Presentations to Gulf Council's Shrimp Bycatch of Finfish Working Group

Overview

- Protocols to expand bycatch estimates from observer data
  - Slides 3-7
- Gear configuration (2- and 4-net) effort and selectivity
  - Slides 8-13
- Gray Triggerfish Bycatch Estimation (SEDAR 100)
  - Slides 14-39
- Use of 2025 observer data to estimate gray triggerfish bycatch rates
  - Slides 40-46

Protocols to expand bycatch estimates from observer data

Steven Smith

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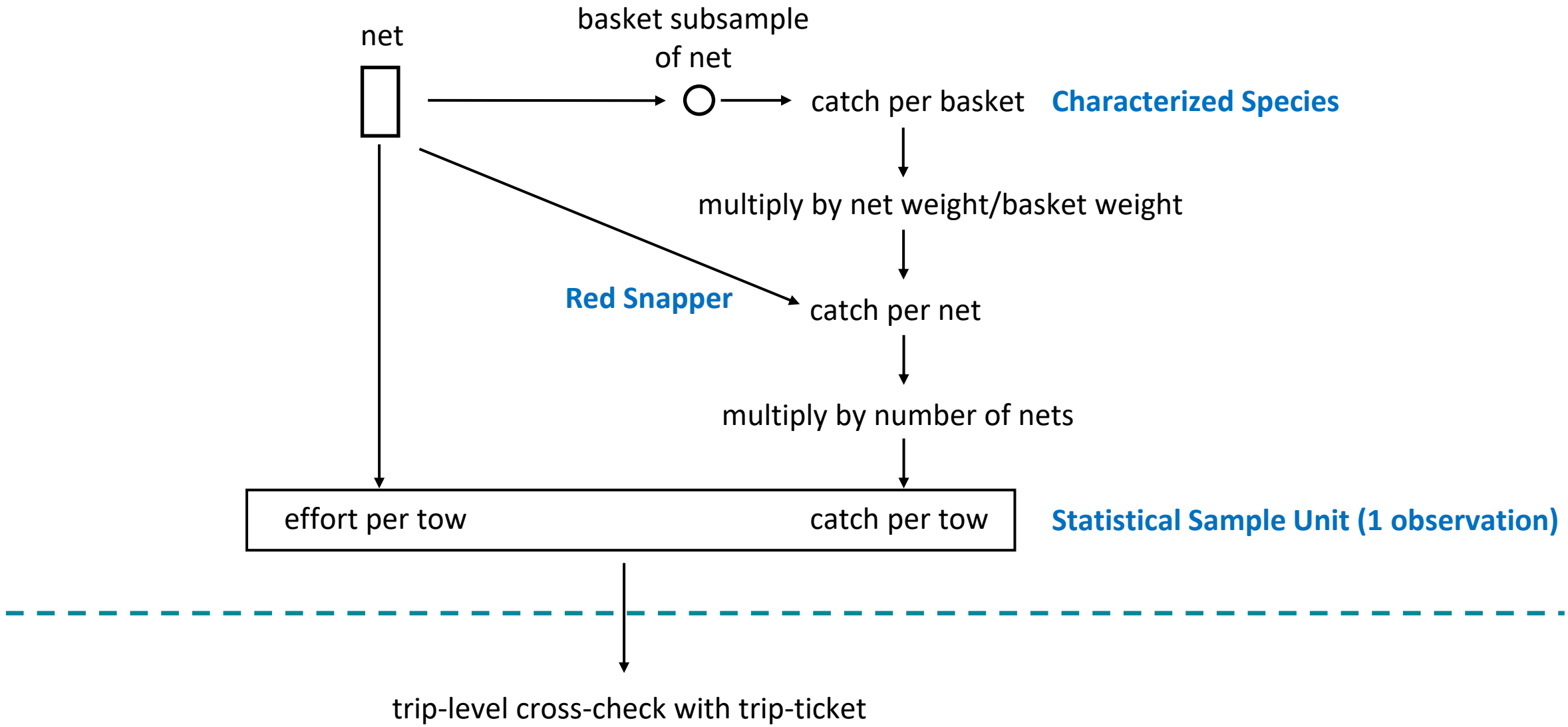
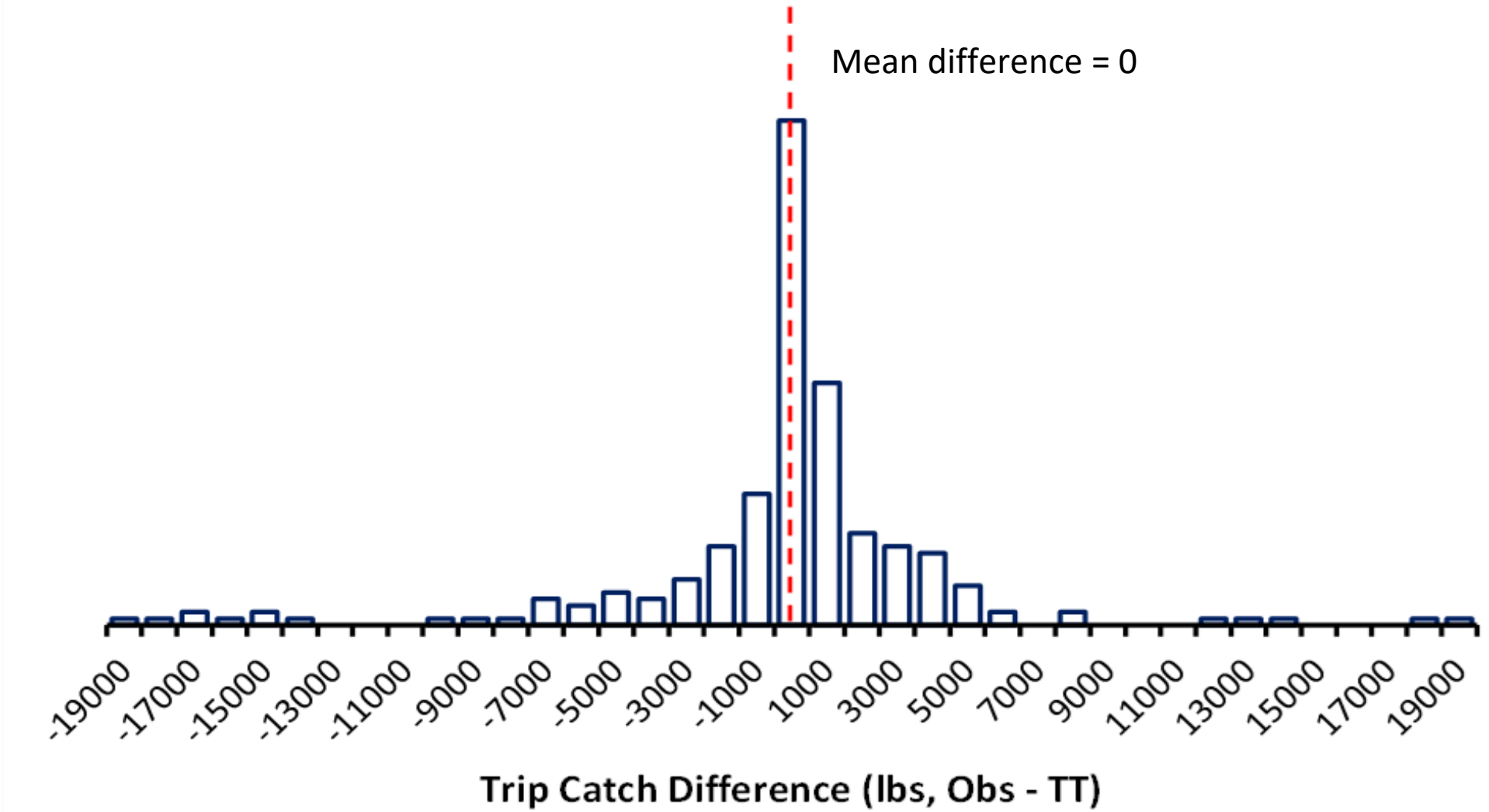
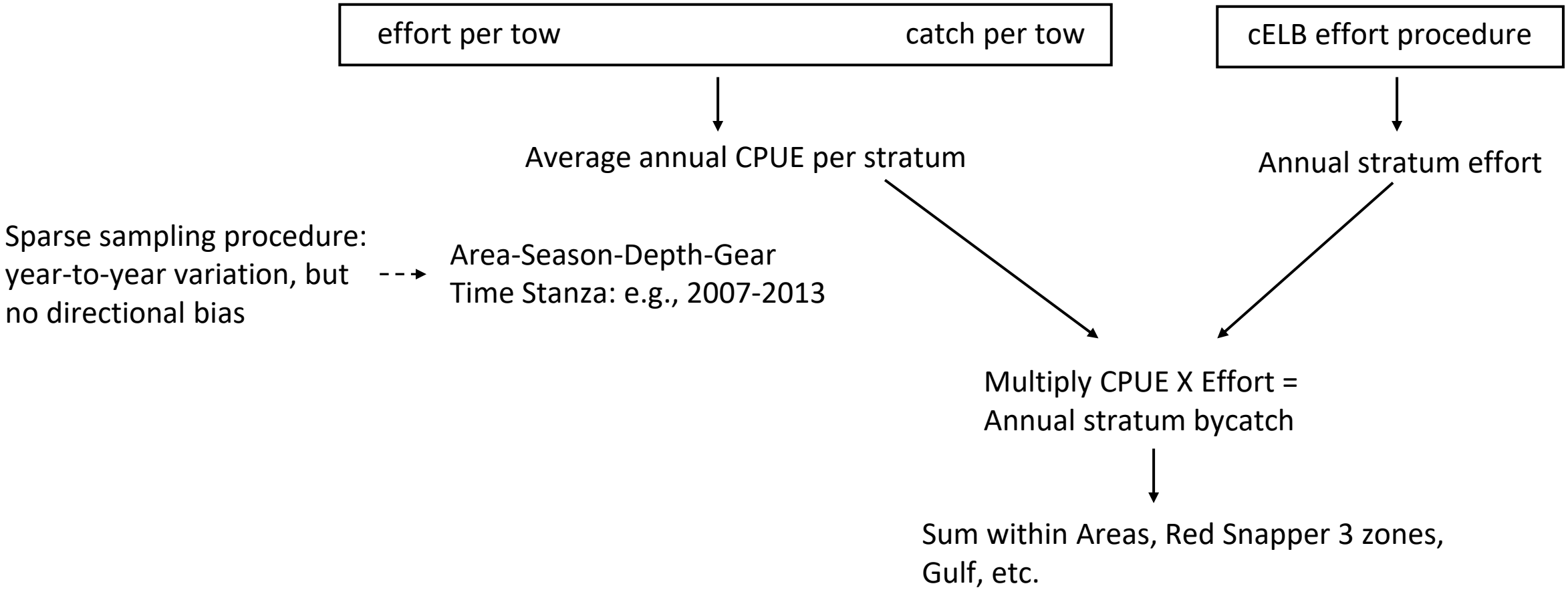


trip catch = average CPUE for sampled trip tows X total trip effort (sum of tow effort for all tows)

Catch Cross-Check: Observer vs. Trip-Ticket




effort per tow
catch per tow
cELB effort procedure
Average annual CPUE per stratum
Annual stratum effort
Sparse sampling procedure:
year-to-year variation, but
no directional bias
Area-Season-Depth-Gear
Time Stanza: e.g., 2007-2013
Multiply CPUE X Effort =
Annual stratum bycatch
Sum within Areas, Red Snapper 3 zones,
Gulf, etc.

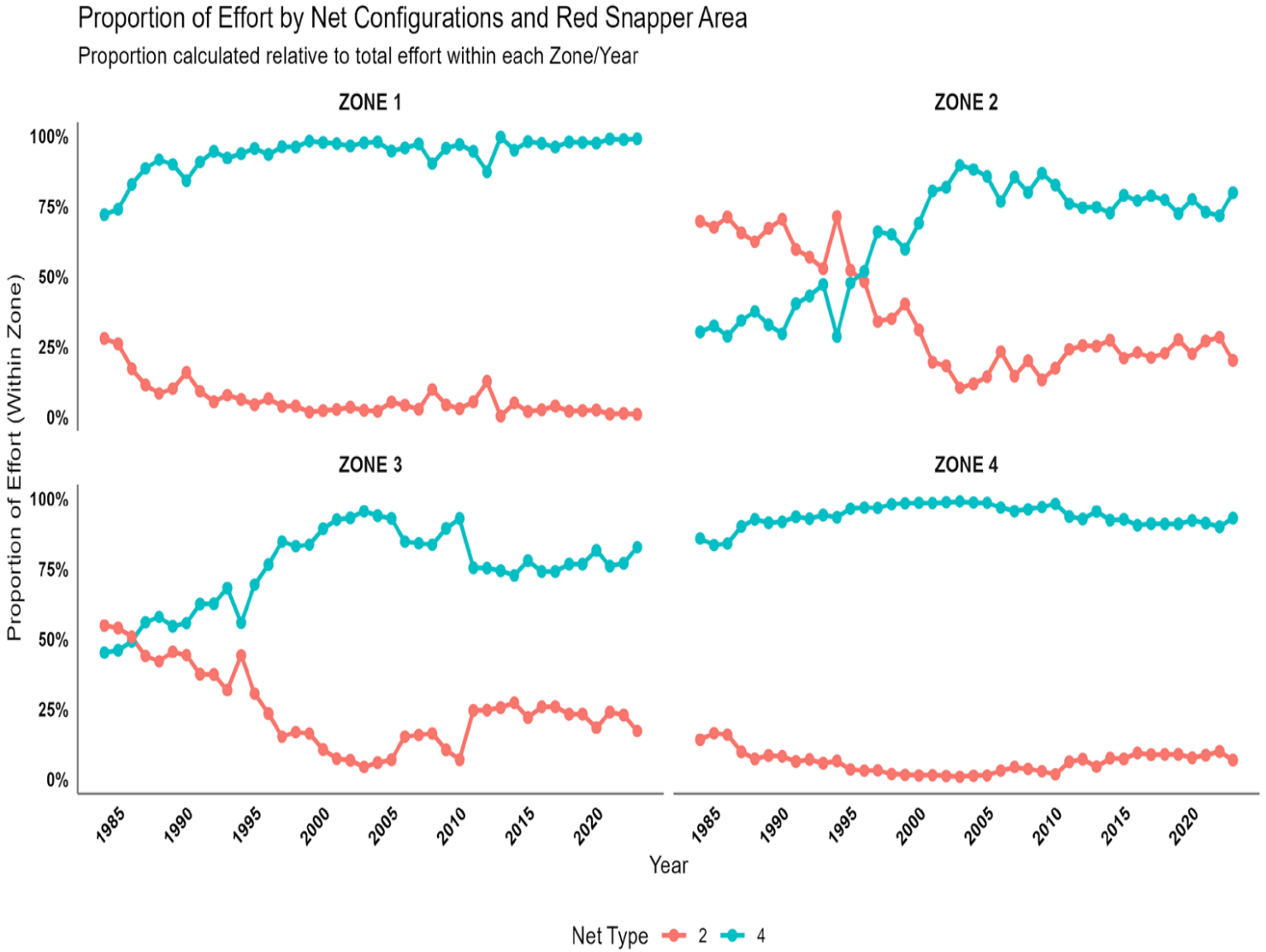
Intermission

Gear configuration (2- and 4-net) effort and selectivity

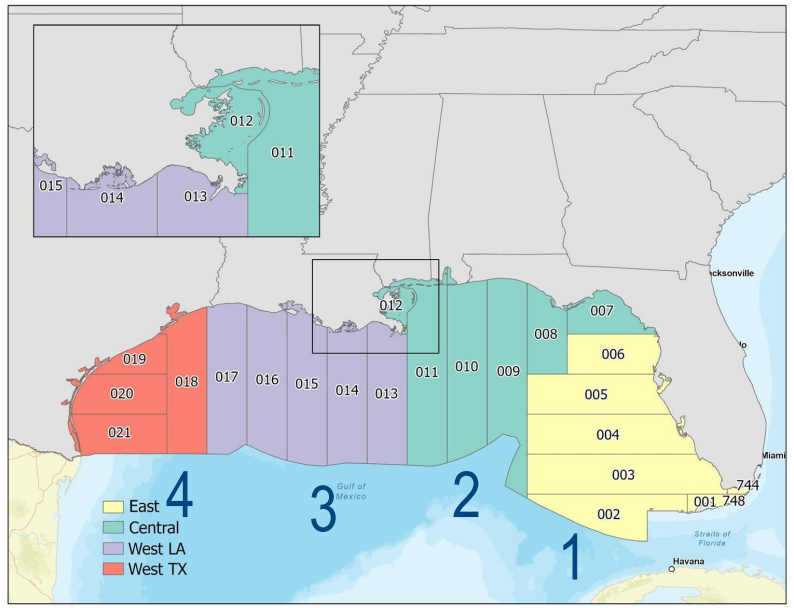
Gary Decossas

NOAA Fisheries

Southeast Fisheries Science Center, FSD - Observer Program



- Proportion of effort by net configuration and red snapper area (1984-2023)
- Effort=tow days by Detloff model
- Zone 1 and 4 consistent 2 net/4 net separation.
- Zone 2 and 3 historical switch mid to late 80s/90s



2-net/4-net configuration based on trip tickets and ALGS

2021-2025 Trip Ticket Landings by Federally Permitted Vessels (SPGM)										
AREA	STATZONES	NETS	NUM_VESSELS	PROPORTION_VESSELS	TOTAL_LANDINGS	BS_LANDINGS	WS_LANDINGS	PS_LANDINGS	RS_LANDINGS	AUX_LANDINGS
1	1-6	2	7	4%	227,928	21,585	42,345	163,867	131	-
1	1-6	4	186	96%	11,442,118	477,971	453,776	10,479,029	26,141	5,201
2	7-12	2	88	34%	9,491,604	3,412,845	6,029,252	49,001	375	131
2	7-12	4	174	66%	27,786,712	15,296,382	11,609,112	829,421	51,797	-
3	13-17	2	231	32%	34,173,369	3,652,493	30,500,538	3,477	-	-
3	13-17	4	490	68%	119,800,831	30,743,571	88,588,877	347,282	2,641	9,110
4	18-21	2	67	14%	5,188,054	1,305,067	3,876,403	6,290	-	294
4	18-21	4	417	86%	90,495,986	68,727,553	21,461,552	303,374	-	3,508

Merging of landings frame from trip tickets (2021-2025) + ALGS survey (2021-2023)[Annual Landings and Gear Survey]

- If vessel is not straight 4-net or 2-net, then classified based on average over three years (avg= b/w 3 & 4 then 4-net, b/w 2&3 then 2-net
- If no ALGS for vessel, then vessel length >=72 ft classified as likely 4-net, <72 ft then likely 2-net (based on observer program expertise and observer data)
- Landings are from vessels that had active SPGM permit at time of unload date.

Explanation of net and TOD catch rate differences

- Larger vessels w/ 4 nets use 40-50 ft headrope length nets
- 2-net vessels may use 65 ft head rope length (LA limit) or 70 ft trawls
- Longer headropes have larger swept area and higher catch rates, per-net, but 4-net configurations have higher catch rates overall.
- Longer headropes open higher and are desirable for white shrimp.
- Brown shrimp are typically active and targeted at night, while white shrimp are active and targeted during the day- but this can vary with turbidity.

2026 shrimp observer program vessel frame

tri	AREA	NETS	NUM_VESSELS_FRAME	SAMPLE_SIZE
1	1-SFL	2	-	-
1	1-SFL	4	48	10
2	1-SFL	2	1	1
2	1-SFL	4	59	3
3	1-SFL	2	2	1
3	1-SFL	4	44	6
1	2-CFL	2	3	1
1	2-CFL	4	9	1
2	2-CFL	2	6	1
2	2-CFL	4	10	1
3	2-CFL	2	2	1
3	2-CFL	4	3	1
1	3-WFL/CENLA	2	22	3
1	3-WFL/CENLA	4	78	12
2	3-WFL/CENLA	2	115	5
2	3-WFL/CENLA	4	166	18
3	3-WFL/CENLA	2	91	4
3	3-WFL/CENLA	4	150	12
1	4-WLA/ETX	2	26	4
1	4-WLA/ETX	4	49	13
2	4-WLA/ETX	2	60	4
2	4-WLA/ETX	4	125	20
3	4-WLA/ETX	2	47	2
3	4-WLA/ETX	4	97	14
1	5-WTX	2	2	1
1	5-WTX	4	15	4
2	5-WTX	2	14	1
2	5-WTX	4	182	12
3	5-WTX	2	12	1
3	5-WTX	4	176	18

- Vessels considered in “sampling” frame if they meet the following criteria:
  - active SPGM permit at the time of selection (~6 weeks prior to start of selection period)
  - reported shrimp landings in prior 3 years & active SPGM permit at the time of those landings (via trip-tickets).
  - not selected in previous Gulf/South Atlantic/Rock Shrimp selections to ensure 1-2% fleet coverage rate + 35% non-response rate.
- In general, 50-70 vessels are selected each time period for the entire Gulf.

Intermission

Gray Triggerfish Bycatch Estimation (SEDAR 100)

Cheston Peterson

Affiliate with University of Miami CIMAS in support of NOAA Fisheries
Southeast Fisheries Science Center, Fisheries Statistics Division

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

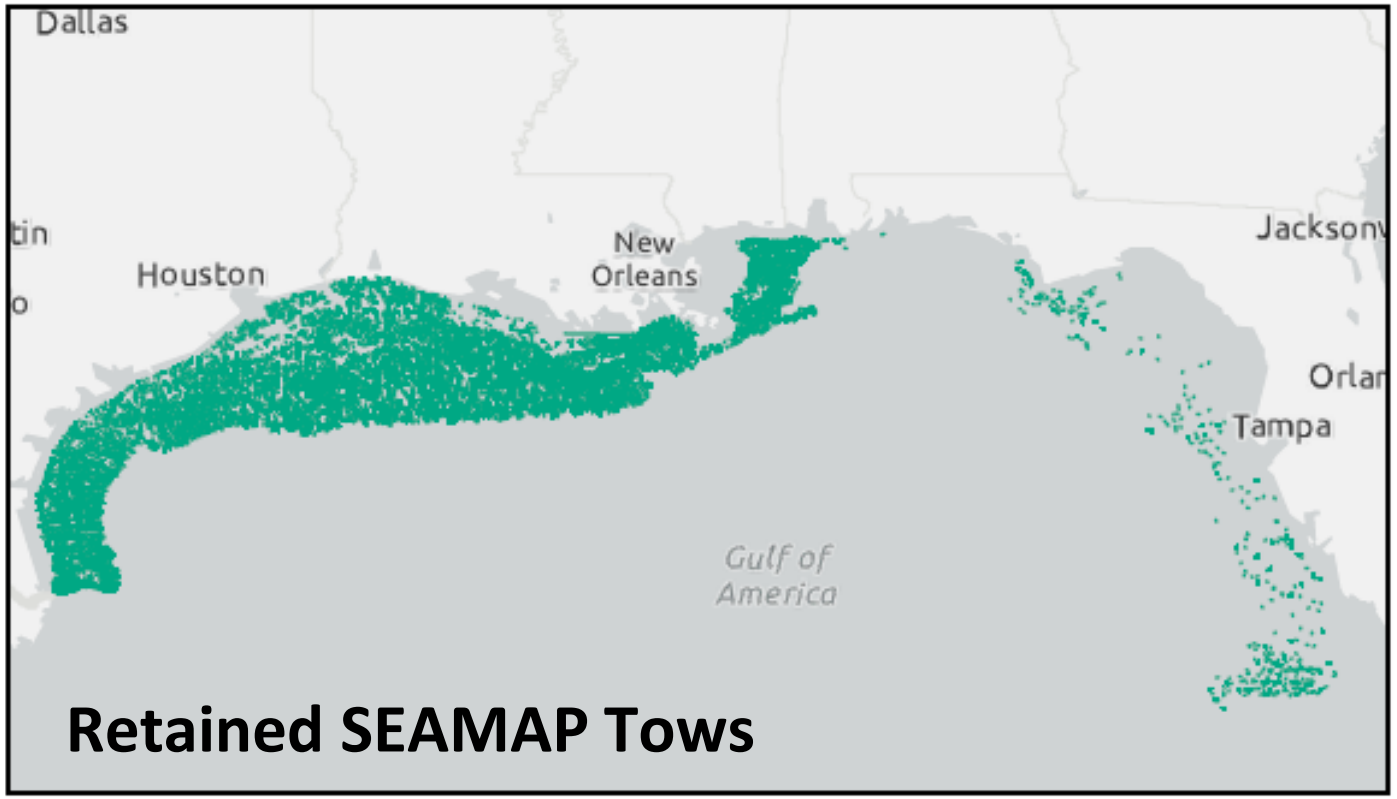
Prepare SEAMAP Analysis-Ready Dataset:

- 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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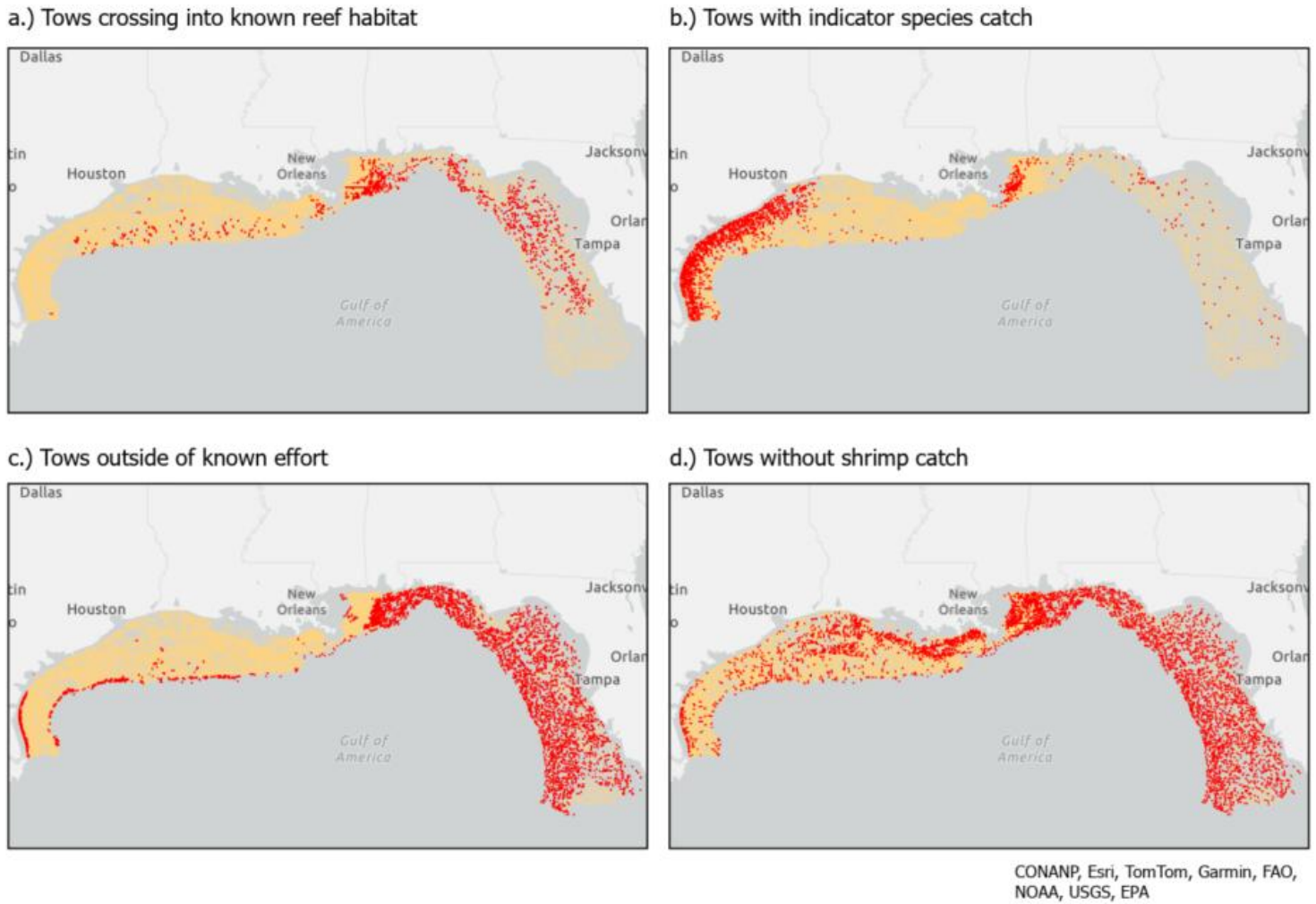


SEAMAP Analysis-Ready Dataset

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

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 Catch B=0	Catch A=0 Catch B>0
Catch A>0 Catch B=0	Catch A>0 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:

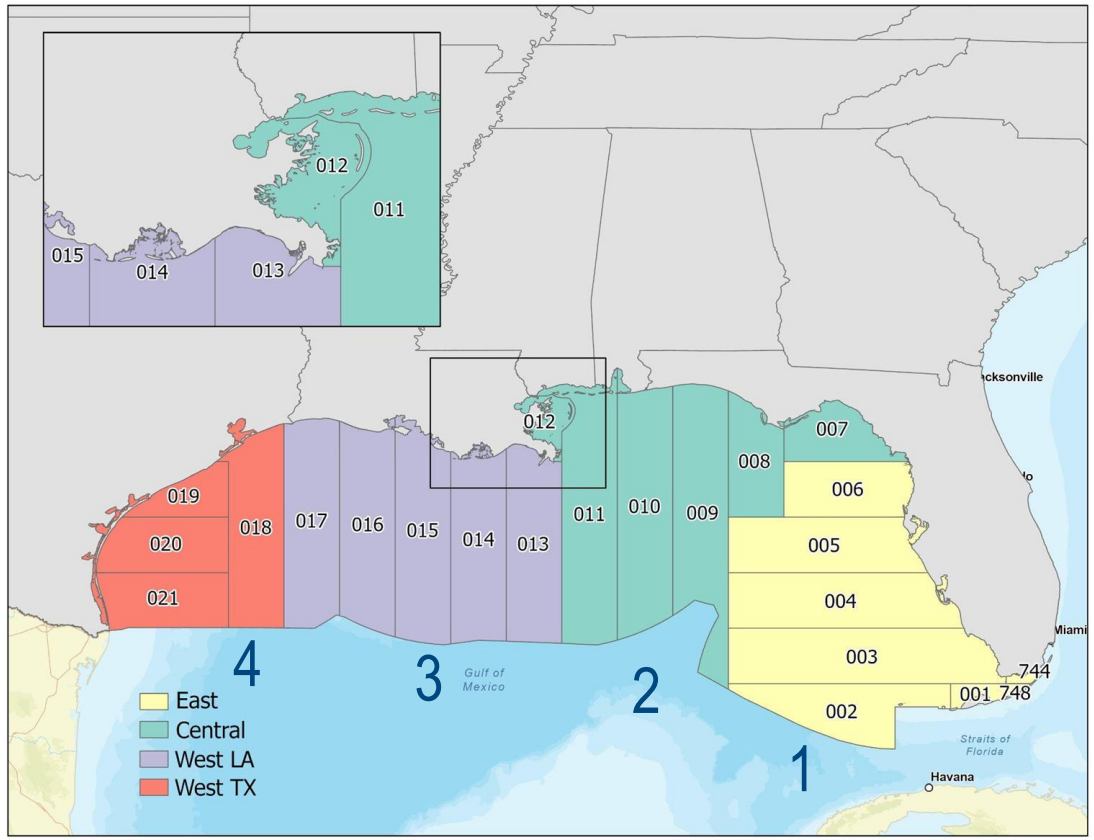
Area (4): StatZones 1-6, 7-12, 13-17, 18-21

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

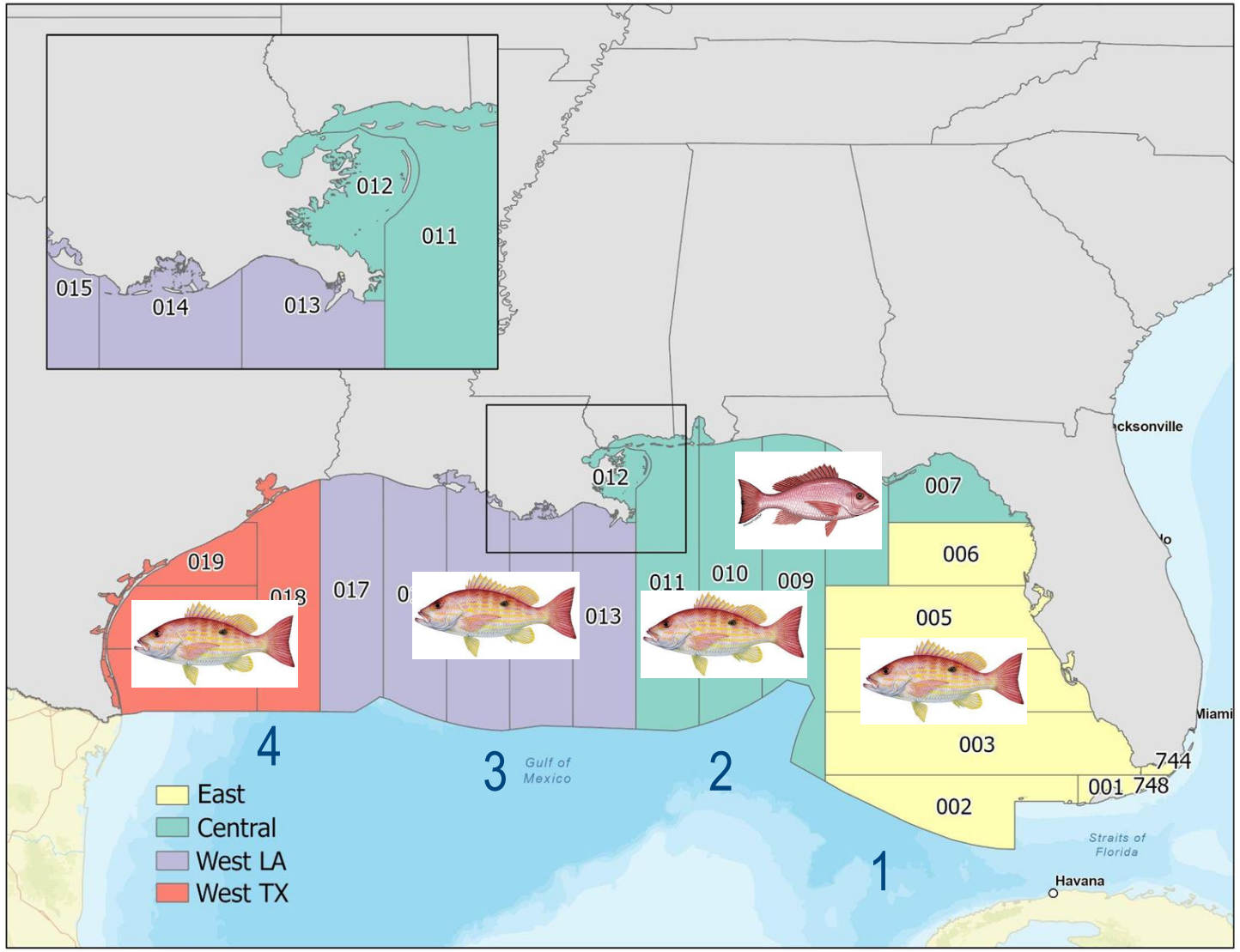
Species Co-Occurrence

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

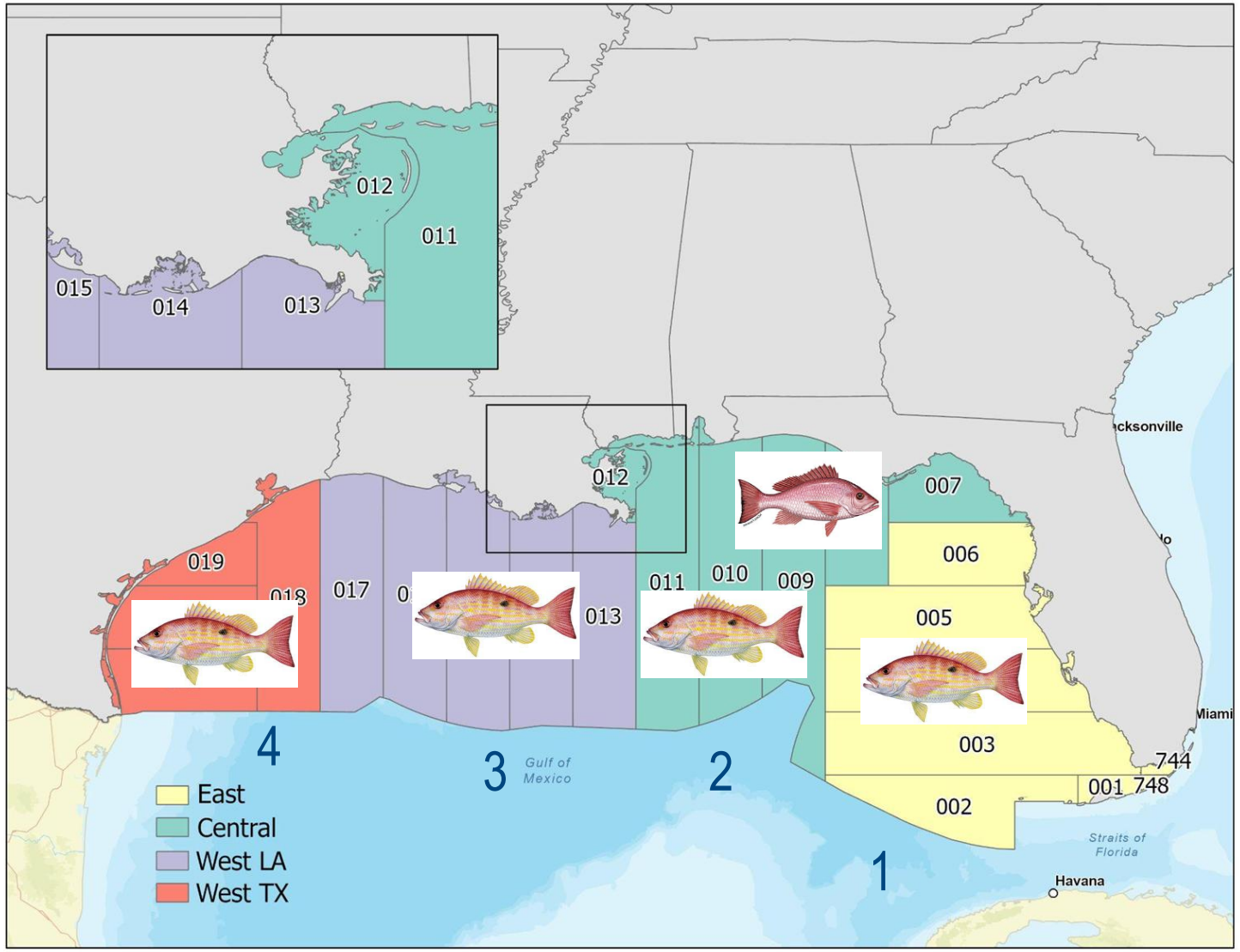
21 total Area-Season-Depth strata

(x3 Eras = 63 total strata)

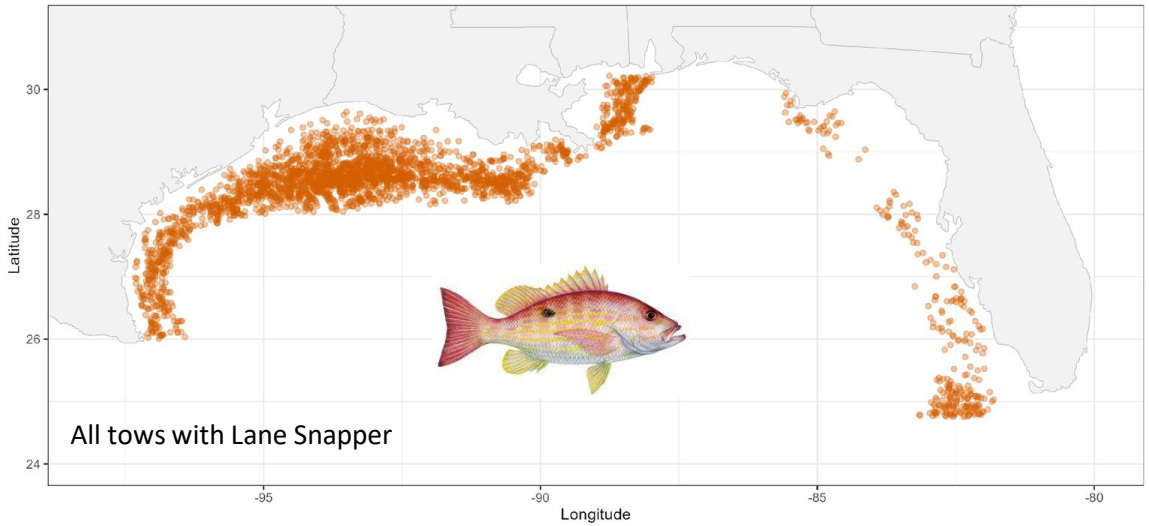
Red Snapper used in

Area 2 - Depth 1 - Seasons 1:3

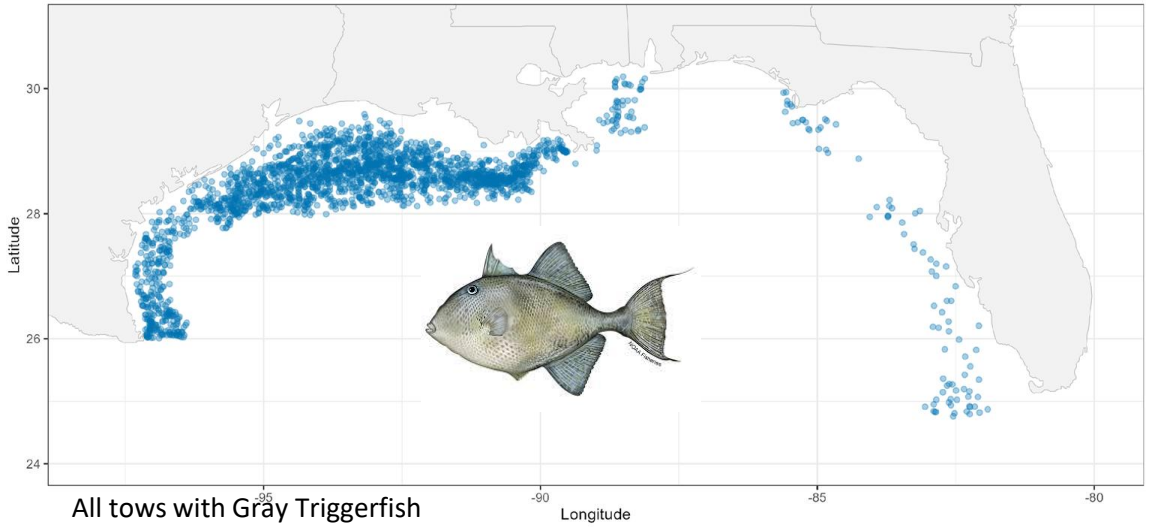
Lane Snapper used in all other strata



Species Co-Occurrence

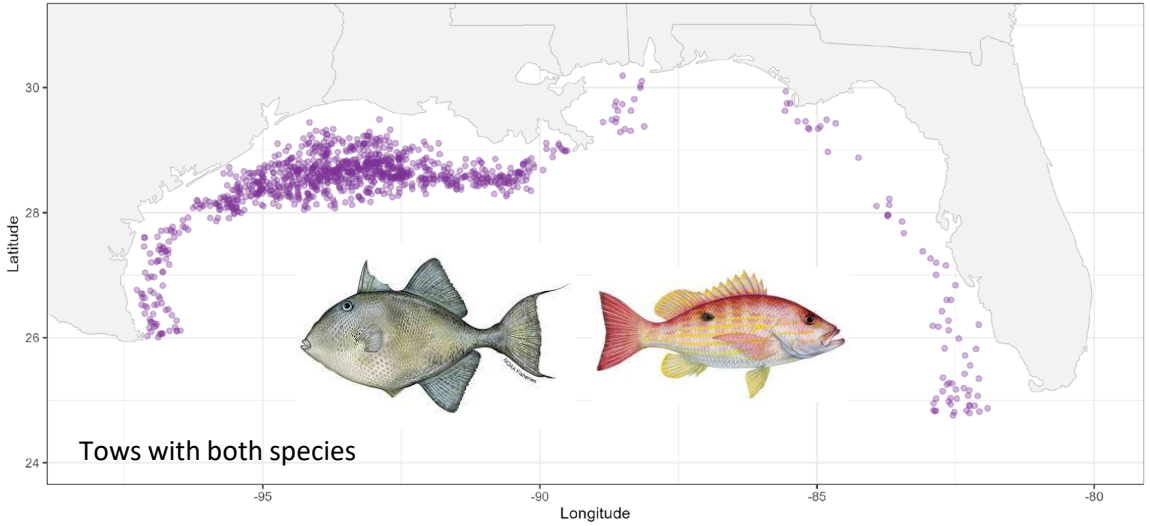


All tows with Lane Snapper



All tows with Gray Triggerfish

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



Tows with both species

	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

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

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

Solving for y_2

Task 3

Calibration for Gray Triggerfish:

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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

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

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:

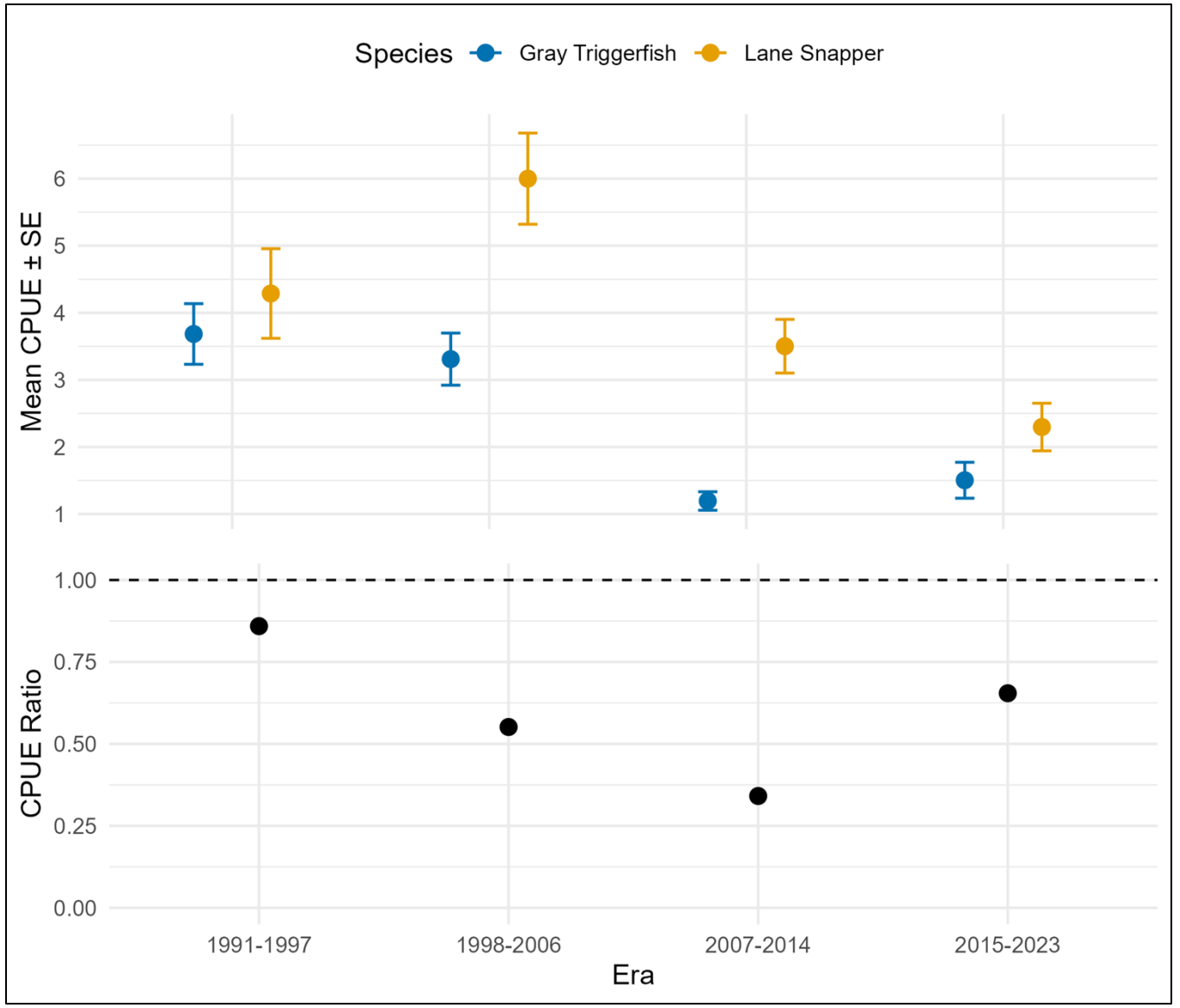
Three eras:

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

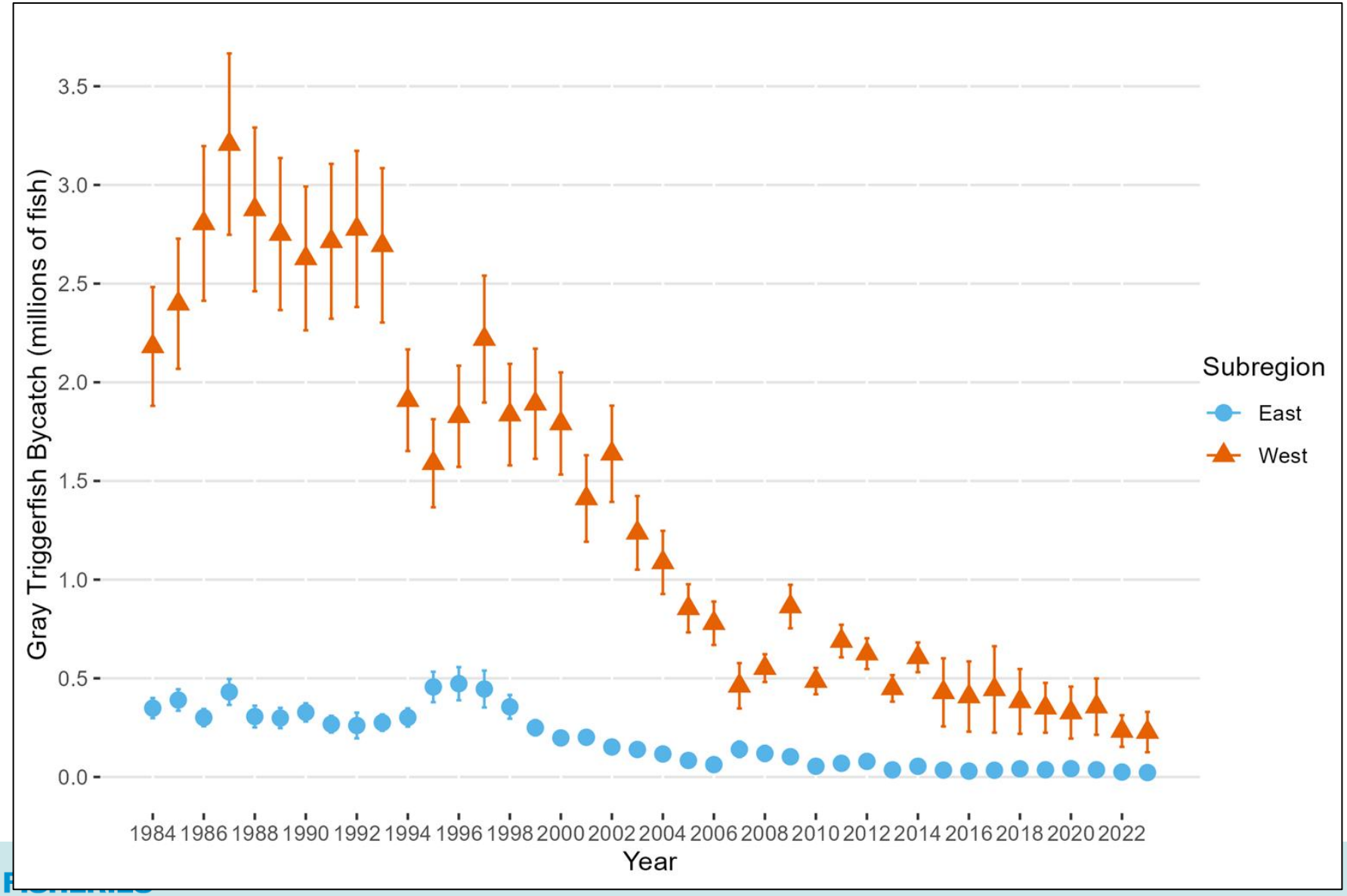
- **n = 64 conversion factors across all strata**

Conversion Factors Through Time

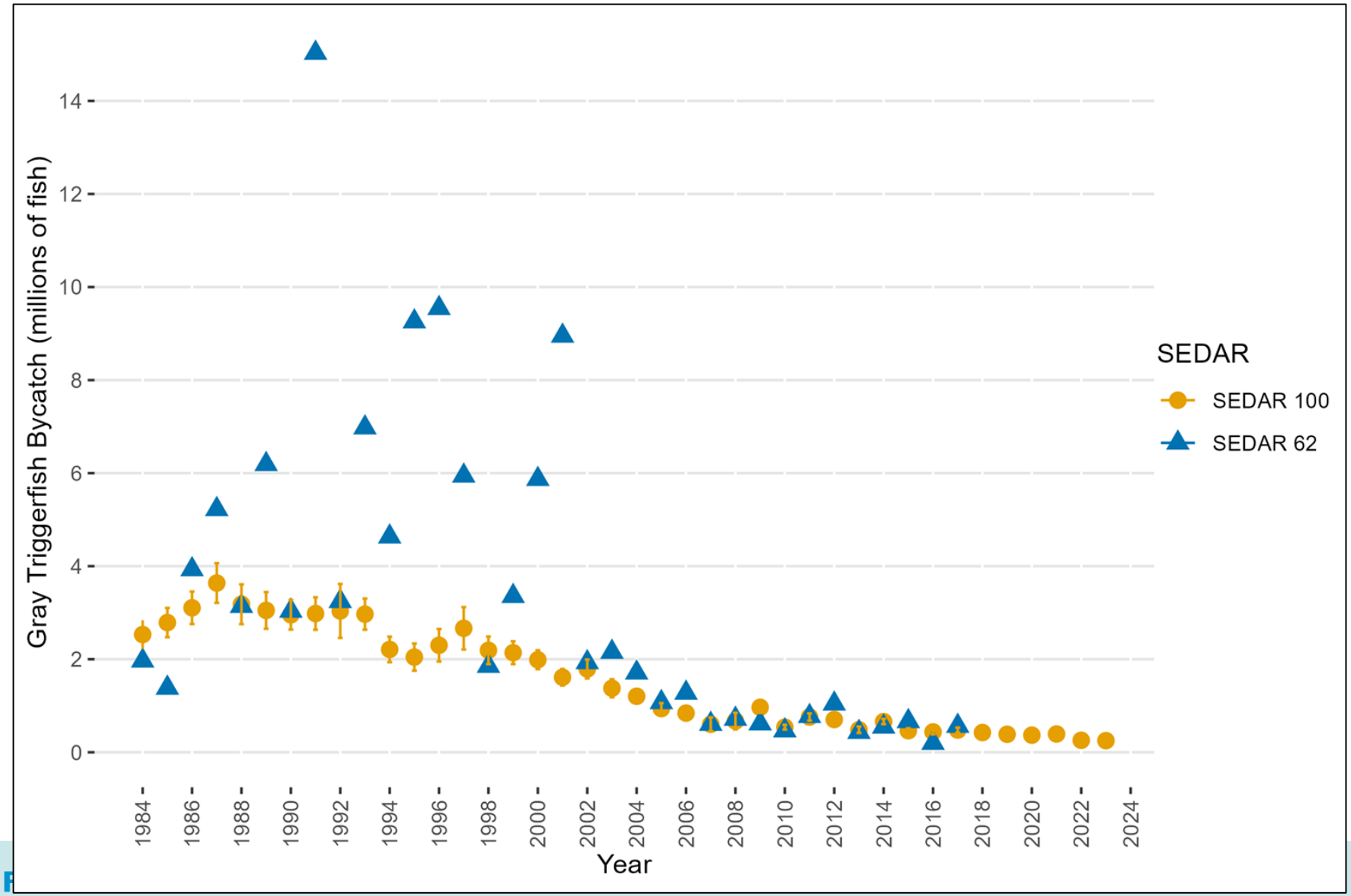
Example strata: Area 3, Season 2, Depth 3



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



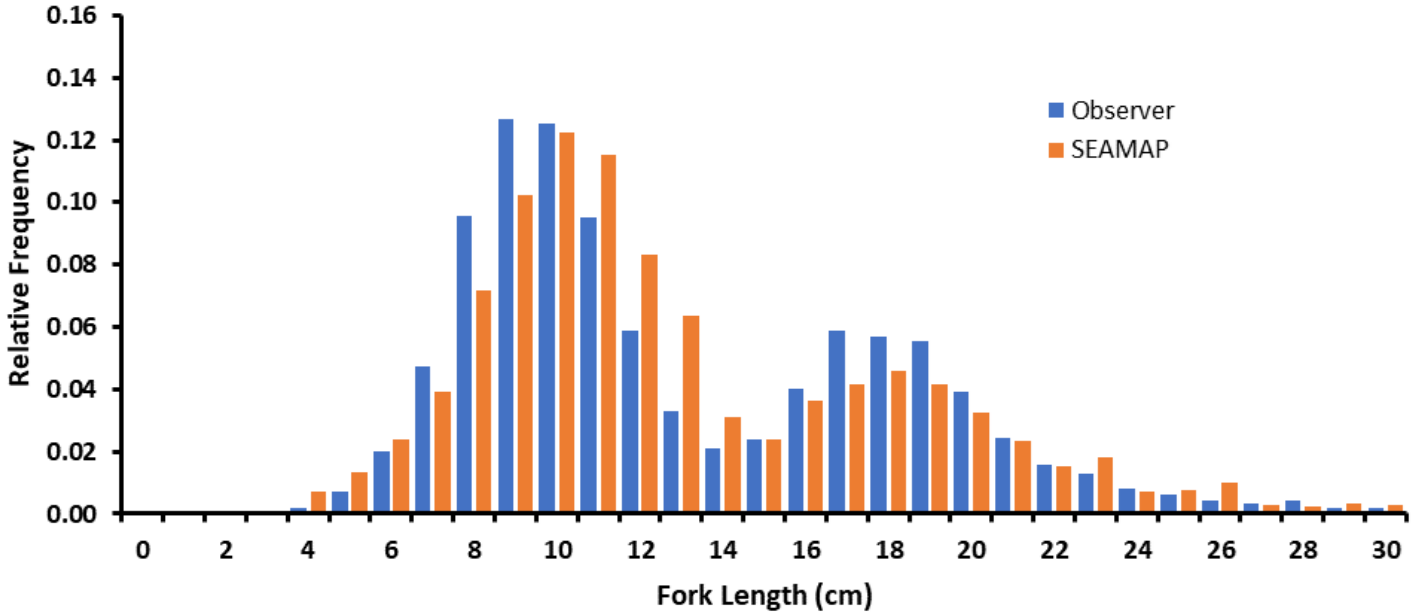
Gray triggerfish bycatch - all Gulf (time-varying conversion factor)



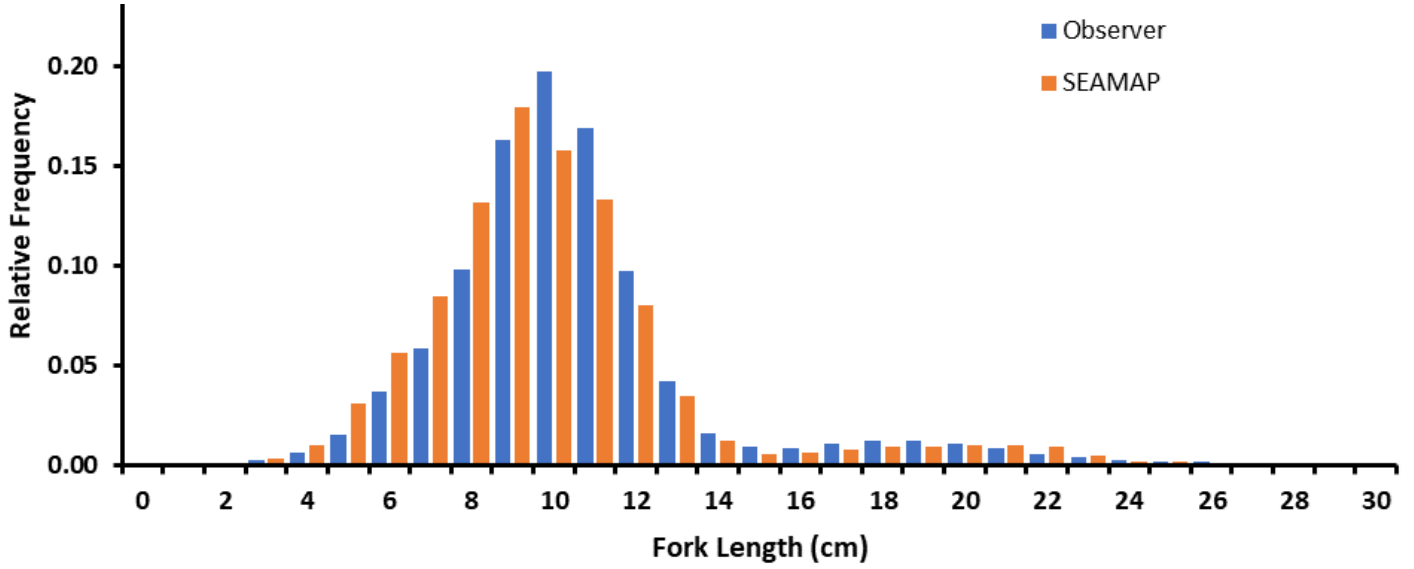
(Zhang 2020, S62-WP-20)

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



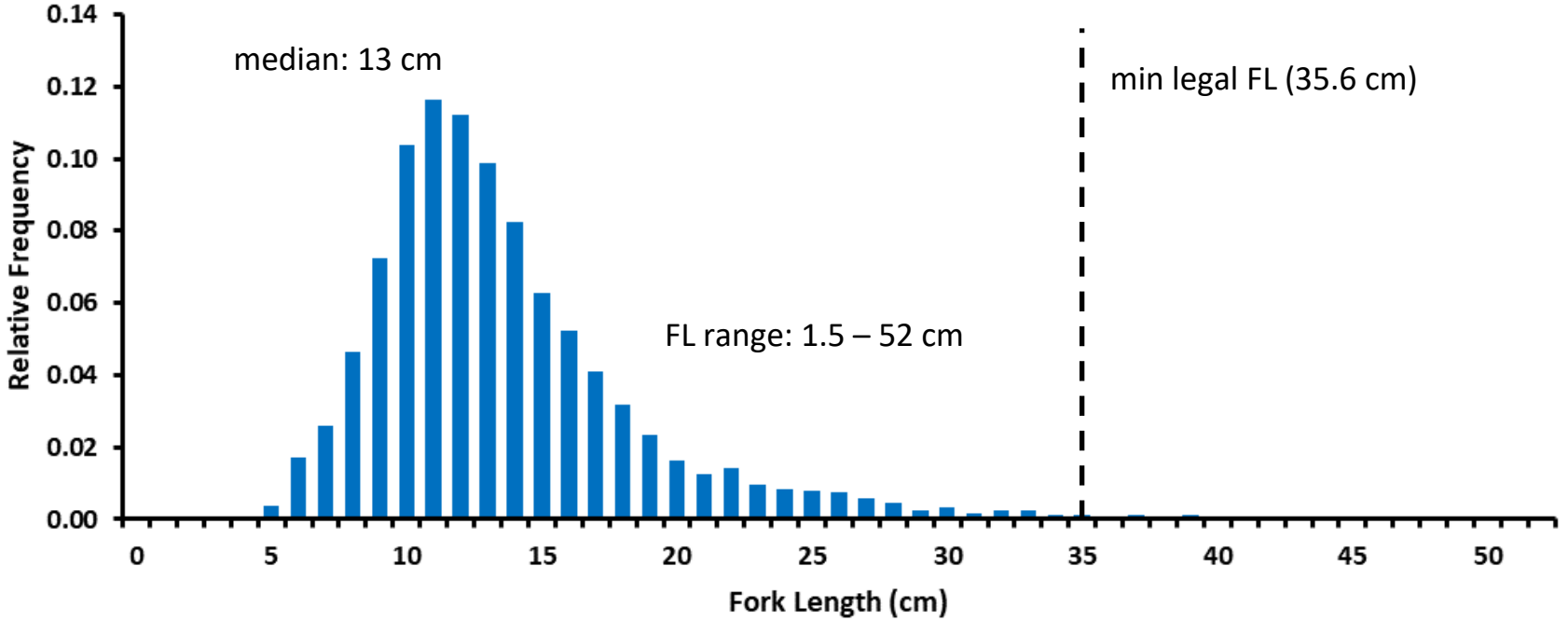
Area: Gulf zones 18-21
Depth: 10-30 fathoms
Season: Sep-Dec

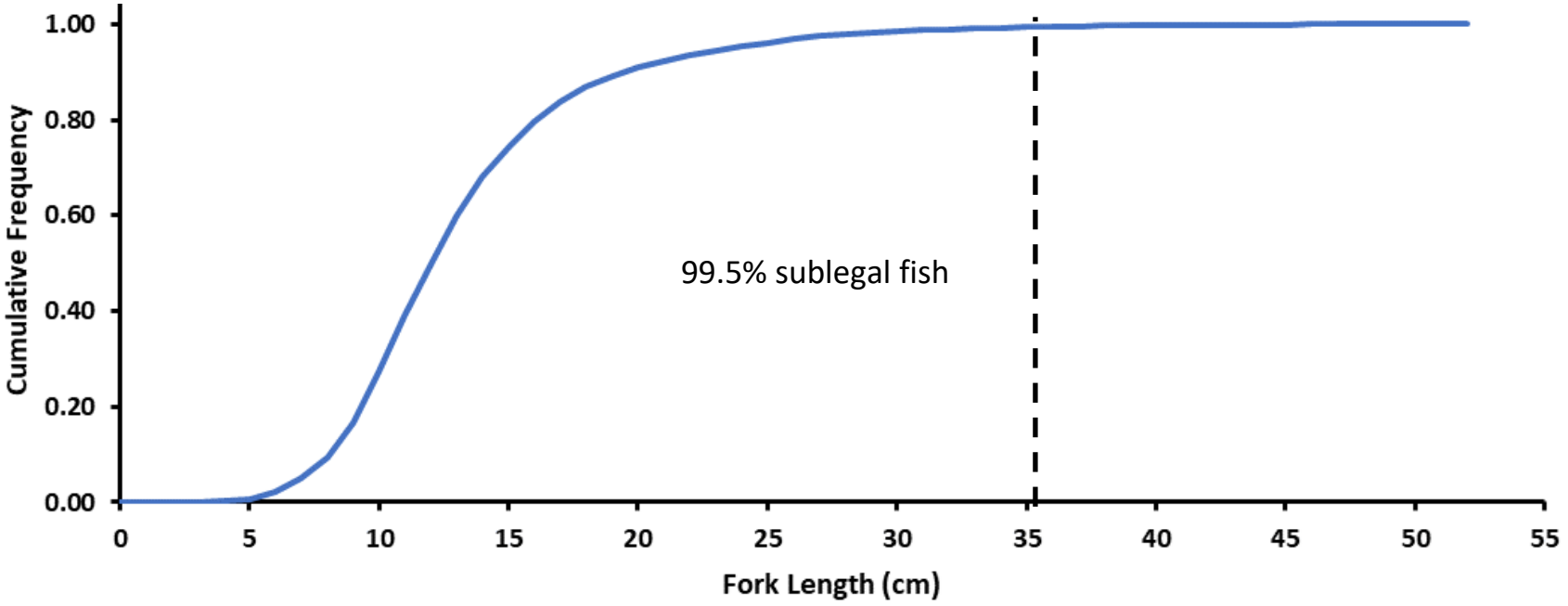


Assumption: length distribution is similar between SEAMAP and commercial trawls for Gray Triggerfish

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

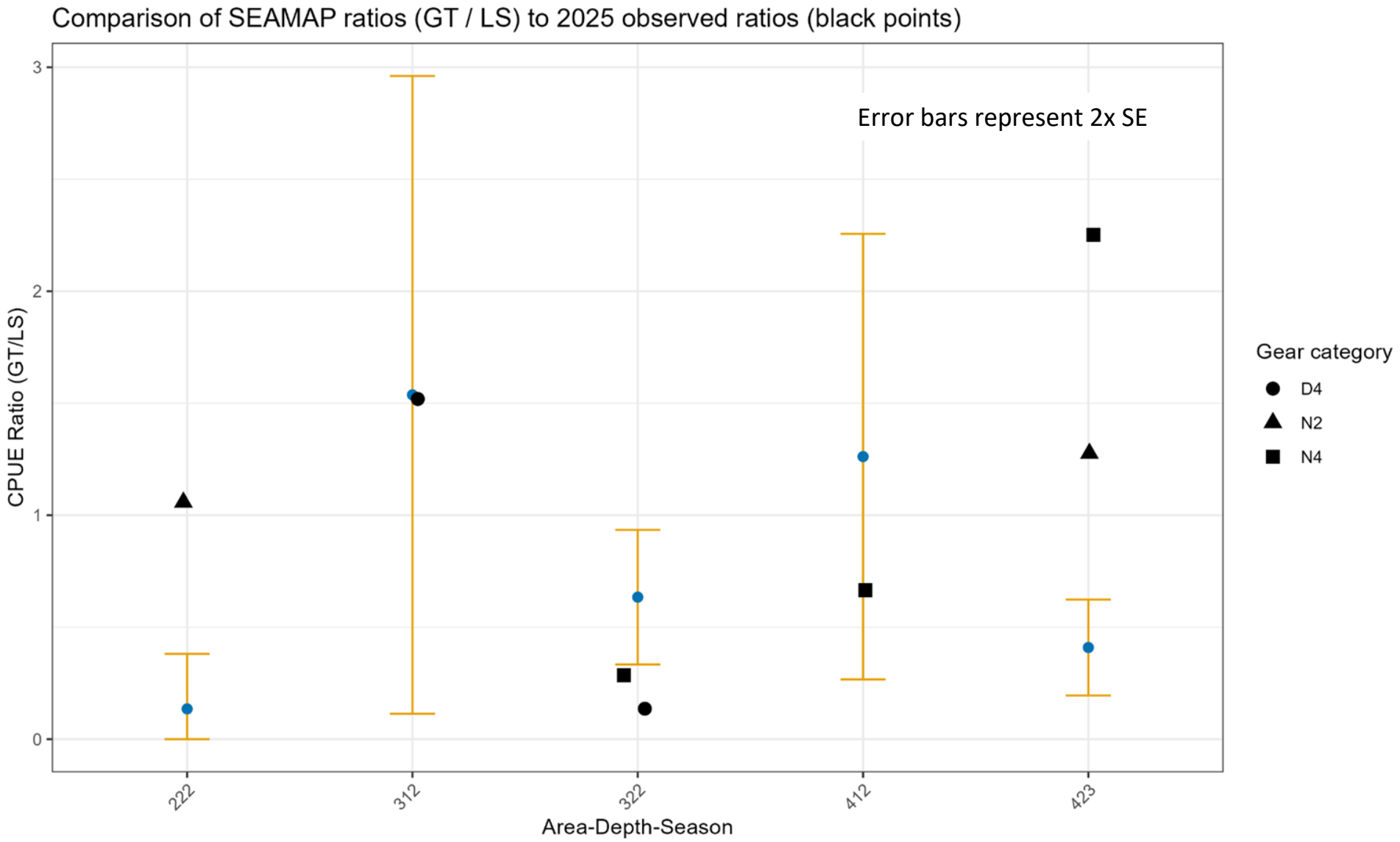
- Sample Size Table, number of tows
- Area-Depth-Season, 4 Gear Types
- Green Shading: strata with n ≥ 10 tows; account for 46% of total estimated fleet effort (Dettloff).

- 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

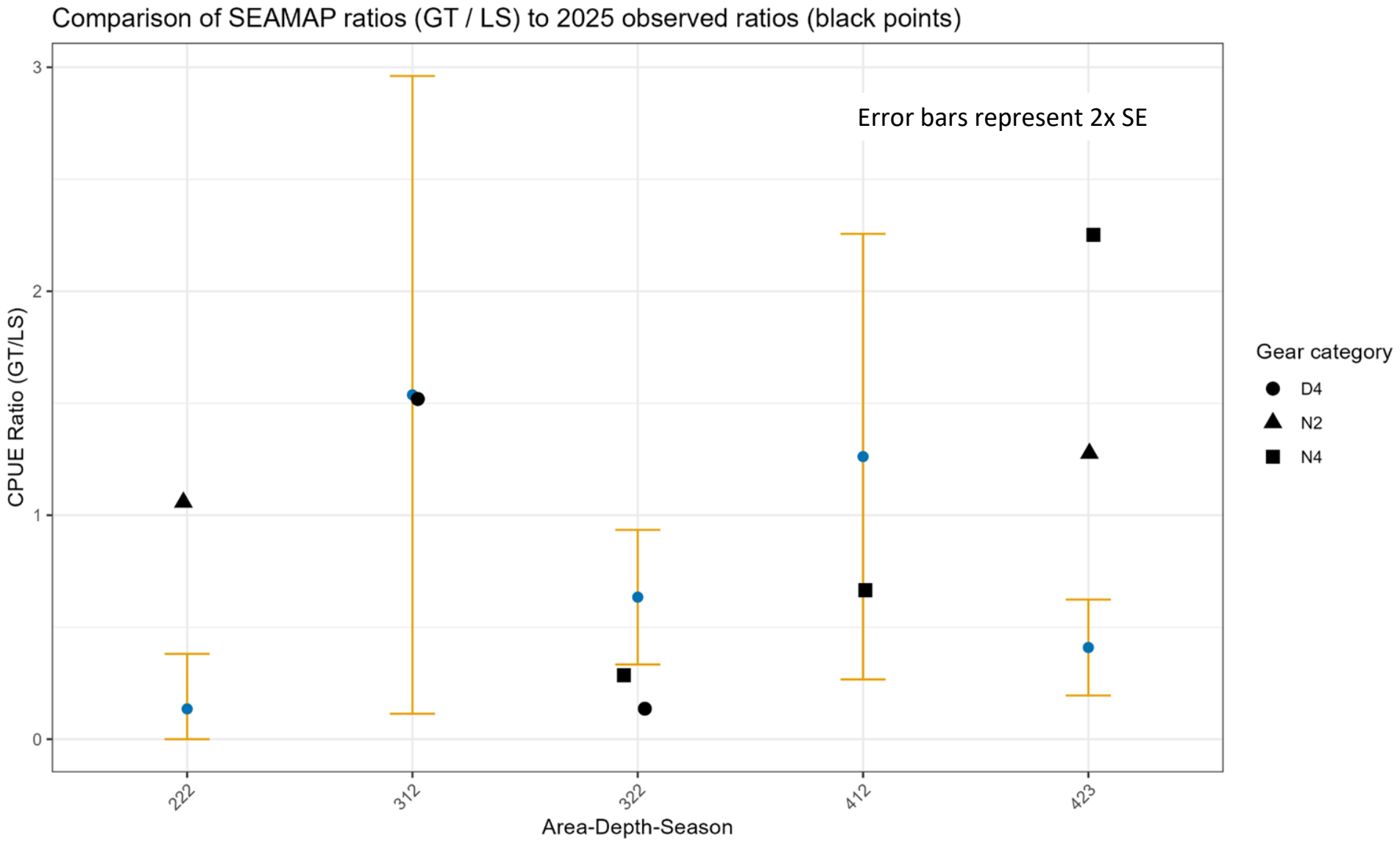
SEAMAP-derived conversion factors (ratio of Gray Triggerfish / Lane Snapper) appear to be free of systemic directional bias - i.e they are not consistently higher or lower than observed ratios.

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

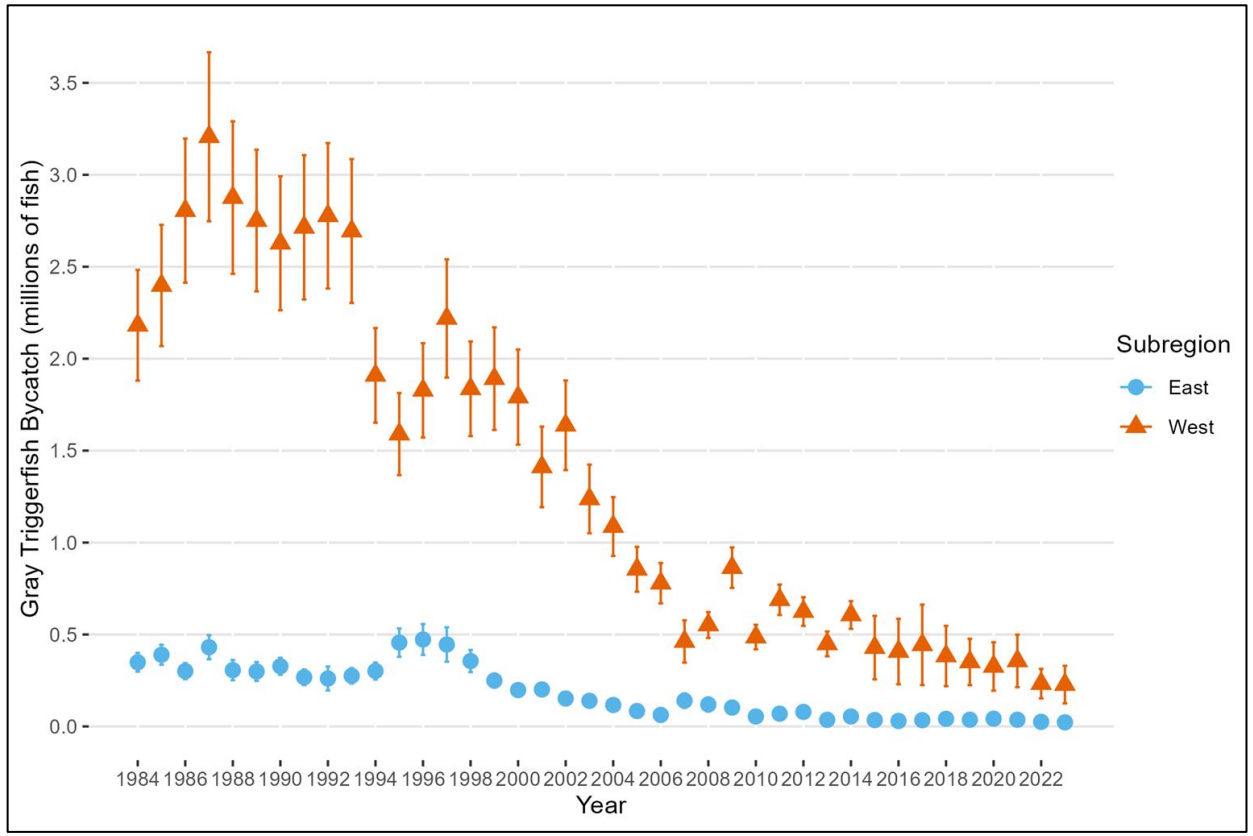


SEAMAP-derived ratios ranged from 0.002 to 8.593 (mean = 0.802, median = 0.429).

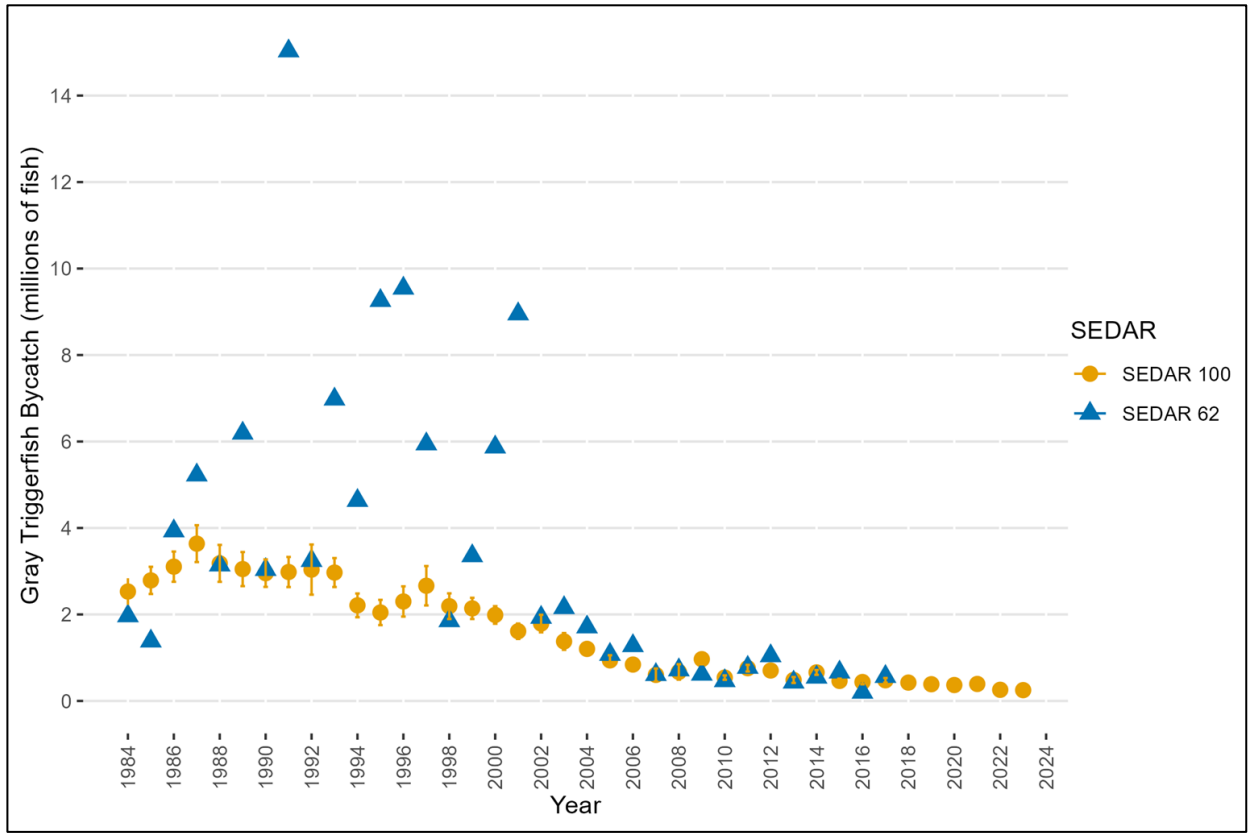
Observed ratios ranged from 0.444 to 9.980 (mean = 3.150, median = 1.220)



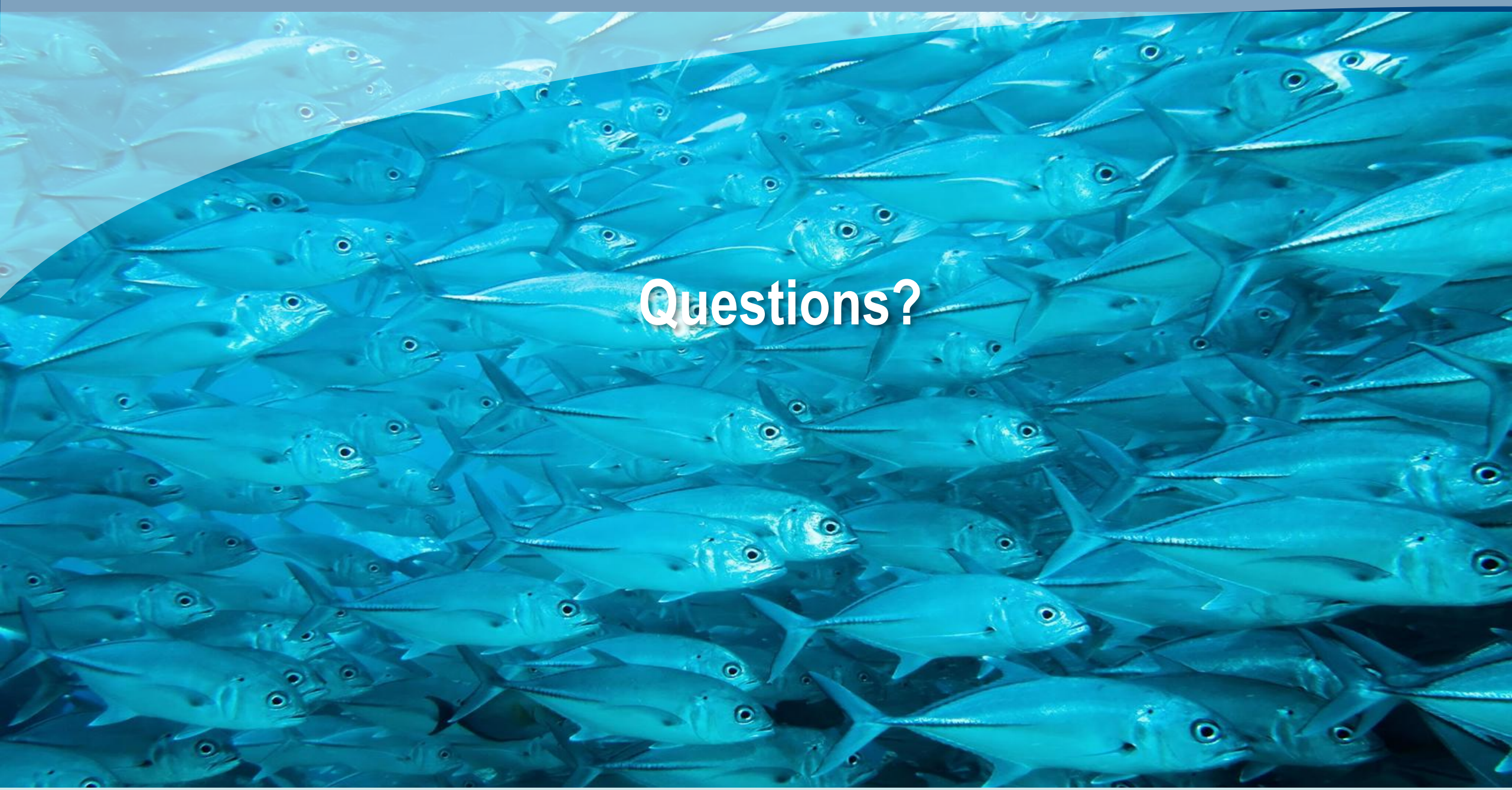
Recommend proxy method as most robust estimates without additional years of observer data



SEDAR 100 Estimates - by subregion



SEDAR 100 compared to SEDAR 62 - total estimates


Questions?