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CPUE Expansion Estimation for Commercial Discards of Gulf of America Tilefishes and Associated Weighted Discard Length Compositions

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Introduction

The general approach for estimating discards for the commercial reef fish fleet utilizes catch-per-unit-effort (CPUE) from the coastal reef fish observer program and total fishing effort from the commercial reef logbook program to estimate total catch,

$$totalCatch = CPUE * totalEffort.$$

For discard estimation, CPUE is computed for total discards, including fish released alive, released dead, released in unknown condition, and used for bait. The primary metric for the coastal observer program is CPUE by species and gear. The principal focus of this study was to apply the discard estimation methods developed for Gulf of America (formally Gulf of Mexico, hereafter the Gulf) Red Grouper in working paper SEDAR61-WP15 (Smith et al. 2018), Gulf Gray Triggerfish in working paper SEDAR62-WP07 (Smith et al. 2019a), and Gulf Vermilion Snapper in working paper SEDAR67-WP12 (Smith et al. 2019b) to Gulf Tilefishes (Golden Tilefish, Blueline Tilefish, and Goldface Tilefish). The stock assessment analyst requested separate discard estimates for Golden Tilefish, as well as combined estimates for the Tilefish Complex. Because initial analyses indicated that Golden Tilefish and Blueline Tilefish differ in their spatial distribution (Figure 1), discards were estimated individually by species and then aggregated.

Weighted discard length composition methods developed for Gulf Red Snapper (SEDAR 74) were also applied to Gulf Tilefishes, though this method was first documented in working paper SEDAR85-WP06 for Gulf Yellowedge Grouper (Atkinson et al. 2023).

Methods

Data Sources

Catch per unit effort was determined from the coastal Reef Fish Observer Program in which scientific observers on commercial fishing vessels recorded detailed information on catch and effort for a subset of trips (Atkinson et al. 2021a, Scott-Denton et al. 2011). The program targeted two principal gears for the Gulf reef fishery, bottom longline and vertical lines (e.g., handlines, electric and hydraulic reels aka bandit reels). Catch by species was recorded according to disposition category: kept (landed), released alive, released dead, released undetermined, and used for bait. Length and weight were recorded for a subsample of individual fish. The Reef Fish Observer Program began in July 2006; for discard estimation of Gulf Tilefishes, complete calendars years 2007-2024 were used. The methodology is defined by the start year of the observer program, with the pre-observer time period representing years prior to 2007, and the observer time period representing years 2007 and beyond.

Total effort was determined from the commercial Coastal Fisheries Logbook Program in which fishers reported basic information on effort and catch by species for every trip (Atkinson et al. 2021b). The coastal logbook program began in 1990 for a subset of vessels in Florida and expanded to all vessels in 1993. For discard estimation of Gulf Tilefishes, complete calendar years 1993-2024 were considered.

Relevant Management History of Gulf of America Tilefishes

There were two key management changes relevant to discard estimation: (1) a series of closures from 2005 to 2009 due to quota monitoring; and (2) the implementation in 2010 of an Individual Fisheries Quota (IFQ) for the Tilefish Complex which comprised of three species — Golden Tilefish, Blueline Tilefish, and Goldface Tilefish. There have also been no minimum size limit restrictions for any tilefish species.

Gear

In the Gulf observer data, a majority of Tilefishes were observed on bottom longline trips; therefore, discard estimation was conducted for only this gear.

Spatial Domain

Per recommendation of the stock assessment analyst, discard estimates were calculated Gulf-wide (Figure 2).

Trip-Level Catch for Observer Data

Observers collected catch data at a sub-trip level (e.g., a specific set and line for vertical line gear), but it was not feasible to sample every set, line, etc., for every trip. Gear-specific procedures were applied to estimate the trip-level landed catch from the observer data (Smith et al. 2018). For Golden Tilefish, the maximum total length to fork length equation and updated fork length to whole weight equation provided for this assessment were used (Garner et al. 2026). All Golden Tilefish were converted to whole weight using the conversion factor of 1.065 estimated by the Gulf States Marine Fisheries Commission (GSMFC, 2025). Blueline Tilefish morphometric equations from SEDAR 50 were used for this assessment. The Golden Tilefish equations were also used for Goldface Tilefish since there was insufficient data to calculate Goldface-specific equations.

Trip-Level Effort for Observer and Logbook Data

For observer data, trip-level effort for bottom longlines was computed as the number of sets fished. This effort variable generally matched trip fishing time reported in vessel logbook data (Smith et al. 2018).

Catch Expansion Procedures and Verification

Observer CPUE was calculated using trip-level nominal effort and catch for a given time period. Statistical estimation of total catch $\hat{C}$ and associated variance followed procedures for a (Horvitz-Thompson) survey design ratio estimator (Jones et al. 1995; Lohr 2010):

$$\hat{C} = \bar{CPUE} * \hat{X},$$

where $\bar{CPUE}$ is observer mean CPUE and $\hat{X}$ is total logbook nominal effort. Species- and gear-specific logbook total effort $\hat{X}$ was calculated in two steps. First, logbook trip effort by gear was summed over trips reporting landings of the target species. Second, to obtain $\hat{X}$, logbook trip

effort was adjusted by the proportion of observer trip effort that reported only discards of the target species. Logbook total trips N were calculated in a similar manner.

Mean CPUE was estimated by

$$\bar{CPUE} = \frac{\bar{y}}{\bar{x}},$$

where $\bar{y}$ is average catch and y_i is observed catch per trip i,

$$\bar{y} = \frac{1}{n}\Sigma_i y_i,$$

$\bar{x}$ is average effort and x_i is observer effort per trip i,

$$\bar{x} = \frac{1}{n}\Sigma_i x_i,$$

and n is the number of observer trips. Variance of total catch was estimated using

$$var\left[\hat{C}\right] = var[\bar{CPUE}] * \widehat{X^2}$$

where the variance of mean CPUE is

$$var[\bar{CPUE}] = \left(1 - \frac{n}{N}\right)\frac{s^2(y|x)}{n\bar{x}^2},$$

N is the total number of logbook trips, and sample variance is

$$s^2(y|x) = \frac{\Sigma_i(y_i - \bar{CPUE}x_i)^2}{n-1}.$$

Standard error of total catch was calculated as

$$SE\left[\hat{C}\right] = \sqrt{var\left[\hat{C}\right]}.$$

The CV of total catch $\hat{C}$ was estimated by

$$CV\left[\hat{C}\right] = \frac{SE\left[\hat{C}\right]}{\hat{C}}.$$

A verification step compared annual total landed catch from logbook data with the estimated observer annual total catch $\hat{C}$. Once verified, the catch expansion procedure was used to estimate annual total discards in weight and number.

Stratification by Trip Catch or Effort Level

Computations of mean CPUE, total catch, and associated standard errors were generalized to include strata for trip catch and/or effort levels. This enabled accurate estimation of total catch (and discards) in cases where observer sampling was not proportional to the fleet with respect to trip catch or effort (Smith et al. 2019a), e.g., observers sampled fewer or more low-catch trips with respect to logbook low-catch trips, etc. Comparisons of observer vs. logbook frequency distributions for trip-level catch, effort, and CPUE were used to delineate strata for trip catch and/or effort levels (e.g., low, moderate, high, etc.).

Hindcast Procedures

For years prior to 2007, before observer data were collected, the hindcast discard estimation procedures described in Smith et al. (2019a) were applied. For this method, the ratio of observer CPUE in weight to logbook CPUE was computed for the observer time period, and then multiplied by the annual logbook CPUE for the hindcast time period to produce an estimated annual observer CPUE. Then, the annual observer CPUE was multiplied by annual logbook effort for the pre-observer time period to estimate total catch $\hat{C}$ in weight. An additional step computed the ratio of the observer CPUE in number to observer CPUE in weight. This ratio was then used to compute the observer estimated discards in number from the discards in weight for the hindcast period. Standard errors for the hindcast period were estimated using the respective CVs of total estimated catch $\hat{C}$ kept and discarded as described in Smith et al. (2019a). Annual length compositions for kept and discarded fish and management history informed the selection of the observer time period used in the hindcasting procedure. Verification compared total landed catch from logbook data with the estimated total catch $\hat{C}$ and standard error from observer data for the hindcast time period.

Discard Length Composition

The length frequency distribution for discards for a given management time frame was computed in the following manner. Average discard CPUE in stratum h was scaled to stratum total effort $\widehat{Y_h}$.

$$\hat{Y}_h = C\bar{P}UE_h * \hat{X}_h$$

and multiplied by stratum proportion of length L to obtain the stratum total discards $\widehat{Y_h}$ at length L,

$$\hat{Y}(L)_h = \hat{Y}_h * p(L)_h.$$

These were summed over all strata to obtain the survey frame total $\hat{Y}$ at length L

$$\hat{Y}(L)_{st} = \Sigma_h \hat{Y}(L)_h,$$

and then converted to relative proportion of length L,

$$p(L)_{st} = \frac{\hat{Y}(L)_{st}}{\Sigma_h \hat{Y}_h} (1)$$

Annual discards-at-length were computed by multiplying eq. (1) and annual estimates of total discards. Discard length compositions were calculated in fork length centimeters.

Results and Discussion

Golden Tilefish

The observer database included 174 bottom longline trips with corresponding trip and set information for Golden Tilefish. Observer sampling effort is summarized in Table 1, distinguishing all trips from the subset of trips that captured Golden Tilefish. A single observer trip in 2009 was removed as an outlier for discarding close to 500 Golden Tilefish in a single trip during the closed season.

Inspection of the annual nominal CPUE (catch in whole pounds per set) from logbook trips reporting Golden Tilefish showed a relatively stable trend from 1993 to 2004 before closures were implemented (Figure 3). Nominal CPUE peaked in 2005 and has slowly decreased over time. Using the trend from Figure 3 and observer sample sizes, catch-effort data for observer and logbook trips catching Golden Tilefish were pooled across the following years: pre-IFQ (2007-2009), IFQ (2010-2014), IFQ (2015-2016), IFQ (2017-2020), and IFQ (2021-2024). These observer and logbook datasets were the basis for subsequent analysis and estimation of catch and discards by management regimes. Observer data from the pre-IFQ period (2007-2009) were used for hindcasting discards for the pre-observer years 1993-2006.

Observer and logbook frequency distributions of trip-level catch, effort, and CPUE were analyzed to determine management regimes where observer sampling of Golden Tilefish trips was representative of the commercial fleet. To better align the observer data with the commercial fleet, observer and logbook trips were stratified into low (L) and high (H) catch categories under both the pre-IFQ and several IFQ management regimes (Table 2).

The proportions of observer trips and effort encountering kept Golden Tilefish by management regime and catch level strata are given in Table 3. These proportions were used to adjust annual logbook total Golden Tilefish trips and effort (Table 4) to account for logbook trips that only had discarded fish. Estimates of observer mean CPUE by management regime and catch level strata are given in Table 5. These CPUEs were the basis for expansion estimates of Golden Tilefish catch and discards.

CPUE expansion estimates of annual total landed catch of Gulf of America Golden Tilefish compared mostly favorably with reported logbook landings for with the exception of 2021-2024 where observer estimates catch was consistently an overestimate (Figure 4). CPUE expansion estimates for annual discards in numbers and weight of Gulf of America Golden Tilefish for 1993-2024 are provided in Figure 5. Estimated discards in number peaked at 17,000 fish in 2016. Discards in weight accounted for about 1 to 12% of the total catch (kept + discards) during 1993-2024.

Blueline Tilefish

The observer database included 139 bottom longline trips with corresponding trip and set information for Blueline Tilefish (Table 1).
The nominal logbook CPUE of Blueline Tilefish from 1993 to 2024 shows a slight increasing then decreasing trend that peaked around 2007. However, to remain consistent with Golden Tilefish, given these species are managed as a complex, the same management regimes were used. Therefore, catch-effort data for observer and logbook trips catching Blueline Tilefish were pooled across the following years: pre-IFQ (2007-2009), IFQ (2010-2014), IFQ (2015-2016), IFQ (2017-2020), and IFQ (2021-2024). Observer data from the pre-IFQ period (2007-2009) were used for hindcasting discards of Blueline Tilefish for the pre-observer years 1993-2006.

Observer and logbook frequency distributions of trip-level catch, effort, and CPUE of Blueline Tilefish were compared. The pre-IFQ (2007-2009) and IFQ (2021-2024) management regimes had a higher proportion of observer trips with high catch relative to the commercial fleet. For the IFQ (2010-2014) time period, effort was the better variable for stratifying where observers went on slightly more high effort trips (> 18 sets). In subsequent analyses, observer and logbook trips were grouped into these strata summarized in Table 6.

The proportions of observer trips and effort encountering kept Blueline Tilefish by management regime and catch/effort level strata are given in Table 7. These proportions were used to adjust the annual logbook trips and effort with Blueline Tilefish to account for logbook trips that discarded only Blueline Tilefish (Table 8). Lastly, estimates of observer mean CPUE by management regime and catch/effort level strata are given in Table 9.

The successful catch verification of Blueline Tilefish provided a reliable framework for estimating total discards (Figure 7). Before IFQ and closures, Blueline Tilefish discards averaged 4% of the total catch (Figure 8B). Discard estimates peaked at 15,000 fish in 2007 and 2008 from closures (Figure 8A). Post-IFQ, discards ranged from 26 to 47% of the total catch, with an average of 6,000 fish discarded.

Goldface Tilefish

There was a total of 18 observer trips reporting Goldface Tilefish from 2007 to 2024 (Table 1). Of those 18 trips, 13 trips reported discards of Goldface Tilefish. This was insufficient to estimate commercial discards of Goldface Tilefish and since there is no minimum size limit for the entire time series, these discards are considered negligible.

Tilefish Complex and Discard Length Compositions

Estimated discards in number (Table 10) and whole weight in pounds (Table 11) are provided for Golden Tilefish, Blueline Tilefish, and combined which will serve as the Tilefish Complex discard estimates. For the stock assessment analyst, the weighted discard length compositions were provided for each species separately in 2 cm bins. Figure 9 shows how those weighted discard length compositions compare by species. While Golden Tilefish tend to be larger fish when kept, this pattern is not evident in the discards, with most years showing larger Blueline Tilefish being discarded.

Comparison to Previous Assessment

The last time Tilefish was assessed was SEDAR 22 with a terminal year of 2009. For that assessment, discards of Tilefish (Golden Tilefish and Blueline Tilefish) were considered using discard logbook data. However, too few trips reported Tilefish discards from 2002 to 2009 to reliably calculate fleet-wide discard estimates. McCarthy (2010) summarized the 2002-2009 discard logbook data for Golden and Blueline Tilefish from vertical and bottom longline vessels. A similar pattern emerged in the vertical line observer data, where Tilefish discards occurred on too few trips to warrant further analysis for this assessment. Since numbers from McCarthy (2010) are not calculated total discard estimates, a direct comparison to the bottom longline discards from this working paper were not conducted.

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Table 1. Number of total bottom longline observer trips as well as total Golden Tilefish, Blueline Tilefish, and Goldface Tilefish trips by year for the Gulf of America.

Year	Total Trips	Golden Tilefish Trips	Blueline Tilefish Trips	Goldface Tilefish Trips
2007	29	2	5	0
2008	5	3	1	0
2009	40	13	15	1
2010	79	22	21	1
2011	91	20	18	3
2012	58	10	6	1
2013	82	25	16	1
2014	27	7	7	0
2015	30	7	6	3
2016	71	17	8	4
2017	34	8	7	1
2018	37	1	1	0
2019	20	1	2	0
2020	5	3	1	1
2021	25	4	4	0
2022	33	13	10	2
2023	25	10	7	0
2024	17	8	4	0

Table 2. Definition of trip strata levels for Gulf of America **Golden Tilefish**, and corresponding percentages of logbook and observer bottom longline trips for each zone and management regime.

					% Trips	
Species	Management Regime	Season	Strata Level	Stratum Code	Logbook	Observer
Golden	Pre-IFQ 2007-2009	Open	Low, Catch <= 2687 lbs	L	74.4	66.7
Golden	Pre-IFQ 2007-2009	Open	High, Catch > 2687 lbs	H	25.6	33.3
Golden	IFQ 2015-2016	Open	Low, Catch <= 3187 lbs	L	69.5	50.0
Golden	IFQ 2015-2016	Open	High, Catch > 3187 lbs	H	30.5	50.0
Golden	IFQ 2017-2020	Open	Low, Catch <= 3335 lbs	L	79.5	61.5
Golden	IFQ 2017-2020	Open	High, Catch > 3335 lbs	H	20.5	38.5

Species	Management Regime	Season	Strata Level	Stratum Code	% Trips	
					Logbook	Observer
Golden	IFQ 2021-2024	Open	Low, Catch <= 1201 lbs	L	63.0	57.1
Golden	IFQ 2021-2024	Open	High, Catch > 1201 lbs	H	37.0	42.9

Table 3. Gulf of America **Golden Tilefish** bottom longline trip and effort adjustment factors by management regime and catch/effort level strata. Strata levels are defined in Table 2; where stratum 'All' is all levels (i.e., no stratification) for the management regime. The proportions of Golden Tilefish observer trips and effort with kept Golden Tilefish were used to respectively adjust annual logbook total trips and effort (Table 4) to account for logbook trips that only had discarded fish.

Species	Management Regime	Season	Strata Type	Strata Level	Number of Observer Trips (n)	Proportion of Observer Data with Kept Golden Tilefish	
						Trips	Effort
Golden	Pre-IFQ 2007-2009	Closed	All	A	5	0.2	0.158
Golden	Pre-IFQ 2007-2009	Open	Catch	L	8	1	1
Golden	Pre-IFQ 2007-2009	Open	Catch	H	4	1	1
Golden	IFQ 2010-2014	Open	All	A	84	0.869	0.858
Golden	IFQ 2015-2016	Open	Catch	L	12	0.917	0.861
Golden	IFQ 2015-2016	Open	Catch	H	12	1	1
Golden	IFQ 2017-2020	Open	Catch	L	8	0.875	0.913
Golden	IFQ 2017-2020	Open	Catch	H	5	1	1
Golden	IFQ 2021-2024	Open	Catch	L	20	0.95	0.998
Golden	IFQ 2021-2024	Open	Catch	H	15	1	1

Table 4. Annual time-series of bottom longline logbook trips (number) and effort (hours) by catch/effort level strata for Gulf of America **Golden Tilefish**.

					Logbook Trips		Logbook Effort	
Species	Year	Season	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
Golden	1993	Open	Catch	L	187	187	4,870	4,870
Golden	1993	Open	Catch	H	18	18	636	636
Golden	1994	Open	Catch	L	299	299	8,970	8,970
Golden	1994	Open	Catch	H	56	56	1,184	1,184
Golden	1995	Open	Catch	L	326	326	8,716	8,716
Golden	1995	Open	Catch	H	87	87	1,993	1,993
Golden	1996	Open	Catch	L	248	248	7,047	7,047
Golden	1996	Open	Catch	H	65	65	1,517	1,517
Golden	1997	Open	Catch	L	278	278	10,507	10,507
Golden	1997	Open	Catch	H	66	66	1,259	1,259
Golden	1998	Open	Catch	L	237	237	7,408	7,408
Golden	1998	Open	Catch	H	46	46	895	895
Golden	1999	Open	Catch	L	280	280	6,932	6,932
Golden	1999	Open	Catch	H	50	50	1,216	1,216
Golden	2000	Open	Catch	L	421	421	9,306	9,306
Golden	2000	Open	Catch	H	45	45	1,631	1,631
Golden	2001	Open	Catch	L	356	356	7,451	7,451
Golden	2001	Open	Catch	H	51	51	1,356	1,356
Golden	2002	Open	Catch	L	365	365	7,438	7,438
Golden	2002	Open	Catch	H	43	43	995	995
Golden	2003	Open	Catch	L	362	362	7,847	7,847
Golden	2003	Open	Catch	H	36	36	1,060	1,060
Golden	2004	Open	Catch	L	246	246	5,275	5,275
Golden	2004	Open	Catch	H	59	59	1,283	1,283
Golden	2005	Open	Catch	L	212	212	3,555	3,555
Golden	2005	Open	Catch	H	65	65	1,224	1,224
Golden	2006	Closed	All	A	2	10	25	158
Golden	2006	Open	Catch	L	164	164	2,963	2,963
Golden	2006	Open	Catch	H	40	40	888	888
Golden	2007	Closed	All	A	3	15	53	335
Golden	2007	Open	Catch	L	132	132	2,578	2,578
Golden	2007	Open	Catch	H	43	43	909	909
Golden	2008	Closed	All	A	2	10	33	208
Golden	2008	Open	Catch	L	175	175	3,727	3,727

					Logbook Trips		Logbook Effort	
Species	Year	Season	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
Golden	2008	Open	Catch	H	45	45	907	907
Golden	2009	Closed	All	A	8	40	50	316
Golden	2009	Open	Catch	L	132	132	2,811	2,811
Golden	2009	Open	Catch	H	63	63	1,851	1,851
Golden	2010	Open	All	A	129	148	2,764	3,223
Golden	2011	Open	All	A	143	165	3,755	4,379
Golden	2012	Open	All	A	173	199	4,337	5,057
Golden	2013	Open	All	A	150	173	4,422	5,157
Golden	2014	Open	All	A	153	176	5,114	5,963
Golden	2015	Open	Catch	L	127	139	4,189	4,867
Golden	2015	Open	Catch	H	54	54	3,250	3,250
Golden	2016	Open	Catch	L	112	122	3,679	4,274
Golden	2016	Open	Catch	H	51	51	3,537	3,537
Golden	2017	Open	Catch	L	122	139	3,919	4,295
Golden	2017	Open	Catch	H	45	45	2,830	2,830
Golden	2018	Open	Catch	L	117	134	3,890	4,263
Golden	2018	Open	Catch	H	37	37	2,132	2,132
Golden	2019	Open	Catch	L	125	143	4,643	5,088
Golden	2019	Open	Catch	H	28	28	1,723	1,723
Golden	2020	Open	Catch	L	164	187	4,891	5,360
Golden	2020	Open	Catch	H	26	26	1,129	1,129
Golden	2021	Open	Catch	L	118	124	2,975	2,982
Golden	2021	Open	Catch	H	65	65	3,157	3,157
Golden	2022	Open	Catch	L	87	92	2,198	2,203
Golden	2022	Open	Catch	H	59	59	2,491	2,491
Golden	2023	Open	Catch	L	84	88	2,464	2,470
Golden	2023	Open	Catch	H	52	52	2,198	2,198
Golden	2024	Open	Catch	L	80	84	2,331	2,336
Golden	2024	Open	Catch	H	41	41	1,407	1,407

Table 5. Estimated observer mean CPUE in weight (lbs.) and number by management regime and catch/effort level strata for expansion estimates of bottom longline Gulf of America **Golden Tilefish** catch and discards.

						Observer CPUE		
Species	Management Regime	Season	Strata Type	Strata Level	Logbook CPUE	Kept (Weight)	Discard (Weight)	Discard (Number)
Golden	Pre-IFQ 2007-2009	Closed	All	A	5.065	0.149	2.683	0.342
Golden	Pre-IFQ 2007-2009	Open	Catch	L	33.222	24.256	0.354	0.095
Golden	Pre-IFQ 2007-2009	Open	Catch	H	218.354	205.241	1.077	0.181
Golden	IFQ 2010-2014	Open	All	A	70.974	75.266	8.315	2.211
Golden	IFQ 2015-2016	Open	Catch	L	25.174	14.172	3.043	0.940
Golden	IFQ 2015-2016	Open	Catch	H	89.425	122.824	11.420	3.754
Golden	IFQ 2017-2020	Open	Catch	L	25.042	13.331	0.247	0.095
Golden	IFQ 2017-2020	Open	Catch	H	93.140	125.095	1.292	0.343
Golden	IFQ 2021-2024	Open	Catch	L	9.848	6.812	0.462	0.192
Golden	IFQ 2021-2024	Open	Catch	H	95.380	130.751	2.335	0.951

Table 6. Definition of trip strata levels for Gulf of America **Blueline Tilefish**, and corresponding percentages of logbook and observer bottom longline trips for each zone and management regime.

					% Trips	
Species	Management Regime	Season	Strata Level	Stratum Code	Logbook	Observer
Blueline	Pre-IFQ 2007-2009	Open	Low, Catch <= 352 lbs	L	50.0	27.3
Blueline	Pre-IFQ 2007-2009	Open	High, Catch > 352 lbs	H	50.0	72.7
Blueline	IFQ 2010-2014	Open	Low, Effort <= 18 sets	L	36.4	17.6
Blueline	IFQ 2010-2014	Open	High, Effort > 18 sets	H	63.6	82.4
Blueline	IFQ 2021-2024	Open	Low, Catch <= 27 lbs	L	17.0	40.0
Blueline	IFQ 2021-2024	Open	High, Catch > 27 lbs	H	83.0	60.0

Table 7. Gulf of America **Blueline Tilefish** bottom longline trip and effort adjustment factors by management regime and catch/effort level strata. Strata levels are defined in Table 6; where stratum 'All' is all levels (i.e., no stratification) for the management regime. The proportions of Blueline Tilefish observer trips and effort with kept Blueline Tilefish were used to respectively adjust annual logbook total trips and effort (Table 8) to account for logbook trips that only had discarded fish.

						Proportion of Observer Data with Kept Blueline Tilefish	
Species	Management Regime	Season	Strata Type	Strata Level	Number of Observer Trips (n)	Trips	Effort
Blueline	Pre-IFQ 2007-2009	Closed	All	A	10	0.2	0.136
Blueline	Pre-IFQ 2007-2009	Open	Catch	L	3	1	1
Blueline	Pre-IFQ 2007-2009	Open	Catch	H	8	1	1
Blueline	IFQ 2010-2014	Open	Effort	L	12	0.667	0.638
Blueline	IFQ 2010-2014	Open	Effort	H	56	0.625	0.582
Blueline	IFQ 2015-2016	Open	All	A	14	0.857	0.833
Blueline	IFQ 2017-2020	Open	All	A	11	0.909	0.95
Blueline	IFQ 2021-2024	Open	Catch	L	10	0.6	0.605
Blueline	IFQ 2021-2024	Open	Catch	H	15	1	1

Table 8. Annual time-series of bottom longline logbook trips (number) and effort (hours) by catch/effort level strata for Gulf of America **Blueline Tilefish**.

					Logbook Trips		Logbook Effort	
Species	Year	Season	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
Blueline	1993	Open	Catch	L	83	83	2,758	2,758
Blueline	1993	Open	Catch	H	21	21	885	885
Blueline	1994	Open	Catch	L	163	163	5,057	5,057
Blueline	1994	Open	Catch	H	41	41	1,487	1,487
Blueline	1995	Open	Catch	L	124	124	3,795	3,795
Blueline	1995	Open	Catch	H	33	33	1,018	1,018
Blueline	1996	Open	Catch	L	88	88	2,708	2,708
Blueline	1996	Open	Catch	H	28	28	794	794

					Logbook Trips		Logbook Effort	
Species	Year	Season	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
Blueline	1997	Open	Catch	L	113	113	3,167	3,167
Blueline	1997	Open	Catch	H	87	87	3,420	3,420
Blueline	1998	Open	Catch	L	108	108	2,884	2,884
Blueline	1998	Open	Catch	H	58	58	1,898	1,898
Blueline	1999	Open	Catch	L	102	102	2,617	2,617
Blueline	1999	Open	Catch	H	41	41	1,255	1,255
Blueline	2000	Open	Catch	L	125	125	3,481	3,481
Blueline	2000	Open	Catch	H	83	83	2,286	2,286
Blueline	2001	Open	Catch	L	115	115	2,850	2,850
Blueline	2001	Open	Catch	H	62	62	1,488	1,488
Blueline	2002	Open	Catch	L	110	110	2,422	2,422
Blueline	2002	Open	Catch	H	37	37	900	900
Blueline	2003	Open	Catch	L	130	130	3,028	3,028
Blueline	2003	Open	Catch	H	60	60	1,432	1,432
Blueline	2004	Open	Catch	L	96	96	2,050	2,050
Blueline	2004	Open	Catch	H	68	68	1,710	1,710
Blueline	2005	Open	Catch	L	101	101	1,612	1,612
Blueline	2005	Open	Catch	H	57	57	996	996
Blueline	2006	Closed	All	A	3	15	45	332
Blueline	2006	Open	Catch	L	88	88	1,639	1,639
Blueline	2006	Open	Catch	H	81	81	1,392	1,392
Blueline	2007	Closed	All	A	6	30	146	1,077
Blueline	2007	Open	Catch	L	51	51	981	981
Blueline	2007	Open	Catch	H	58	58	1,076	1,076
Blueline	2008	Closed	All	A	6	30	154	1,136
Blueline	2008	Open	Catch	L	76	76	1,379	1,379
Blueline	2008	Open	Catch	H	83	83	1,500	1,500
Blueline	2009	Closed	All	A	3	15	75	553
Blueline	2009	Open	Catch	L	75	75	1,599	1,599
Blueline	2009	Open	Catch	H	61	61	1,325	1,325
Blueline	2010	Open	Effort	L	9	14	124	194
Blueline	2010	Open	Effort	H	27	43	832	1,429
Blueline	2011	Open	Effort	L	21	32	188	295
Blueline	2011	Open	Effort	H	34	54	1,270	2,181
Blueline	2012	Open	Effort	L	33	50	285	447

					Logbook Trips		Logbook Effort	
Species	Year	Season	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
Blueline	2012	Open	Effort	H	34	54	1,119	1,922
Blueline	2013	Open	Effort	L	19	28	196	307
Blueline	2013	Open	Effort	H	36	58	1,389	2,385
Blueline	2014	Open	Effort	L	22	33	276	433
Blueline	2014	Open	Effort	H	51	82	1,937	3,327
Blueline	2015	Open	All	A	80	93	2,288	2,746
Blueline	2016	Open	All	A	56	65	1,729	2,075
Blueline	2017	Open	All	A	96	106	2,888	3,040
Blueline	2018	Open	All	A	85	94	2,768	2,913
Blueline	2019	Open	All	A	163	179	5,095	5,362
Blueline	2020	Open	All	A	166	183	4,303	4,529
Blueline	2021	Open	Catch	L	34	57	919	1,520
Blueline	2021	Open	Catch	H	152	152	3,847	3,847
Blueline	2022	Open	Catch	L	19	32	479	792
Blueline	2022	Open	Catch	H	127	127	3,029	3,029
Blueline	2023	Open	Catch	L	20	33	624	1,032
Blueline	2023	Open	Catch	H	120	120	3,222	3,222
Blueline	2024	Open	Catch	L	26	43	902	1,492
Blueline	2024	Open	Catch	H	83	83	2,110	2,110

Table 9. Estimated observer mean CPUE in weight (lbs.) and number by management regime and catch/effort level strata for expansion estimates of bottom longline Gulf of America **Blueline Tilefish** catch and discards.

						Observer CPUE		
Species	Management Regime	Season	Strata Type	Strata Level	Logbook CPUE	Kept (Weight)	Discard (Weight)	Discard (Number)
Blueline	Pre-IFQ 2007-2009	Closed	All	A	0.404	0.091	61.230	12.836
Blueline	Pre-IFQ 2007-2009	Open	Catch	L	5.127	4.563	0.000	0.000
Blueline	Pre-IFQ 2007-2009	Open	Catch	H	65.139	78.331	2.449	0.778
Blueline	IFQ 2010-2014	Open	Effort	L	25.128	29.182	10.817	2.260
Blueline	IFQ 2010-2014	Open	Effort	H	13.334	11.133	8.990	1.860
Blueline	IFQ 2015-2016	Open	All	A	13.919	12.731	12.247	2.730
Blueline	IFQ 2017-2020	Open	All	A	19.308	19.012	6.607	1.961
Blueline	IFQ 2021-2024	Open	Catch	L	0.237	0.261	0.606	0.119
Blueline	IFQ 2021-2024	Open	Catch	H	23.200	22.870	7.501	1.930

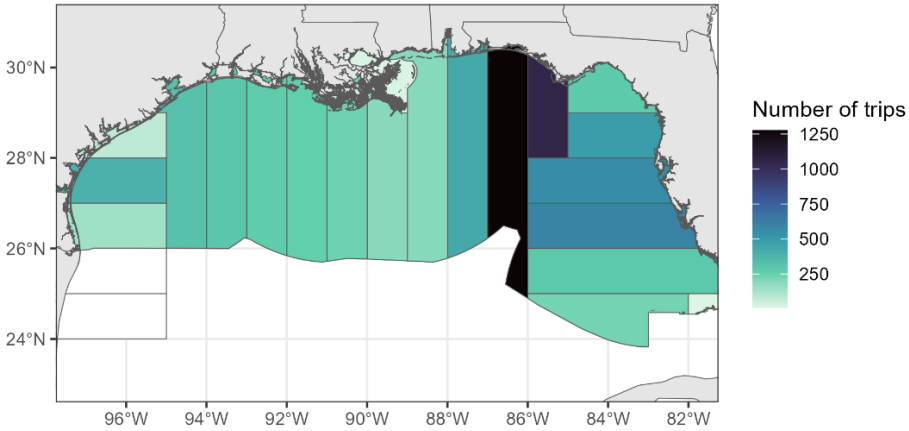
Table 10. CPUE expansion estimates for Gulf of America Golden Tilefish, Blueline Tilefish, and combined bottom longline discards in number with associated standard errors.

	Golden Tilefish		Blueline Tilefish		Tilefish Complex	
Year	Discard Number	SE	Discard Number	SE	Discard Number	SE
1993	335	113	262	85	597	141
1994	728	223	431	140	1,159	263
1995	885	256	367	119	1,252	283
1996	717	212	372	121	1,089	244
1997	706	205	1,471	478	2,176	520
1998	695	222	698	227	1,393	318
1999	751	238	644	209	1,396	317
2000	997	338	959	311	1,956	460
2001	865	283	739	240	1,604	371
2002	933	309	447	145	1,380	341
2003	753	253	722	234	1,475	345
2004	710	207	937	304	1,647	368
2005	723	204	633	206	1,357	290
2006	1,615	467	4,419	1,149	6,034	1,240
2007	524	209	14,666	4,761	15,190	4,766
2008	589	235	15,754	5,115	16,343	5,120
2009	710	283	8,135	2,641	8,845	2,656
2010	7,128	1,388	3,097	1,152	10,225	1,804
2011	9,683	1,885	4,723	1,757	14,407	2,577
2012	11,184	2,177	4,584	1,705	15,769	2,766
2013	11,403	2,220	5,132	1,909	16,535	2,928
2014	13,188	2,567	7,166	2,665	20,354	3,701
2015	16,775	4,988	7,495	3,413	24,270	6,044
2016	17,295	5,143	5,664	2,579	22,959	5,753
2017	1,381	569	5,962	4,225	7,342	4,264
2018	1,138	469	5,714	4,050	6,852	4,077
2019	1,077	444	10,518	7,455	11,594	7,468
2020	899	371	8,883	6,296	9,782	6,307
2021	3,576	1,424	7,608	2,804	11,183	3,145
2022	2,793	1,112	5,942	2,190	8,734	2,456
2023	2,565	1,021	6,343	2,338	8,908	2,552
2024	1,787	712	4,251	1,567	6,038	1,721

Table 11. CPUE expansion estimates for Gulf of America Golden Tilefish, Blueline Tilefish, and combined bottom longline discards in whole weight (lbs.) with associated standard errors.

	Golden Tilefish		Blueline Tilefish		Tilefish Complex	
Year	Discard Pounds	SE	Discard Pounds	SE	Discard Pounds	SE
1993	1,383	466	824	284	2,206	546
1994	3,183	984	1,357	469	4,540	1,090
1995	4,050	1,223	1,154	399	5,204	1,286
1996	3,219	977	1,171	404	4,390	1,057
1997	3,221	973	4,628	1,598	7,849	1,871
1998	2,952	947	2,197	759	5,149	1,213
1999	3,211	1,020	2,028	700	5,238	1,237
2000	4,090	1,396	3,018	1,042	7,108	1,742
2001	3,625	1,188	2,324	803	5,949	1,434
2002	3,881	1,288	1,407	486	5,287	1,376
2003	3,107	1,048	2,272	785	5,379	1,309
2004	3,217	973	2,948	1,018	6,166	1,408
2005	3,449	1,056	1,992	688	5,441	1,260
2006	10,959	3,775	19,400	5,687	30,358	6,826
2007	2,791	1,192	68,603	23,690	71,394	23,720
2008	2,857	1,220	73,256	25,297	76,113	25,326
2009	3,837	1,639	37,132	12,823	40,969	12,927
2010	26,802	5,993	14,948	5,706	41,750	8,275
2011	36,411	8,142	22,796	8,702	59,207	11,917
2012	42,054	9,404	22,109	8,440	64,163	12,636
2013	42,879	9,588	24,769	9,455	67,647	13,466
2014	49,589	11,089	34,586	13,202	84,175	17,241
2015	51,925	15,425	33,626	15,448	85,551	21,830
2016	53,400	15,863	25,410	11,673	78,810	19,695
2017	4,720	2,068	20,083	13,962	24,803	14,114
2018	3,810	1,669	19,249	13,382	23,059	13,485
2019	3,486	1,527	35,431	24,631	38,917	24,679
2020	2,785	1,220	29,923	20,803	32,709	20,838
2021	8,749	3,362	29,777	11,014	38,526	11,515
2022	6,834	2,626	23,200	8,581	30,035	8,974
2023	6,273	2,411	24,793	9,170	31,067	9,482
2024	4,365	1,677	16,731	6,188	21,096	6,412

(A) Golden Tilefish



(B) Blueline Tilefish

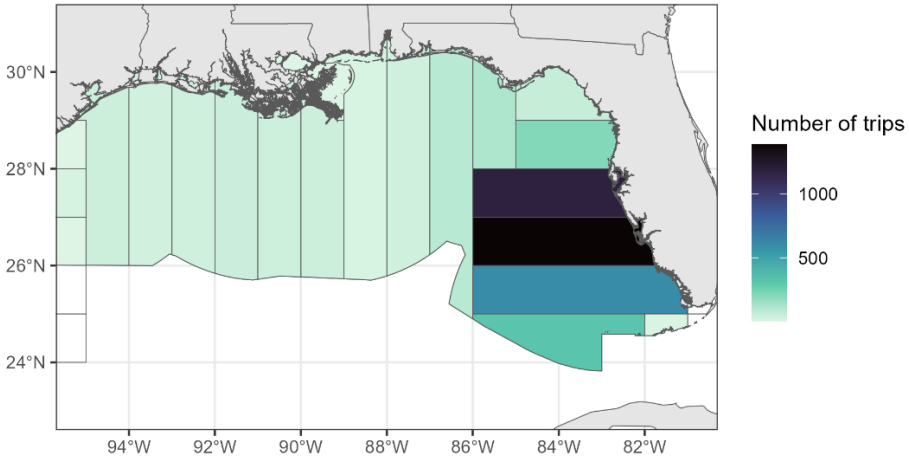


Figure 1. Distribution of (A) Golden Tilefish and (B) Blueline Tilefish caught on logbook trips from 1993 – 2024.

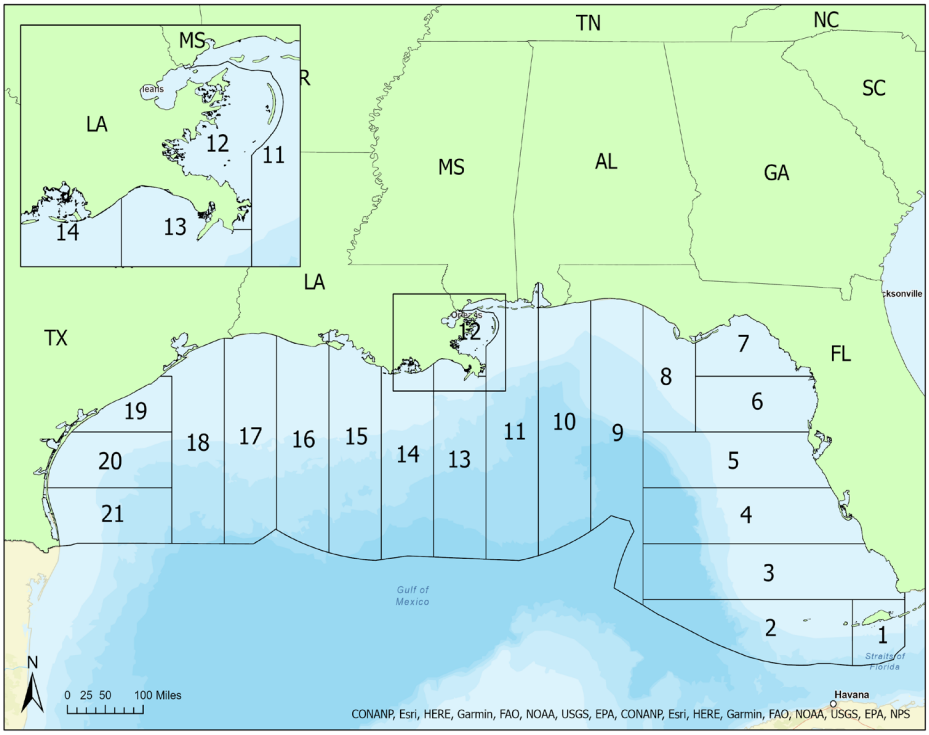


Figure 2. Map of observer fishing areas.

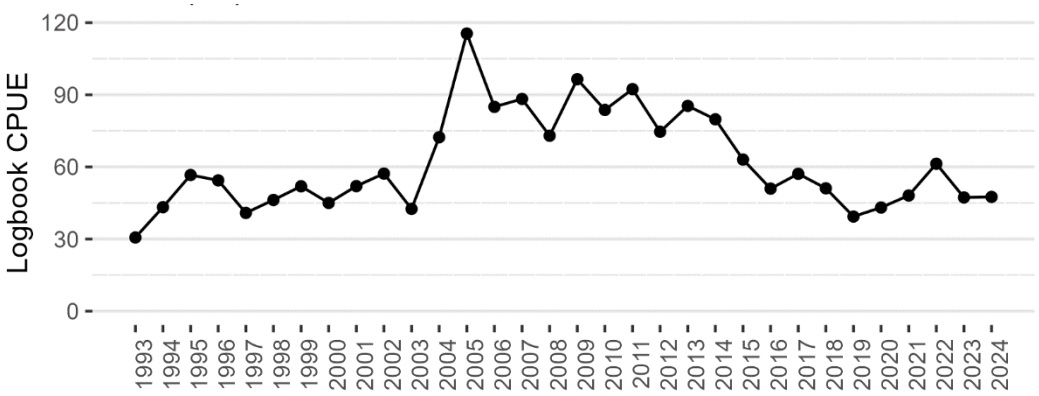


Figure 3. CPUE (catch in whole pounds per hour) time-series for logbook data from 1993 - 2024 for bottom longline trips landing Gulf of America **Golden Tilefish**.

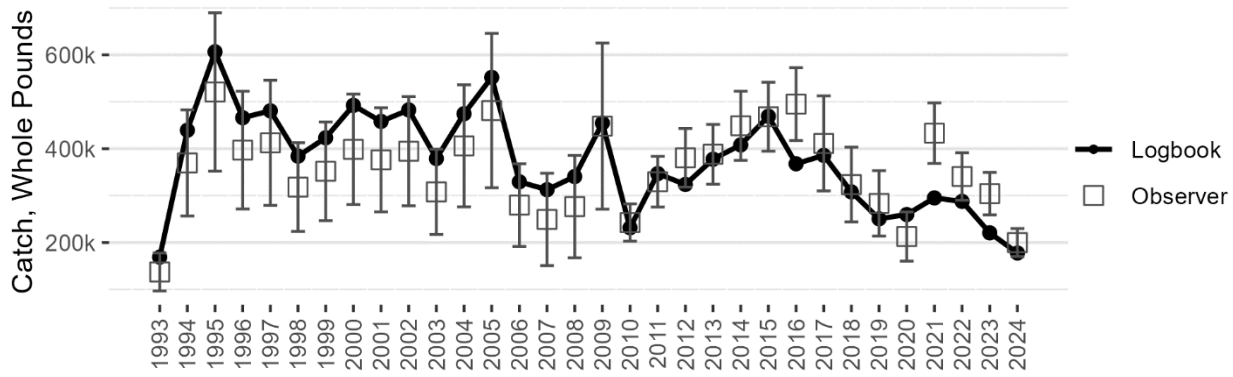


Figure 4. Comparison of bottom longline reported annual logbook landings of Gulf of America **Golden Tilefish** (solid black line) with CPUE expansion estimates from observer data (open squares). Error bars (SE) are shown for observer estimates.

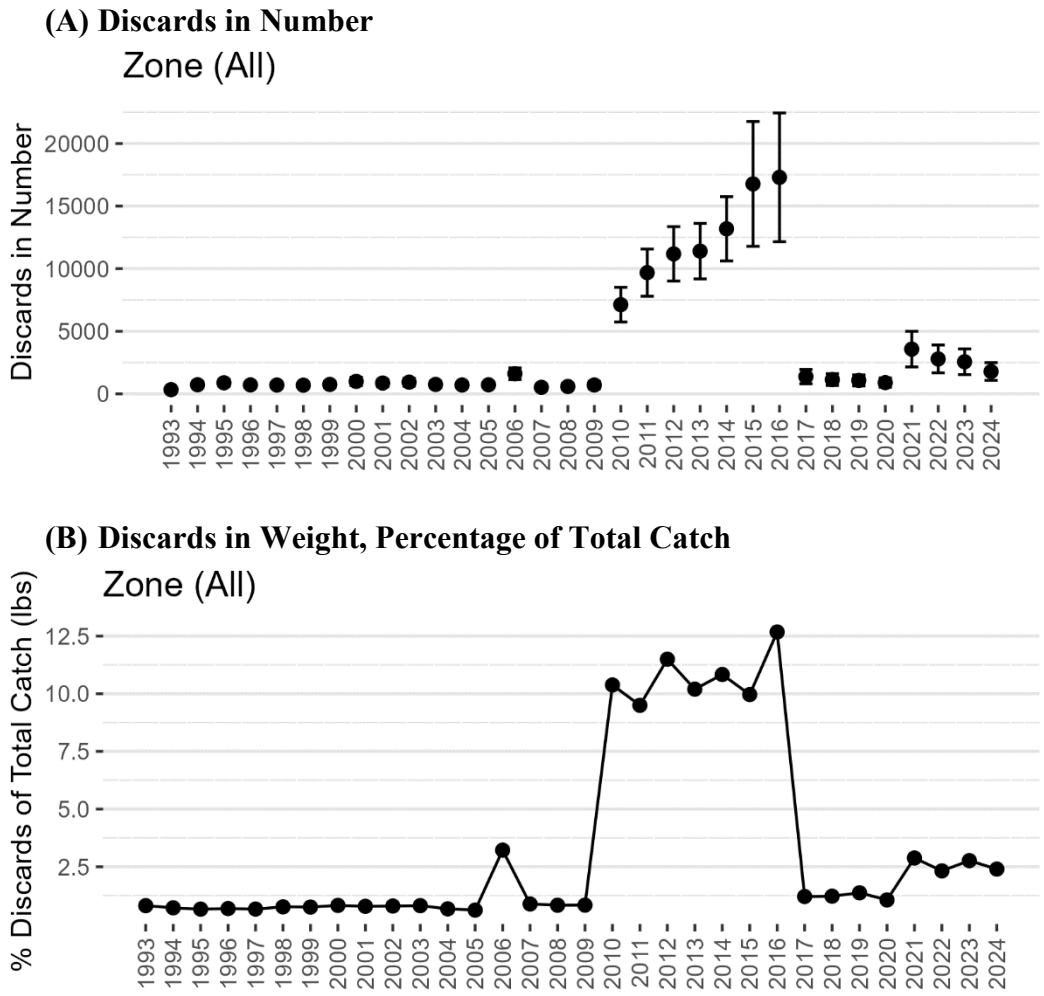


Figure 5. Observer CPUE expansion estimates of Gulf of America **Golden Tilefish** bottom longline annual discards (+/-SE) in (A) number and (B) weight expressed as percentage of total catch (kept + discards) for 1993 - 2024.

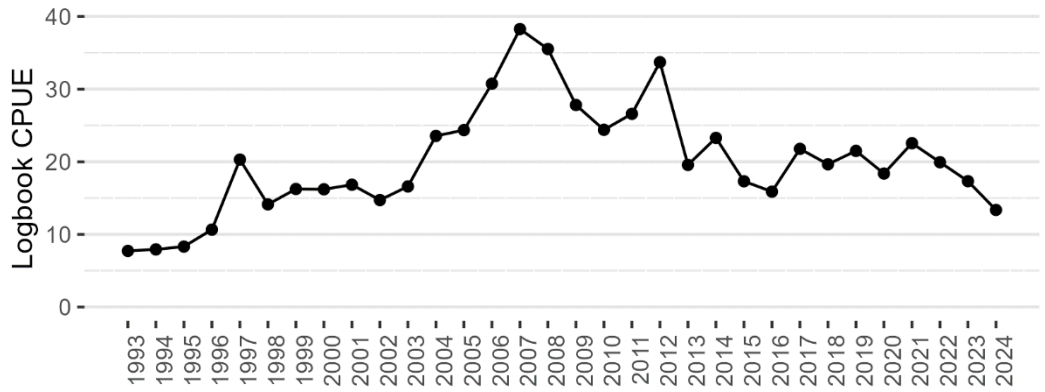


Figure 6. CPUE (catch in whole pounds per hour) time-series for logbook data from 1993 - 2024 for bottom longline trips landing Gulf of America **Blueline Tilefish**.

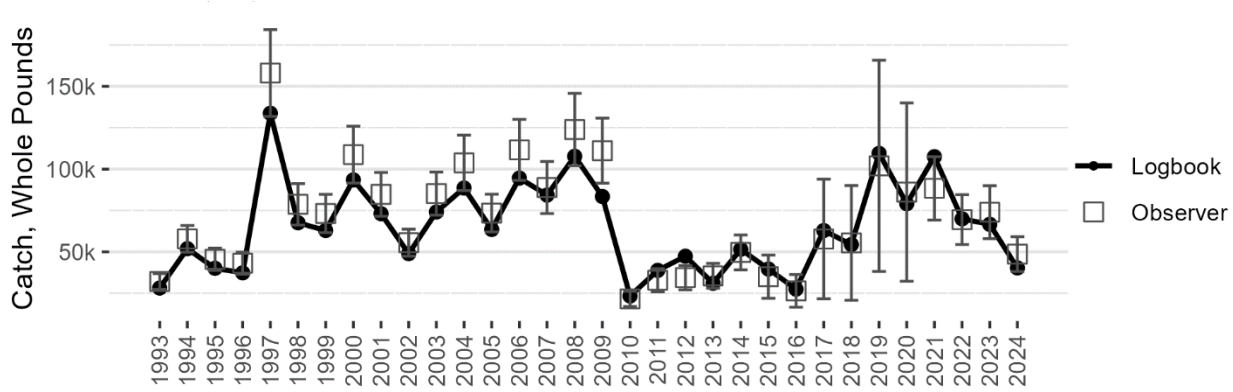
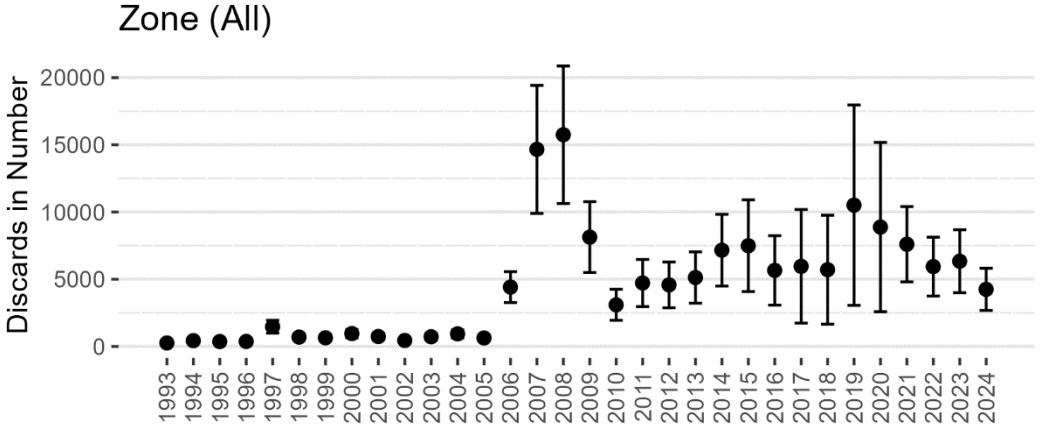


Figure 7. Comparison of bottom longline reported annual logbook landings of Gulf of America **Blueline Tilefish** (solid black line) with CPUE expansion estimates from observer data (open squares). Error bars (SE) are shown for observer estimates.

(A) Discards in Number



(B) Discards in Weight, Percentage of Total Catch

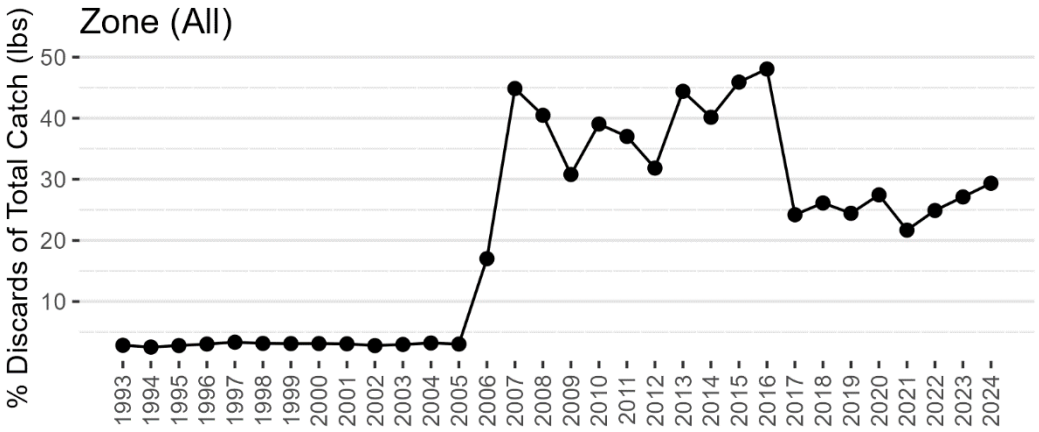


Figure 8. Observer CPUE expansion estimates of Gulf of America **Blueline Tilefish** bottom longline annual discards (+/-SE) in (A) number and (B) weight expressed as percentage of total catch (kept + discards) for 1993 - 2024.

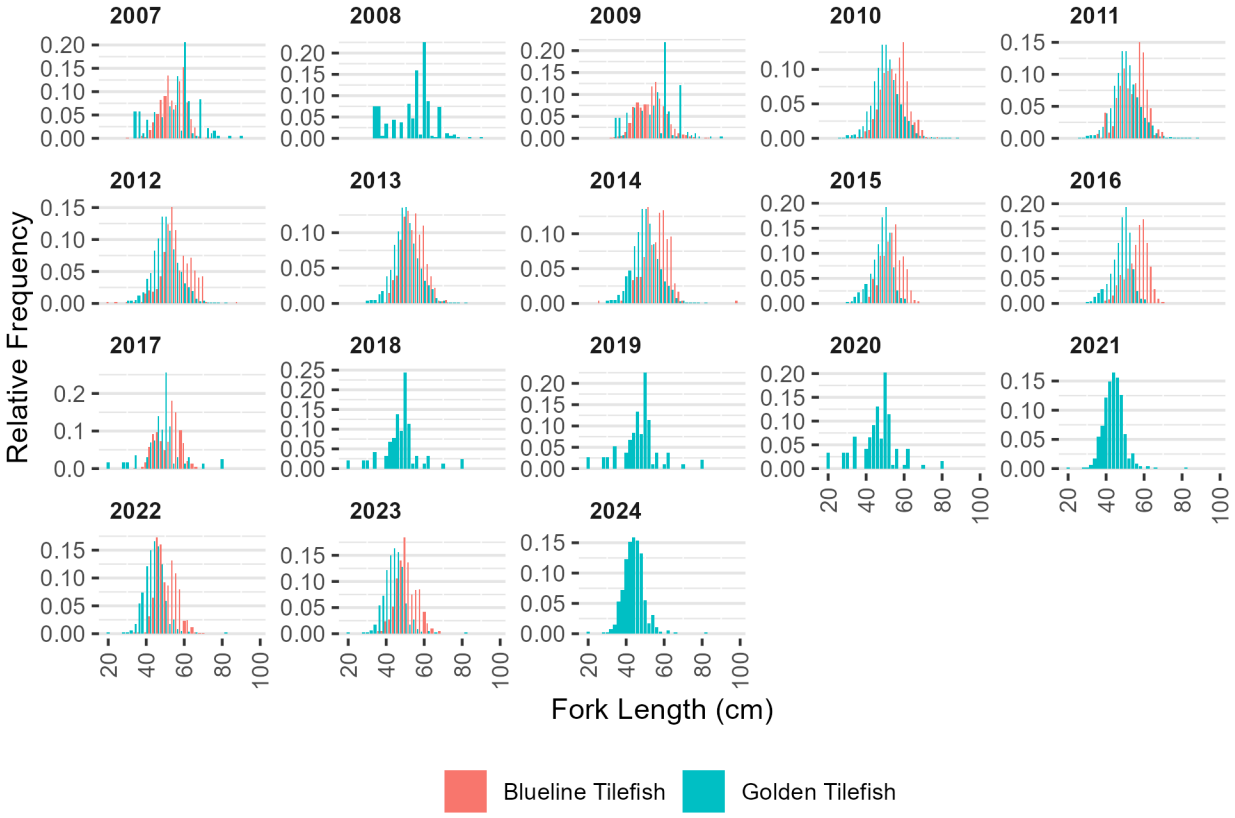


Figure 9. Commercial weighted annual discard length compositions for Golden Tilefish and Blueline Tilefish. Some years for Blueline Tilefish were removed for confidentiality.