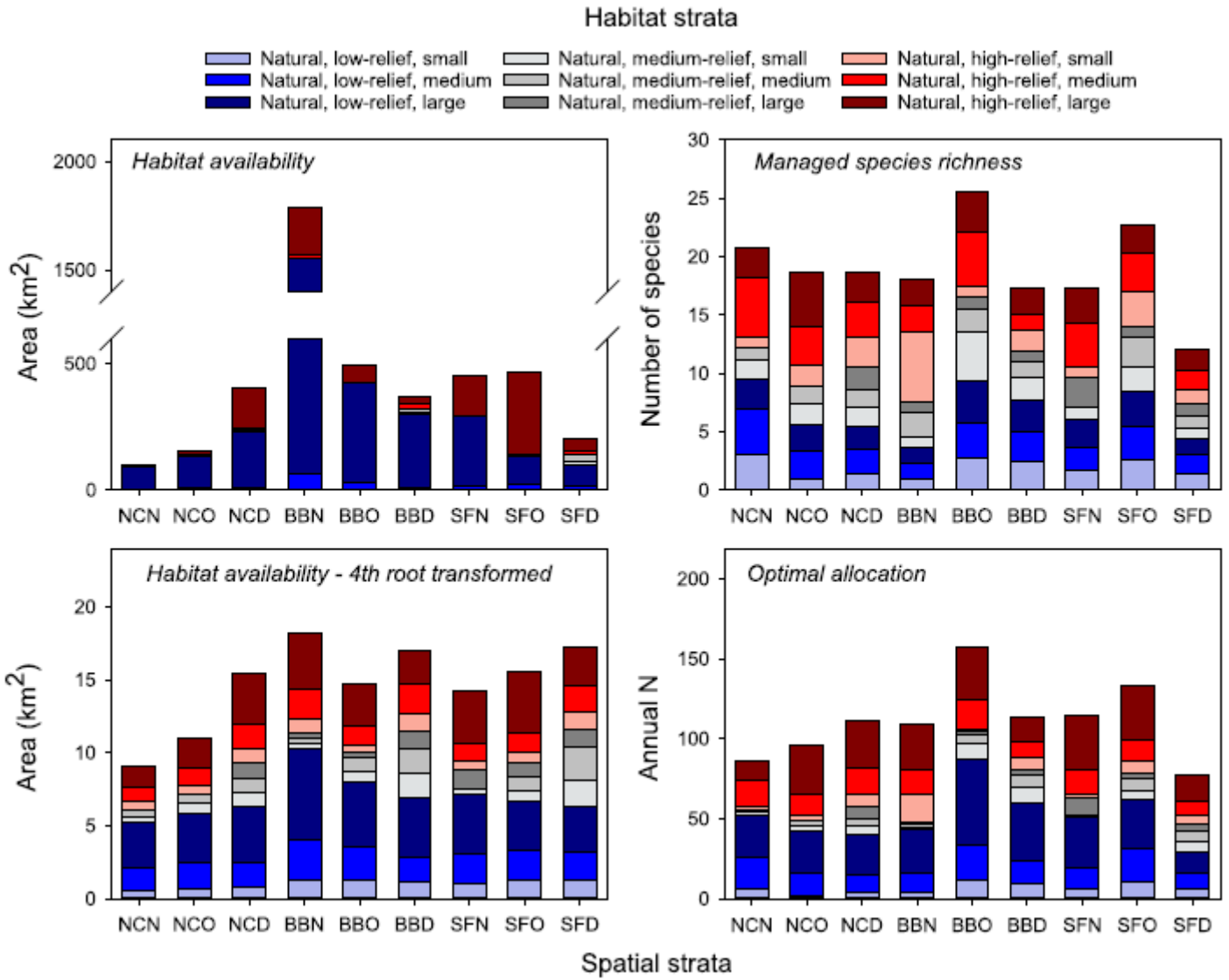
High relief

Moderate relief

Low relief



Natural Reef Effort Allocation



Artificial Reef Habitat Stratification

Increasing Size of Feature

Small | Medium | Large

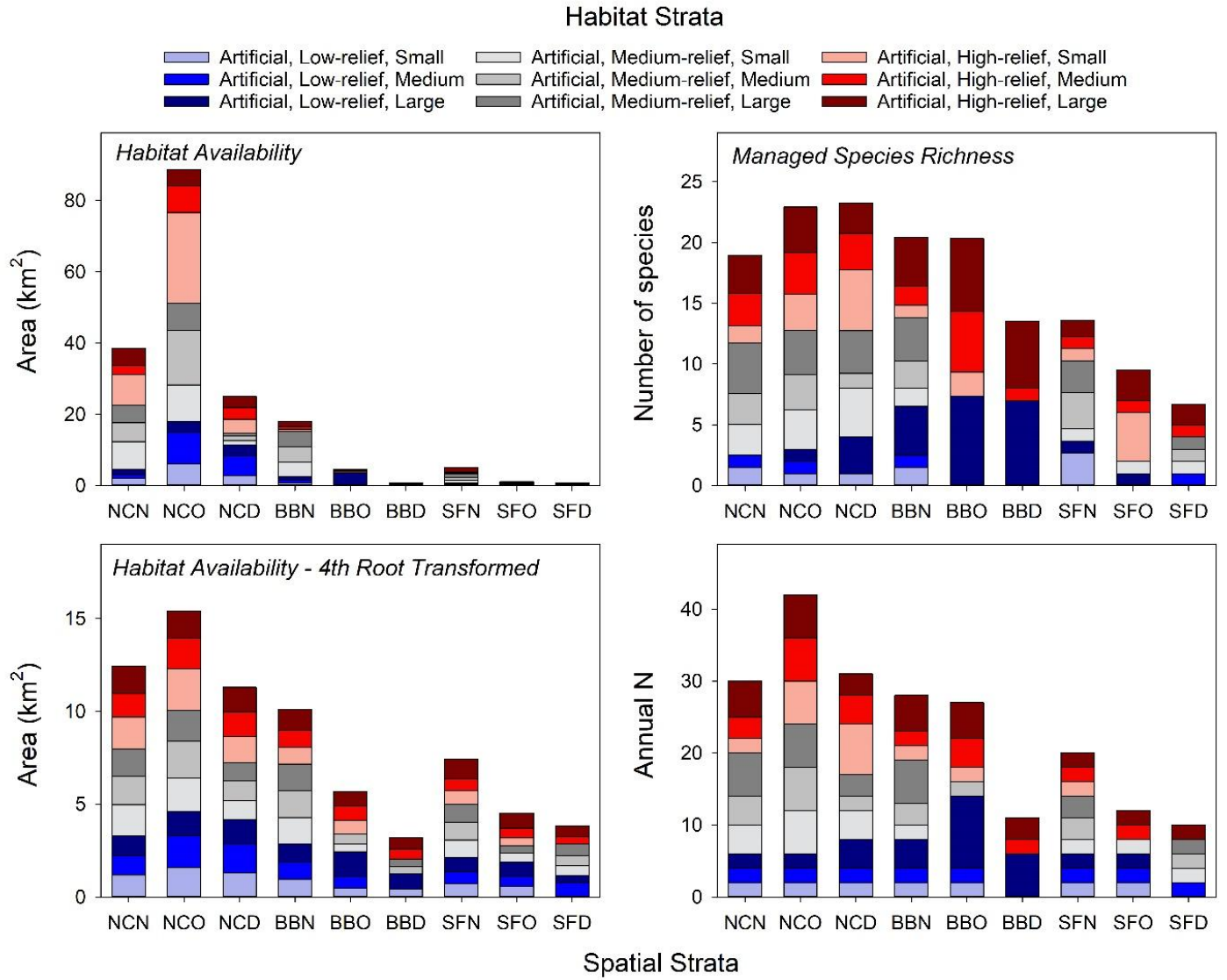
Increasing Relief

High relief

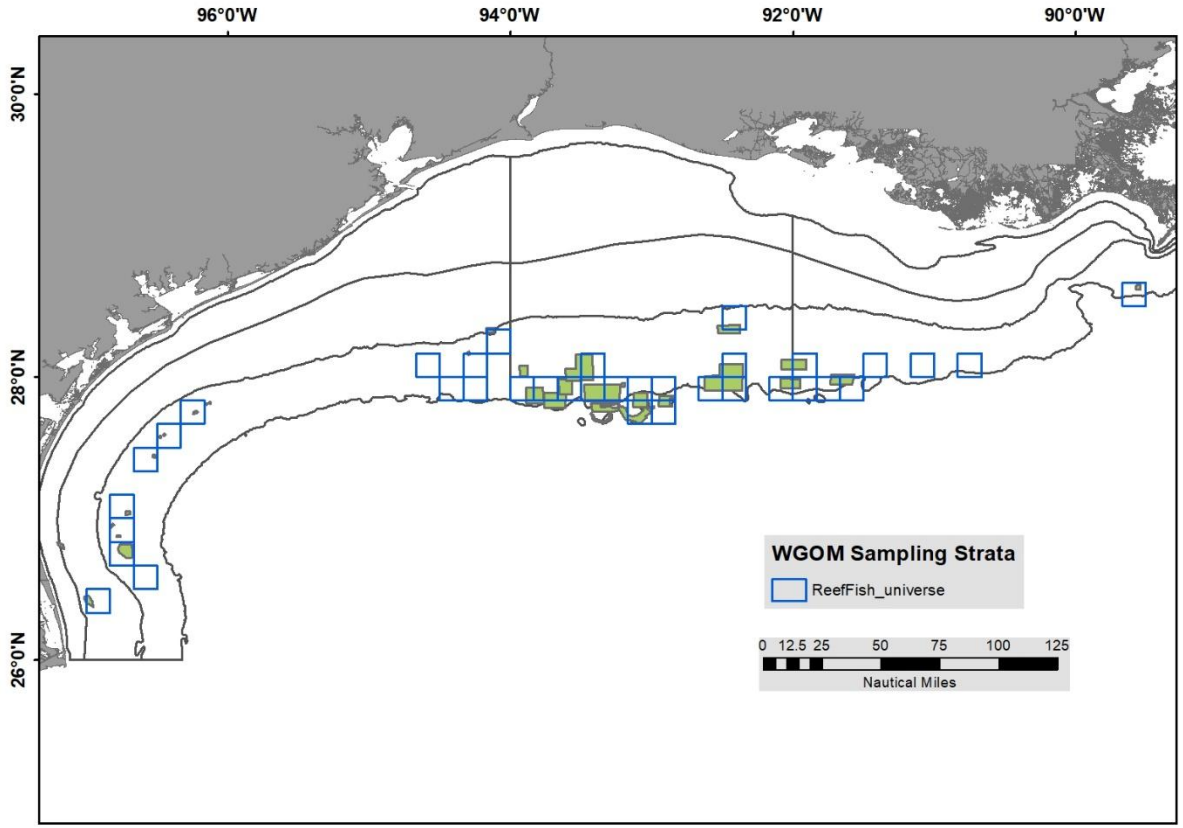
Moderate relief

Low relief

Artificial Reef Effort Allocation

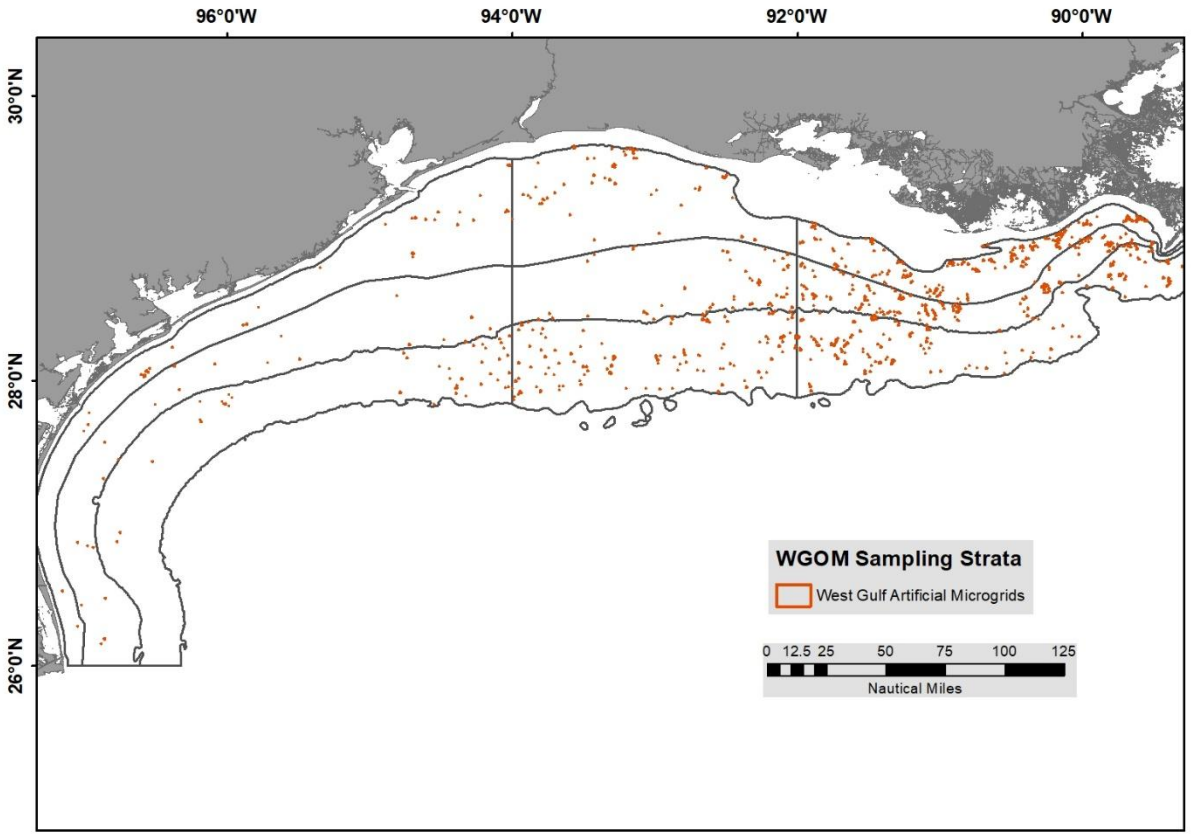


Western Gulf Challenges / Solutions



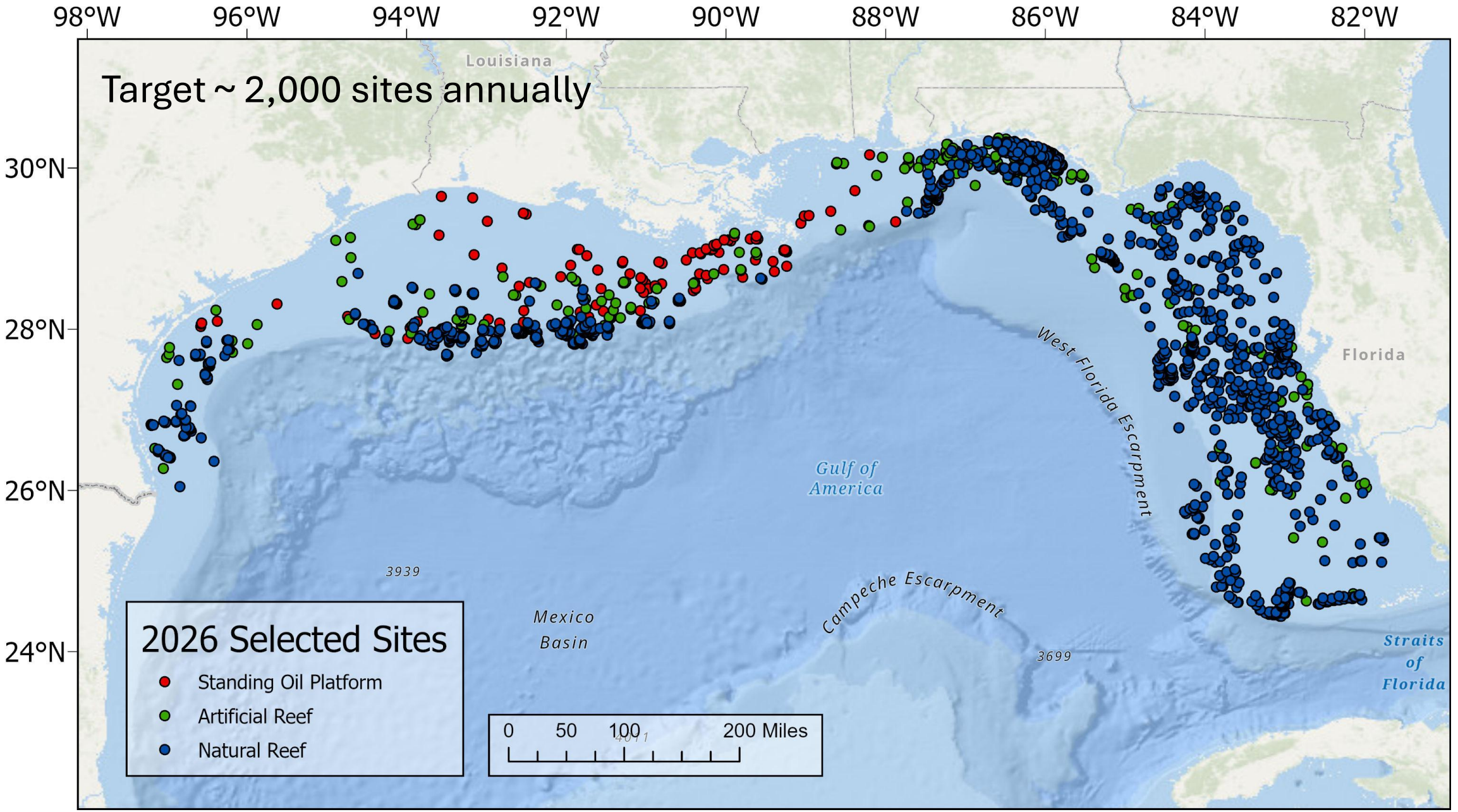
- Limited mapping data:
  - Targeted, not random
  - Spatially restricted
- Fish data lacking for many strata
- Interim approach:
  - Included ‘Unclassified’ natural habitat stratum
  - Effort allocation proportional to habitat availability
  - Adjusted annually (with new mapping data)

Western Gulf Challenges / Solutions

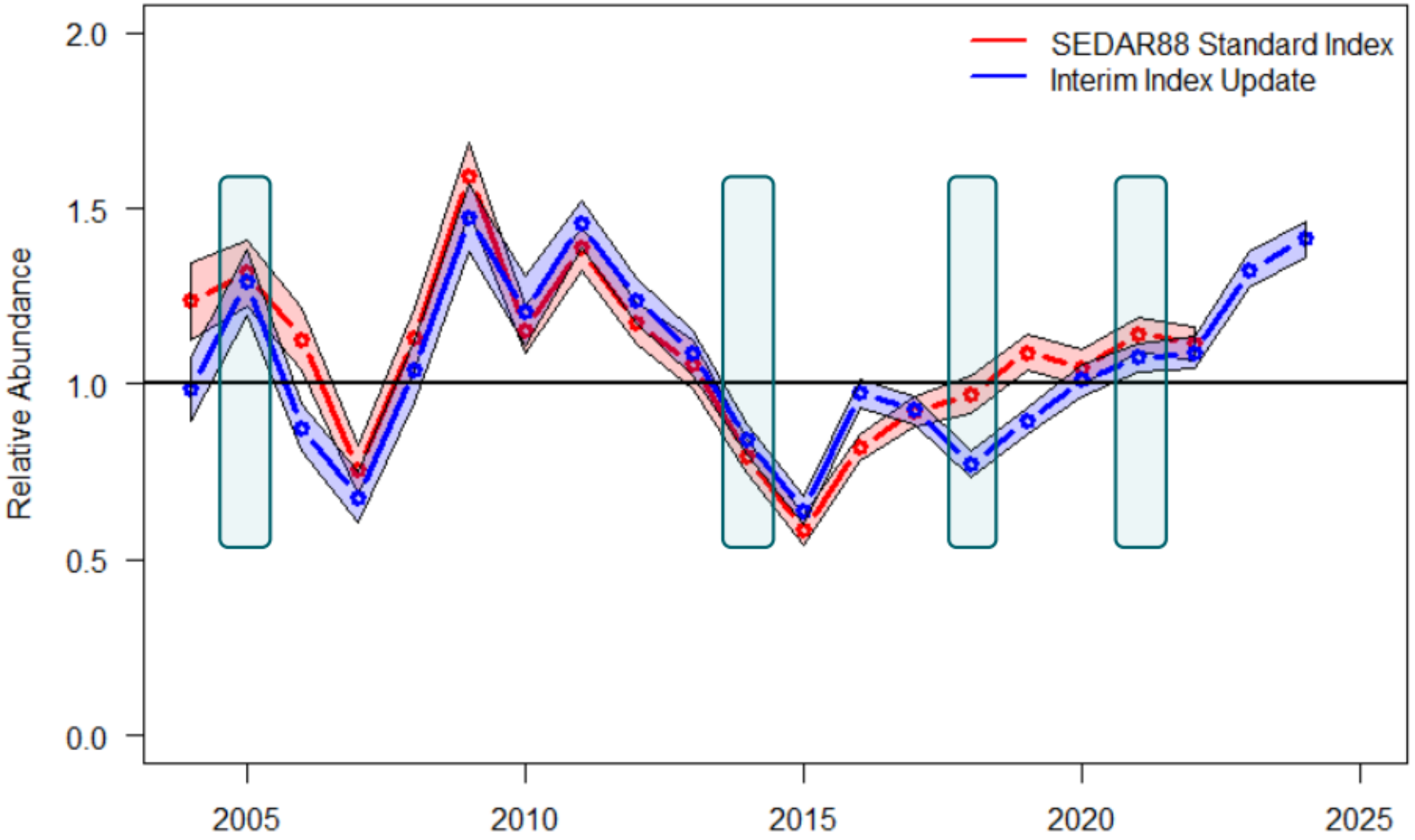


- For artificial reefs, compiled available information
  - Platforms
  - Artificial reefs
  - Pipelines

- Similar to natural reefs, effort proportional to availability


Target ~ 2,000 sites annually
98°W
96°W
94°W
92°W
90°W
88°W
86°W
84°W
82°W
30°N
28°N
26°N
24°N
Louisiana
Florida
West Florida Escarpment
Gulf of America
Campeche Escarpment
Mexico Basin
Straits of Florida
3939
3699
2026 Selected Sites
Standing Oil Platform
Artificial Reef
Natural Reef
0
50
100
200 Miles

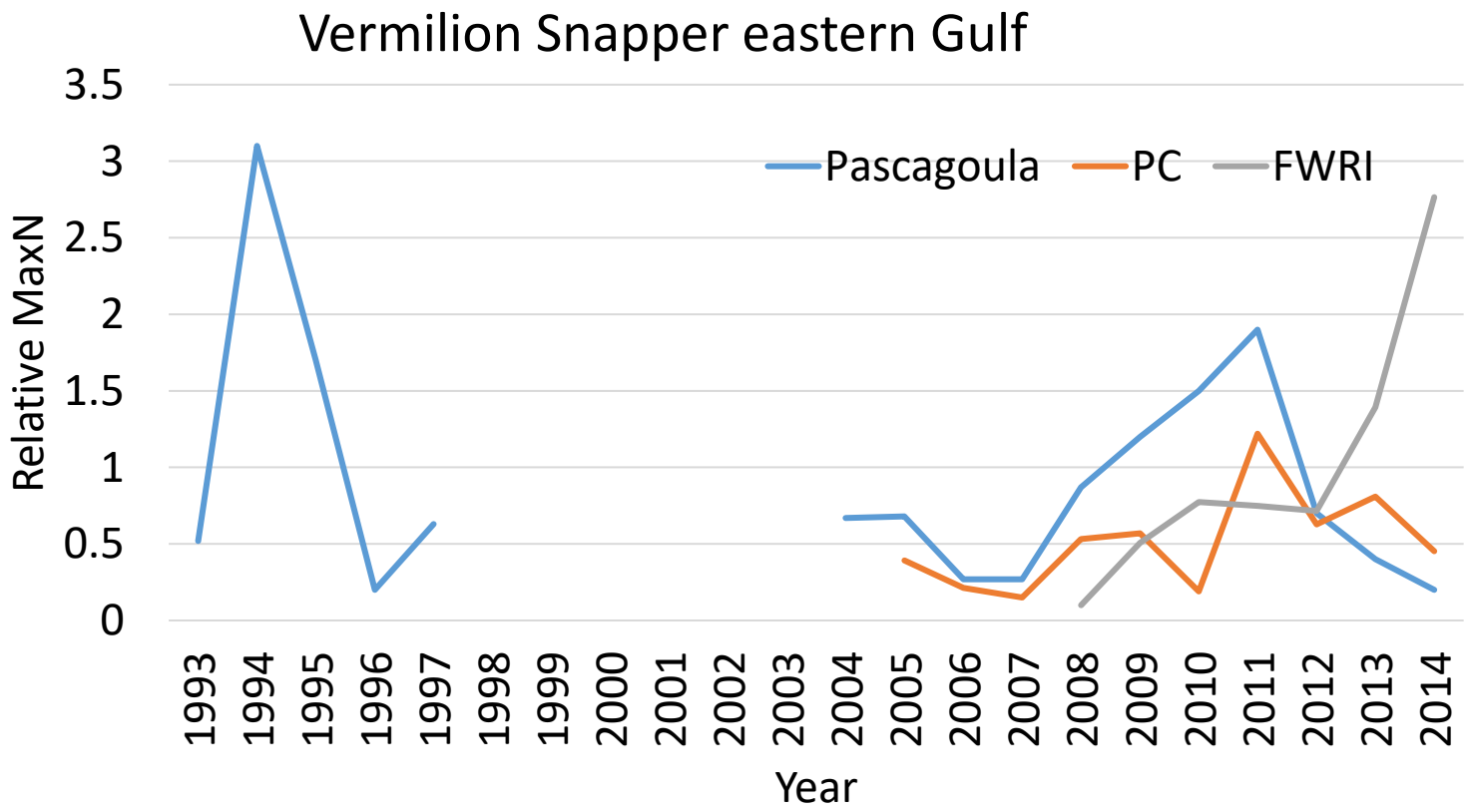
Part II. Application



Application – Assessment and Management

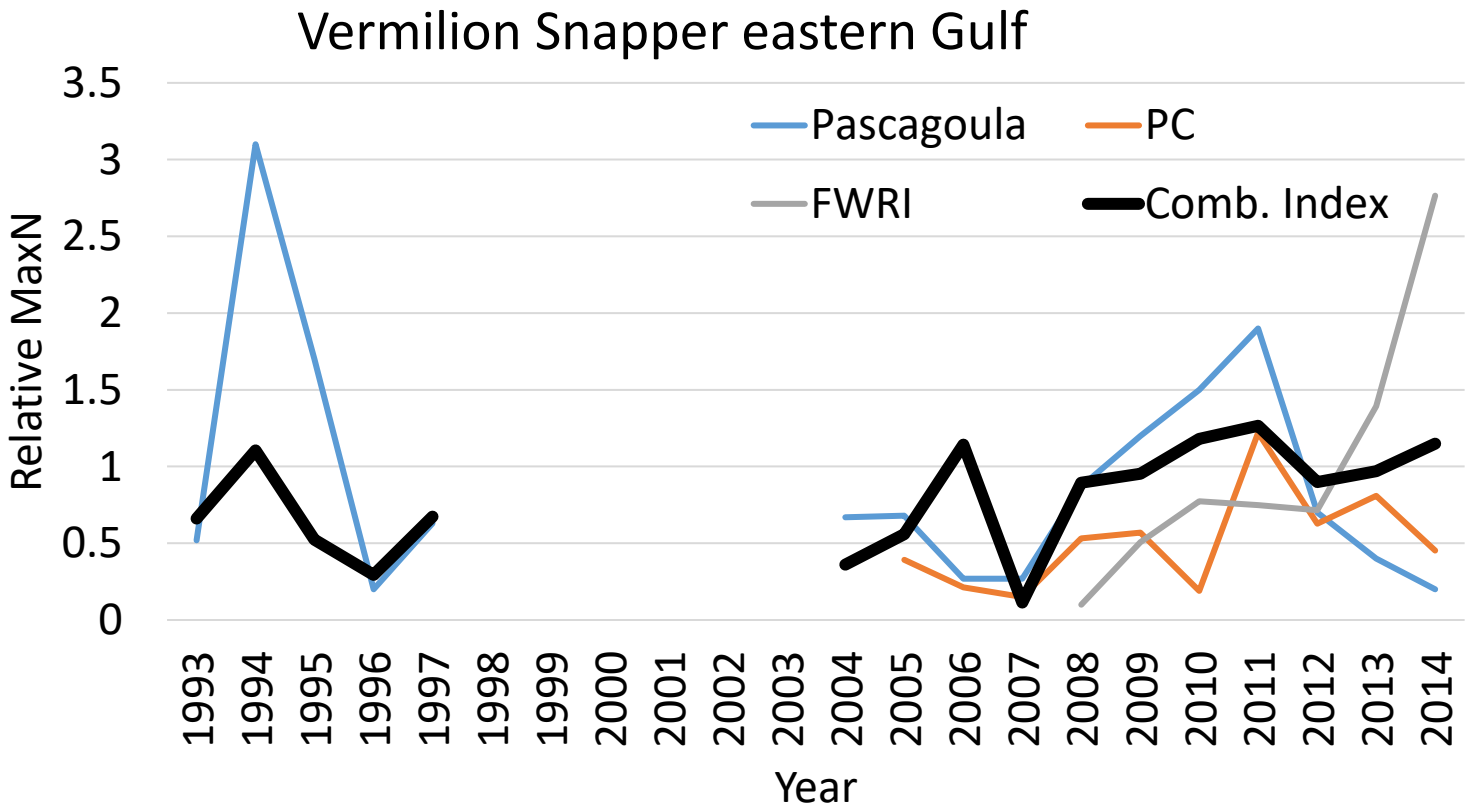
- Indices of relative abundance – key inputs for assessment / interim analyses

- Historically, separate indices for each survey:
  - Conflicting trends
  - Often defaulted to SEAMAP / Pascagoula due to length of time series



Application – Assessment and Management

- Approach developed to combine data into a single index
  - Accommodates differences in explanatory variables
- Extended to include data from G-FISHER



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journal homepage: www.elsevier.com/locate/fishres

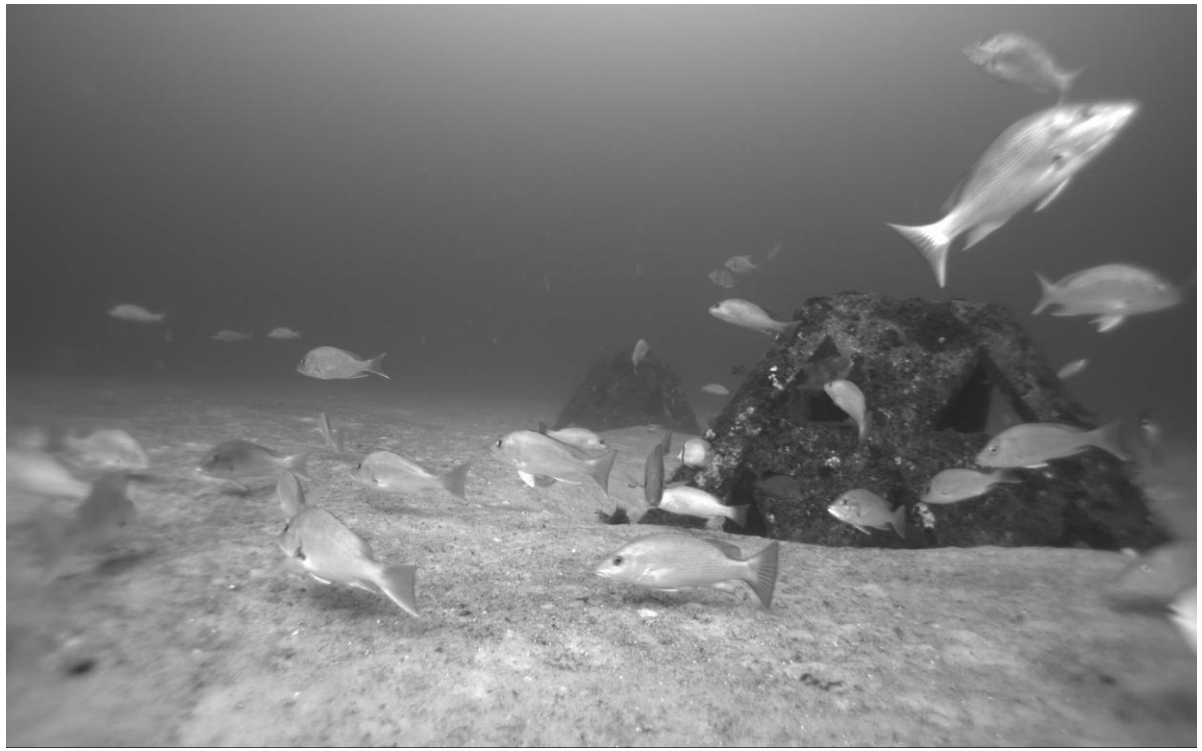
A novel habitat-based approach for combining indices of abundance from multiple fishery-independent video surveys

Kevin A. Thompson [a,*], Theodore S. Switzer [a], Mary C. Christman [b], Sean F. Keenan [a], Christopher L. Gardner [c], Katherine E. Overly [c], Matt D. Campbell [d]

Combined Video Index ≈ G-FISHER Index

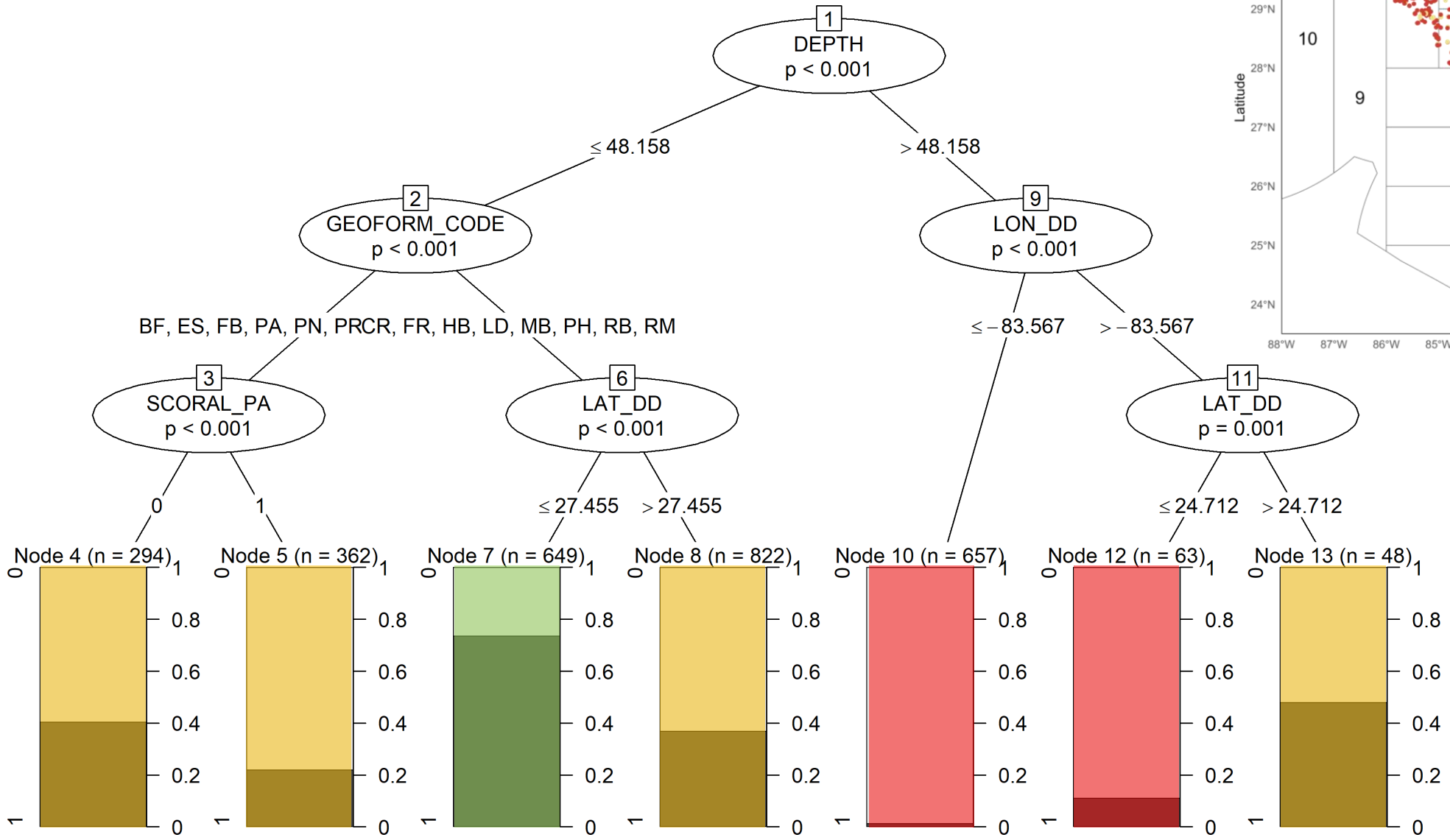
Index Methods

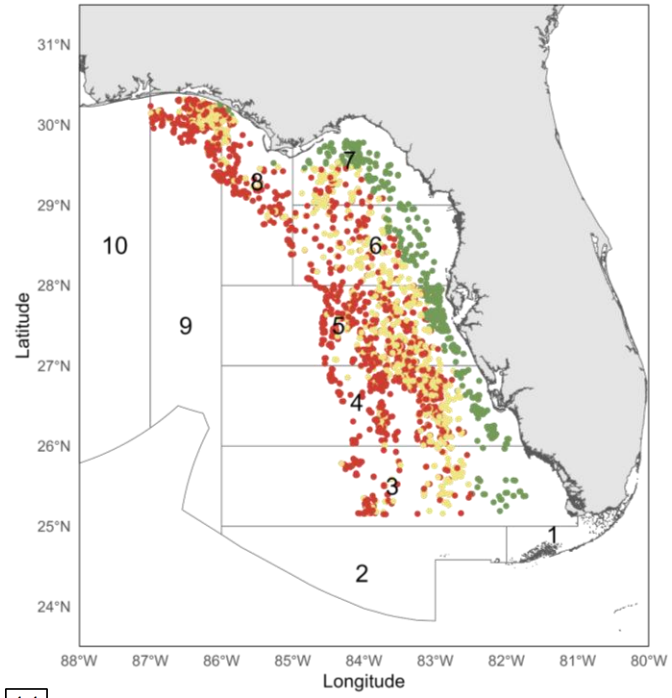
- A weighted design-based index
- Classification and regression trees (CART) on presence / absence data
- Post-stratify each survey based on proportion positive:
  - Low (less than 0.5X average proportion positive)
  - Medium
  - High (2X plus average proportion positive)



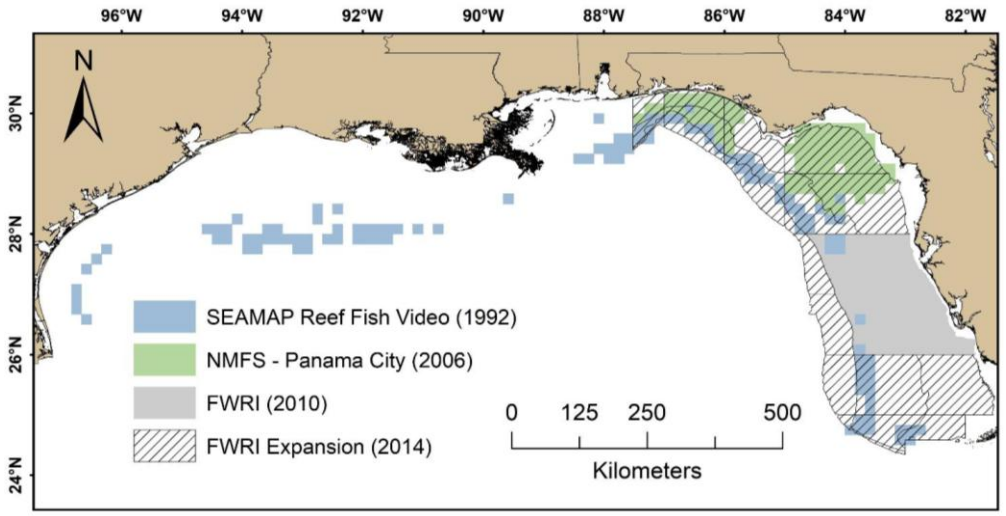
Species(P/A) ~ Depth + Latitude + Longitude + Habitat Strata + Max Vertical Relief + Geoform + GenHab + Algae + Hard coral + Soft coral + Seagrass + Sponge + Unknown sessile + Rock + Sediment + Relief + Artificial

CART Output Example

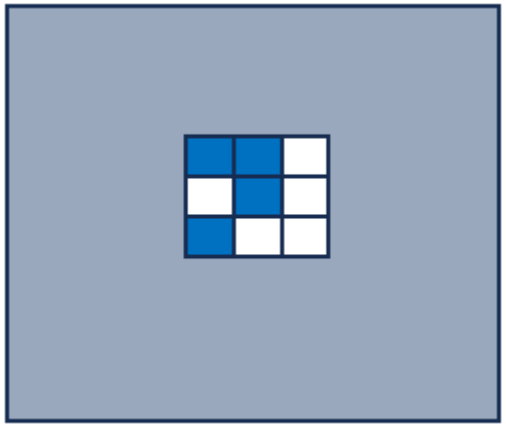


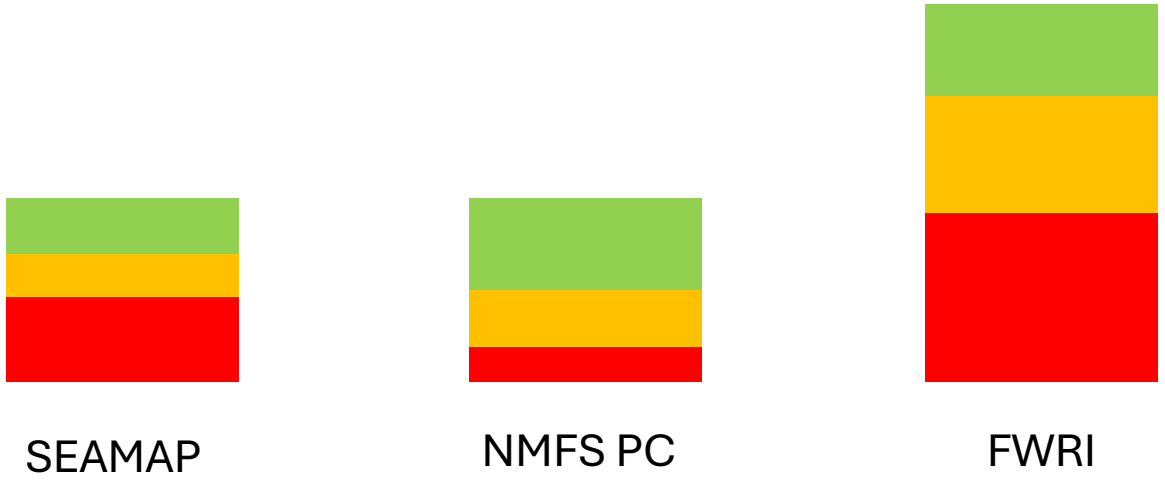


Habitat Weighting



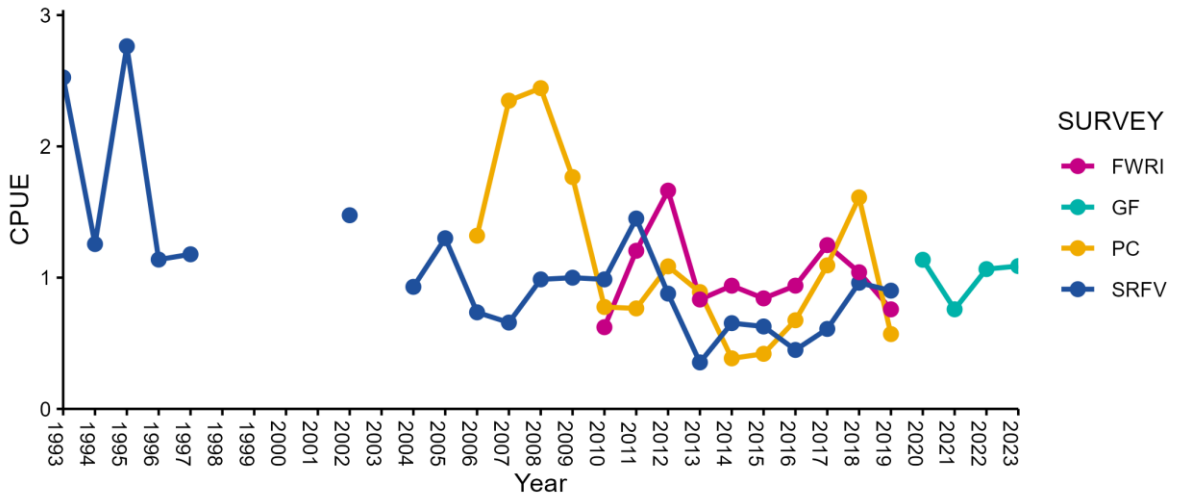
- Estimate total area coverage for each survey domain
- Calculate percentage of reef habitat (at microgrid scale) based on random mapping data – estimate total reef coverage
- Partition proportionally among strata (historical data only)

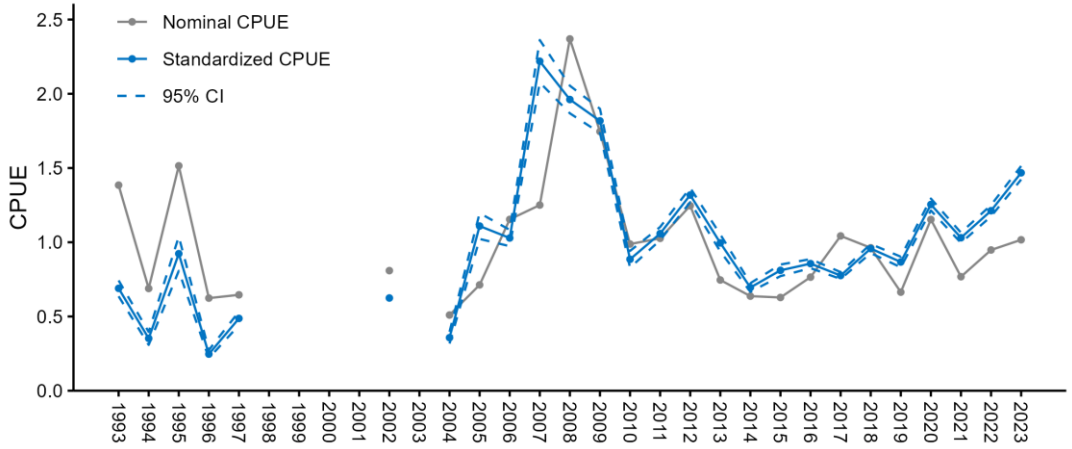




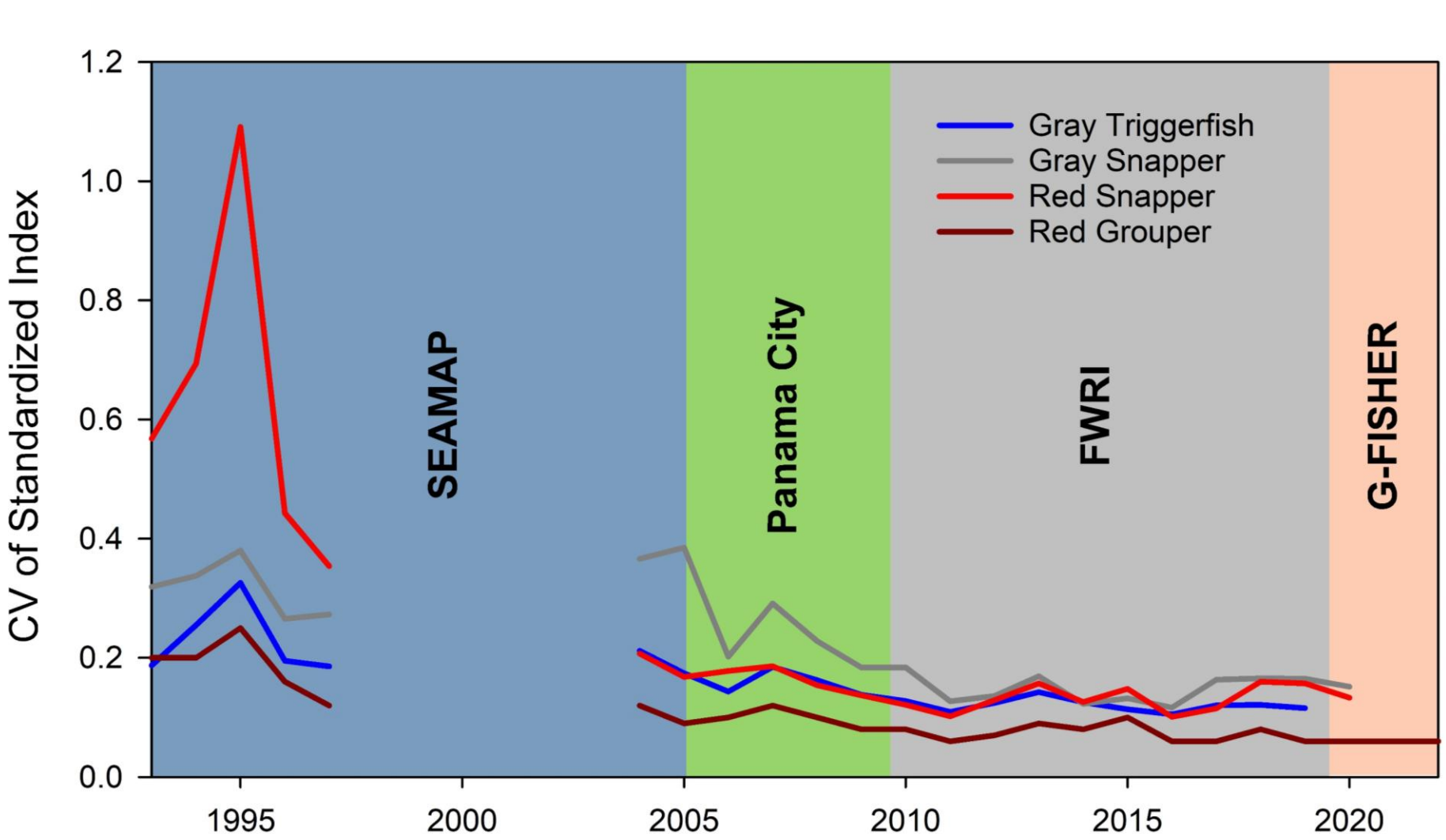
Final Index Values

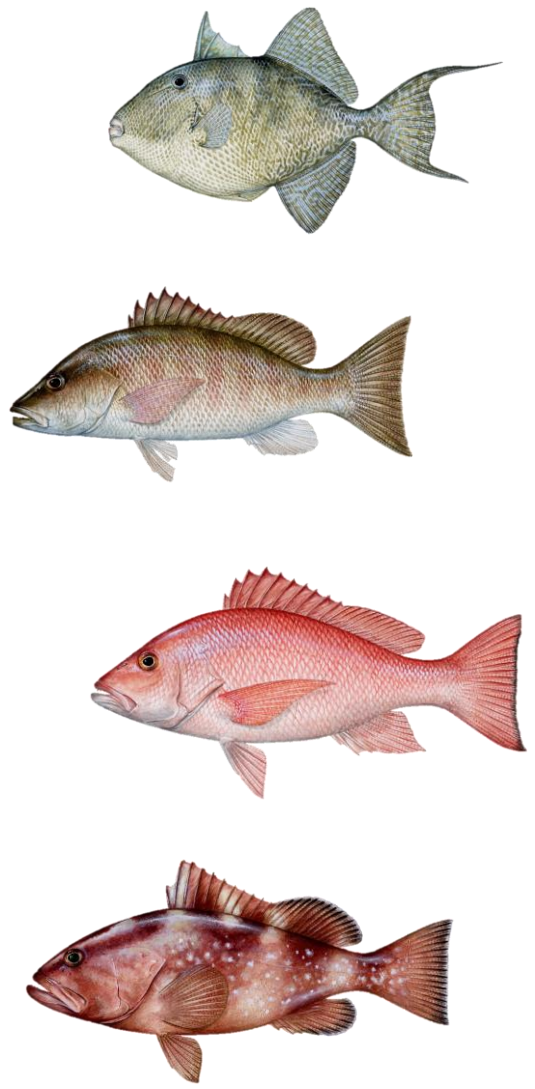
- Relative abundance data (MaxN)
- Weighted average at the stratum level
  - Year x Survey x Stratum
- Weighted by habitat proportion
  - Annual weights scaled to sum to 1
- Negative binomial error distribution



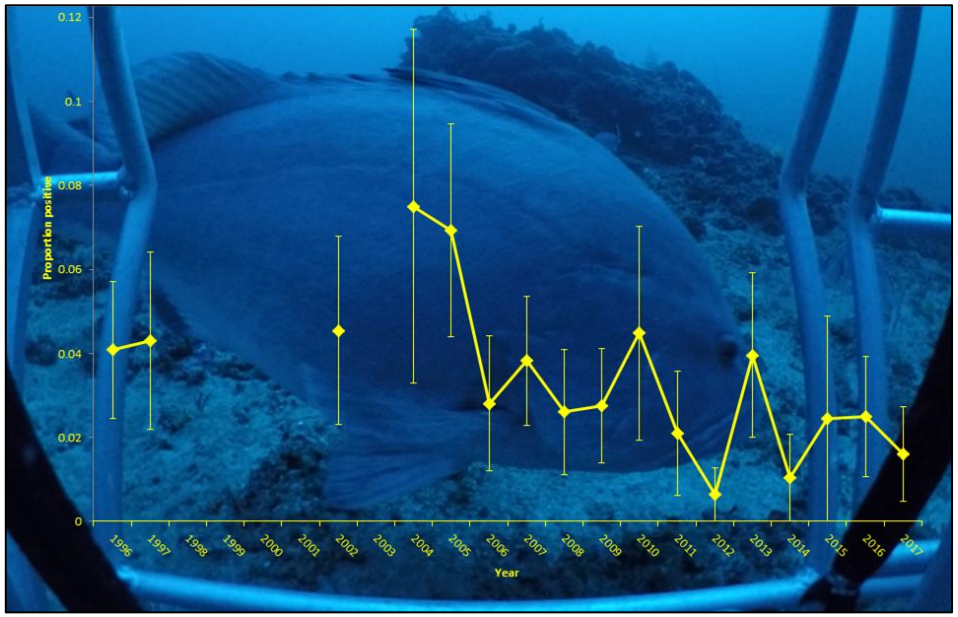


Benefits of Data Integration





Assessment Contributions (pre G-FISHER)



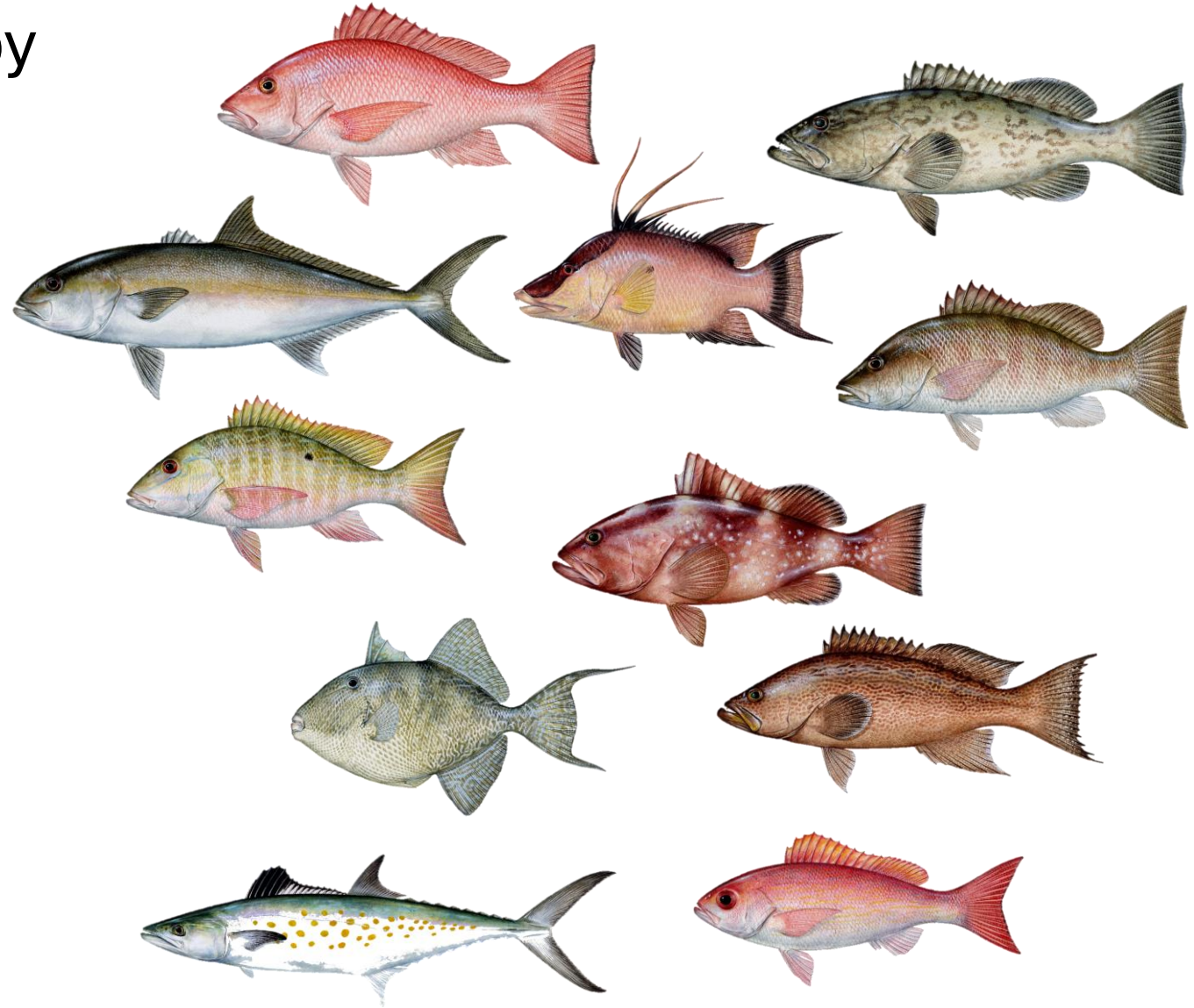
Survey: Species, Assessments:

SMRFV: 20, 36
PCV: 13, 22
FWC: 10,19

Red Snapper	(4)	(3)	(3)
Gray Triggerfish	(3)	(2)	(2)
Greater Amberjack	(3)	(2)	(2)
Vermilion Snapper	(3)	(2)	(2)
Gag	(3)	(2)	(2)
Red Grouper	(3)	(3)	(2)
Gray Snapper	(2)	(1)	(2)
Yellowtail Snapper	(2)	(0)	(0)
Mutton Snapper	(2)	(0)	(1)
Scamp	(1)	(1)	(2)
Black Grouper	(1)	(0)	(1)
Hogfish	(1)	(1)	(0)
Almaco Jack	(1)	(1)	(0)
Lane Snapper	(1)	(1)	(0)
Lesser Amberjack	(1)	(1)	(0)
Snowy Grouper	(1)	(0)	(0)
Speckled Hind	(1)	(0)	(0)
Wenchman Snapper	(1)	(0)	(0)
Yellowmouth Grouper	(1)	(0)	(0)
Black Sea Bass	(0)	(2)	(0)
Total	(36)	(22)	(19)

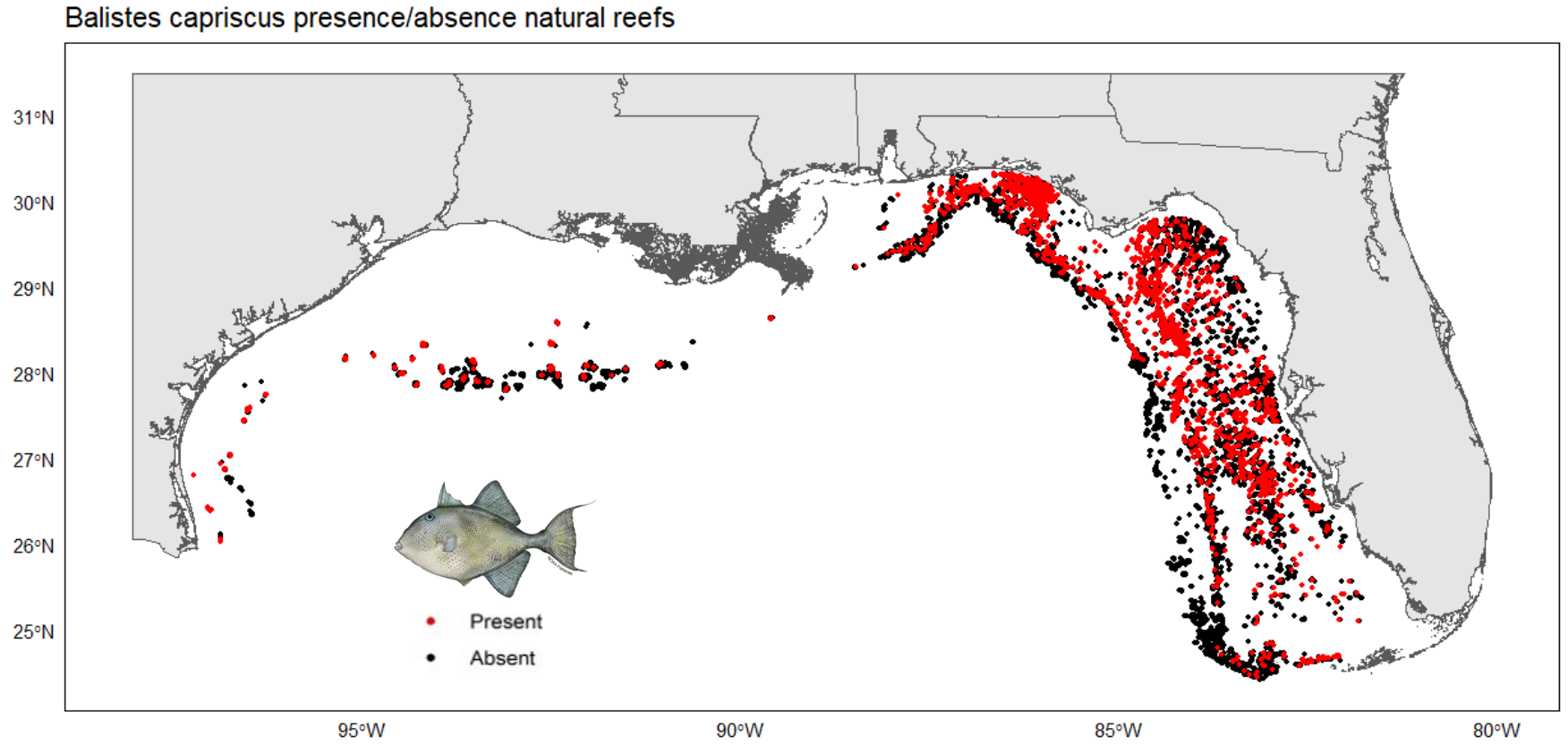
Assessment Examples

- Specific index methods vary by species:
  - Distribution
  - Habitat preferences
  - Stock delineation
- Robustness of G-FISHER facilitates species-specific adaptability
- Case studies:
  - Gray Triggerfish (Gulf-wide)
  - Red Snapper (Sub-regions)
  - Hogfish (Eastern Gulf - truncated)

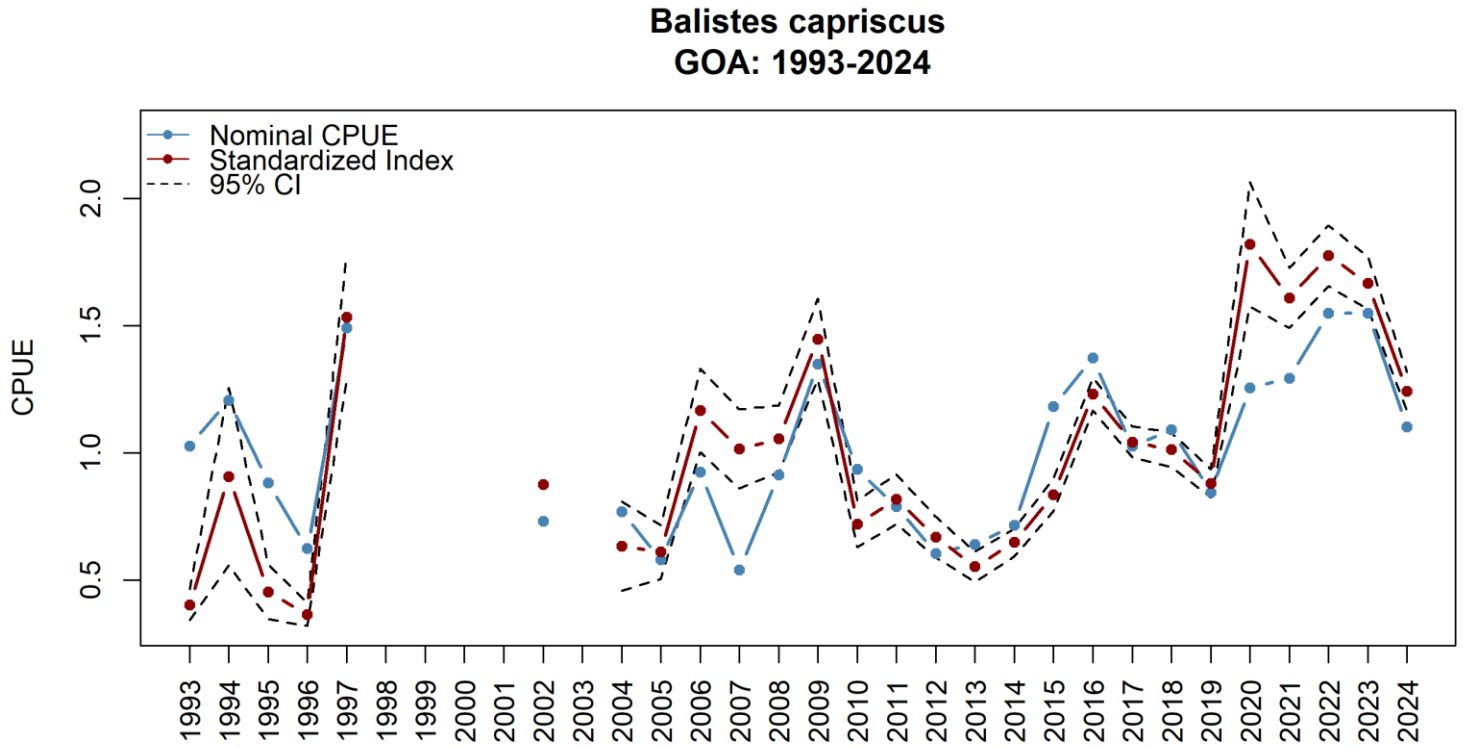


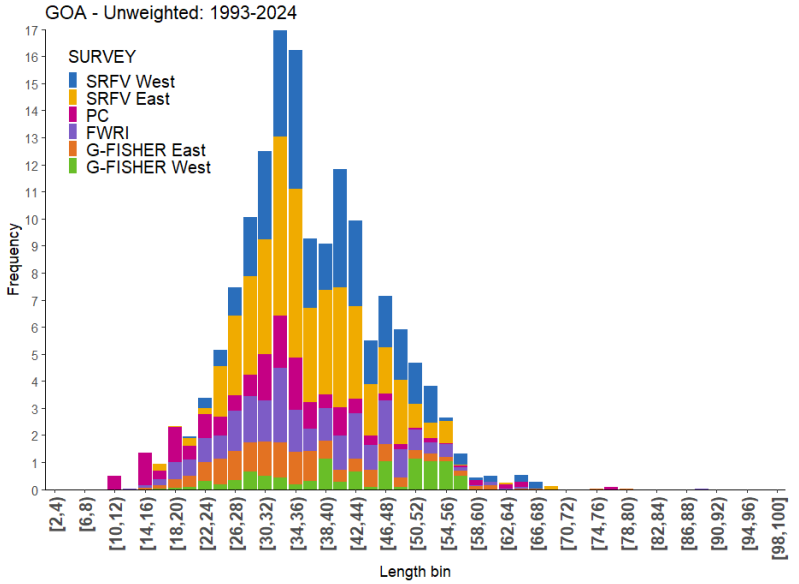
SEDAR 100 – Gray Triggerfish

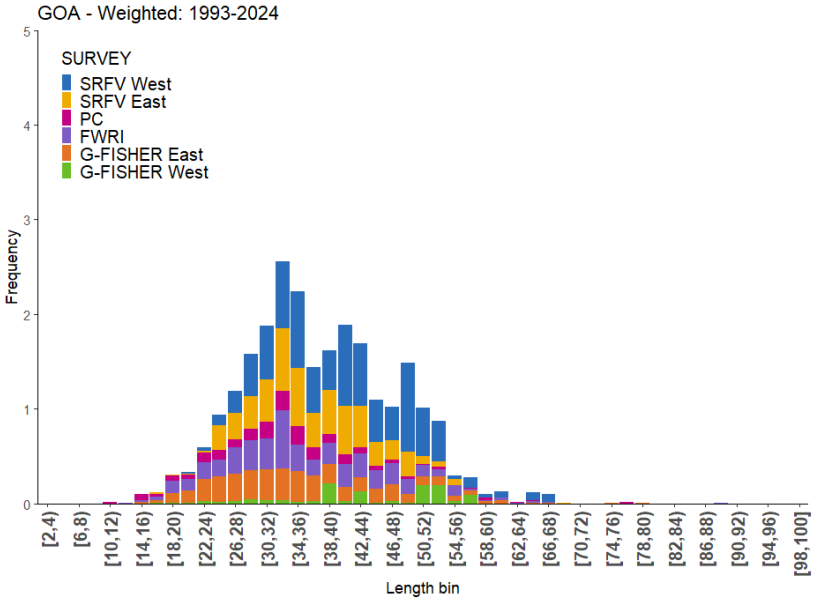
- Gulf-wide index: 1993 – 2024
- Natural reefs



SEDAR 100 – Gray Triggerfish

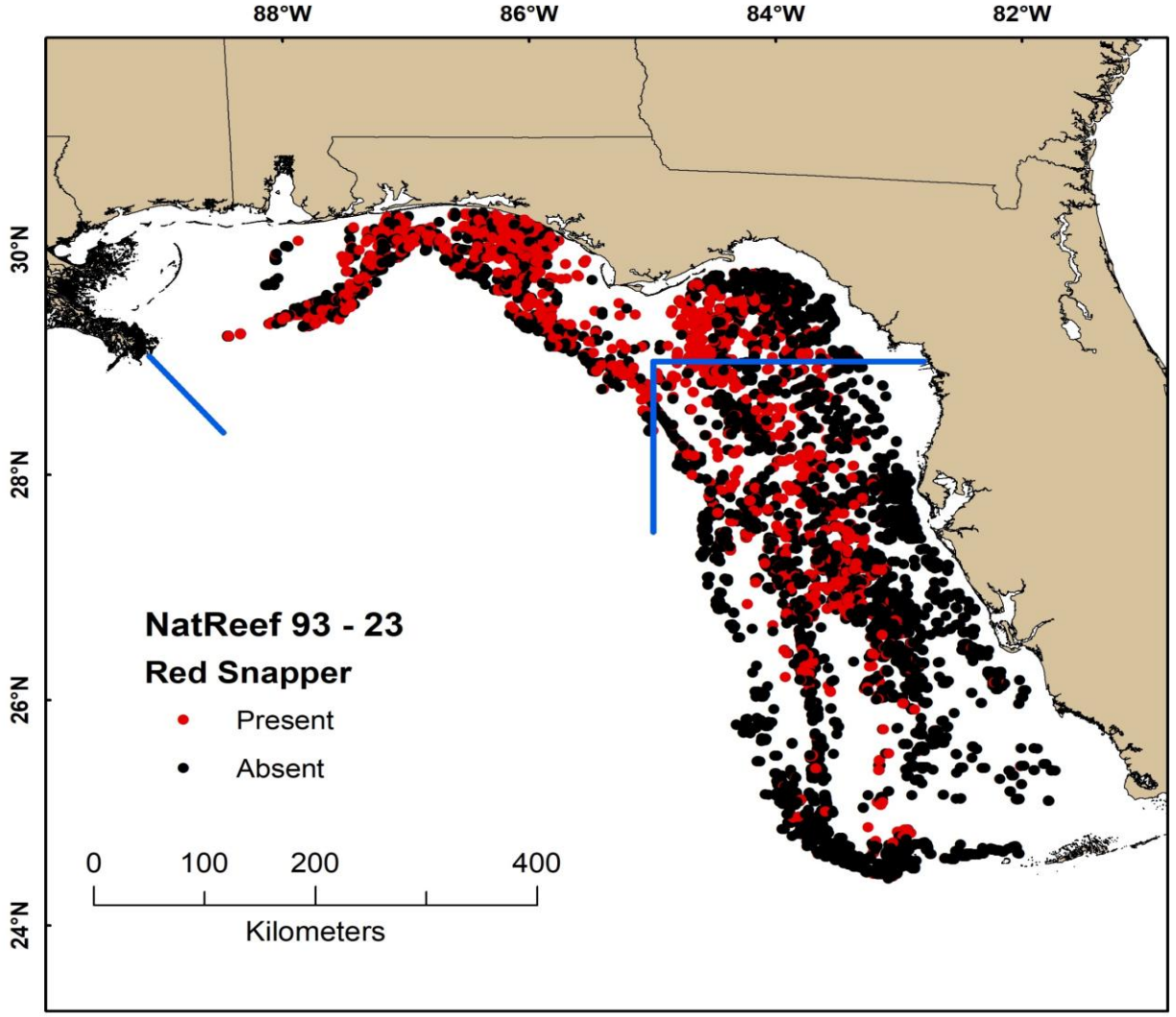




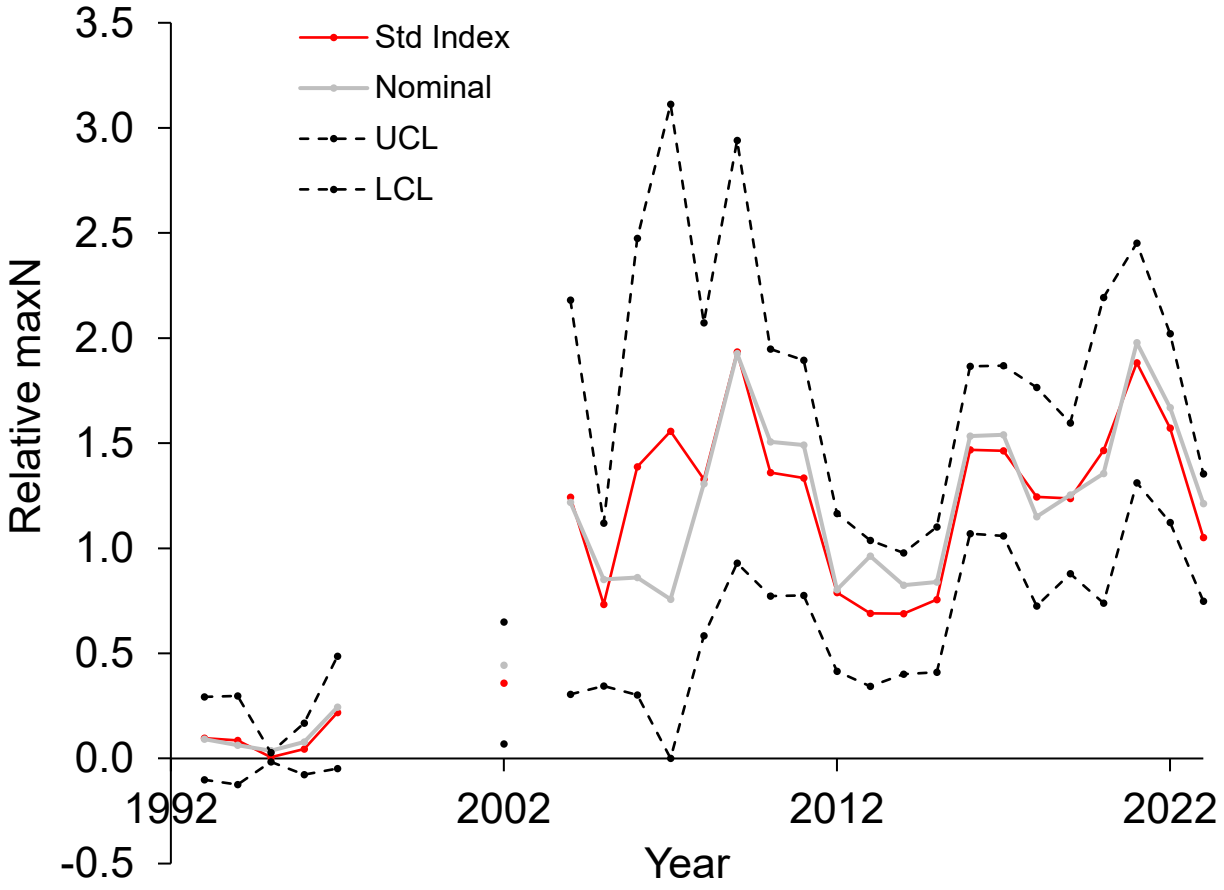


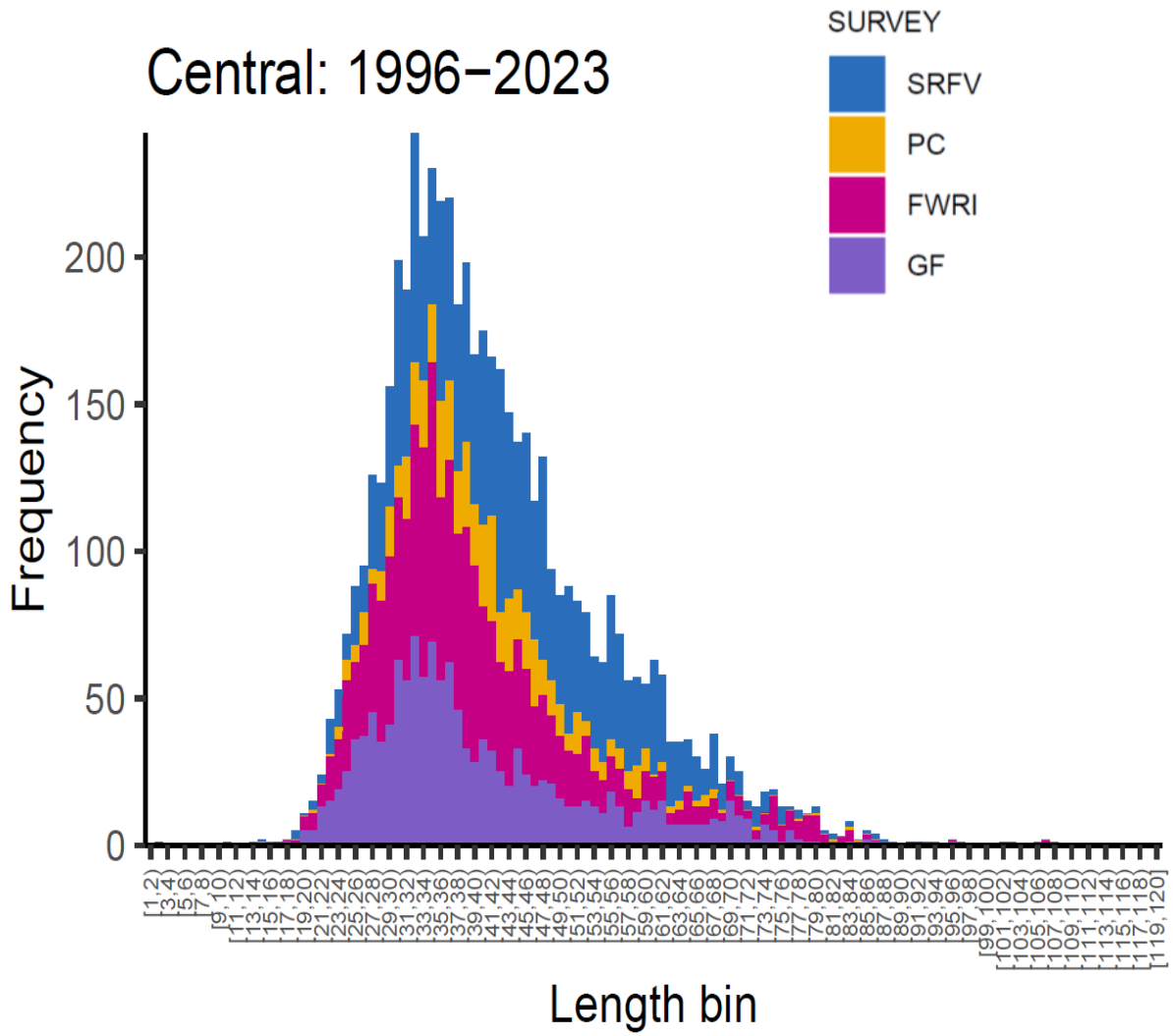
SEDAR 98 – Red Snapper

- Natural reef
- Multiple regions
- Central Gulf: 1993 – 2023
- Eastern: 2010 – 2023

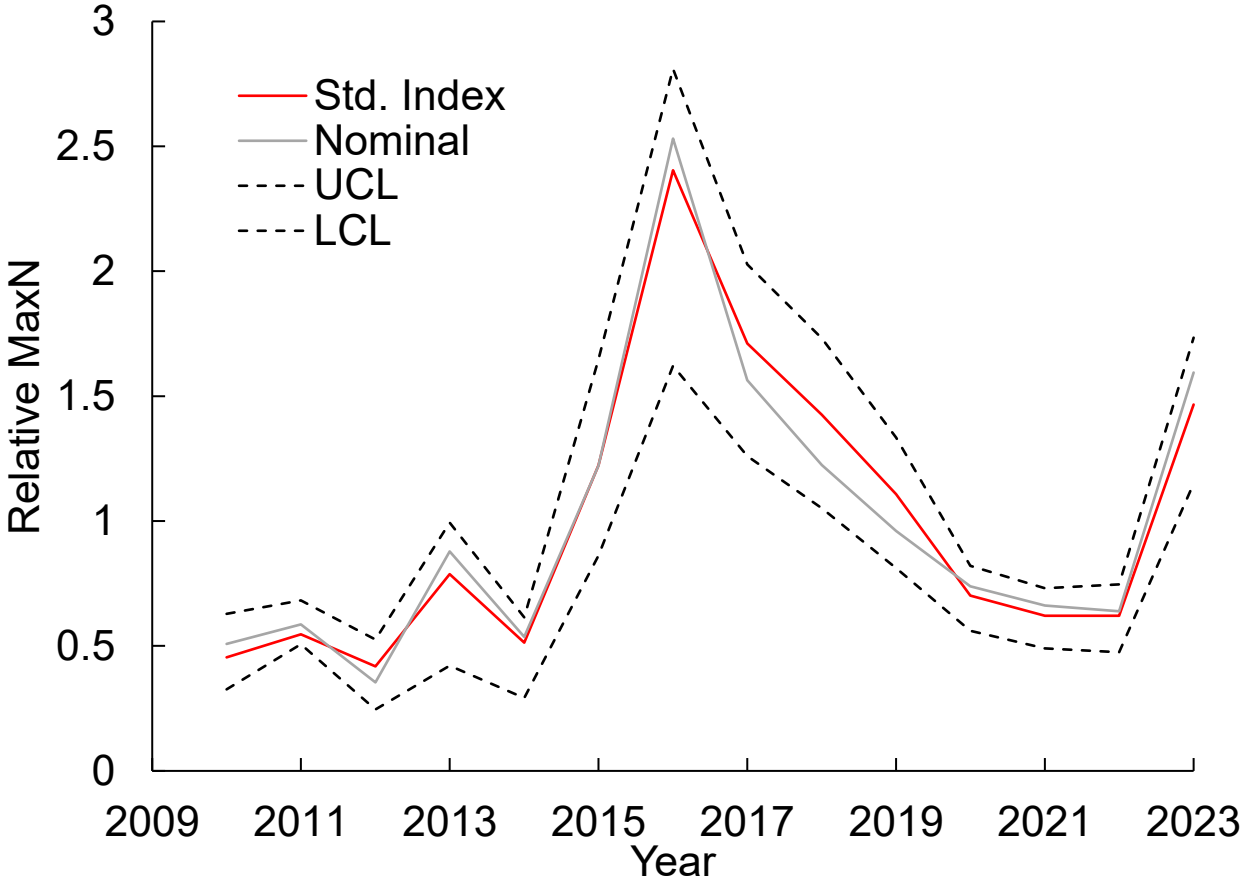


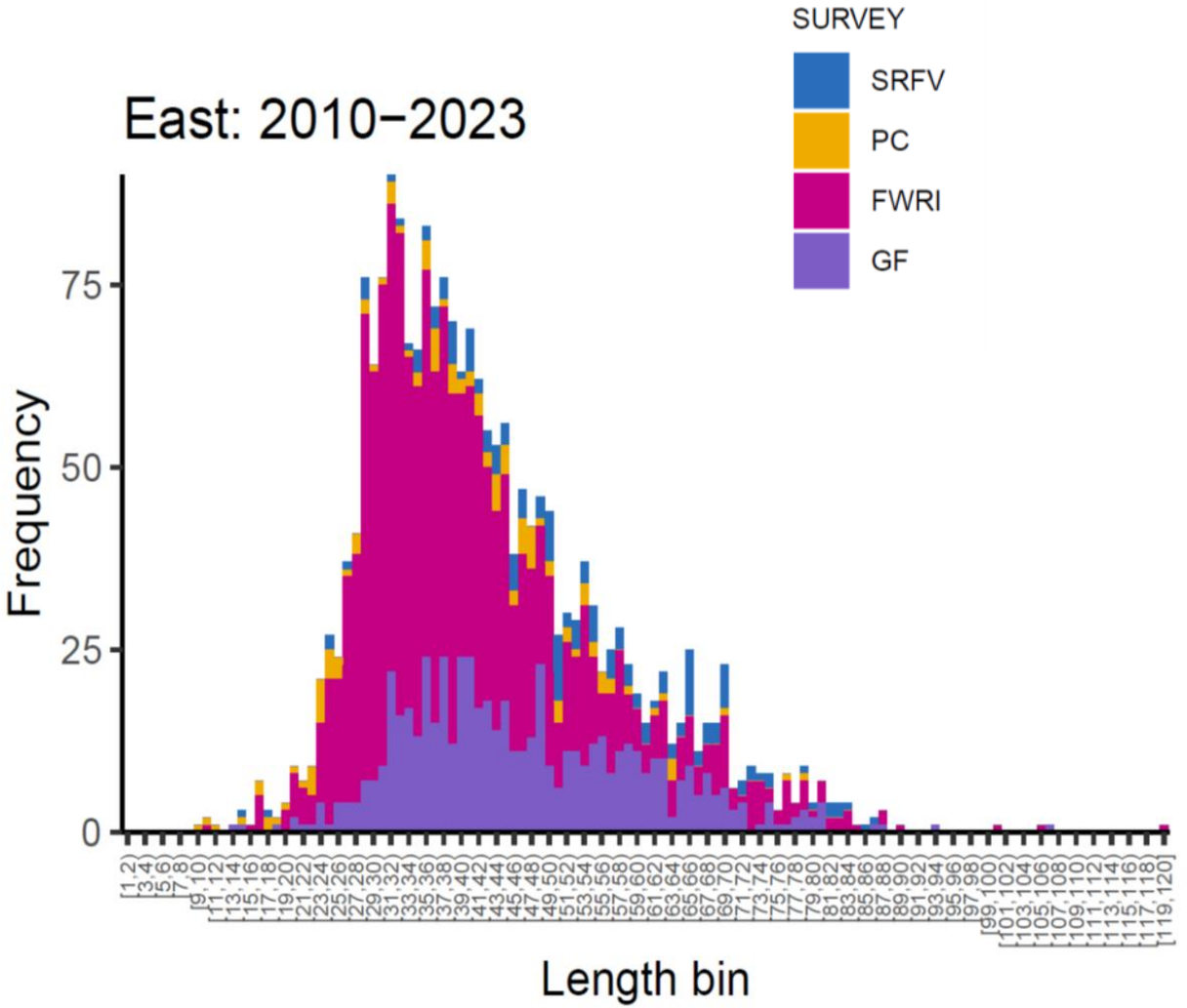
Central Natural Reef





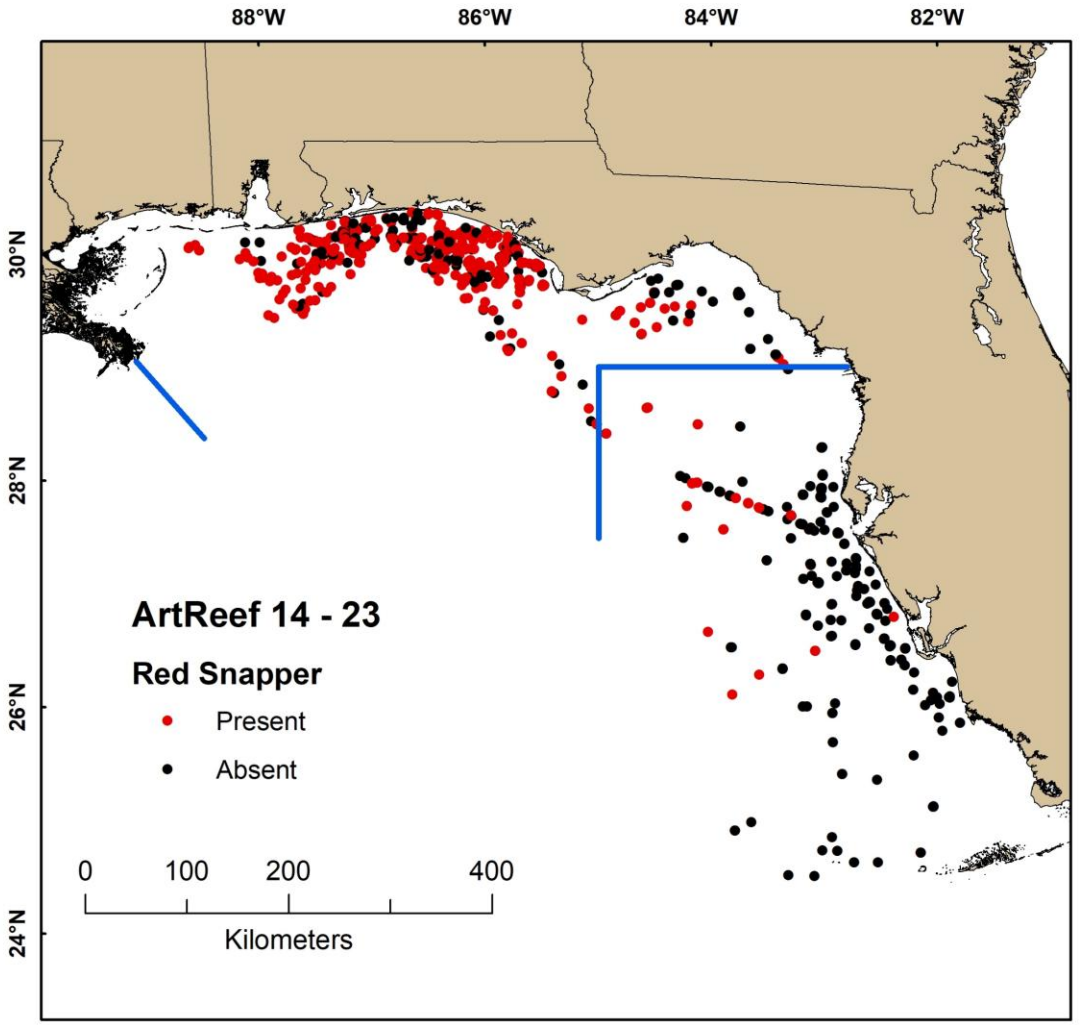
East Natural Reef



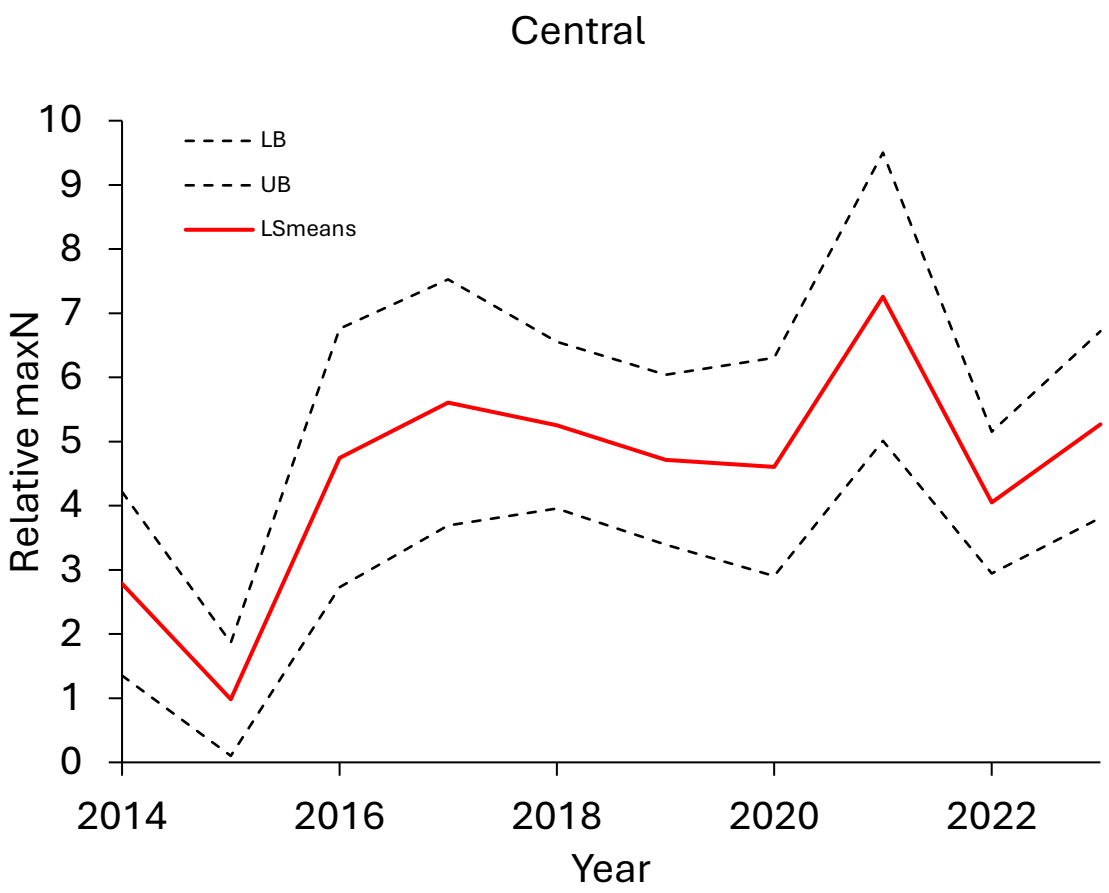


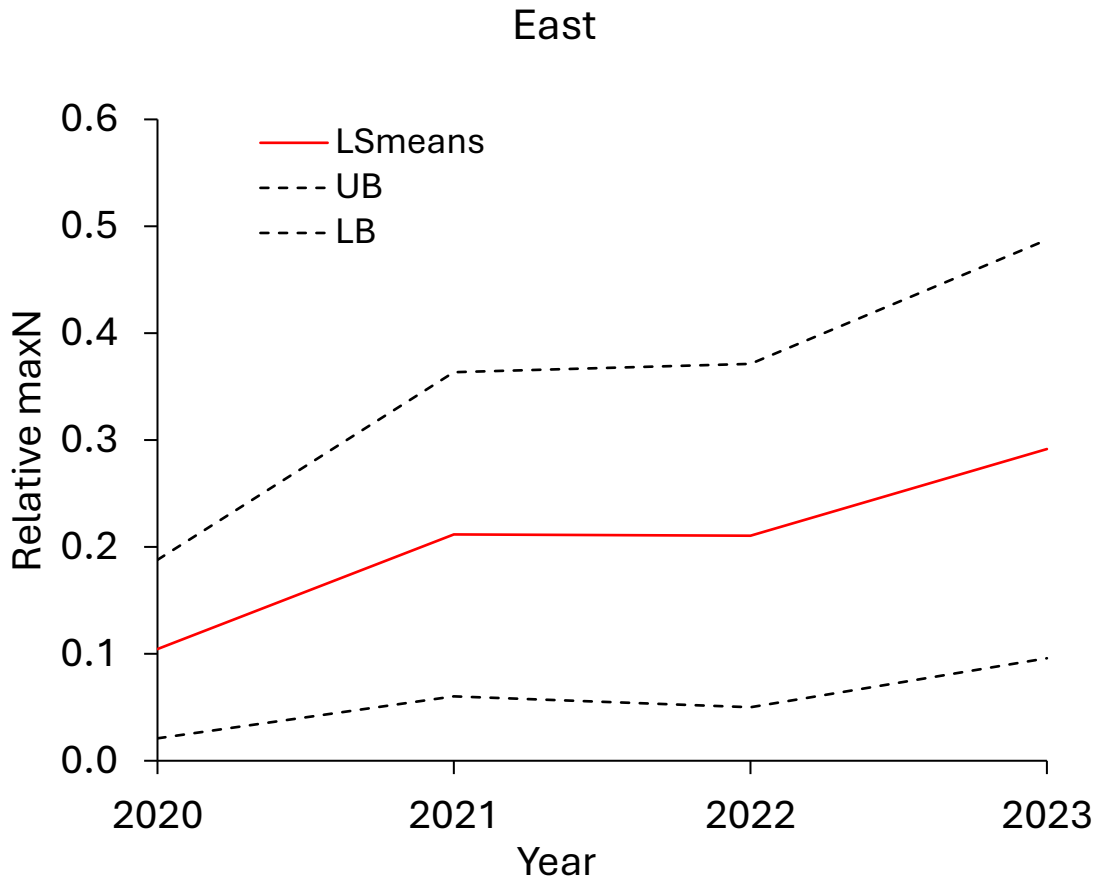
Artificial Sampling Frame

- Artificial reef habitats throughout the eastern Gulf of America
- Central Gulf: 2014 – 2023
- Eastern: 2015 – 2023
- Enhanced sampling effort beginning in 2020 (G-FISHER)



Artificial Reefs



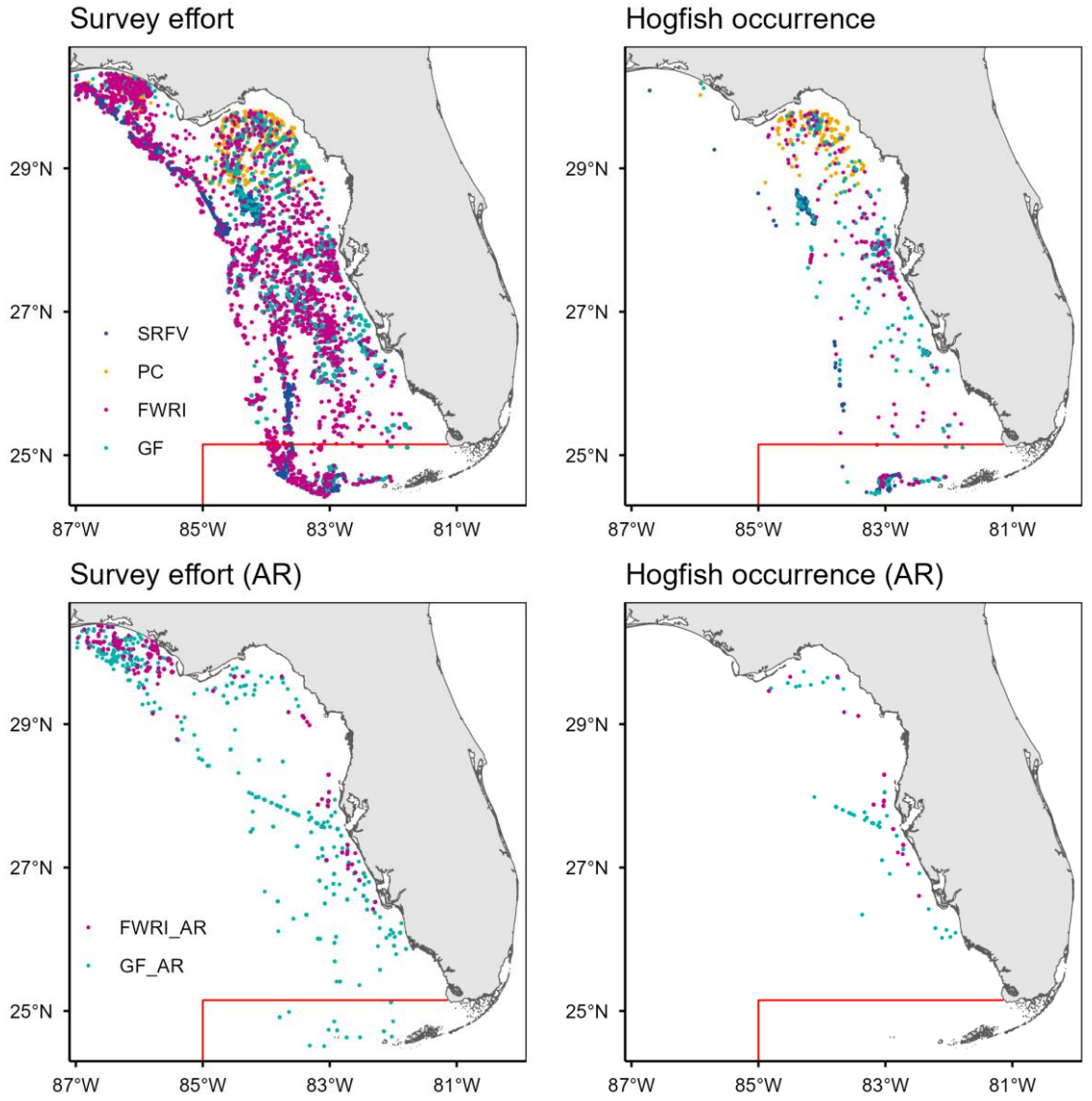


- Methods suitable, but not recommended for use
- Panel recommendation – incorporate into G-FISHER (appropriate weight)

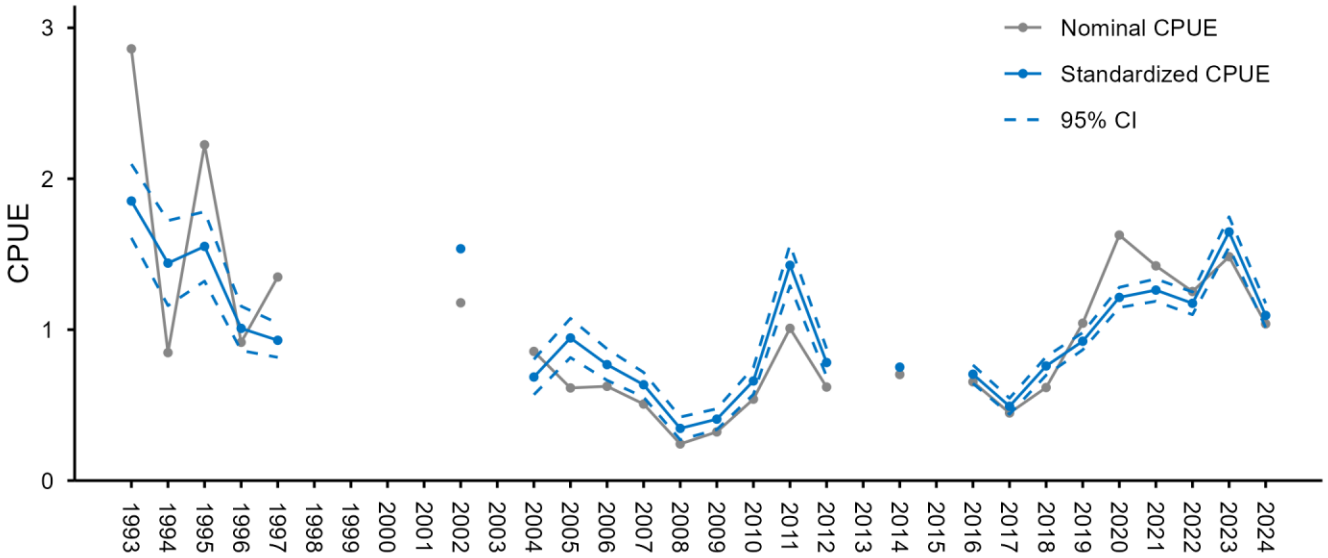
SEDAR 94 – Hogfish

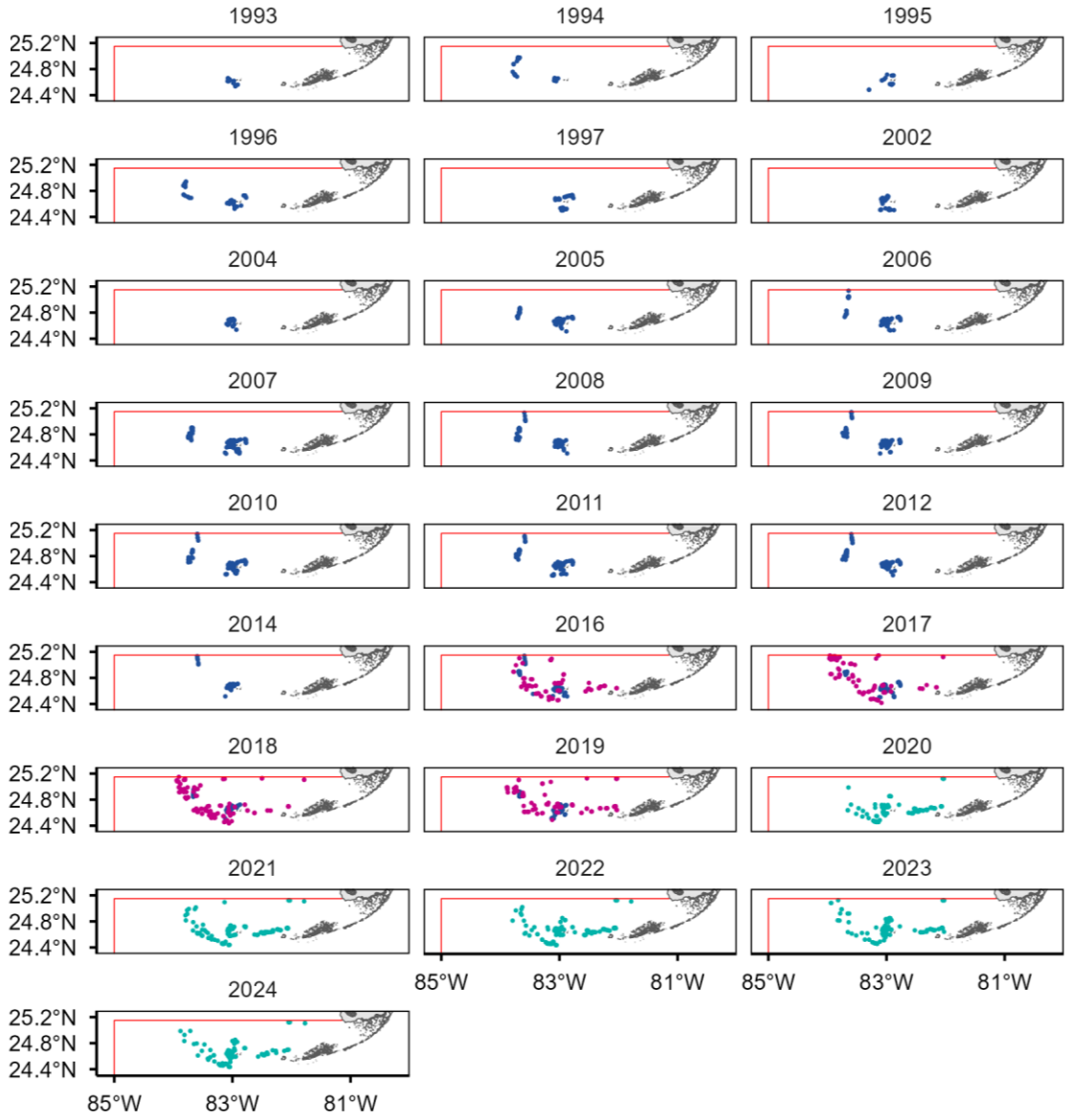
Novel aspects

- Unconventional stock boundary
  - New estimate of reef habitat
- Integrated artificial reefs
  - Gulf: estimate proportion of natural and artificial reefs
  - Atlantic: artificial sampling too sparse (possible in future)



SEDAR 94 – Hogfish

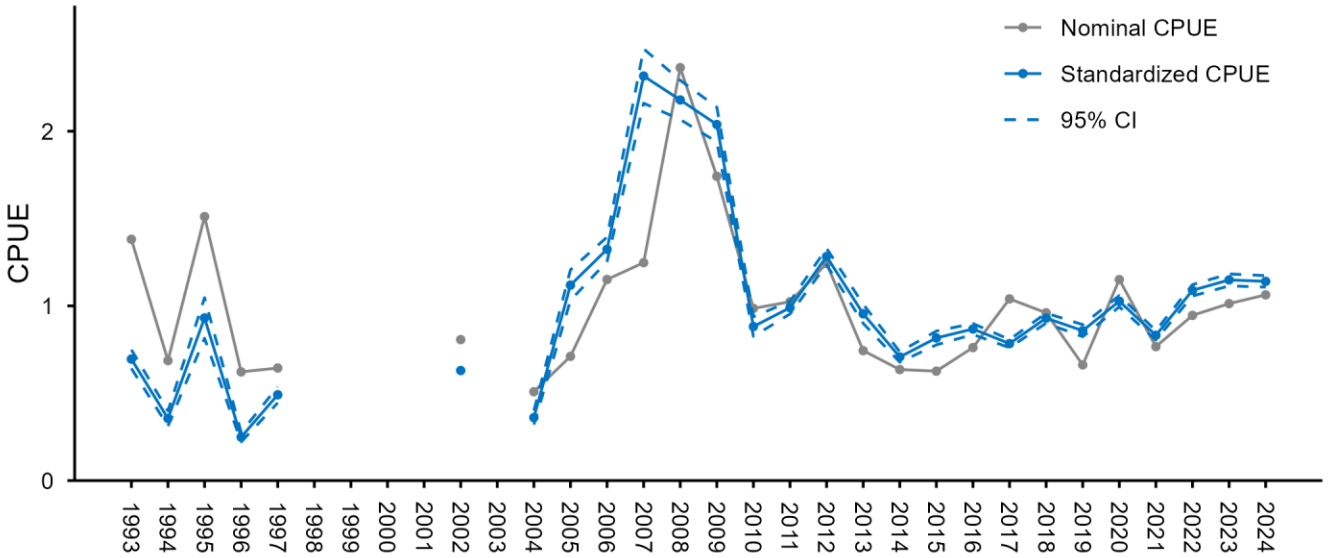


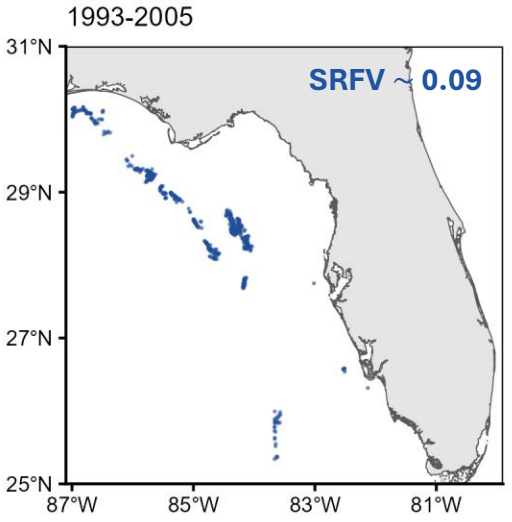


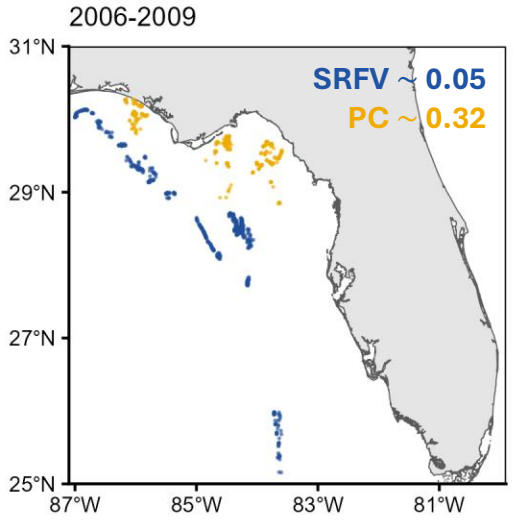
Atlantic index

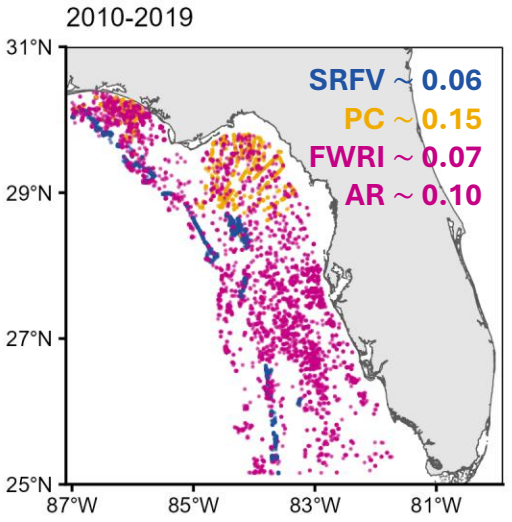
- Survey domain consistent
- Index spans full time series
- More robust moving forward

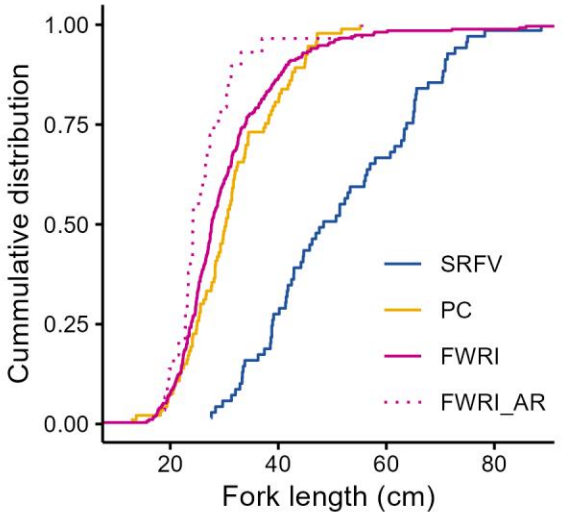
SEDAR 94 – Hogfish











Gulf index

- Spatial expansion survey effort
- Shift in spatial selectivity of stock
- Index truncated (2006-2024)

West Florida Shelf Red Tide Models

RESTORE SCIENCE PROGRAM

About Projects Funding Opportunities Resources

Red Tide and Reef Fish Modeling

Full Title: Operationalizing the West Florida Shelf ecosystem model and application to red tides, stock assessment, and catch advice for Gulf reef fish

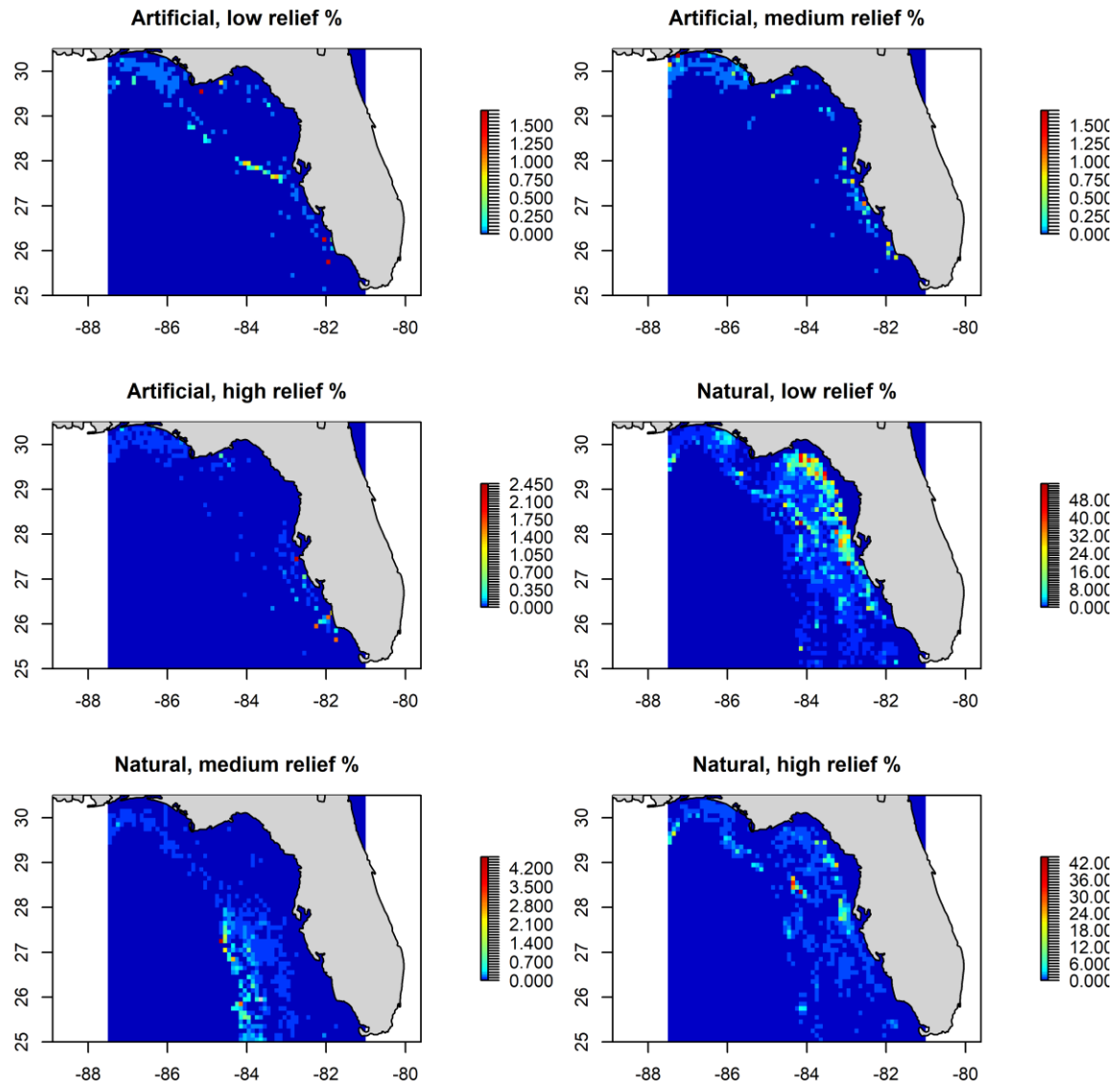
The project team will update and improve upon an ecosystem model of the West Florida Shelf to account for red tide mortality when assessing Gulf reef fish. The project will develop new approaches to map red tides using satellites, and biogeochemical models to map oxygen concentrations in relation to red tides. These products will be incorporated into a spatially explicit fisheries ecosystem model to estimate red tide mortality on valuable commercial and recreational species. Estimates of red tide mortality will be incorporated into stock assessments and recommendations on acceptable biological catch, or the amount of fish that can be harvested each year, for reef fish species that will undergo stock assessments between 2024-2028. The acceptable biological catch is a recommendation that accounts for scientific uncertainty and serves to prevent overfishing.

Lead Investigator: David Chagaris, Nature Coast Biological Station, University of Florida (dchagaris@ufl.edu)

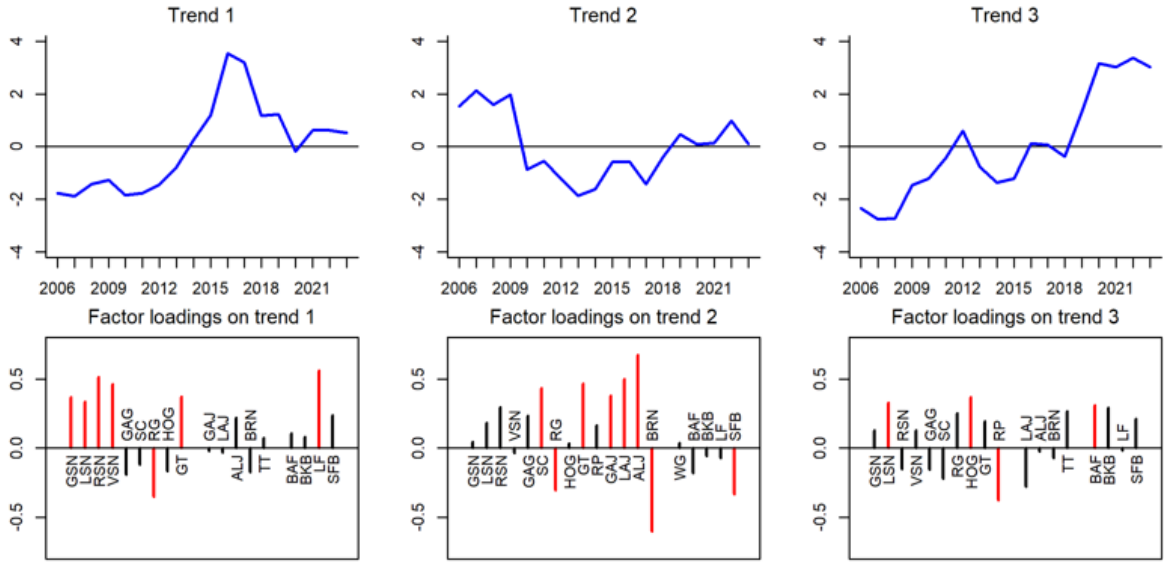
Natural Resource Managers: Ryan Rindone, Gulf Council, and Daniel Luers, NOAA Southeastern Regional Office

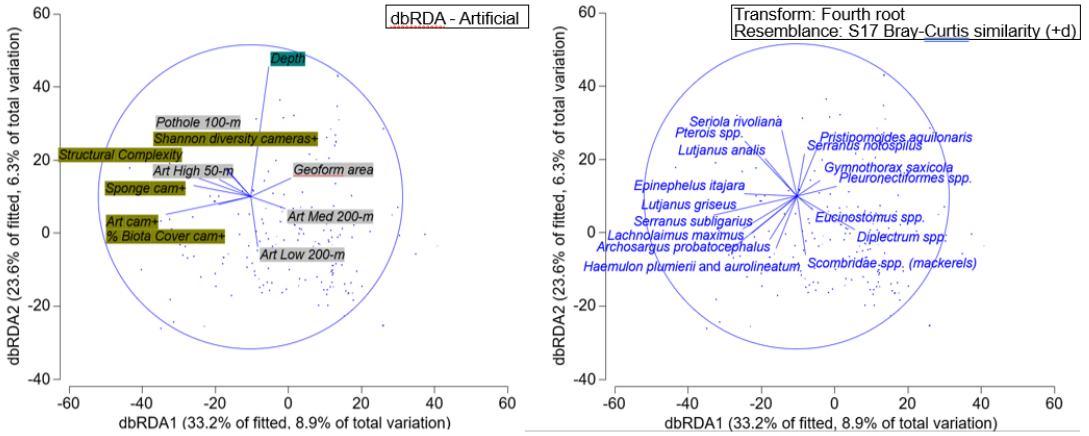
Project Team: Chuanmin Hu, University of South Florida, College of Marine Science; Michael Stukel, Florida State University, Department of Earth, Ocean, and Atmospheric Science; Sven Kranz, Rice University, BioSciences

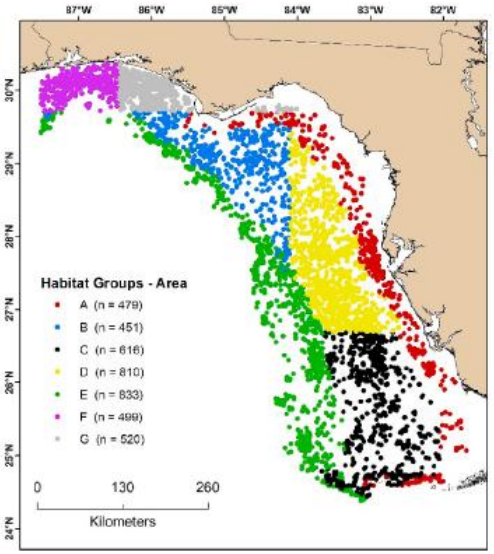
Collaborators: Kate Siegfried, NOAA Southeast Fisheries Science Center; Mandy Karnauskas, NOAA Southeast Fisheries Science Center; Skyler Sagarese, NOAA Southeast Fisheries Science Center; Ted Switzer, Florida Fish and Wildlife Commission Fish and Wildlife Research Institute; Michael Sipos, Florida Sea Grant; Casey Streeter, commercial fisherman and founder of Florida Commercial Watermen's Conservation group; Dylan Hubbard, Captain and co-owner of Hubbard's Marina

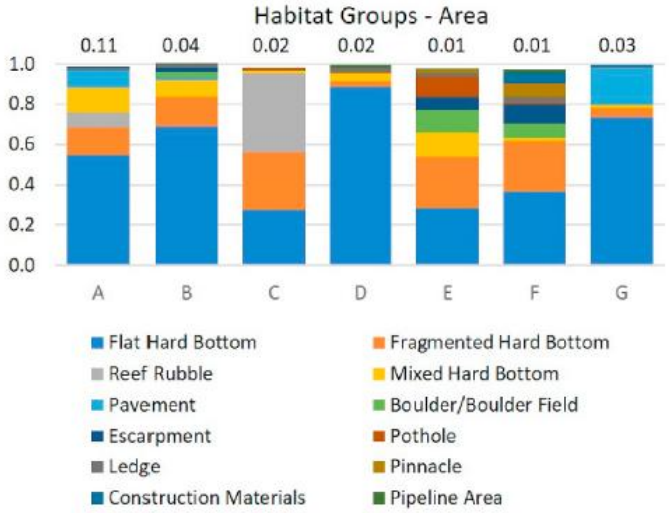


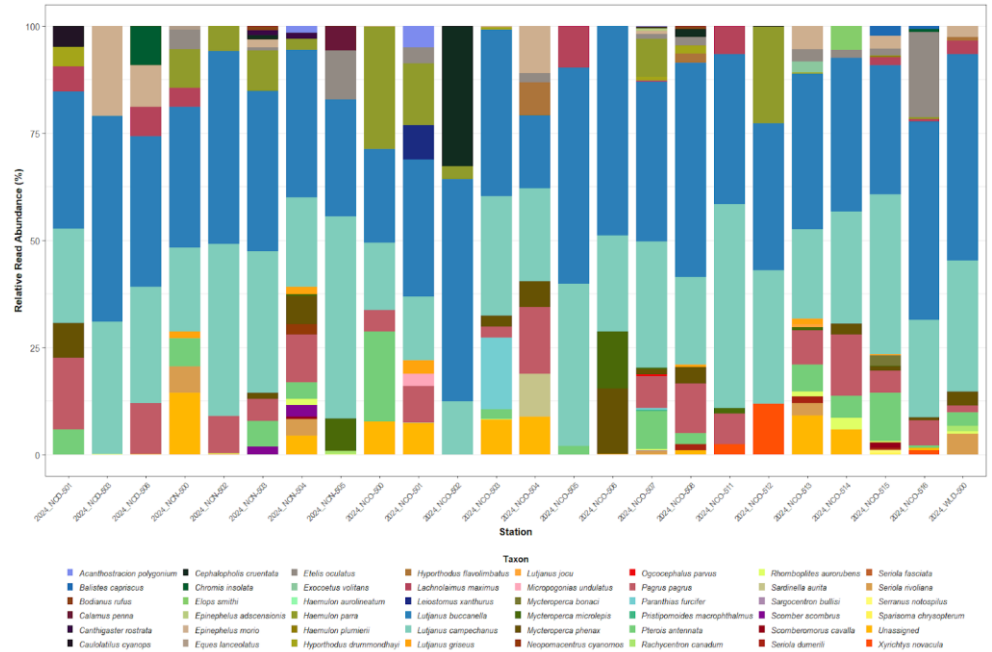
Many Other Applications!



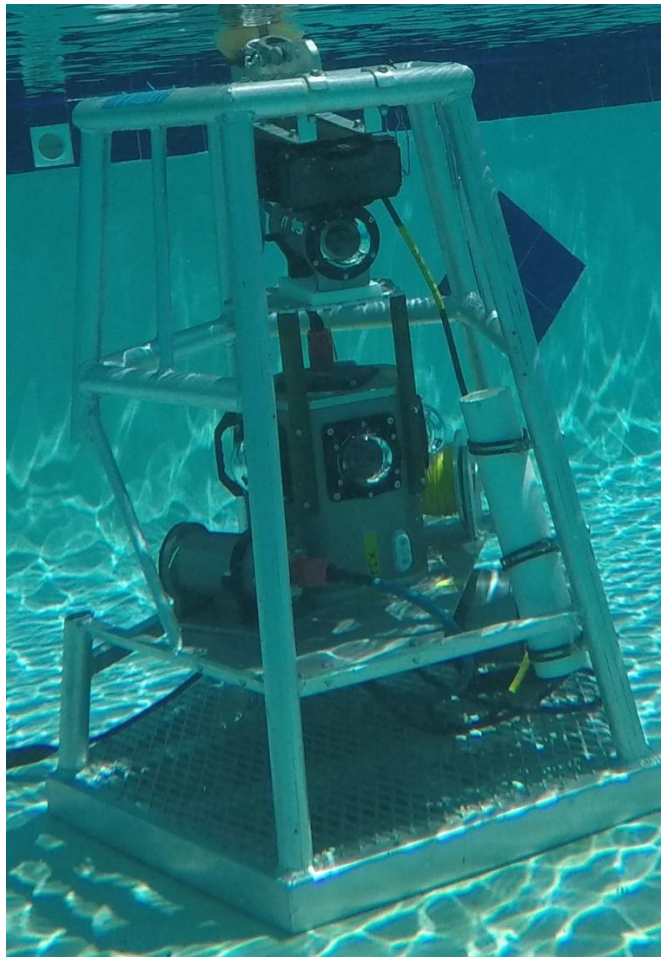


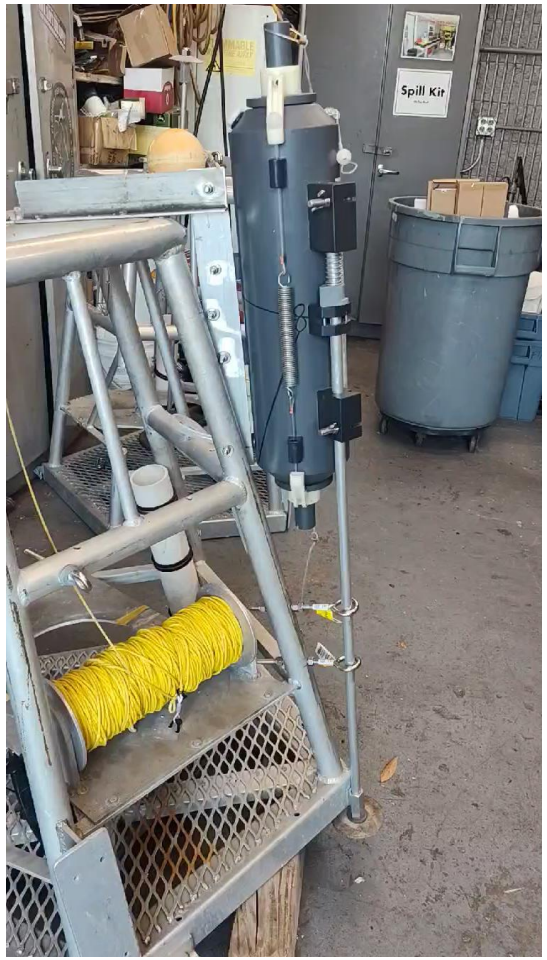






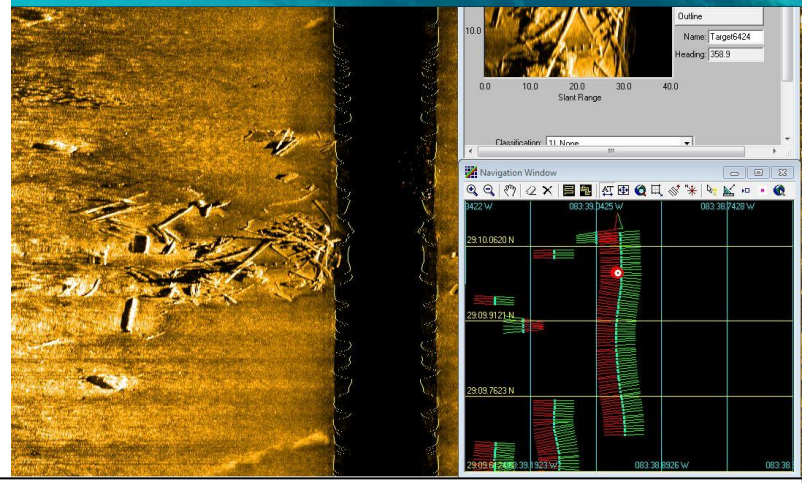
Part III. Adaptation

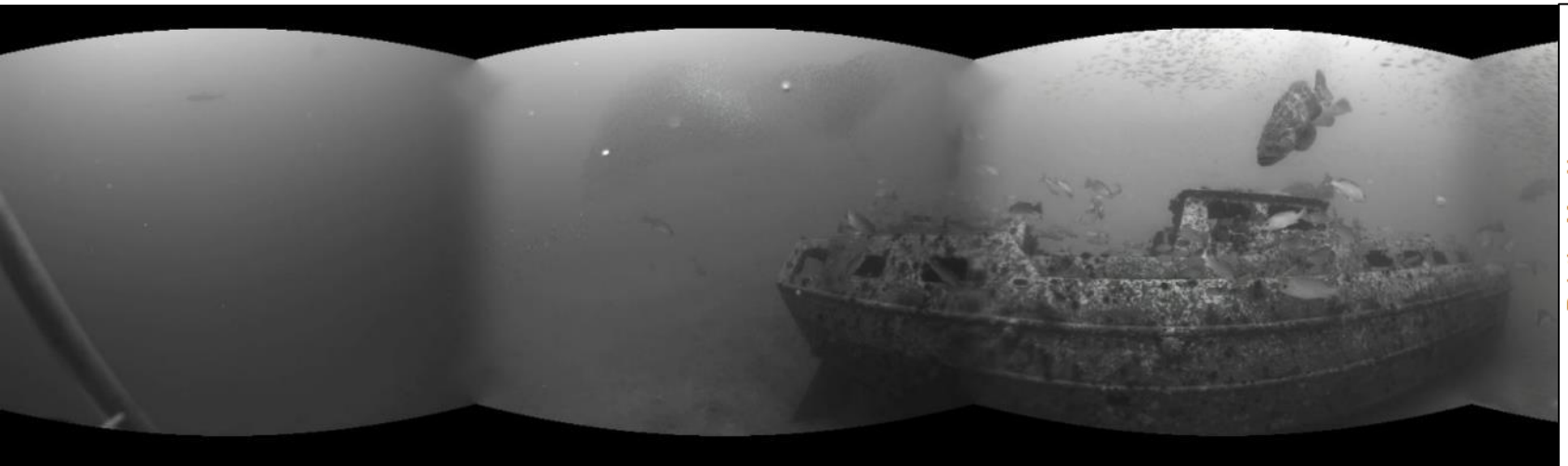


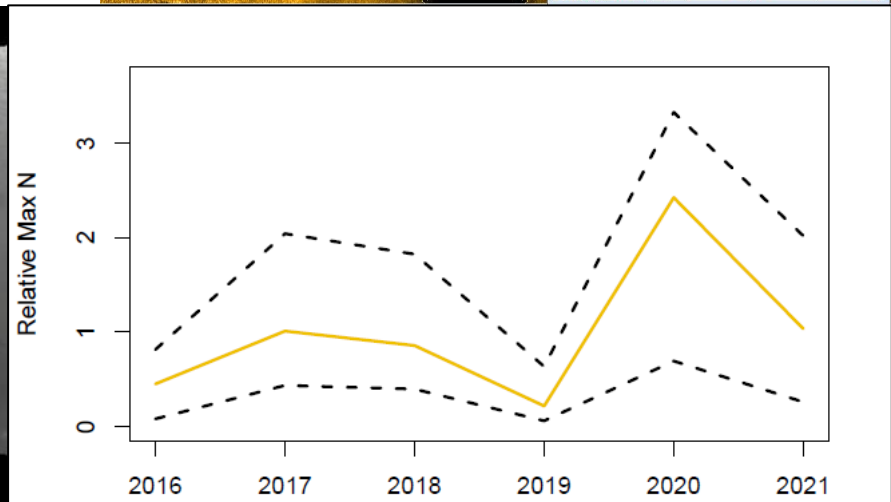


Artificial Reefs

- Initial survey – natural reefs only
- G-FISHER expansion – full integration of artificial reefs (standard methods)
- Sufficient time series – integration into indices
- Potential for indexing new species (Goliath Grouper)?





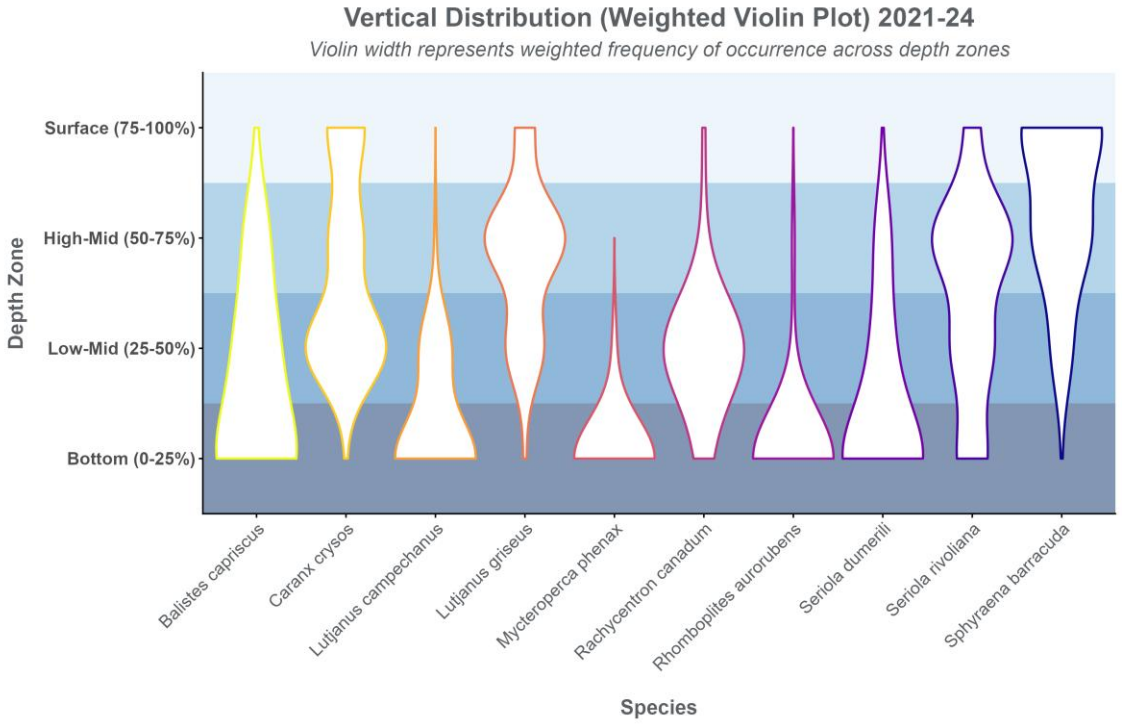


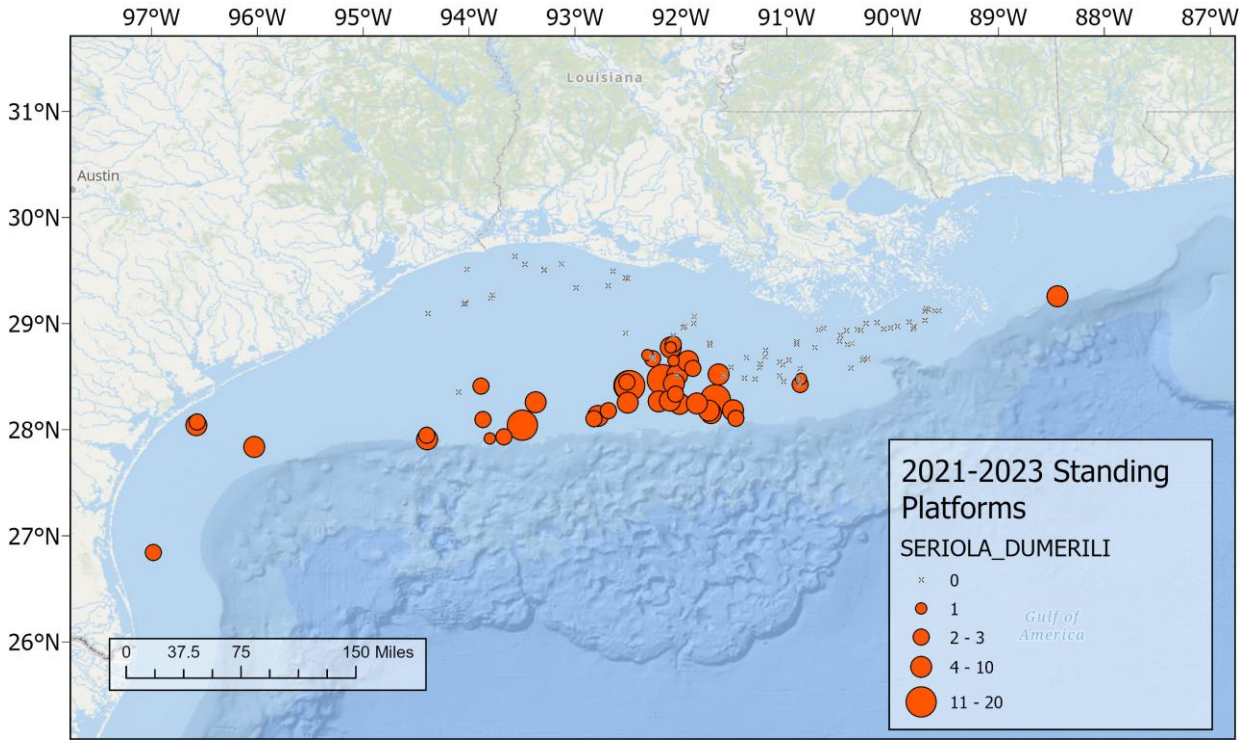
Platforms

- Unique artificial habitat – unique survey approach?

Platforms

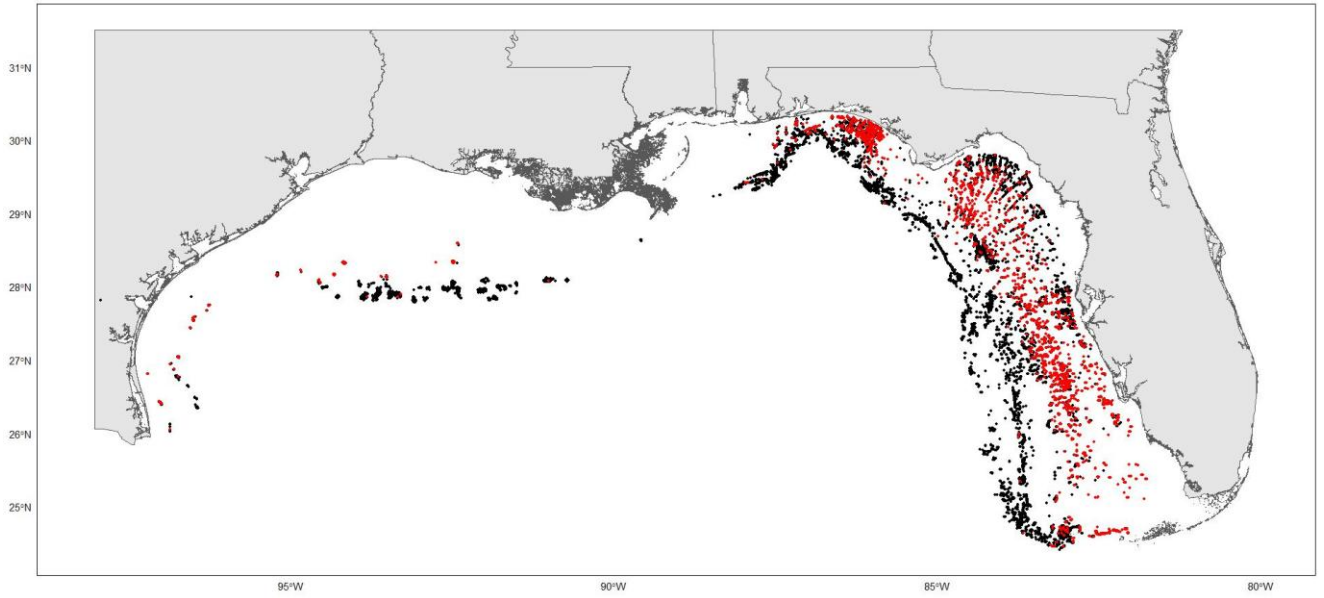
- Species-specific depth distributions
- Approach – vertical transect survey of full water column
- Short time series – evaluating how to best incorporate into G-FISHER

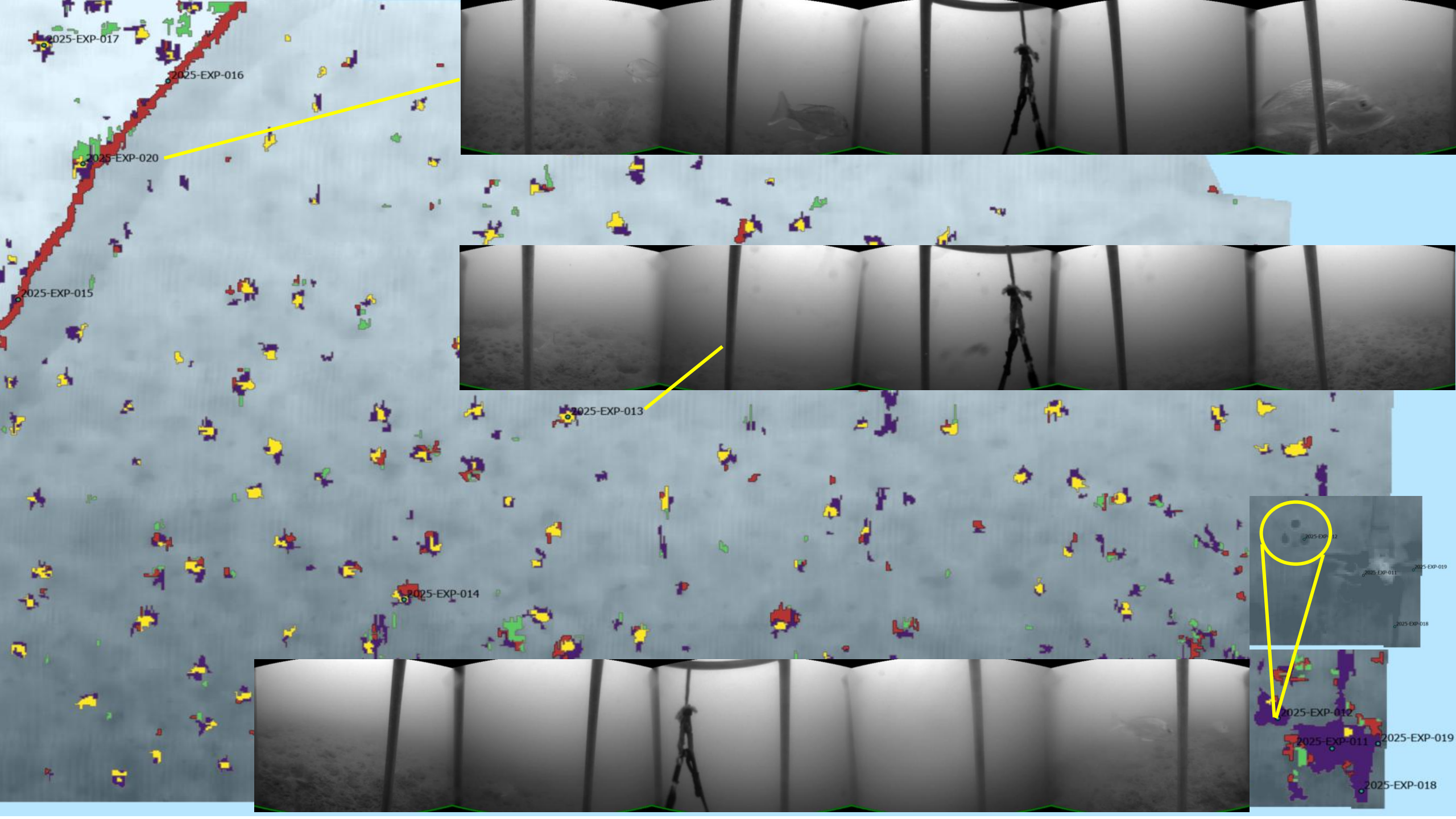




Spatial Gaps

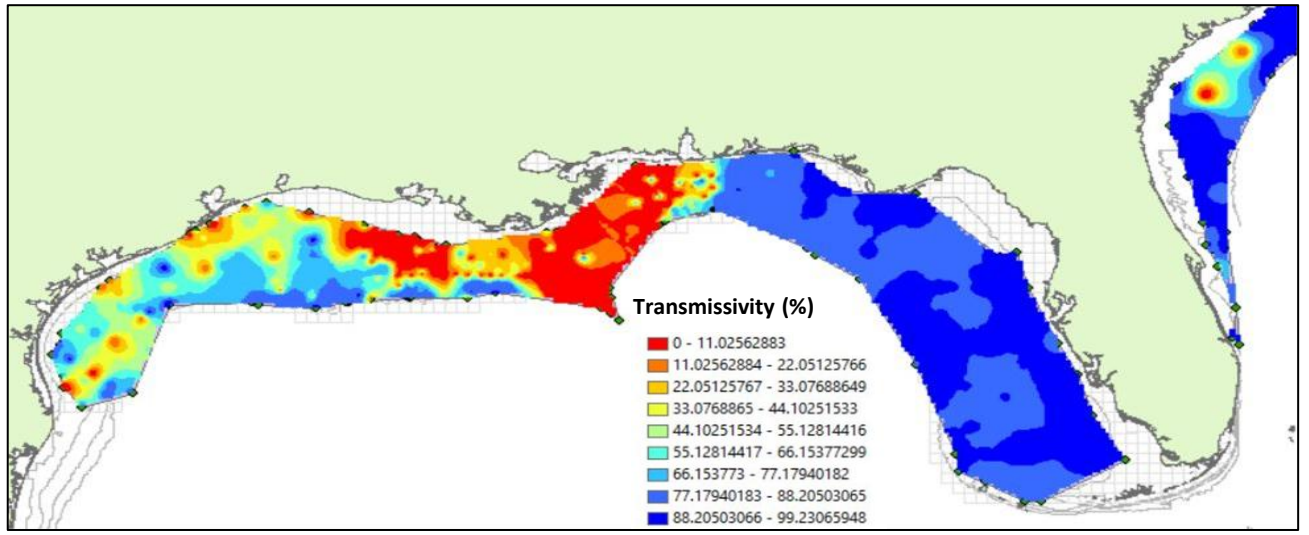
- Western Gulf – natural reef sampling frame limited on the shelf
- Function of mapping effort, not lack of habitat
- Significant number of features identified (‘Reef anomalies’ from Great Red Snapper Count)

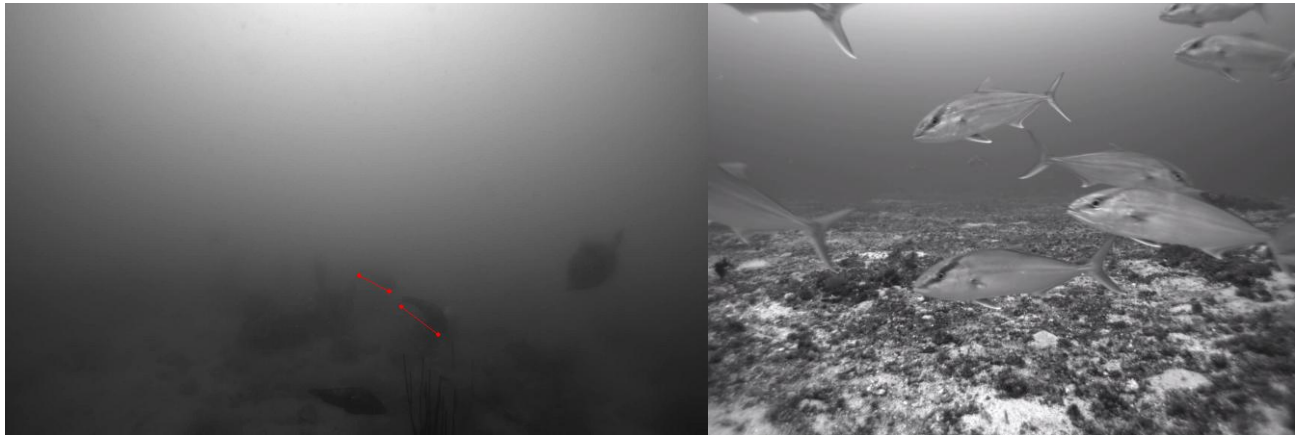



2025-EXP-017
2025-EXP-016
2025-EXP-020
2025-EXP-015
2025-EXP-013
2025-EXP-014
2025-EXP-012
2025-EXP-011
2025-EXP-019
2025-EXP-018

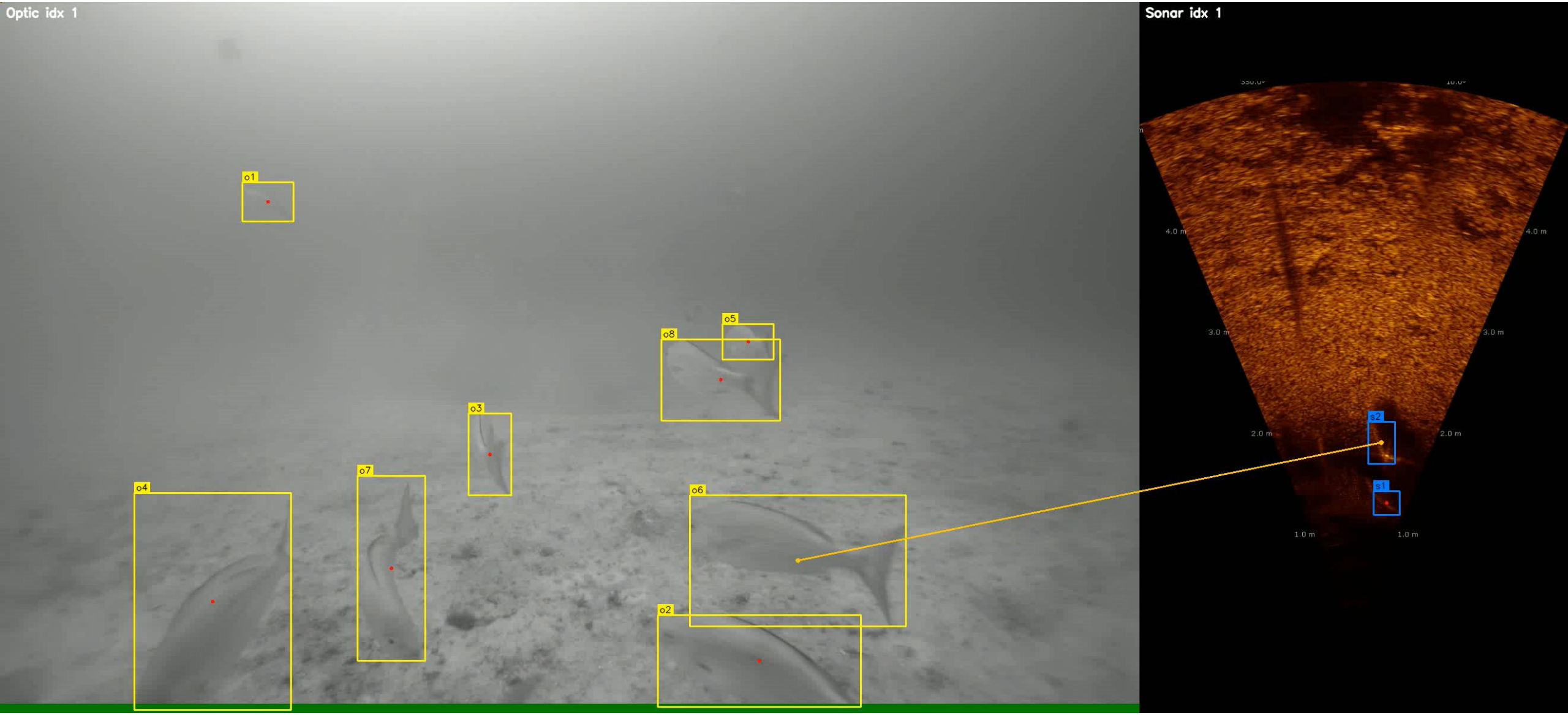
Optical Survey Limitations

- Visibility rarely an issue in the eastern Gulf
- Very different in the western Gulf – particularly on the shelf
- Influences utility of optical survey data:
  - Limited FOV – can account for
  - Unusable video problematic



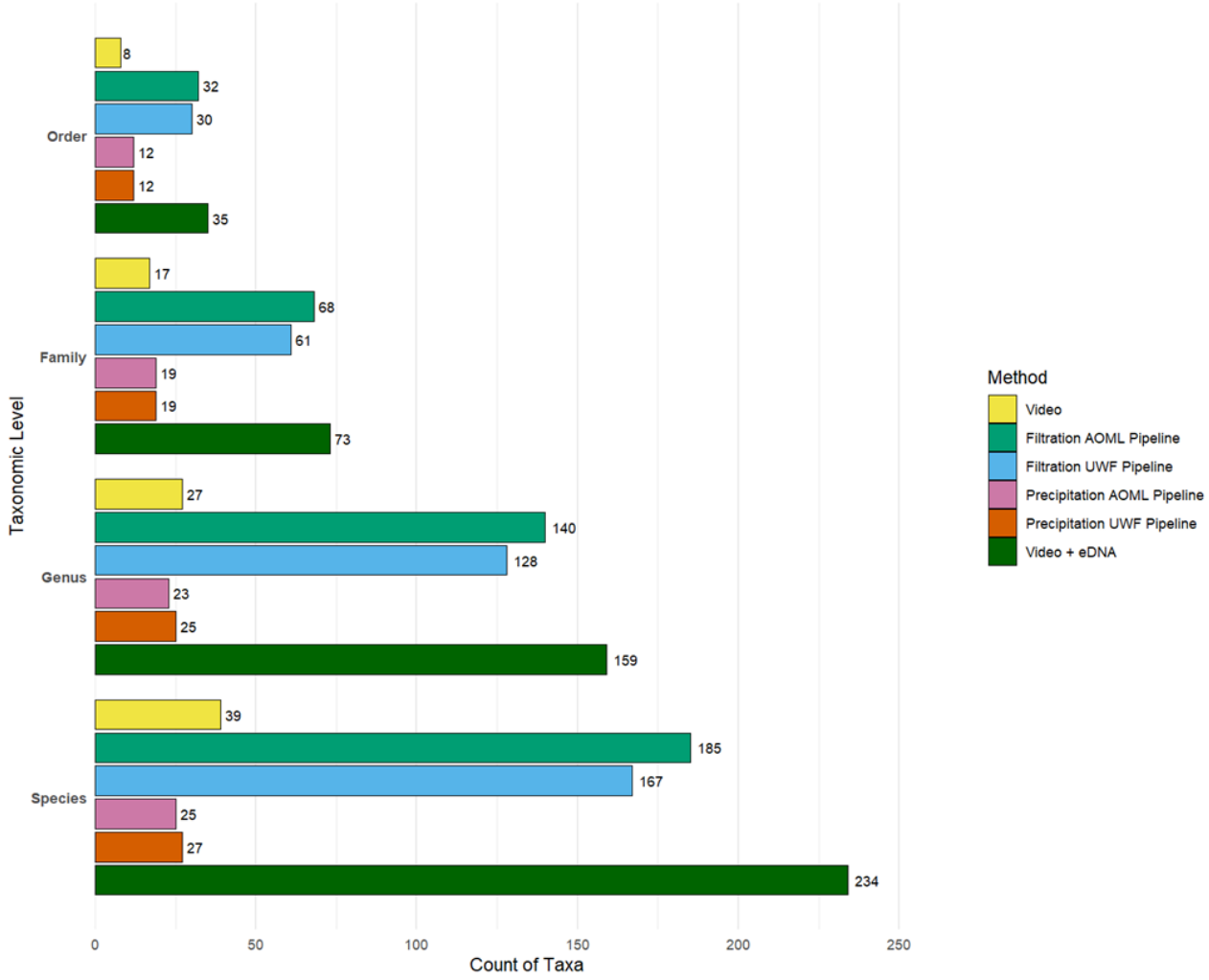


Optical Survey Limitations – Acoustic Cameras



Optical Survey Limitations - eDNA

- Significant integration of eDNA into G-FISHER:
  - DNA library improvements
  - Evaluation of collection methods
  - Optimization of primers
- Metabarcoding (multispecies presence / absence)
- qPCR (quantitative proxy to abundance / biomass – select taxa)



Data Timeliness

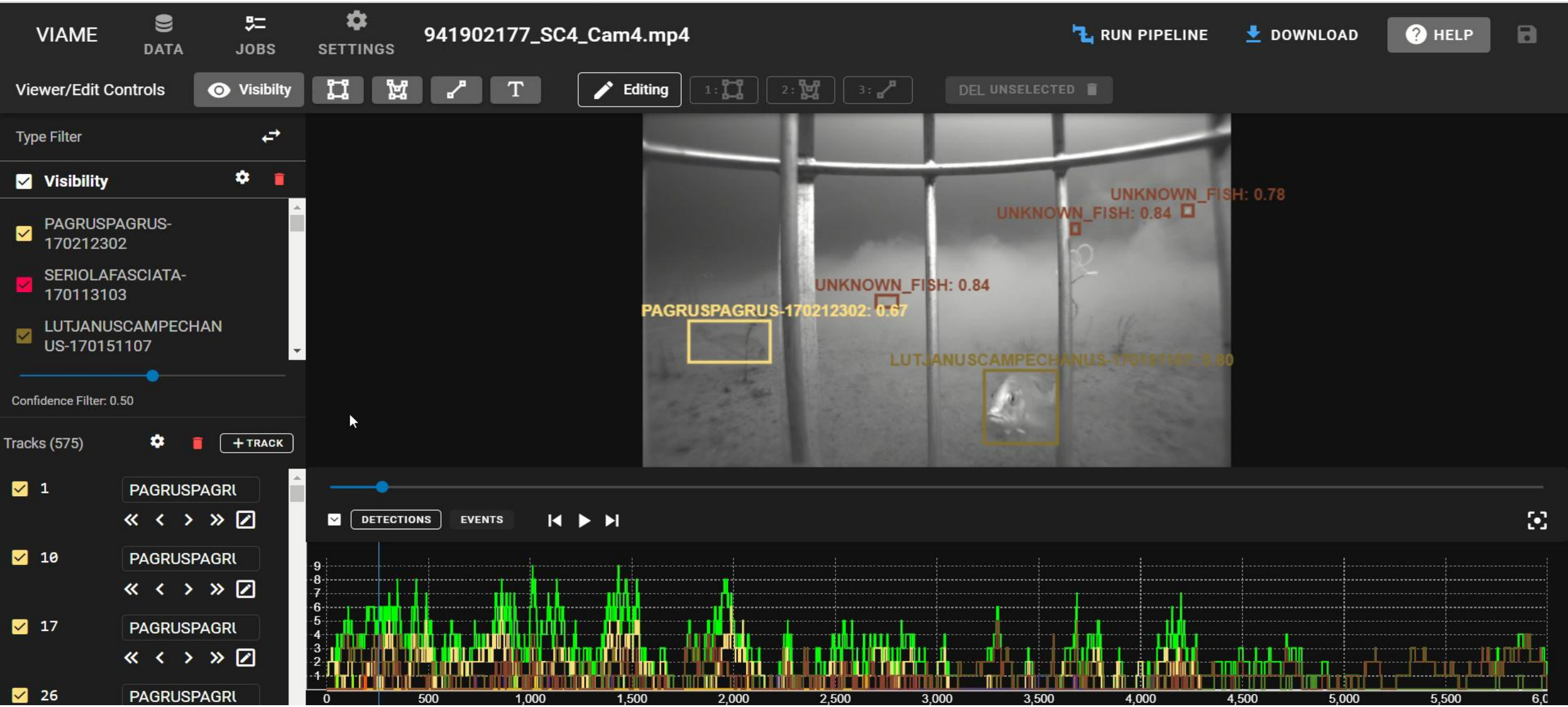
- Video annotation is labor intensive!
- ~ 15-month lag between survey completion and data availability
- Streamlining with AI/ML (detailed proposal this fall)

Last Collection Aug/Sep 2025

Manual Video Annotation (10,000+ Hours)

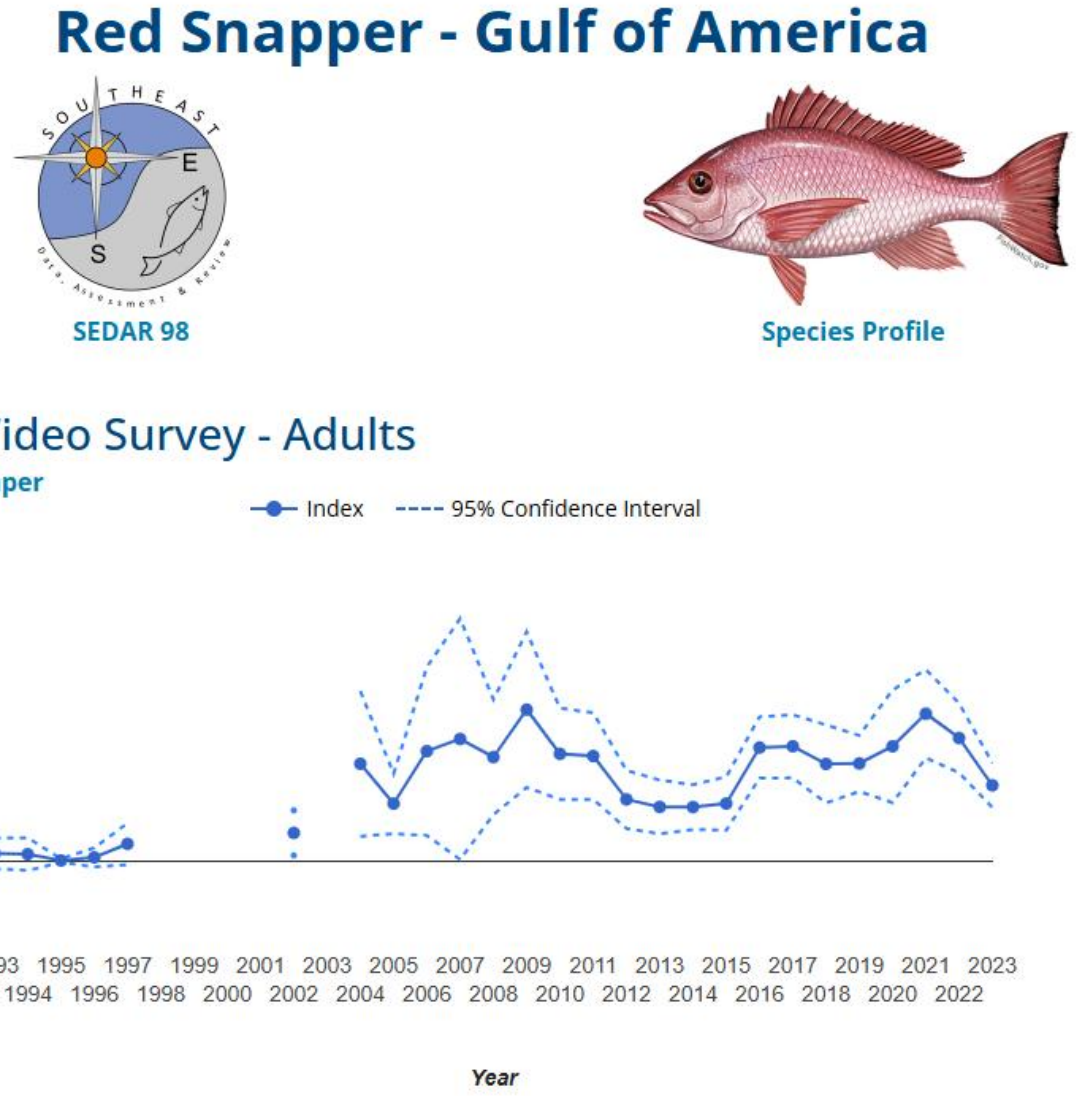
Final Data November 2026

Data Timeliness



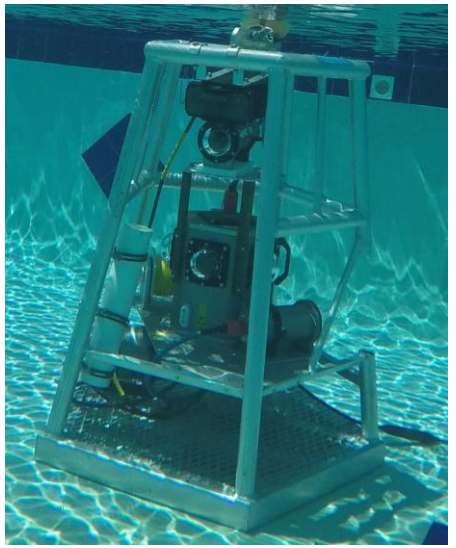
Data Availability

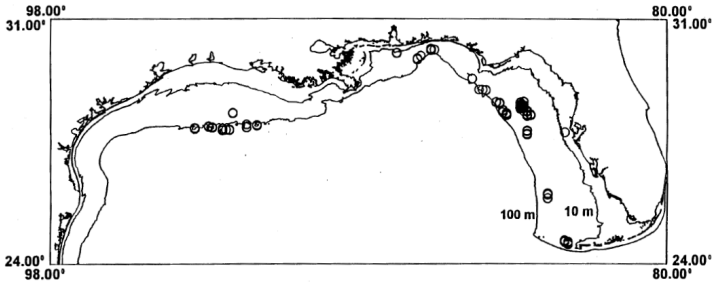
- Southeast Abundance of Fish and Shrimp Data Visualizer (SEAFiSh)
  - Public facing website for **everyone** to access
  - Streamlined G-FISHER combined index code and output
  - Yearly updates following video QA/QC
  - 14 species, 16 indices

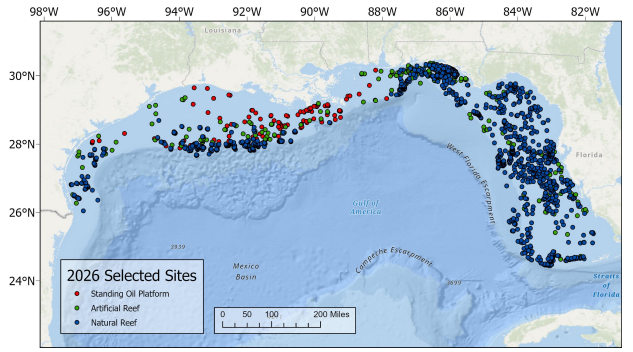


Conclusions

- Video survey / G-FISHER has come a long way in 3+ decades
- Most comprehensive survey of reef fishes and their habitats in the Gulf
- Critical source of fishery independent data for most managed reef fishes





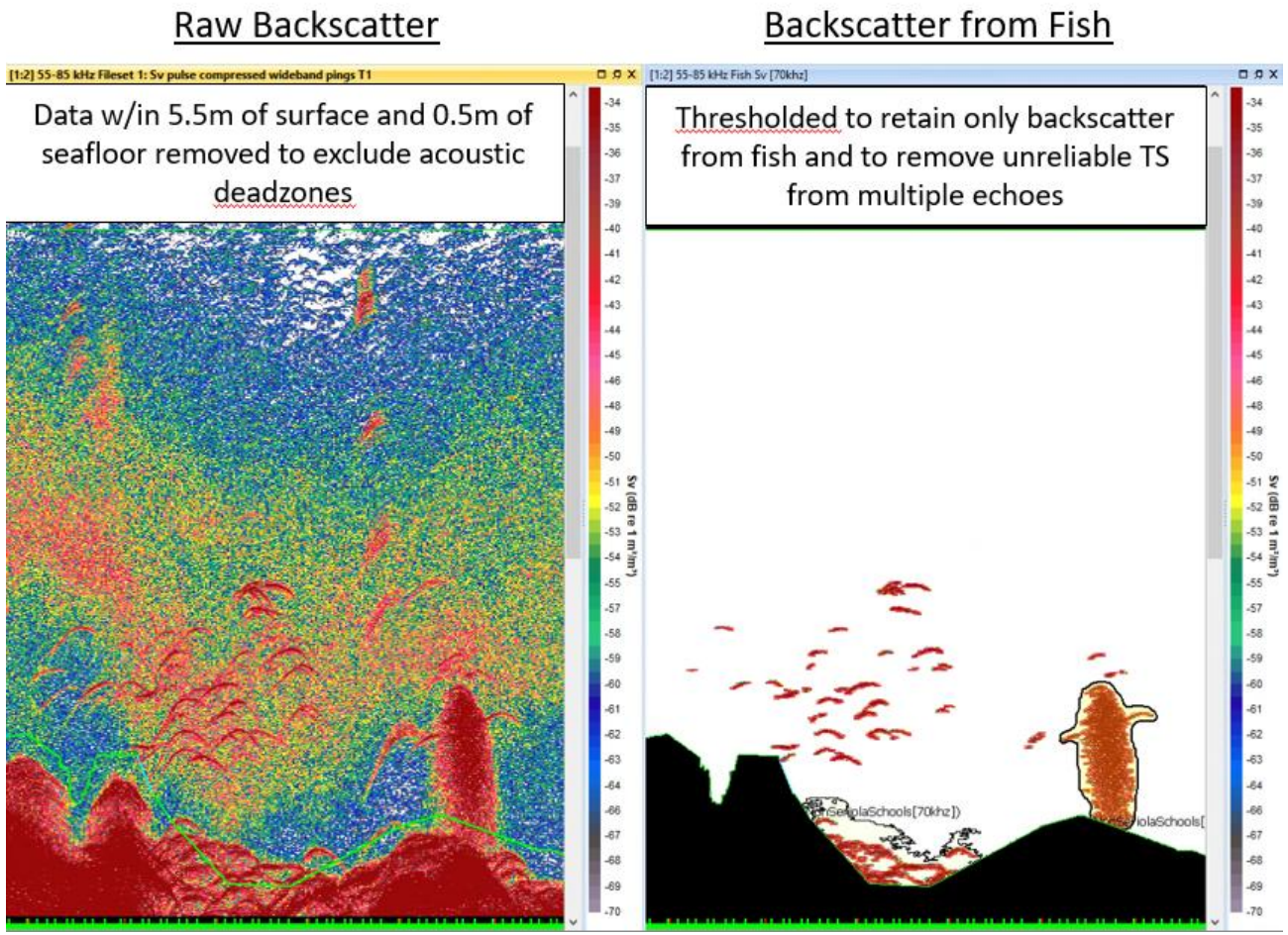


Then…

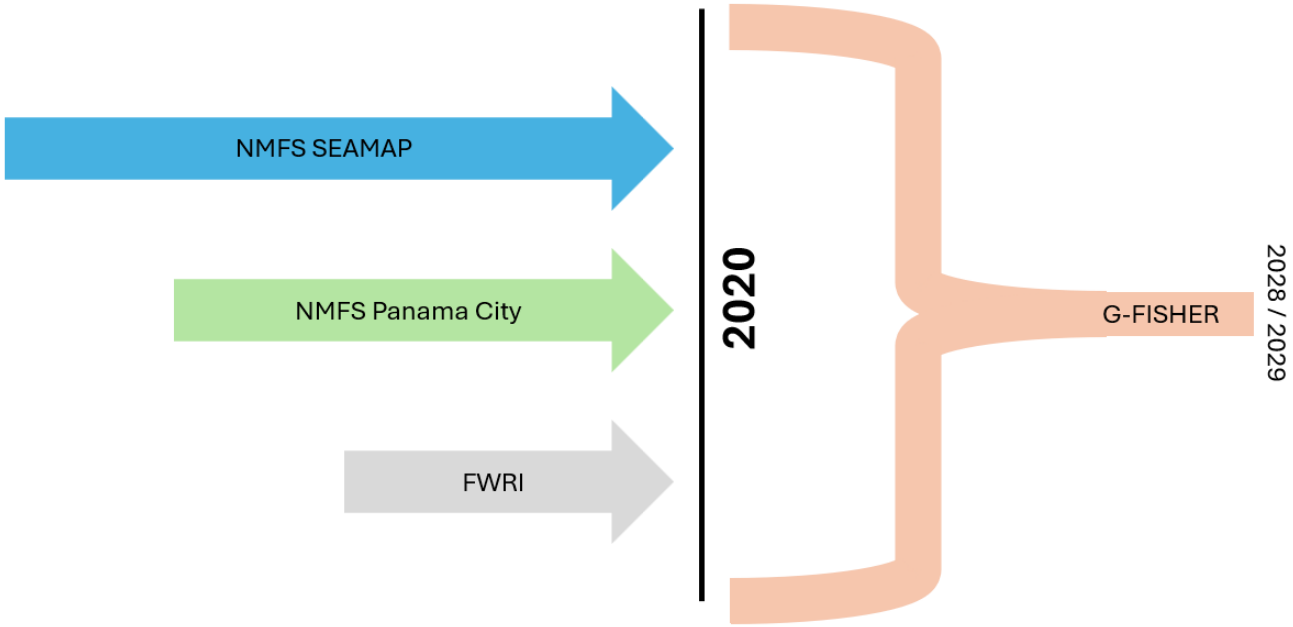
…Now

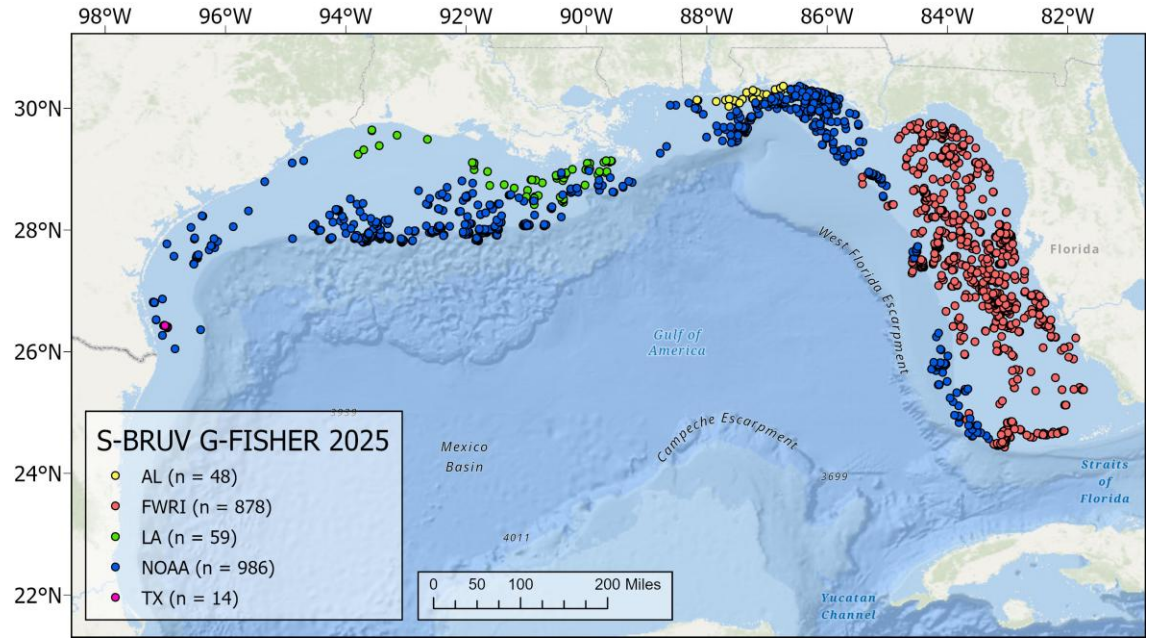
Conclusions

- Continued evaluation essential
- Limitations ⟶ Solutions
  - Analytical
  - Technological
- Utility of G-FISHER data / analyses will continue to improve



Future of G-FISHER?





G-FISHER StoryMap

Questions?