# Triggerfish Bycatch Estimation (SEDAR 100)

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# Problem statement

- Some species are not quantified in the observer program (e.g. Gray Triggerfish) meaning the improved shrimp bycatch method developed for Red Snapper is not a suitable approach.
- While SEAMAP data cannot be used as a direct substitute for commercial trawls, it can be used in concert with observer data for an alternative bycatch estimation method
- However, SEAMAP data must be filtered for use in bycatch estimation to better reflect habitat matching commercial shrimp operations.
- This assessment of Gray Triggerfish (SEDAR 100) required an alternative approach to estimate bycatch from the shrimp fleet.
- As a stop-gap measure, we suggested estimating bycatch using other species in the observer data, determined through co-occurrence analysis of SEAMAP trawl data limited to samples with gear and habitat matching commercial shrimp operations.

# Task 1

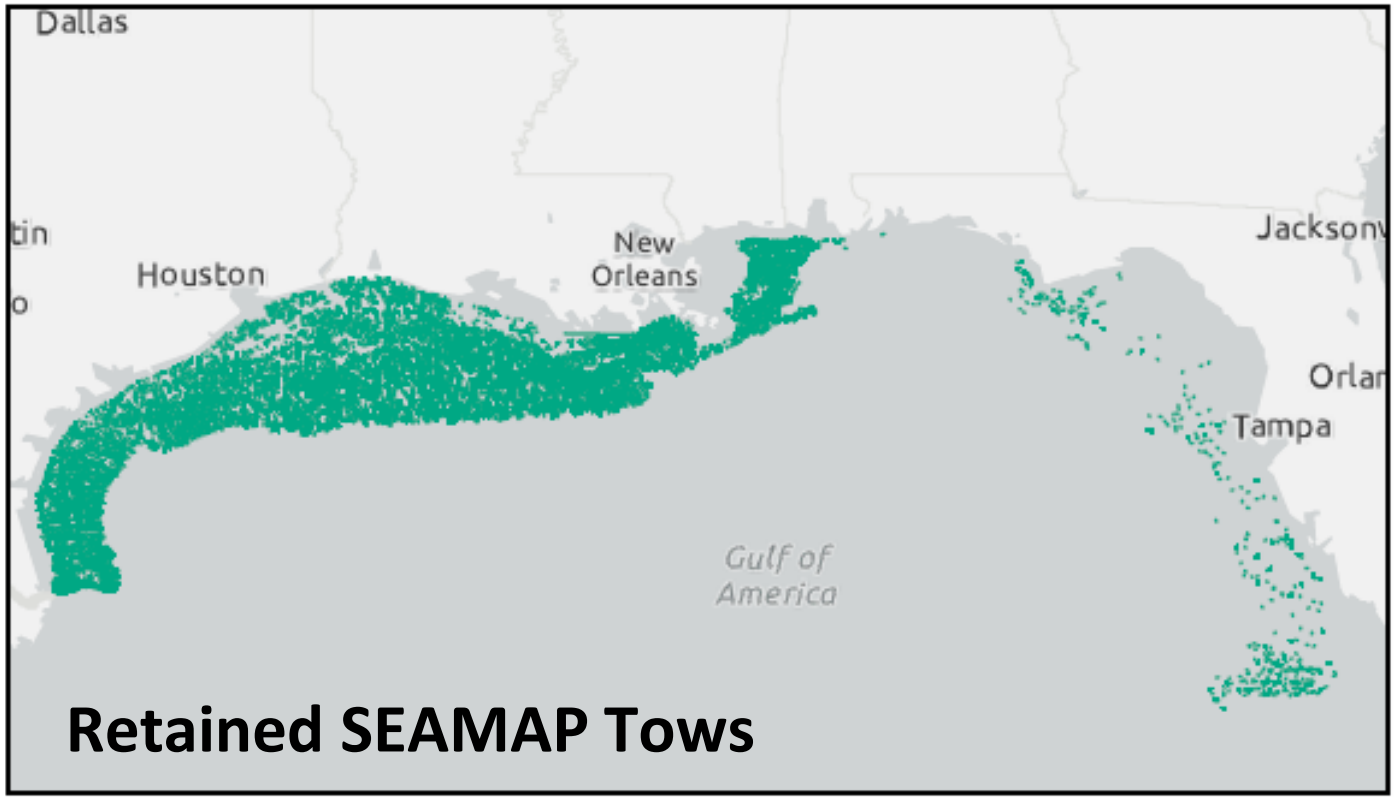
## Prepare SEAMAP Analysis-Ready Dataset:

- Filter SEAMAP data using existing habitat, catch, and effort data to include only tows representative of habitat in which the shrimp fleet operates by delineating SEAMAP tows on soft-bottom or reef/hard-bottom habitat.
  - Existing data sets for use in Task 1:
    - SEAMAP catch data - catch indicators of habitat (e.g. octocorals for reef/hard-bottom, shrimp catch rates for soft-bottom).
    - Vertical line observer program - sets are associated with 500 m2 grid cells can be cross-matched with SEAMAP tow tracks for indicators of habitat
    - Shrimp fleet ELB effort data (2007-2023)

# SEAMAP Analysis-Ready Dataset

**Four filters were applied to SEAMAP data. Tows were removed if:**

- They intersected known reef habitat
- There was presence of a reef indicator species in catch (octocorals)
- They were outside known commercial fleet effort area
- There was 0 shrimp catch



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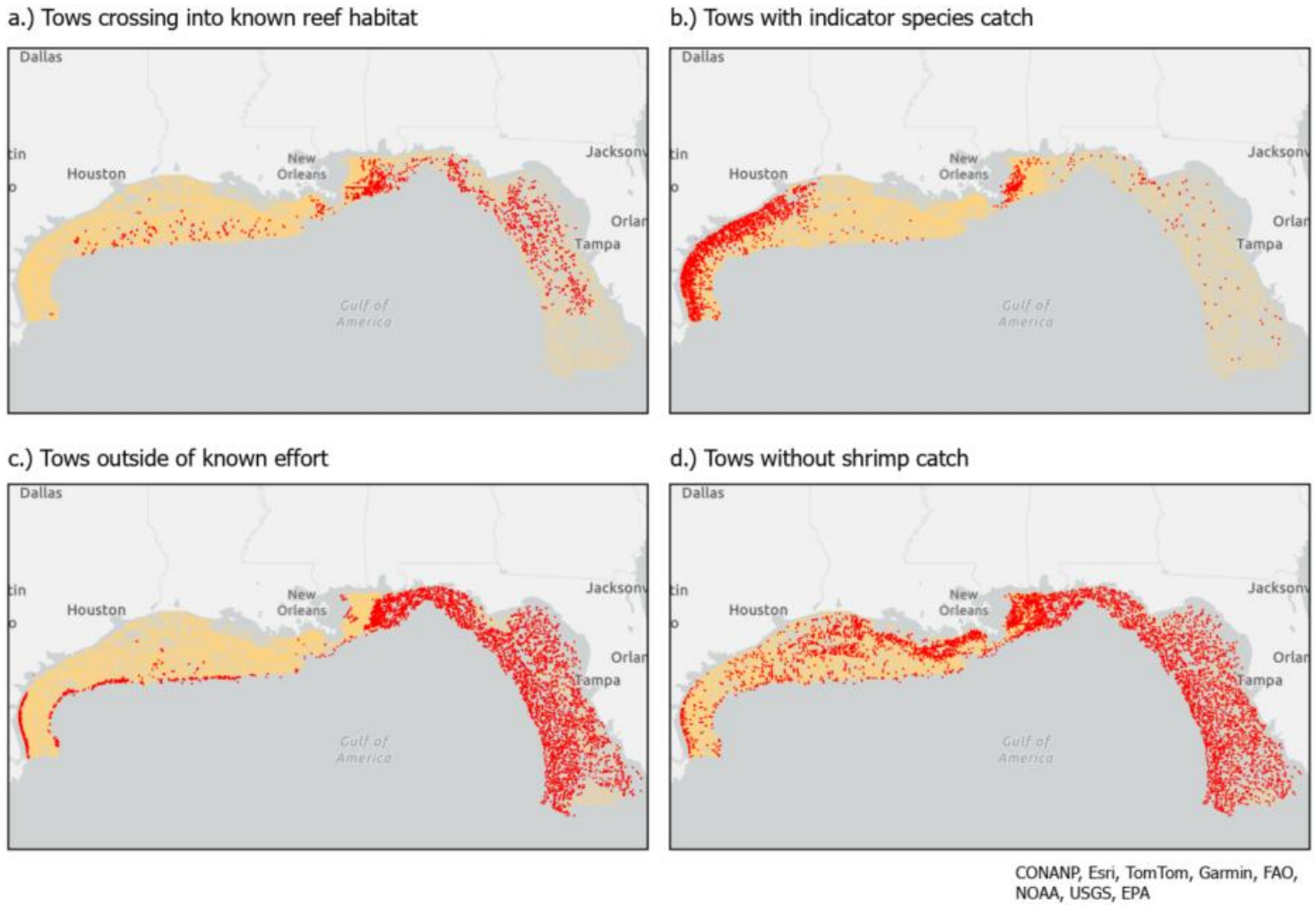

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| filter | # removed (from original) | % removed (from original) | # removed (cumulative) | % removed (cumulative) |
|---|---|---|---|---|
| has reef | 1189 | 4.87 | 1189 | 4.87 |
| has indicator species | 1998 | 8.19 | 3153 | 12.92 |
| falls outside of effort | 4577 | 18.75 | 6802 | 27.87 |
| has no shrimp catch | 5289 | 21.67 | 9017 | 36.94 |

# Task 2

## Co-occurrence Analysis:

- Use filtered SEAMAP data to determine associations between Gray Triggerfish and co-occurring species to identify proxy species for bycatch estimation.
  - Suitable proxies are positively associated and consistently co-occur with Gray Triggerfish and are among those quantified on observer trips.
  - Co-occurrence analysis allows for blocking (e.g. location/region, depth, season) to examine spatial/temporal co-occurrence. Stratum-level bycatch estimation allows for use of multiple proxies if associations are spatio-temporally variable.

# Species Co-Occurrence

Uses basic principles of probability theory

Occurrence: proportion of sample units where species is present
p(A): occurrence of species A
p(B): occurrence of species B

Species Interaction Factor (SIF)

$$SIF = \frac{p(A,B)}{p(A) \times p(B)} \quad \frac{\text{observed co-occurrence of A and B}}{\text{expected co-occurrence of A and B}}$$

| SIF | Association |
|---|---|
| >1 | positive |
| =1 | none |
| <1 | negative |

Statistical Test for SIF=1: Chi-Square, 2x2 Contingency Table

**Sample Size Requirement:**
5 or more samples per table category

Number of Sample Units

| | |
|---|---|
| Catch A=0<br>Catch B=0 | Catch A=0<br>Catch B>0 |
| Catch A>0<br>Catch B=0 | Catch A>0<br>Catch B>0 |

**Example: stratum 423 (1749 total tows)**

$$\textbf{SIF} = \frac{0.06}{(0.13 \times 0.32)} = 1.44; \quad \chi^2 = 25.89,\ p < 0.001$$

| | |
|---|---|
| 1065 | 459 |
| 119 | 106 |

# Species Co-Occurrence

**Stratification Scheme:**

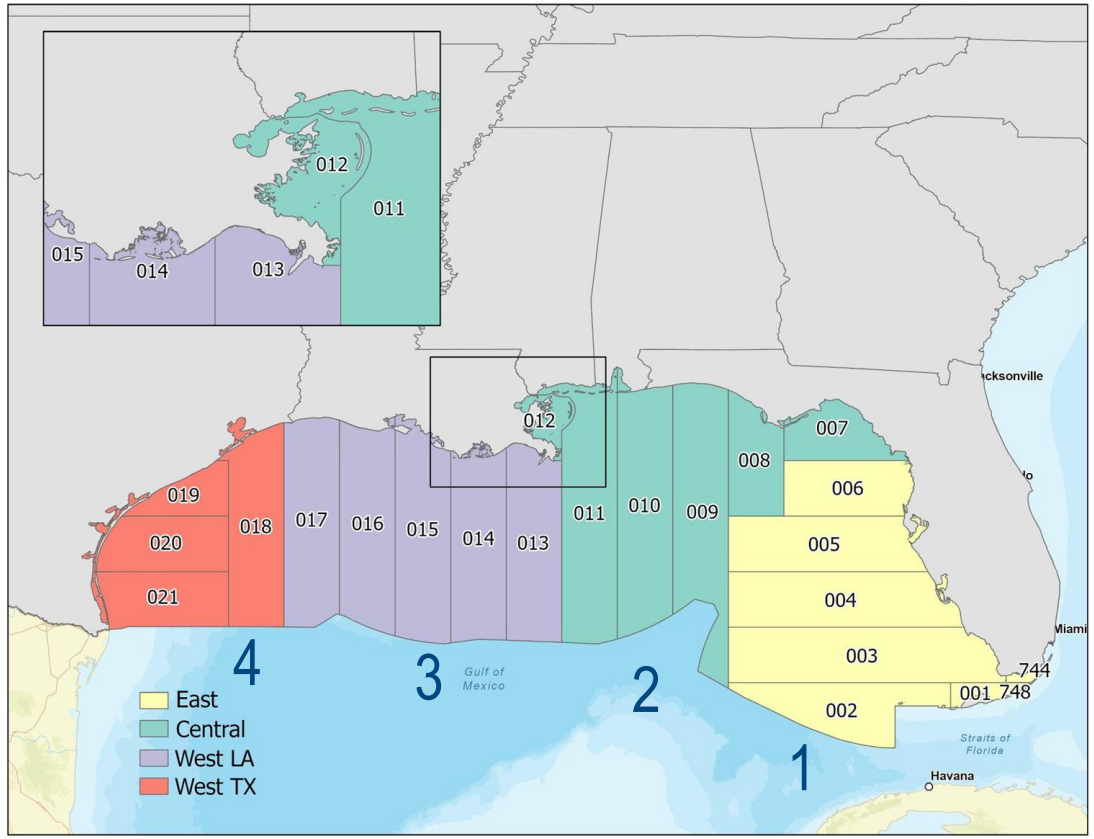
**Area (4)**: StatZones 1-6, 7-12, 13-17, 18-21

**Depth (2)**: < 10 fathoms, > 10 fathoms *

**Seasons (3)**: Jan-Apr, May-Aug, Sep-Dec

* Depths were pooled for Area 1

** Season 2-3 SEAMAP data were averaged for Season 1



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**Seasons (3)**: Jan-Apr, May-Aug, Sep-Dec

**Area 1:** Area-Season

**Areas 2-4 :** Area-Season-Depth

* Depths were pooled for Area 1

** Season 2-3 SEAMAP data were averaged for Season 1

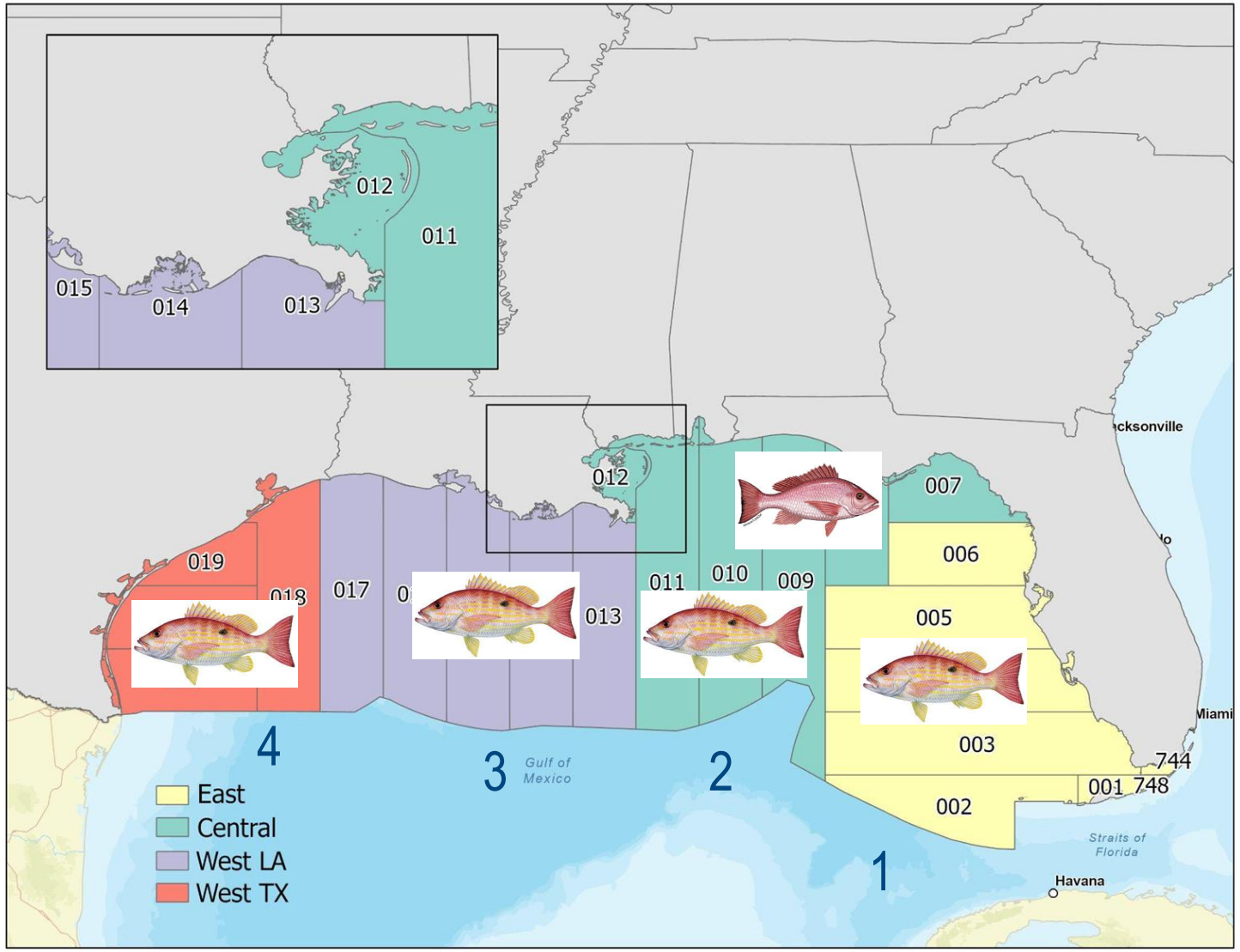
# Species Co-Occurrence

**Lane snapper** positively associated with gray triggerfish in most strata

In Area 2, **Red Snapper** had a stronger association at Depth 1 (<10 fathoms)

For some strata, statistics could not be run on the co-occurrence analysis, but SIF values were positive (> 1)

Associations were stable across time of day.



# Species Co-Occurrence

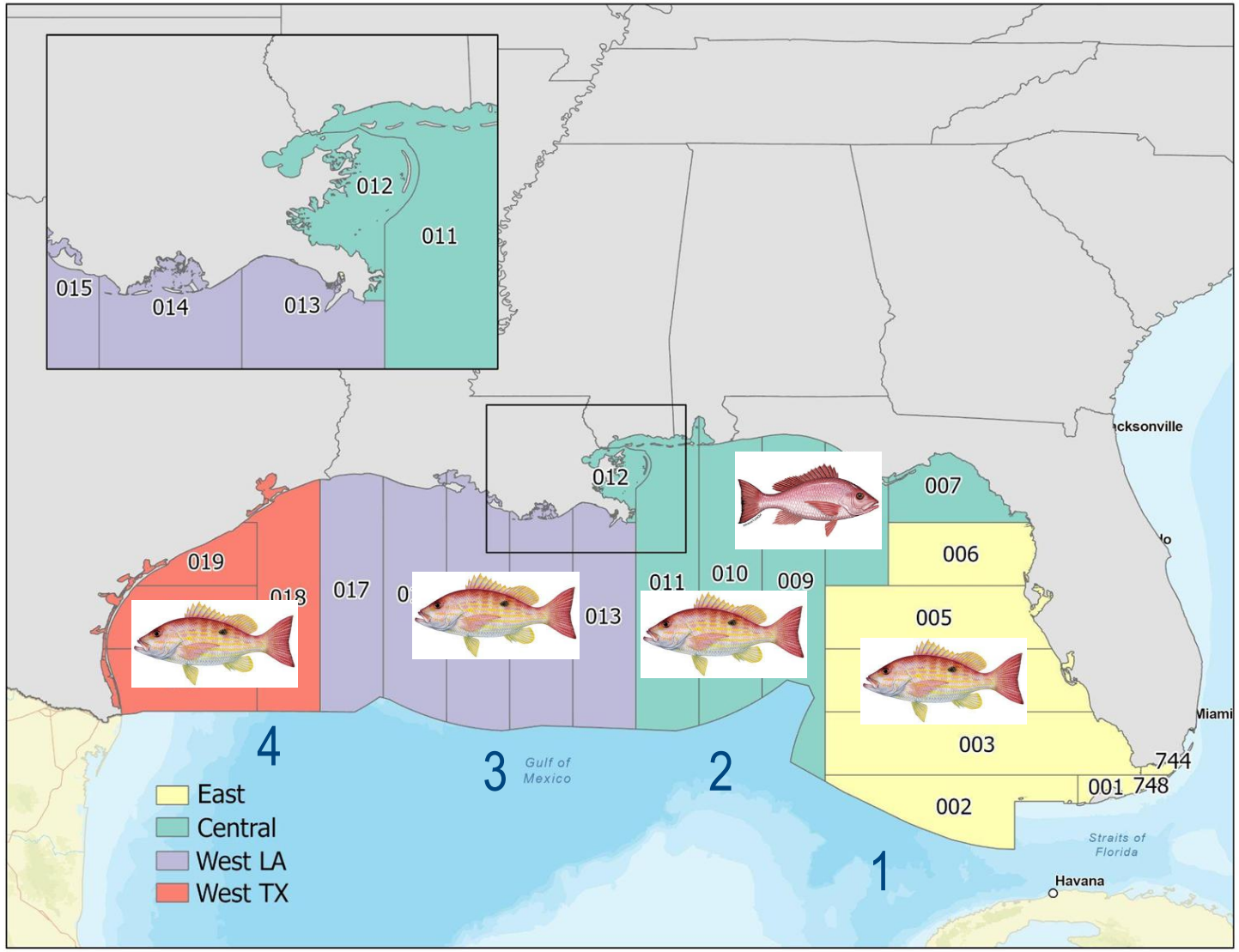
**21 total Area-Season-Depth strata**

**(x3 Eras = 63 total strata)**

**Red Snapper** used in

**Area 2 - Depth 1 - Seasons 1:3**

**Lane Snapper** used in all other strata



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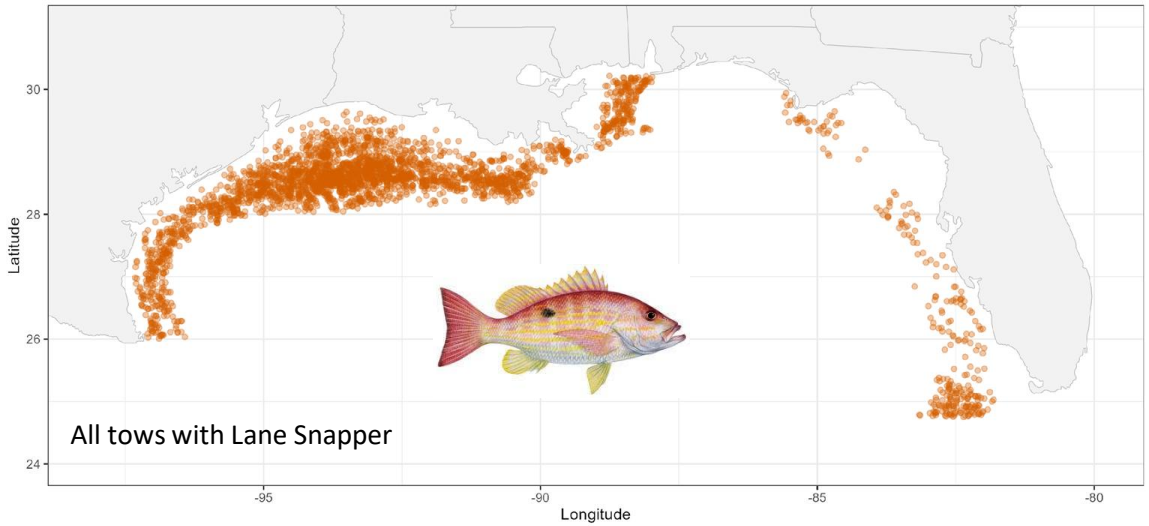
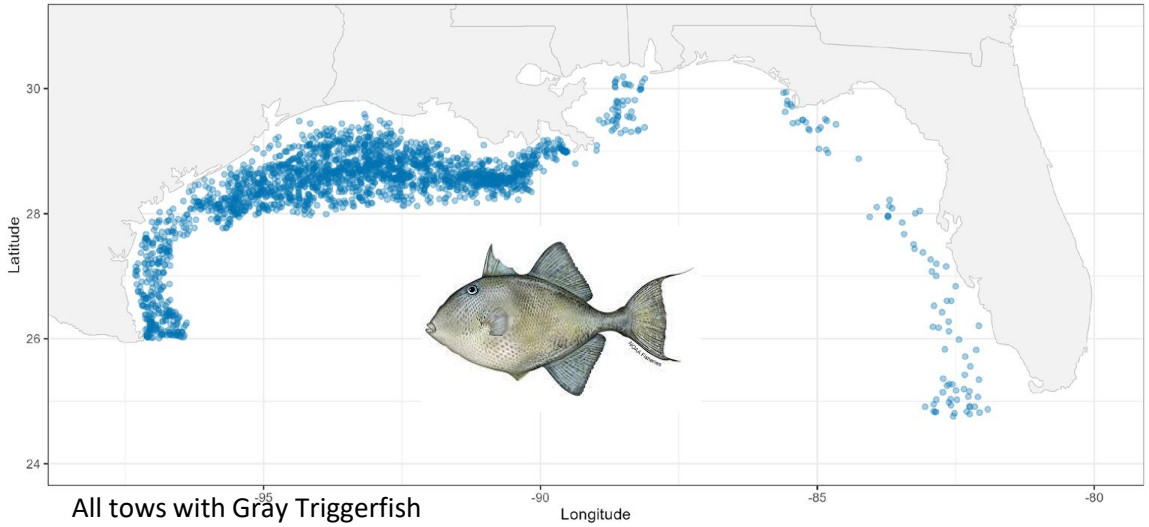
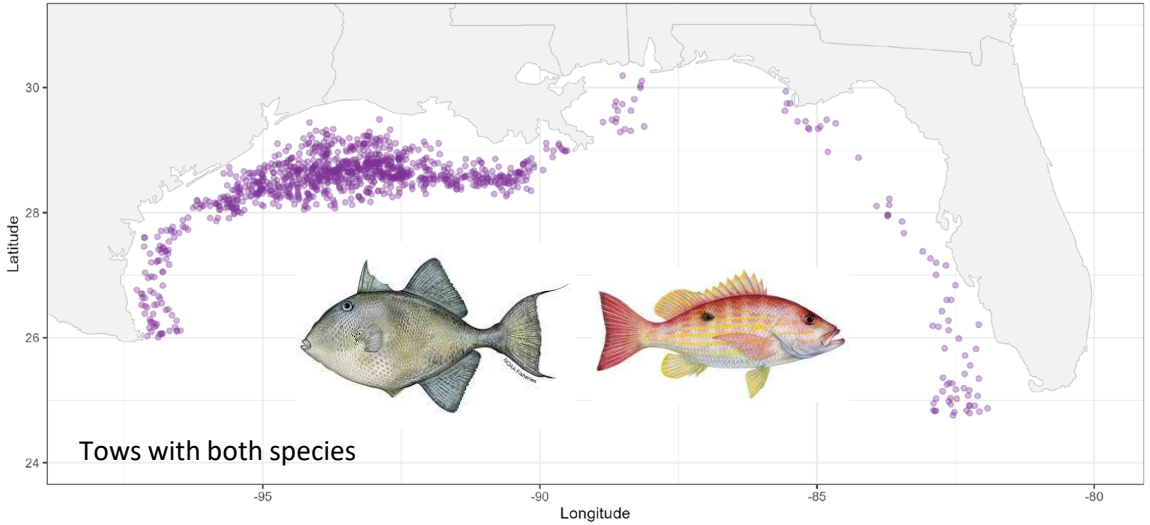



## Positive tows from filtered SEAMAP data (n = 15,393 tows)




| | Gray Triggerfish | Lane Snapper |
|---|---|---|
| Positive Tows | 2452 | 3162 |
| Proportion Positive | 0.16 | 0.21 |
| Total Catch (number of fish) | 12,627 | 37,475 |

# Task 3

## Bycatch Estimation:

Conduct previously vetted strata-level bycatch estimation methods on co-occurring species to calibrate Gray Triggerfish estimates.

- Shrimp observer data using the method used for Red Snapper
  - ('nowcast' and 'hindcast', SEDAR98-RD01)
- SEAMAP conversion factor used to adjust the bycatch estimates from co-occurring species to Gray Triggerfish.
  - Conversion factors ranged from 0.002 to 8.59 (mean = 0.80, median = 0.43)

# Task 3

## Calibration for Gray Triggerfish:

- SEAMAP conversion factor used to adjust the bycatch estimates from co-occurring species to Gray Triggerfish.

Key assumption:

$$\frac{\text{GT cpue}_{\text{SEAMAP}}}{\text{LS cpue}_{\text{SEAMAP}}} = \frac{\text{GT cpue}_{\text{Observer}}}{\text{LS cpue}_{\text{Observer}}}$$

- Conversion factor calculated and applied at strata level

# Task 3

## Calibration for Gray Triggerfish:

$$\frac{\text{GT cpue}_{SEAMAP}}{\text{LS cpue}_{SEAMAP}} = \frac{\text{GT cpue}_{Observer}}{\text{LS cpue}_{Observer}} \longleftrightarrow \frac{y_1}{x_1} = \frac{y_2}{x_2}$$

**3 knowns, 1 unknown**

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**3 knowns, 1 unknown**

$$\frac{\text{GTcpue}_{SEAMAP}}{\text{LScpue}_{SEAMAP}} = \frac{y_2}{\text{LScpue}_{Observer}}$$

**Solving for $y_2$**

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**Solving for $y_2$**

$$\frac{\text{GTcpue}_{SEAMAP}}{\text{LScpue}_{SEAMAP}} \times \text{LScpue}_{Observer} = y_2$$

# Task 3

## Calibration for Gray Triggerfish:

$$\text{Gray triggerfish bycatch} = \frac{\text{GT cpue}_{SEAMAP}}{\text{LS cpue}_{SEAMAP}} \times \text{LS Bycatch}_{Observer}$$

- Conversion factor calculated and applied at strata level

**Suggestion during data workshop from working group: explore time-varying conversion factor**

# Bycatch Estimation of Proxy Species:

- SEAMAP data used to calculate a calibration factor to adjust the bycatch estimates of the proxy species to Gray Triggerfish.

- Conversion factor calculated and applied at strata level

***Time-varying conversion factor:***

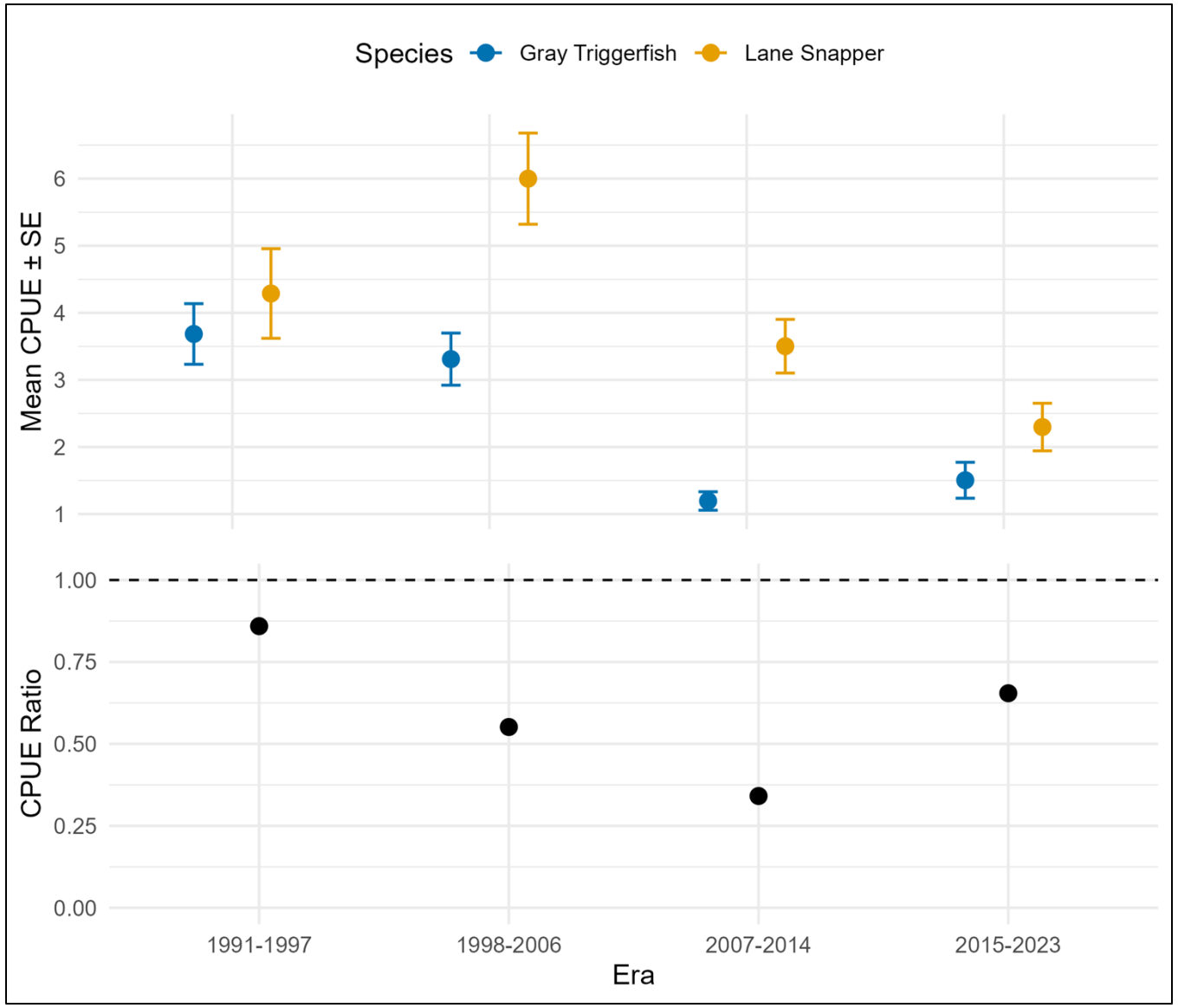
Three eras:

- 1987-2006
- 2007-2013
- 2014-2023

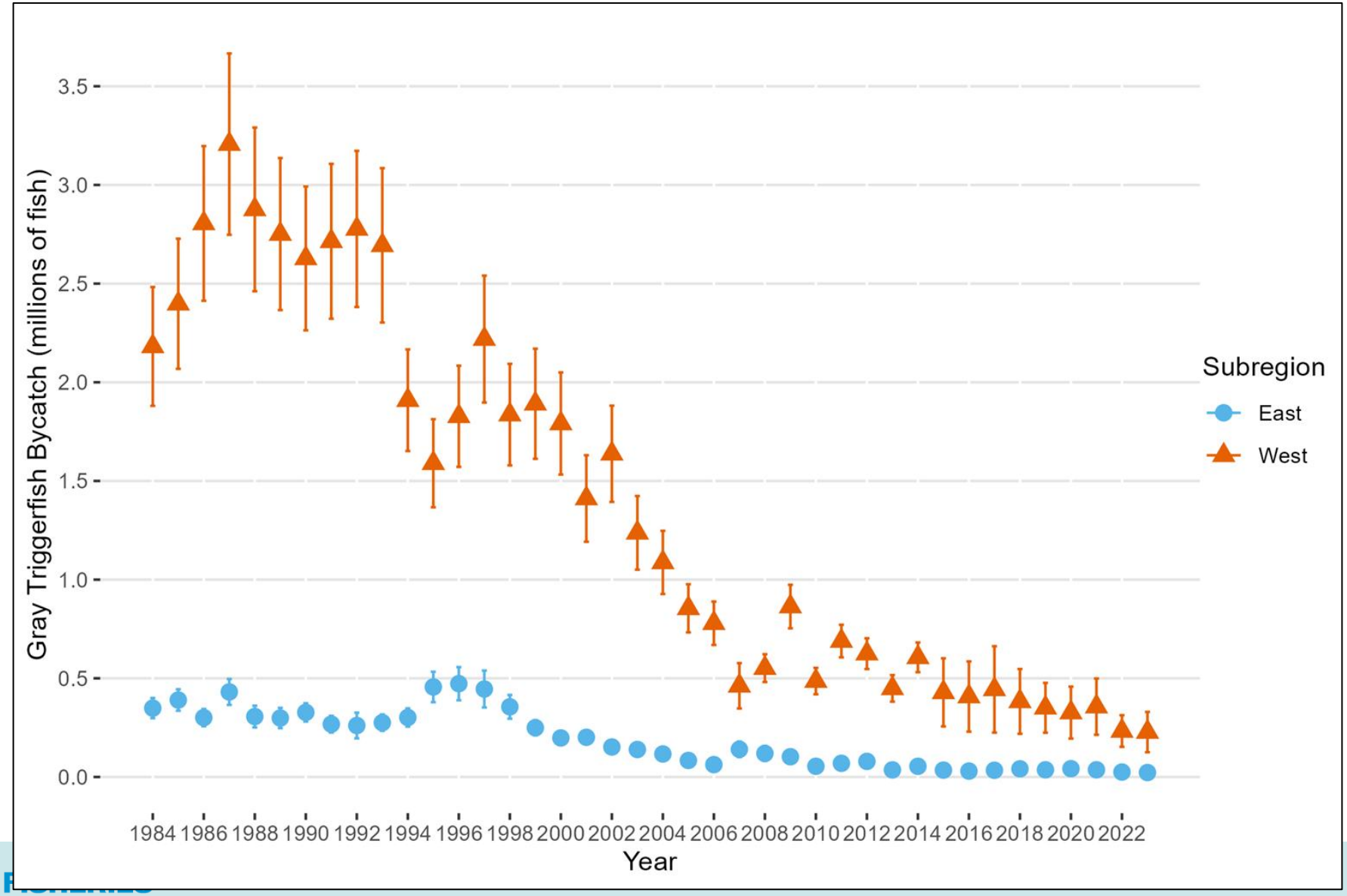
- **n = 64 conversion factors across all strata**

## Conversion Factors Through Time

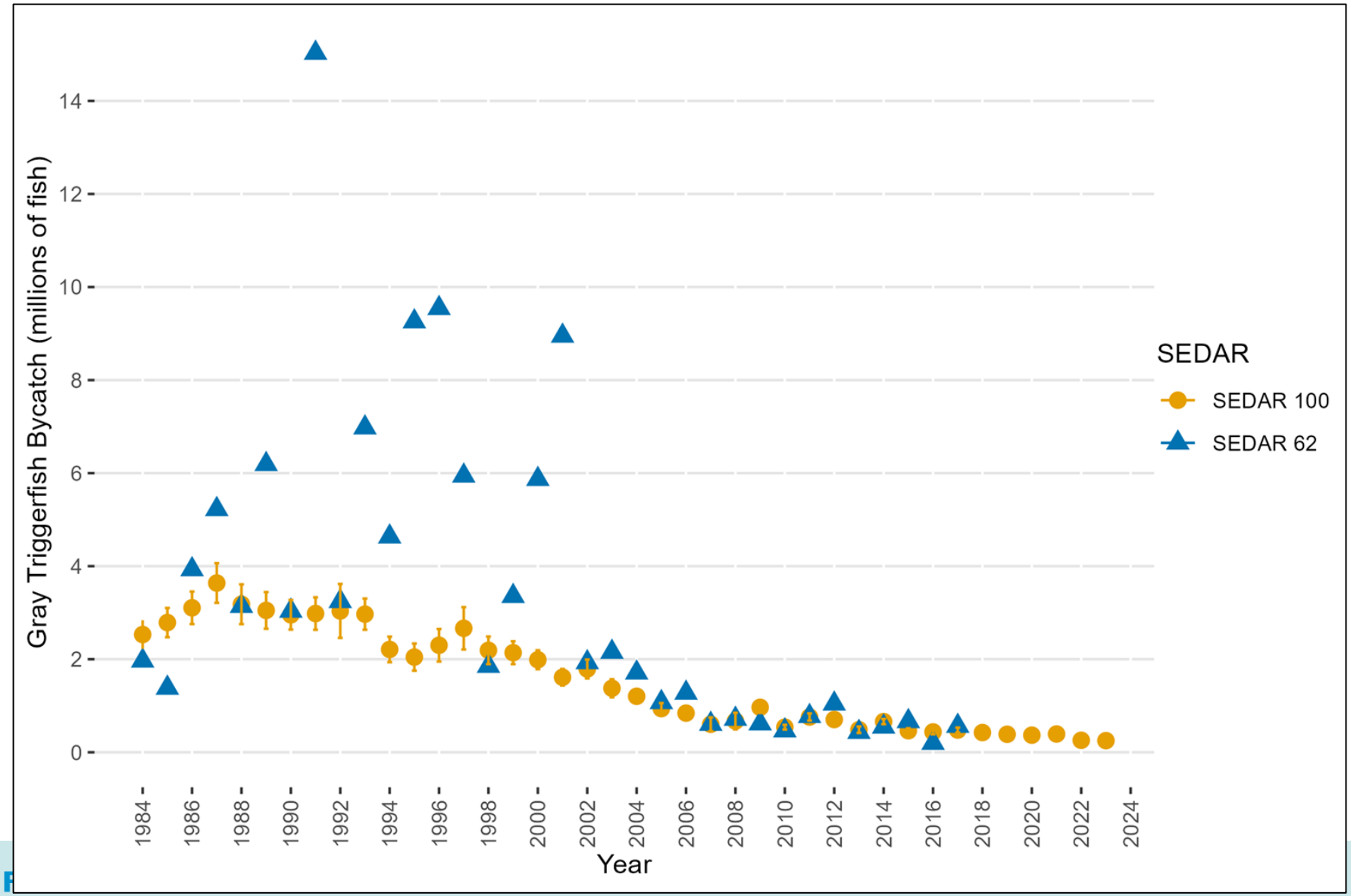
Example strata: Area 3, Season 2, Depth 3



# Gray Triggerfish bycatch – by Subregion (time-varying conversion factor)



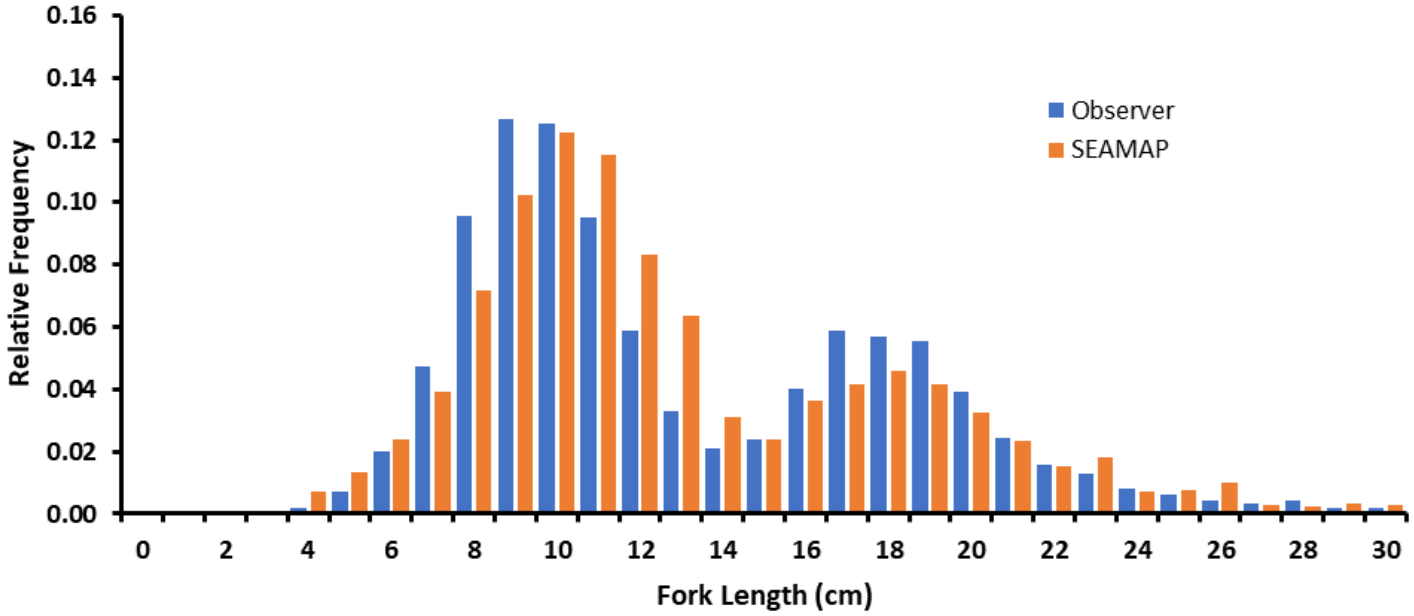
# Gray triggerfish bycatch - all Gulf (time-varying conversion factor)



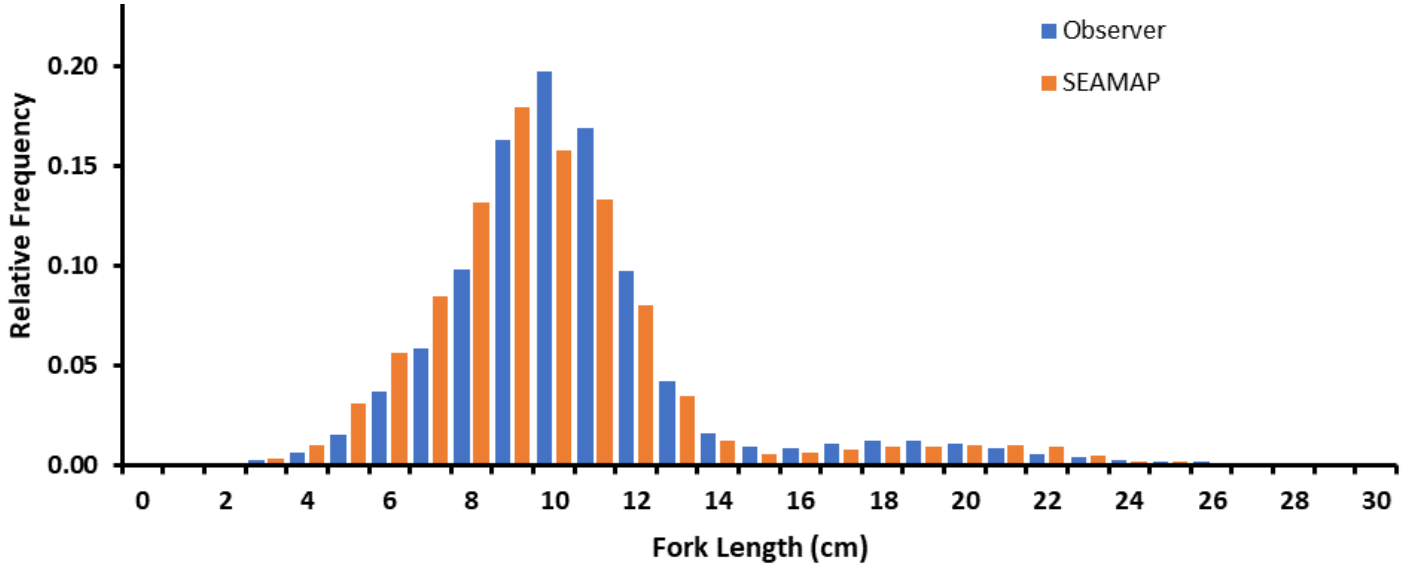

(Zhang 2020, S62-WP-20)

# Shrimp Observer and SEAMAP Red Snapper length distributions were similar within area-depth-season strata

Area: Gulf zones 13-17
Depth: 10-30 fathoms
Season: Sep-Dec



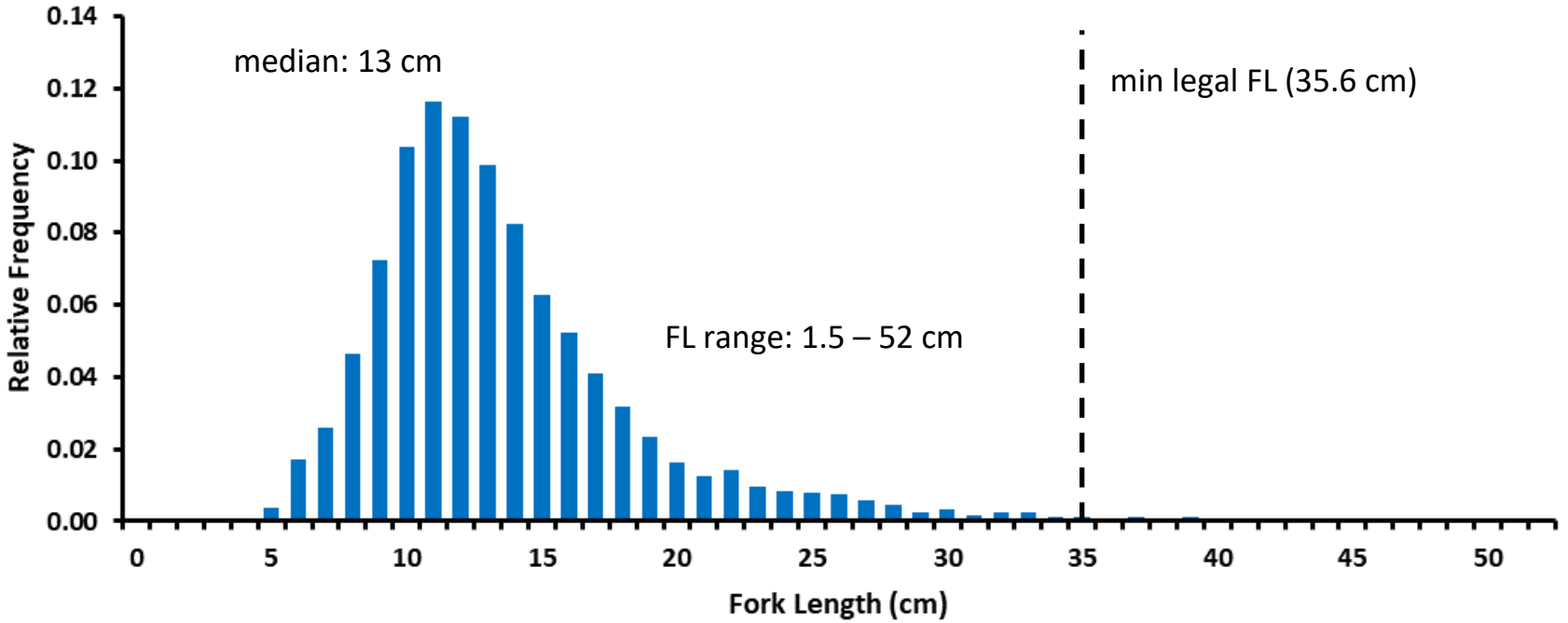

Area: Gulf zones 18-21
Depth: 10-30 fathoms
Season: Sep-Dec

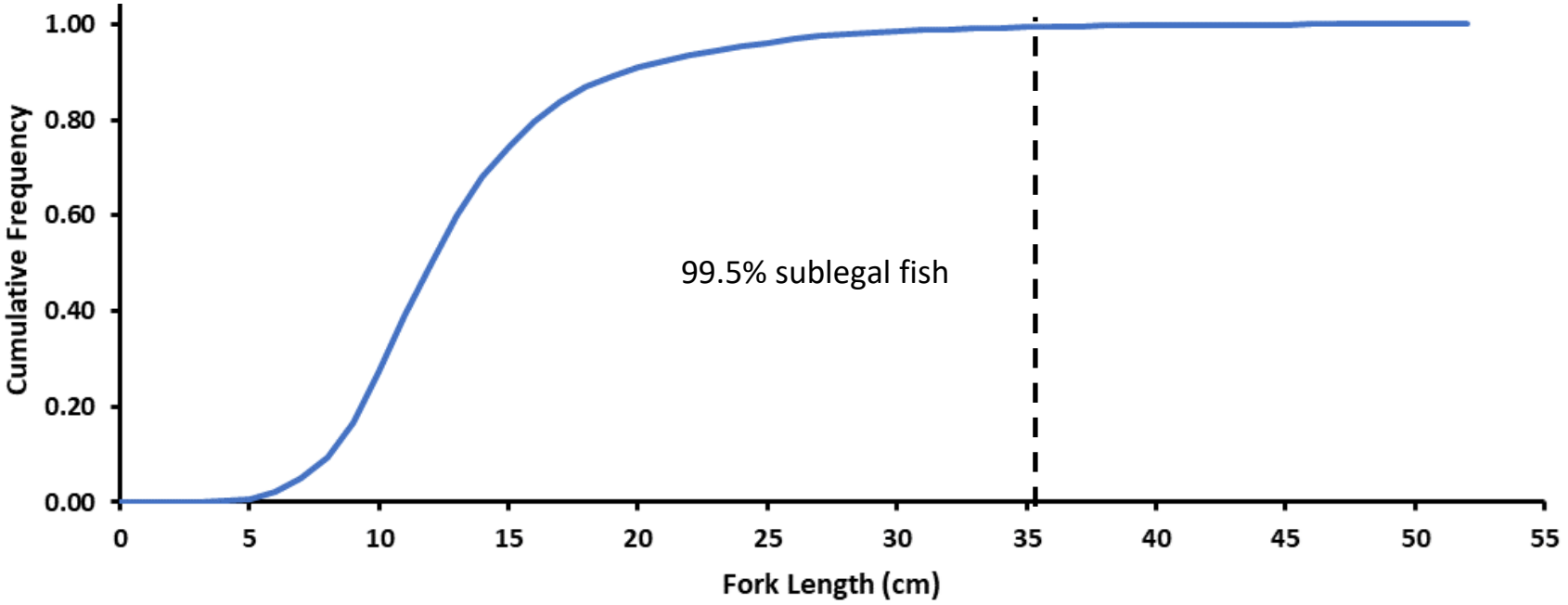



Assumption: length distribution is similar between SEAMAP and commercial trawls for Gray Triggerfish

## Gray Triggerfish
## SEAMAP Sampled Lengths

- Filtered for shrimp habitat tows
- 6,312 sampled lengths



# Intermission

# Use of 2025 observer data to estimate gray triggerfish bycatch rates

# 2025 Observer Sampling

| YEAR=2025 | VALUE | % | |
|---|---|---|---|
| NUM_TRIPS | 67 | - | TRIPS OBSERVED |
| NUM_GTF_POS_TRIPS | 20 | 30% | PROPORTION POSITIVE TRIPS 2025: GRAY TRIGGERFISH |
| NUM_LS_POS_TRIPS | 24 | 36% | PROPORTION POSITIVE TRIPS 2025: LANE SNAPPER |
| NUM_TOWS | 2,472 | - | TOWS OBSERVED |
| NUM_GTF_POS_TOWS | 182 | 7% | PROPORTION POSITIVE TOWS 2025: GRAY TRIGGERFISH |
| NUM_LS_POS_TRIPS | 302 | 12% | PROPORTION POSITIVE TOWS 2025: LANE SNAPPER |

| FIELD | NUMBERS | WEIGHT (G) | |
|---|---|---|---|
| TOTAL_GTF | 601 | 31.5 | Number and weight of Gray Triggerfish sampled in 2025 |
| TOTAL_LS | 4,680 | 251.5 | Number and weight of Lane Snapper sampled in 2025 |

| STATZONE | NUM_GTF | PROP_GTF | NUM_LS | PROP_LS |
|---|---|---|---|---|
| 1 | - | 0.00% | 956 | 20.43% |
| 2 | 1 | 0.17% | 2,405 | 51.39% |
| 3 | - | 0.00% | 565 | 12.07% |
| 4 | - | 0.00% | 22 | 0.47% |
| 5 | - | 0.00% | - | 0.00% |
| 6 | - | 0.00% | 3 | 0.06% |
| 7 | - | 0.00% | - | 0.00% |
| 8 | - | 0.00% | - | 0.00% |
| 9 | - | 0.00% | - | 0.00% |
| 10 | - | 0.00% | - | 0.00% |
| 11 | 1 | 0.17% | 4 | 0.09% |
| 12 | - | 0.00% | - | 0.00% |
| 13 | - | 0.00% | - | 0.00% |
| 14 | 74 | 12.31% | 6 | 0.13% |
| 15 | 54 | 8.99% | 2 | 0.04% |
| 16 | 5 | 0.83% | 7 | 0.15% |
| 17 | 23 | 3.83% | 84 | 1.79% |
| 18 | 93 | 15.47% | 262 | 5.60% |
| 19 | 283 | 47.09% | 137 | 2.93% |
| 20 | 20 | 3.33% | 50 | 1.07% |
| 21 | 45 | 7.49% | 177 | 3.78% |
| 22 | 2 | 0.33% | - | 0.00% |
| TOTAL | 601 | | 4,680 | |

# 2025 Observer Sampling

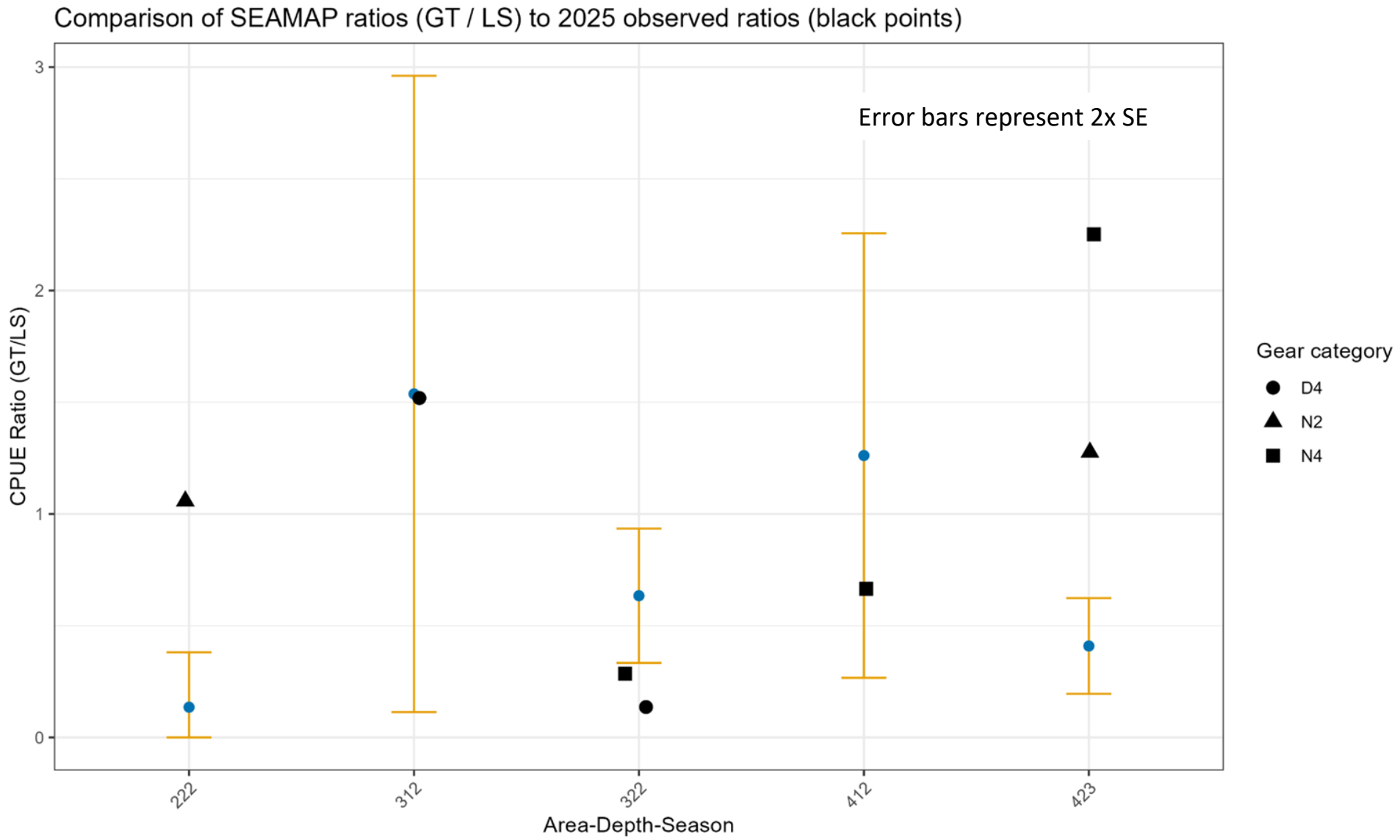
- Sample Size Table, number of tows
- Area-Depth-Season, 4 Gear Types
- Green Shading: strata with n ≥ 10 tows; account for 46% of total estimated fleet effort (Dettloff).

- Time stanzas of 7+ years: strata with sufficient sampling accounted for 89% of total estimated fleet effort (Dettloff).

| | | | Gear | | | |
|---|---|---|---|---|---|---|
| Area | Depth | Season | D2 | D4 | N2 | N4 |
| 1 | <10f | Jan-Apr | 0 | 0 | 0 | 7 |
| 1 | <10f | May-Aug | 0 | 0 | 0 | 25 |
| 1 | <10f | Sep-Dec | 0 | 0 | 0 | 0 |
| 1 | 10-30f | Jan-Apr | 0 | 0 | 0 | 73 |
| 1 | 10-30f | May-Aug | 0 | 0 | 0 | 20 |
| 1 | 10-30f | Sep-Dec | 0 | 0 | 0 | 0 |
| 1 | >30f | Jan-Dec | 0 | 0 | 0 | 8 |
| 2 | <10f | Jan-Apr | 0 | 4 | 0 | 17 |
| 2 | <10f | May-Aug | 49 | 0 | 99 | 12 |
| 2 | <10f | Sep-Dec | 0 | 0 | 0 | 0 |
| 2 | 10-30f | Jan-Apr | 0 | 6 | 0 | 24 |
| 2 | 10-30f | May-Aug | 0 | 11 | 31 | 38 |
| 2 | 10-30f | Sep-Dec | 0 | 0 | 0 | 0 |
| 2 | >30f | Jan-Apr | 0 | 1 | 0 | 4 |
| 2 | >30f | May-Aug | 0 | 21 | 0 | 37 |
| 2 | >30f | Sep-Dec | 0 | 0 | 0 | 0 |
| 3 | <10f | Jan-Apr | 0 | 8 | 0 | 9 |
| 3 | <10f | May-Aug | 16 | 51 | 38 | 79 |
| 3 | <10f | Sep-Dec | 0 | 9 | 0 | 9 |
| 3 | 10-30f | Jan-Apr | 0 | 21 | 0 | 30 |
| 3 | 10-30f | May-Aug | 0 | 31 | 0 | 59 |
| 3 | 10-30f | Sep-Dec | 0 | 0 | 0 | 1 |
| 3 | >30f | Jan-Apr | 0 | 1 | 0 | 0 |
| 3 | >30f | May-Aug | 0 | 1 | 0 | 0 |
| 3 | >30f | Sep-Dec | 0 | 0 | 0 | 0 |
| 4 | <10f | Jan-Apr | 91 | 3 | 5 | 1 |
| 4 | <10f | May-Aug | 51 | 24 | 20 | 44 |
| 4 | <10f | Sep-Dec | 45 | 30 | 15 | 26 |
| 4 | 10-30f | Jan-Apr | 4 | 6 | 4 | 7 |
| 4 | 10-30f | May-Aug | 5 | 0 | 8 | 157 |
| 4 | 10-30f | Sep-Dec | 4 | 2 | 44 | 156 |
| 4 | >30f | Jan-Apr | 0 | 1 | 0 | 1 |
| 4 | >30f | May-Aug | 0 | 0 | 0 | 0 |
| 4 | >30f | Sep-Dec | 0 | 4 | 0 | 6 |

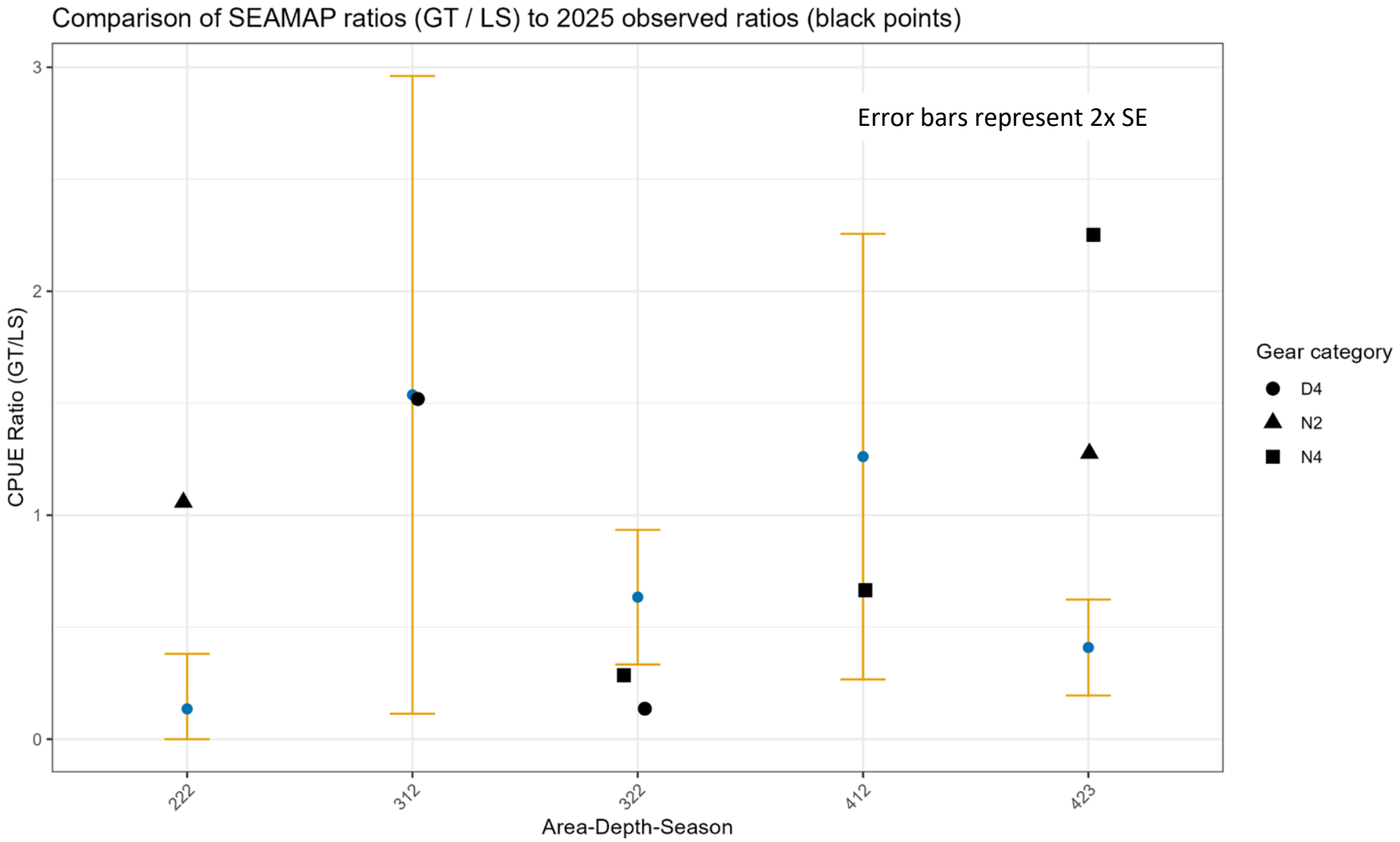
SEAMAP-derived conversion factors (ratio of Gray Triggerfish / Lane Snapper) appear to be free of systemic directional bias - i.e they are not consistently higher or lower than observed ratios.

Observed ratios higher than SEAMAP-derived ratios indicate a higher proportion of Gray Triggerfish than expected from the SEDAR 100 method, and vice versa.

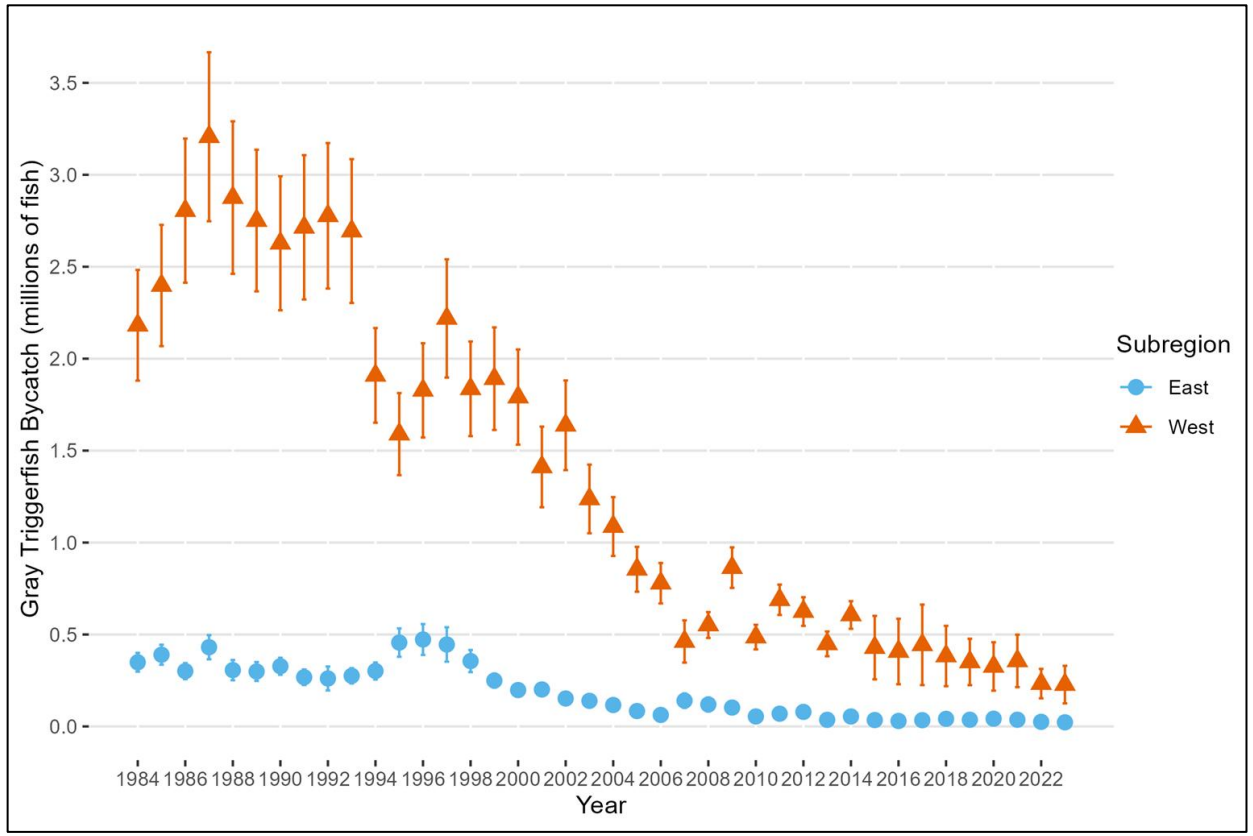


SEAMAP-derived ratios ranged from 0.002 to 8.593 (mean = 0.802, median = 0.429).

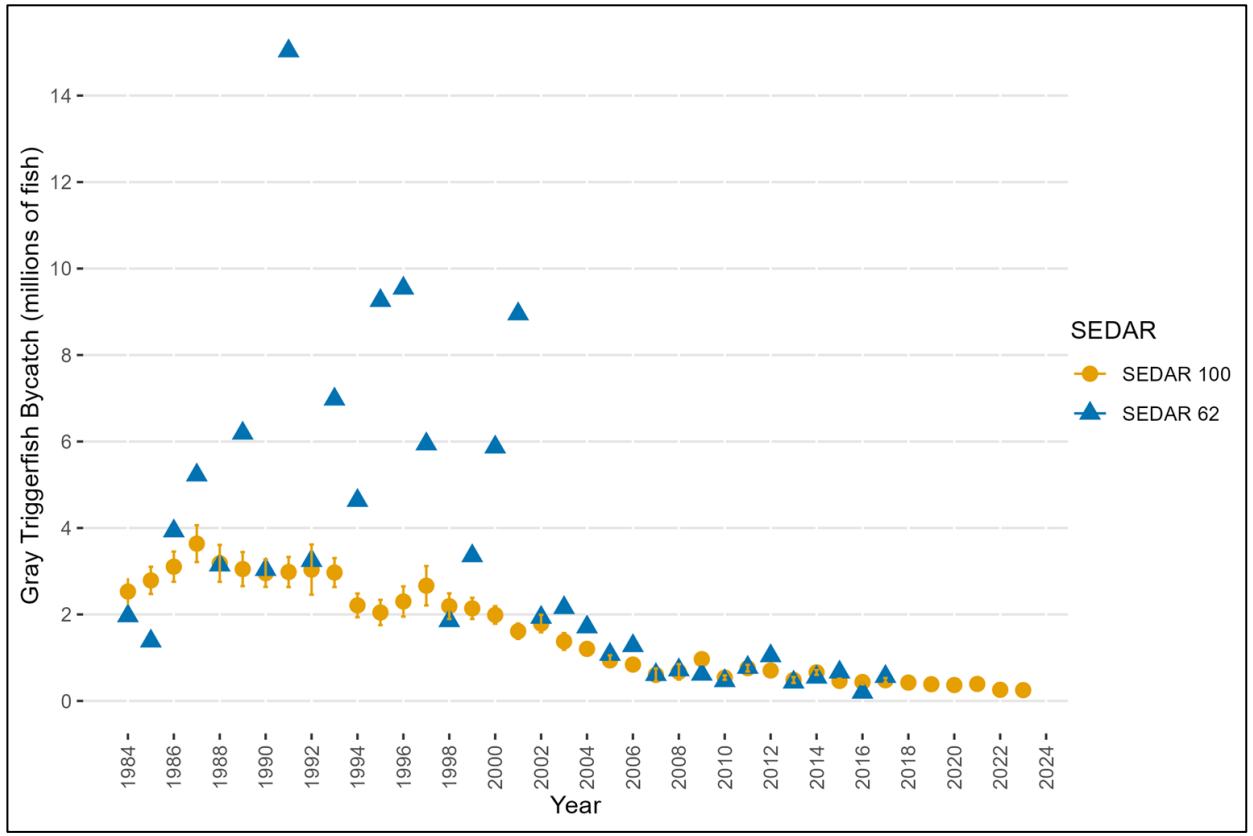
Observed ratios ranged from 0.444 to 9.980 (mean = 3.150, median = 1.220)



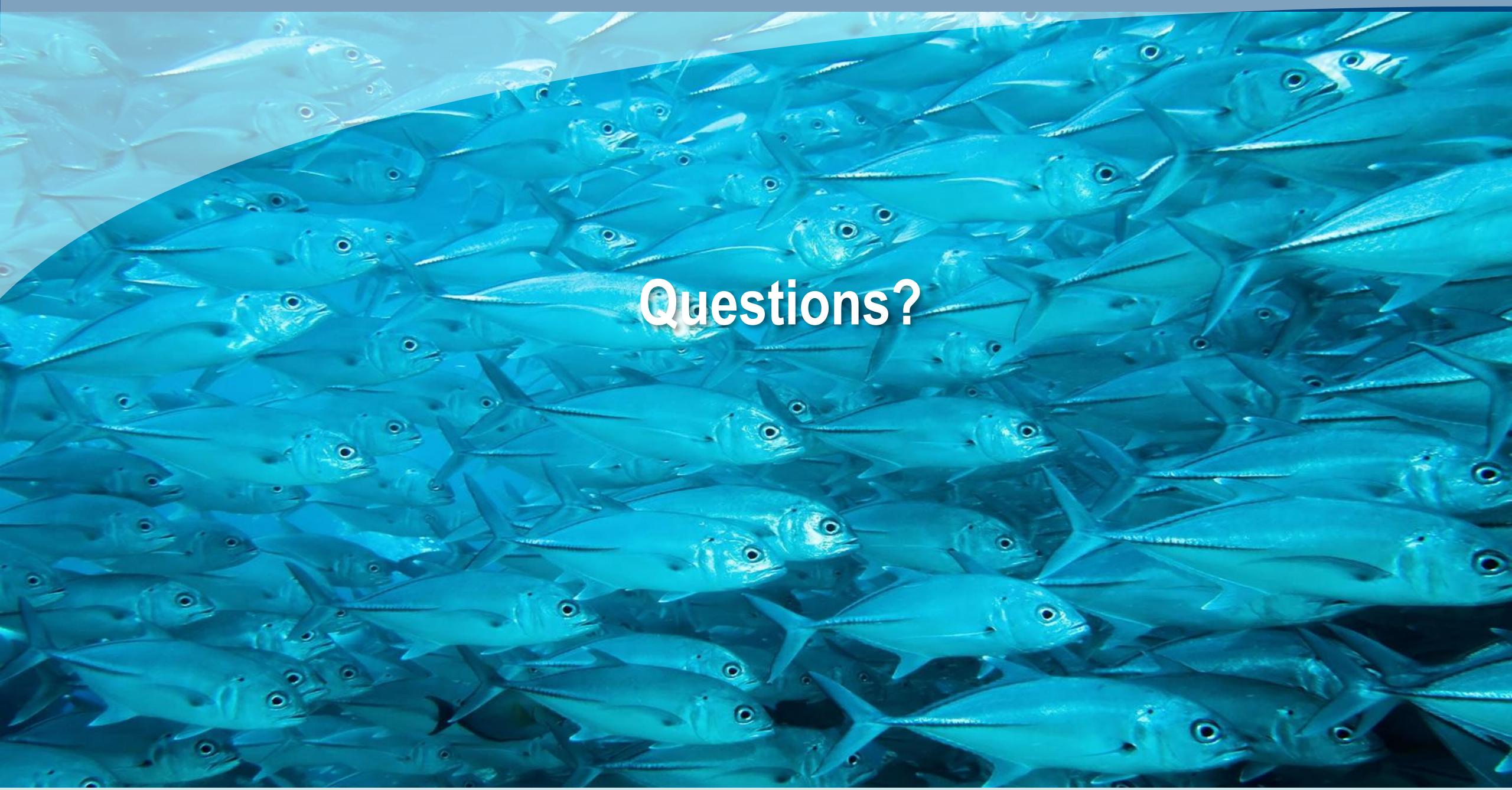
Recommend proxy method as most robust estimates without additional years of observer data




**SEDAR 100 Estimates - by subregion**




**SEDAR 100 compared to SEDAR 62 - total estimates**


Questions?