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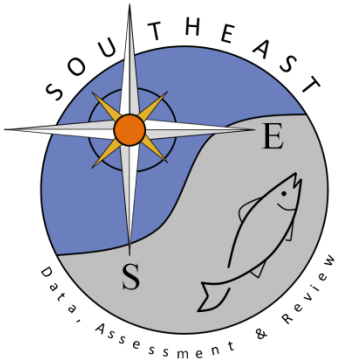

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Estimated Commercial Discards of Gulf of Mexico Red Snapper Using Discard Logbook and Observer Data from 1996-2023

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Introduction

For the previous assessment (SEDAR 74) of Gulf of Mexico Red Snapper, commercial discards were calculated using the Discard Logbook Program (DLP) from 1995-2006 and the Reef Fish Observer Program from 2007-2019. Utilizing two sources and methods to estimate discards was warranted because the observer program began at the same time the Individual Fishing Quota (IFQ) was implemented in 2007. Therefore, there is no observer data prior to IFQ to use in a hindcasting procedure (Smith et al. 2019a). For SEDAR 74, commercial discard estimates from each respective analysis were input into the assessment model as is without correcting for differences in methodology and data quality. The Southeast Fisheries Science Center (SEFSC) no longer recommends the use of discard logbook data for estimating discards for SEDAR based upon an analysis to determine the reliability of discard logbook data (Alhale et al. 2024). Given that only discard logbook data are available prior to IFQ, we propose a calibration to adjust the discard logbook-derived estimates, bringing them into closer alignment with the more reliable observer-derived estimates.

The general approach for estimating discards utilizes catch-per-unit-effort (CPUE) from the observer or discard logbook programs and total fishing effort from the Coastal Fisheries Logbook Program (CFLP) to estimate total catch,

$$totalCatch = CPUE * totalEffort.$$

Total discards include fish released alive, released dead, released in unknown condition, and used for bait. This working paper applies the standard method for estimating commercial discards using discard logbook data from 1996-2023 (Methods Part I). This method became the standard during SEDARs 32 and 41 (McCarthy, 2013 and 2015). Next, this working paper applies the standard method for estimating discards using observer data from 2007-2023 (Methods Part II). The same methodology used for SEDAR 74 was applied and was initially developed for Gulf of Mexico Red Grouper in SEDAR61-WP15(Smith et al. 2018). The method was improved in the following assessments: Gulf of Mexico Gray Triggerfish in SEDAR62-WP07 (Smith et al. 2019a) and Gulf of Mexico Vermilion Snapper in SEDAR67-WP12 (Smith et al. 2019b). The overlapping years in annual discard estimates of Red Snapper discards (2007-2023) were used to adjust the discard logbook-derived estimates from 1996-2006 and presented in the Methods Part III section of this working paper. Length compositions were prepared and weighted similarly to the previous SEDARs referenced for the discard estimation.

Data Sources

Discard Logbook

In August 2001, the SEFSC initiated a program to collect commercial fishing vessel discard data from the Gulf of Mexico and South Atlantic fisheries. A reporting form was developed that supplements the existing vessel coastal logbook forms that are currently mandatory for those fisheries (Poffenberger and McCarthy, 2004).

Data collection for the discard logbook program involves, each year, a 20% random sample of vessels with Gulf of Mexico reef fish, South Atlantic snapper-grouper, king mackerel, Spanish mackerel, dolphin/wahoo, and shark permits selected to report the number of animals discarded by species. Additional detail on changes to the sampling design over time is summarized in Alhale et al. (2024).

Reported data includes the numbers of discards by species, estimated condition of the fish when released, reason for release (due to regulations or unmarketable/unwanted), and the fishing area where the animal was discarded. There are six options for the condition of released fish: all animals are dead, majority of the animals are dead, all animals are alive when released, majority of animals are alive, the fish are kept but not sold, and the condition of the animals is unknown. All conditions except for unknown were used in the analysis.

Observer Programs

The Reef Fish Observer Program (RFOP) began in July 2006 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 targets two principal gears for the Gulf of Mexico reef fishery, bottom longline and vertical lines (e.g., handlines, electric and hydraulic reels aka bandit reels). The Shark Bottom Longline Observer Program (SBLOP) is responsible for collecting data of the shark bottom longline fishery in the Gulf of Mexico and South Atlantic (Decossas & Mathers 2023). Due to the limited vessels within the shark bottom longline fishery, observers also board vessels that are targeting reef fish species with bottom longline gear under a different permit. For discard estimation, only trips selected under the SBLOP that went on reef fish trips are included in the analysis. Rather than distinguish between each observer program, all analyses using observer data will be indicated as OBS.

Catch by species are recorded according to disposition category: kept (landed), released alive, released dead, released undetermined, and used for bait. Length and weight were also recorded for a subsample of individual fish.

Coastal Logbook

The Coastal Fisheries Logbook Program records the commercial fishing and non-fishing activity of fishermen with South Atlantic Snapper and Grouper, Gulf of Mexico Reef Fish, King Mackerel, Spanish Mackerel, and Atlantic Dolphin and Wahoo permits (Atkinson et al. 2021b, Poffenberger 2003). Total effort was determined from the commercial logbook data in which fishers reported basic information on effort and catch by species for every trip.

Relevant Management History of Gulf of Mexico Red Snapper

There were several minimum size changes of Gulf of Mexico Red Snapper starting in 1984. Relevant to commercial discard analyses, the minimum size limit was 14 inches total length (TL) from February 1994 to December 1995. From January 1996 the size limit was increased to 15” TL and remained in effect until April 2007. Since 2007, the minimum size limit has been 13” TL (12” FL).

For SEDAR 74, discard logbook-derived estimates of Gulf of Mexico Red Snapper started in 1995 because of a change in the minimum size limit from 14" to 15" TL. However, this was an error in previously provided management history information. Based on federal registrar notices, the minimum size limit change to 15" TL was effective for the commercial fishery on January 1, 1996. Consequently, applying the same logic as SEDAR 74–where no discard data was available to inform the discard rate of Red Snapper under the 14" TL management regime–discard estimates using discard logbook data were calculated starting in 1996.

As mentioned, the Gulf of Mexico Red Snapper IFQ program was implemented in 2007. Prior to this, the fishery was managed based on a series of closures summarized in Table 1. These closure dates are used to calculate discards by open and closed season from 1996-2006.

Gear

In the Gulf of Mexico, observer and discard logbook data reported Red Snapper on both vertical line and bottom longline trips. Therefore, discard estimation was conducted for each gear separately.

Spatial Domain

Discard estimates were conducted for the Gulf of Mexico, defined as statistical zones 1-21 (Fig. 1). Per recommendation of the stock assessment analysts, discards were estimated separately by the eastern (1-6), central (7-12), and western (13-21) subregions. For all analyses, the stock boundary and subregions were defined using area fished.

Part I Methodology – Discard Logbook Discard Estimation

The technique used to calculate discards followed the methods recommended in SEDAR 32 by calculating discard rates directly from the discard logbook data. Total effort of the vertical line (hook hours fished) and bottom longline (hooks fished) fisheries as reported to the logbook program was used to calculate total discards of Red Snapper. Those methods developed for SEDAR 32 and 41 had become the standard approach for commercial fishery discard calculation in cases where observer reported data are insufficient for discard calculation (McCarthy, 2013 and 2015).

Data Filtering

Data filtering followed the methods recommended during SEDARs 32 and 41 (McCarthy, 2013 and 2015). Coastal logbook data were filtered to exclude trips landing only mackerel species (*Scomberomorus cavalla, Scomberomorus maculatus, Scomberomorus regalis, Scomber japonicus, Scomber scombrus, Auxis thazard, and Decapterus macarellus*) because it was generally believed by the SEDAR 32 and 41 panels that for trips targeting mackerel only, the likelihood of catching species other than mackerel was extremely low. To avoid removing mixed effort trips, however, only trips with 100% mackerel landings were excluded.

Coastal logbook data were also filtered to remove possible erroneous data by eliminating trips that fished in multiple subregions (East, Central, and/or West zones) or in the South Atlantic and Gulf of Mexico and trips fishing more than 24 hours per day. Trips with effort values greater than the 99.5 percentile of the distribution of the data (by gear) were also removed.

The subset of coastal logbook data used to calculate total effort was used to subset the discard logbook data to the same trips. That way any coastal logbook data removed for fishing for mackerel species or considered an outlier was also not considered when calculating discard rates using discard logbook data. An additional discard logbook data filter was meant to address the main issue of reliability of discard logbook data (Alhale et al. 2024). Fishers remain in reporting compliance by returning discard logbooks with reports of "no discards". Reports of "no discards" have increased overtime across all gears. To account for this misreporting, discard logbook data are filtered to remove records from vessels that never reported discards of any species during a year. Furthermore, data from commercial vessels that took more than two standard deviations above the mean number of trips to report a discard of any species was removed from the analysis. The cut points used to exclude discard reports due to a high number of "no discard" reports by a vessel in a given year are summarized in Table 2. An example of this filter would be data from pre-IFQ vertical line vessels that took more than four, two, or three (East, Central, and West subregions, respectively) trips without reporting discards of any species were excluded.

For SEDAR 98, data were stratified by subregion (East, Central, and West) and season (open vs. closed). Additionally, to separate discard data before and after IFQ implementation, two management regimes were defined as pre-IFQ 2002-2006 and IFQ 2007-2023. The mean discard rate was calculated per strata as the number of discards per hook hour fished for vertical line vessels and the number of hooks fished for bottom longline vessels. Annual total effort of all trips by vertical line and bottom longline vessels within each stratum was multiplied by the mean discard rate to calculate total discards of Red Snapper.

For years prior to 2002 (the first year of discard data), the mean discard rate, by subregion and season, for the years 2002-2006 was used to calculate discards for the years 1996-2001 when only total effort data were available.

Part I Methodology – Observer Discard Estimation

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). This scaling up procedure to estimate trip-level catch is standard practice before analyzing the observer data.

Trip-Level Effort for Observer and Logbook Data

For observer data, trip-level effort for vertical lines was computed as the cumulative daily fishing time (hours) from first hook in to last hook out; this time metric included the active fishing time as well as transit time between fishing locations during a given trip day. This effort variable generally matched trip fishing time reported in vessel logbook data (Smith et al. 2018). For bottom longlines, trip-level effort was the number of sets fished; this effort variable matched the number of sets 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

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

Standard error of total catch was calculated as

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

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

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

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 of Red Snapper. This enabled accurate estimation of total catch (and discards) in cases where observer sampling was not proportional to the fleet with respect to catch or effort (Smith et al. 2019a). For example, observers may have sampled fewer low-catch trips with respect to logbook low-catch trips. 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.).

Discard Length Composition

The weighted length frequency distribution for discards 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 annual proportion of length L to obtain the annual 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 weighted discard length compositions differ from nominal discard length compositions when additional trip catch or effort stratification is applied to a given management regime.

Part III Methodology - Calibration

Discard logbook-derived estimates of commercial discards are often an over estimate compared to observer-derived estimates. This has been compared in previous assessments including SEDAR 68 South Atlantic Scamp (McCarthy et al. 2020) and SEDAR 28U Gulf of Mexico Cobia (Smith et al. 2020)

Analysts typically have higher confidence in observer data than in logbook reported data due to a history of suspected underreporting (Alhale et al 2024). In addition, the estimation method using observer data can be validated by estimating landed catch of the target species. No such verification is available using discard logbook data. Therefore, bias correction factors (*CF*) were calculated on IFQ data and applied to pre-IFQ discard logbook estimates, $\widehat{D}$, by open and closed season.

$$CF_h = \frac{1}{n} \Sigma_h \frac{\widehat{D}_{IFQ\ OBS_h}}{\widehat{D}_{IFQ\ DLP_h}}$$

Where *h* is the annual discard number by subregion. OBS is observer data and DLP is discard logbook data. The adjusted discard logbook pre-IFQ estimates are

$$\widehat{D}_{preIFQ\ OBS_h} = \widehat{D}_{preIFQ\ DLP_h} * CF_h$$

The associated standard errors (SE) are derived from discard logbook pre-IFQ estimates (Goodman 1960),

$$SE = \widehat{D}_{preIFQ\ DLP_h}{}^2 * Var(CF_h) + CF_h{}^2 Var\left(\widehat{D}_{preIFQ\ DLP_h}\right) - Var\left(\widehat{D}_{preIFQ\ DLP_h}\right) Var(CF_h)$$

Results and Discussion

Vertical Line

Commercial vertical discards were calculated using discard logbook from 1996-2023 following the same methods as SEDAR 74. Mean discard rates by subregion and management regime (pre-IFQ and IFQ) and total logbook effort used for the expansion are shown in Tables 3 and 4, respectively. The recalculated discards for the pre-IFQ management regime are consistent to SEDAR 74 estimates for the Central subregion, but significantly more than estimates for the East

and West subregions (Fig. 2). This deviation is largely driven by an oversight in generating the numbers for SEDAR 74. A standard discard logbook flag is created to remove trips from vessels that report "no discards" the entire year. However, this flag was not applied for SEDAR 74 leading to lower discard rates because more zeros were included when calculating an average rate. Other minor discrepancies to the code are subtle changes in filtering of outlier values from trips submitted to the logbook as well as updates to the definition of fishery closures.

Discard estimates for the IFQ time period were estimated for each subregion separately using commercial observer data (Table 5). The same management regimes defined for SEDAR 74 were used for SEDAR 98 analysis with the additional years added to the third time period (2007, 2008-2013, 2014-2023). This management regimes were informed by the length frequencies (Fig. 3) and nominal logbook CPUE (catch in whole pounds per hours fished) (Fig. 4). A comparison of logbook and observer catch distributions show that observer disproportionally sampled low catch trips compared to the fleet for several subregion-management regimes (Table 6). The proportion of observer trips reporting kept Red Snapper by strata (Table 7) were used to adjust annual logbook Red Snapper trips and effort (Table 8) to account for logbook trips that only had discarded fish. The kept and discard CPUEs calculated from observer data are provided in Table 9. The kept CPUEs are used to predict the landed catch of Red Snapper for the vertical line fleet. This catch verification compared favorably to logbook catch except in the third time period (2014-2023) for the West and Central subregions (Fig 5). With the increased quota and high catch trips in more recent years, observer CPUEs consistently underestimate catch. The estimated discards of Red Snapper from 2007-2023 are shown in Figure 6 in both numbers and a percentage of total catch. At most commercial discards of Red Snapper for the vertical line fleet were about 40 percent of the total catch in the Eastern zone and has steadily decreased across all subregions as landed catch has increased over time. SEDAR 98 discards align with SEDAR 74 discards (Fig. 7) with the additional years of observer data improving estimates for the third time period (2014-2023). Weighted discard length compositions are also provided in Figure 8.

The discard estimates for the IFQ time period using each method and data source were used to calculate correction factors by subregion to adjust the discard logbook derived estimates from 1996-2006 (Table 10). The discard numbers (by year and open vs. closed season) and standard errors for the entire time series are provided in Table 11. Note that estimated discards in weight are only provided for the IFQ years because observer data CPUEs are calculated in number and weight. Given the behavior for discarding Red Snapper drastically changed since IFQ was implemented, it would be inappropriate to apply a mean discard weight calculated from the observer data and apply it to pre-IFQ discard estimates. Figure 9 shows the final time series as well as the discard logbook data following the procedure in SEDAR 74. The observer derived discards after 2007 and the subsequently adjusted discard logbook numbers are lower than the discard logbook data for the entirety of the time series. Interestingly the drastic change in discard numbers between the pre-IFQ and IFQ years in the Western zone remains a sharp decline on IFQ was implemented. Across all subregions discards during the IFQ years are lower than the pre-IFQ era when the fishery was managed by seasonal closures.

Bottom Longline

Discards were calculated for the commercial bottom longline fishery using discard logbook data from 1996-2023. The recalculated discards for the pre-IFQ period using the discard logbook generally matched those submitted for SEDAR 74, though were consistently slightly lower (Fig. 10). Again, these differences are most likely due to a flag not applied in the analysis for SEDAR 74 to remove discard logbook trips from vessels that reported "no discards" for the entire year of reporting. The discard logbook discard rates and logbook total effort for bottom longline are shown in Tables 3 and 4, respectively.

For the post-IFQ time period where discards were calculated using the observer data. Similar to SEDAR 74, observed trips catching Red Snapper in the Central subregion were low and the East and Central subregions were aggregated for discard estimation (Table 12). The length frequency distribution has not changed throughout the IFQ time period with the majority of discards attributed to lack of available quota (Figure 11), however there has been a steady increase in nominal logbook CPUE (catch in whole pounds per number of sets fished) across all subregions (Figure 12). For this reason, all logbook and observer data were stratified by time periods (2007-2014 and 2015-2023). A comparison of catch distributions between logbook and observer data indicated that observer sampled more low catch trips relative to the fleet (Table 13). The proportion of observer trips reporting kept Red Snapper by the subregion, management regime, and catch stratifications (Table 14) were used to adjust annual logbook total Red Snapper trips and effort (Table 15) to account for logbook trips that only had discarded fish. Estimates of observer mean CPUE by subregion, management regime, and catch strata are shown in Table 16. These CPUEs were the basis for expansion estimates of Red Snapper catch and discards. Following SEDAR 74 methods, the East and Central observer CPUE was applied to the East and Central logbook effort separately to estimate subregion specific catch and discards. The predicted catch using the observer kept CPUEs mostly tracked the logbook catch with some directional bias in the second time period (2015-2023) across all subregions (Fig. 13). The predicted catch was consistently lower than the logbook reported catch, though differences weren't of significant magnitude. The estimated discards of Red Snapper using the observer data from 2007-2023 are shown in Figure 14 in number and as a percentage of the total catch. Across all subregions, the percent of discards to total catch has decreased over time with discards in the most recent years accounting for about 20 percent of the total catch. With the additional years of data, analysts were able to define time periods in order to account for changes in CPUE over time. This led to differences in SEDAR 98 numbers to SEDAR 74 where all observer data from 2007-2019 had to be pooled due to low sample sizes in the West subregion (Fig. 15). The final product from the observer methodology is the weighted discard length composition provided by year (Fig. 16). The weighted discard length composition is meant to adjust strata where observers disproportionally sampled trips relative to the fleet.

The discard estimates for the IFQ era using the discard logbook and observer methods were used to calculate correction factors by subregion to adjust the pre-IFQ discard logbook derived estimates (Table 10). The final discard numbers and standard errors are provided in Table 17. Figure 17 shows the final time series as well as the discard logbook data following the procedure in SEDAR 74. The observer derived discards after 2007 and the subsequently adjusted discard logbook numbers are lower than the discard logbook data for the entirety of the time series, with

the biggest divergence in the post-IFQ years. Overall, discards remain consistent through time for the Central and West regions, whereas the East region shows an initial dip in discards following the change to IFQ in 2007 followed by an increase and a relatively stable pattern thereafter until 2023.

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Tables

Table 1. Commercial closure dates of Gulf of Mexico Red Snapper from 1996-2006.

Year	First Date Closed	Last Date Closed	Year	First Date Closed	Last Date Closed
1996	01/01/1996	01/31/1996	2003	01/01/2003	02/01/2003
1996	04/05/1996	09/14/1996	2003	02/10/2003	03/01/2003
1996	10/07/1996	12/31/1996	2003	03/10/2003	04/01/2003
1997	01/01/1997	01/31/1997	2003	04/10/2003	05/01/2003
1997	03/26/1997	09/02/1997	2003	05/10/2003	06/01/2003
1997	09/15/1997	10/01/1997	2003	06/10/2003	07/01/2003
1997	10/06/1997	12/31/1997	2003	07/10/2003	08/01/2003
1998	01/01/1998	02/01/1998	2003	08/07/2003	10/01/2003
1998	02/15/1998	03/01/1998	2003	10/10/2003	11/01/2003
1998	03/15/1998	04/01/1998	2003	11/10/2003	12/01/2003
1998	04/13/1998	09/01/1998	2003	12/07/2003	12/31/2003
1998	09/15/1998	10/01/1998	2004	01/01/2004	02/01/2004
1998	10/15/1998	11/01/1998	2004	02/10/2004	03/01/2004
1998	11/02/1998	12/31/1998	2004	03/10/2004	04/01/2004
1999	01/01/1999	02/01/1999	2004	04/10/2004	05/01/2004
1999	02/15/1999	03/01/1999	2004	05/10/2004	06/01/2004
1999	03/15/1999	04/01/1999	2004	06/10/2004	07/01/2004
1999	04/15/1999	09/01/1999	2004	07/10/2004	08/01/2004
1999	09/10/1999	10/01/1999	2004	08/10/2004	10/01/2004
1999	10/10/1999	11/01/1999	2004	10/10/2004	11/01/2004
1999	11/05/1999	12/31/1999	2004	11/10/2004	12/01/2004
2000	01/01/2000	02/01/2000	2004	12/15/2004	12/31/2004
2000	02/10/2000	03/01/2000	2005	01/01/2005	02/01/2005
2000	03/10/2000	04/01/2000	2005	02/10/2005	03/01/2005
2000	04/10/2000	05/01/2000	2005	03/10/2005	04/01/2005
2000	05/08/2000	09/01/2000	2005	04/10/2005	05/01/2005
2000	09/10/2000	10/01/2000	2005	05/10/2005	06/01/2005
2000	10/10/2000	11/01/2000	2005	06/10/2005	07/01/2005
2000	11/10/2000	12/01/2000	2005	07/10/2005	08/01/2005
2000	12/08/2000	12/31/2000	2005	08/10/2005	09/01/2005
2001	01/01/2001	02/01/2001	2005	09/10/2005	10/01/2005
2001	02/10/2001	03/01/2001	2005	10/10/2005	11/01/2005
2001	03/10/2001	04/01/2001	2005	11/10/2005	12/01/2005

Year	First Date Closed	Last Date Closed	Year	First Date Closed	Last Date Closed
2001	04/10/2001	05/01/2001	2005	12/10/2005	12/31/2005
2001	05/10/2001	06/01/2001	2006	01/01/2006	02/01/2006
2001	06/10/2001	07/01/2001	2006	02/10/2006	03/01/2006
2001	07/06/2001	10/01/2001	2006	03/10/2006	04/01/2006
2001	10/10/2001	11/01/2001	2006	04/10/2006	05/01/2006
2001	11/10/2001	12/01/2001	2006	05/10/2006	06/01/2006
2001	12/03/2001	12/31/2001	2006	06/10/2006	07/01/2006
2002	01/01/2002	02/01/2002	2006	07/10/2006	08/01/2006
2002	02/10/2002	03/01/2002	2006	08/10/2006	09/01/2006
2002	03/10/2002	04/01/2002	2006	09/10/2006	10/01/2006
2002	04/10/2002	05/01/2002	2006	10/10/2006	11/01/2006
2002	05/10/2002	06/01/2002	2006	11/10/2006	12/01/2006
2002	06/10/2002	07/01/2002	2006	12/10/2006	12/31/2006
2002	07/07/2002	08/01/2002			
2002	08/07/2002	10/01/2002			
2002	10/10/2002	11/01/2002			
2002	11/10/2002	12/01/2002			
2002	12/07/2002	12/31/2002			

Table 2. Discard logbook cut points used to filter vessels that took more than two standard deviations from the mean number of trips to report a discard of any species.

		97.5 Percentile for Number of Trips	
Subregion	Management Regime	Bottom Longline	Vertical Line
East	Pre-IFQ	5.55	4.00
East	IFQ	5.00	5.00
Central	Pre-IFQ	3.05	2.00
Central	IFQ	5.65	7.00
West	Pre-IFQ	3.40	3.00
West	IFQ	3.00	7.00

Table 3. Mean commercial discard rate and coefficient of variation (CV) by gear, subregion, management regime (pre-IFQ and IFQ) and season (open vs. closed). Discard rates were based on discard logbook data from 2002-2023.

Vertical Line

Subregion	Management Regime	Season	Discard Rate	Discard Rate CV
East	Pre-IFQ	Open	0.03846	0.18047
East	Pre-IFQ	Closed	0.10375	0.32748
East	IFQ	Open	0.10842	0.06719
Central	Pre-IFQ	Open	0.30584	0.08845
Central	Pre-IFQ	Closed	0.25248	0.14225
Central	IFQ	Open	0.11582	0.05611
West	Pre-IFQ	Open	0.41457	0.10377
West	Pre-IFQ	Closed	0.21484	0.15227
West	IFQ	Open	0.04329	0.09412

Bottom Longline

Subregion	Management Regime	Season	Discard Rate	Discard Rate CV
East	Pre-IFQ	Open	0.00018	0.32787
East	Pre-IFQ	Closed	0.00043	0.25935
East	IFQ	Open	0.00265	0.06203
Central	Pre-IFQ	Open	0.00011	1.00000
Central	Pre-IFQ	Closed	0.00014	0.49938
Central	IFQ	Open	0.00335	0.38089
West	Pre-IFQ	Open	0.00170	0.22362
West	Pre-IFQ	Closed	0.00025	0.37802
West	IFQ	Open	0.00683	0.28316

Table 4. Total coastal logbook effort and associated trips used in the discard logbook discard estimation. These data are summarized is after the standard filters identified in SEDAR 32 and 41 (McCarthy, 2013 and 2015) are applied.

Vertical Line

		East Zone		Central Zone		West Zone	
Year	Season	Trips	Effort	Trips	Effort	Trips	Effort
1996	Open	1,142	193,267	2,182	2,868,935	691	2,252,176
1996	Closed	4,127	698,166	735	562,896	2,560	2,174,662
1997	Open	993	144,052	2,173	2,410,245	909	2,869,784
1997	Closed	4,369	736,614	706	554,370	2,641	2,462,238
1998	Open	748	162,820	2,689	2,420,601	982	2,248,962
1998	Closed	3,996	719,326	1,021	605,537	2,546	2,719,800
1999	Open	989	159,910	2,814	2,745,951	1,157	2,424,509
1999	Closed	4,403	838,708	1,133	679,779	2,076	2,497,492
2000	Open	928	217,710	2,557	2,251,114	1,113	2,333,460
2000	Closed	4,352	888,230	1,568	891,723	2,027	2,454,063
2001	Open	785	192,380	2,774	2,161,141	962	2,230,605
2001	Closed	4,146	771,765	1,515	1,015,223	2,024	3,055,581
2002	Open	905	193,435	2,972	2,038,447	988	2,385,870
2002	Closed	3,603	634,136	1,768	1,118,897	1,989	2,636,311
2003	Open	961	173,300	2,850	2,349,419	1,117	2,316,212
2003	Closed	3,463	569,320	1,806	1,496,674	1,988	2,858,593
2004	Open	1,069	168,426	2,391	1,752,901	983	2,020,191
2004	Closed	3,081	456,069	2,022	1,408,639	2,228	3,150,122
2005	Open	890	152,106	2,087	1,347,926	965	2,005,415
2005	Closed	2,616	444,228	1,490	1,206,408	1,636	2,723,041
2006	Open	847	180,027	1,969	1,549,979	724	1,461,132
2006	Closed	2,393	488,419	1,337	1,271,411	1,903	3,075,194
2007	Open	2,485	537,417	3,023	3,816,852	1,042	3,607,937
2008	Open	2,664	470,299	3,171	4,219,310	834	2,422,287
2009	Open	3,193	728,794	3,271	5,958,534	797	2,158,194
2010	Open	2,319	712,932	2,220	3,837,122	609	2,105,108
2011	Open	2,348	472,542	2,622	5,913,122	801	1,766,116
2012	Open	2,592	595,695	2,682	6,308,340	807	2,561,792
2013	Open	2,878	750,040	2,229	4,525,621	654	2,134,340
2014	Open	3,095	1,102,910	2,403	4,779,375	721	1,771,597
2015	Open	2,951	1,322,350	2,334	3,362,763	907	2,090,419
2016	Open	2,751	889,081	2,519	3,776,768	995	2,209,007
2017	Open	2,494	629,540	2,561	3,758,850	952	1,961,457
2018	Open	2,275	643,465	2,030	2,723,960	912	1,668,036
2019	Open	2,233	504,491	2,029	2,823,145	910	1,700,378
2020	Open	2,176	476,592	1,633	2,441,142	787	1,256,848

		East Zone		Central Zone		West Zone	
Year	Season	Trips	Effort	Trips	Effort	Trips	Effort
2021	Open	2,049	486,793	1,481	2,026,976	752	1,102,979
2022	Open	1,540	328,298	1,288	1,989,475	682	1,097,254
2023	Open	1,444	249,096	1,300	2,079,792	664	1,253,922

Bottom Longline

		East Zone		Central Zone		West Zone	
Year	Season	Trips	Effort	Trips	Effort	Trips	Effort
1996	Open	1,140	25,111,860	253	3,120,645	248	3,115,380
1996	Closed	384	7,393,564	61	860,750	76	702,780
1997	Open	1,157	30,069,060	286	3,832,890	143	1,972,730
1997	Closed	265	6,827,050	42	661,850	50	363,480
1998	Open	1,117	30,480,245	230	2,692,370	129	2,261,720
1998	Closed	222	5,406,290	45	543,500	30	335,400
1999	Open	1,128	33,639,608	226	2,135,500	220	4,055,250
1999	Closed	205	6,445,490	42	491,950	91	1,170,550
2000	Open	1,039	28,409,257	328	4,223,156	197	3,545,750
2000	Closed	211	6,288,025	53	644,910	99	822,600
2001	Open	1,160	28,694,488	316	3,876,703	167	2,112,288
2001	Closed	191	4,809,285	48	631,850	90	513,150
2002	Open	1,056	23,707,116	352	3,833,562	196	2,806,872
2002	Closed	225	5,545,874	78	907,050	104	945,040
2003	Open	1,146	26,081,580	350	4,641,944	180	4,010,900
2003	Closed	271	5,238,810	79	881,090	103	1,551,600
2004	Open	1,059	23,118,855	287	3,241,058	143	3,519,300
2004	Closed	319	7,074,480	103	1,202,230	210	2,496,700
2005	Open	930	15,917,291	346	3,358,670	139	3,078,010
2005	Closed	329	6,021,616	99	893,850	120	2,000,400
2006	Open	1,038	20,999,294	367	3,339,470	87	2,248,900
2006	Closed	339	6,189,879	113	1,004,200	123	1,956,000
2007	Open	1,023	25,492,018	219	3,758,660	81	2,014,300
2008	Open	979	23,767,123	306	4,996,008	51	1,696,250
2009	Open	507	11,773,319	171	3,283,850	61	2,209,250
2010	Open	369	7,572,110	86	1,017,320	55	1,272,400
2011	Open	595	11,525,048	72	1,468,605	61	1,275,300
2012	Open	579	9,257,339	111	2,253,559	42	881,800
2013	Open	573	11,075,102	99	1,925,196	58	1,646,821
2014	Open	637	13,912,715	167	1,769,700	28	1,348,200
2015	Open	615	13,684,162	215	2,873,115	54	1,571,750
2016	Open	710	15,638,474	171	2,217,186	47	1,673,090

		East Zone		Central Zone		West Zone	
Year	Season	Trips	Effort	Trips	Effort	Trips	Effort
2017	Open	674	15,687,273	231	2,120,755	51	1,492,440
2018	Open	593	13,637,589	240	2,866,383	50	1,256,242
2019	Open	623	13,105,197	135	2,094,920	66	1,670,850
2020	Open	649	11,661,999	137	2,512,220	95	1,833,245
2021	Open	620	10,873,120	156	2,926,650	64	1,195,150
2022	Open	541	9,158,975	102	1,861,050	44	863,000
2023	Open	515	10,052,600	82	1,656,050	50	1,390,150

Table 5. Number of total and Red Snapper coastal observer vertical line trips by year and subregion for the Gulf of Mexico.

	East Zone		Central Zone		West Zone	
Year	Total Observer Trips	Red Snapper Observer Trips	Total Observer Trips	Red Snapper Observer Trips	Total Observer Trips	Red Snapper Observer Trips
2007	34	28	44	43	19	17
2008	23	17	16	13	14	14
2009	19	13	21	19	6	5
2010	31	20	21	20	4	5
2011	51	34	41	41	13	10
2012	122	86	99	96	33	33
2013	60	25	55	55	10	7
2014	50	31	42	35	17	17
2015	92	50	78	76	31	31
2016	73	46	45	44	24	22
2017	29	19	26	24	12	12
2018	16	12	15	16	8	8
2019	9	8	13	13	8	8
2020	3	3	12	12	5	5
2021	12	9	24	24	5	5
2022	19	16	24	22	13	12
2023	28	17	16	14	10	10

Table 6. Definition of trip catch level strata for Gulf of Mexico Red Snapper, and corresponding percentages of logbook and observer vertical line trips for each zone and management regime.

Zone	Management Regime	Strata Level	Stratum Code	% Trips	
				Logbook	Observer
East	First (2007)	Low, Catch <= 139 lbs	L	57.1	85.7
East	First (2007)	High, Catch > 139 lbs	H	42.9	14.3
East	Second (2008-2013)	Low, Catch <= 56 lbs	L	26.0	48.2
East	Second (2008-2013)	Moderate, 56< Catch <= 127 lbs	M	20.5	7.7
East	Second (2008-2013)	High, Catch > 127 lbs	H	53.5	44.1
East	Third (2014-2023)	Low, Catch <= 78 lbs	L	27	45.0
East	Third (2014-2023)	Moderate, 78< Catch <= 250 lbs	M	24	18.5
East	Third (2014-2023)	High, Catch > 250 lbs	H	49	36.5
Central	Third (2014-2023)	Low, Catch <= 595 lbs	L	45.7	58.6
Central	Third (2014-2023)	High, Catch > 595 lbs	H	54.3	41.4
West	First (2007)	Low, Catch <= 1452 lbs	L	50.1	76.5
West	First (2007)	High, Catch > 1452 lbs	H	49.9	23.5
West	Third (2014-2023)	Low, Catch <= 702 lbs	L	26.4	27.7
West	Third (2014-2023)	Moderate, 702< Catch <= 2200 lbs	M	20.2	11.5
West	Third (2014-2023)	High, Catch > 2200 lbs	H	53.4	60.8

Table 7. Gulf of Mexico Red Snapper vertical line trip and effort adjustment factors by management regime and catch level strata. Catch level strata are defined in Table 6; catch level stratum 'All' is all levels (i.e., no stratification) for the management regime. The proportions of Red Snapper observer trips and effort with kept Red Snapper 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 Red Snapper	
Zone	Management Regime	Strata Type	Strata Level	Number of Observer Trips (n)	Trips	Effort
East	First (2007)	Catch	L	24	0.333	0.317
East	First (2007)	Catch	H	4	1	1
East	Second (2008-2013)	Catch	L	94	0.479	0.505
East	Second (2008-2013)	Catch	M	15	1	1
East	Second (2008-2013)	Catch	H	86	1	1
East	Third (2014-2023)	Catch	L	95	0.716	0.697
East	Third (2014-2023)	Catch	M	39	1	1
East	Third (2014-2023)	Catch	H	77	1	1
Central	First (2007)	All	A	43	0.674	0.774
Central	Second (2008-2013)	All	A	244	0.865	0.874
Central	Third (2014-2023)	Catch	L	164	0.927	0.933
Central	Third (2014-2023)	Catch	H	116	1	1
West	First (2007)	Catch	L	13	0.923	0.965
West	First (2007)	Catch	H	4	1	1
West	Second (2008-2013)	All	A	74	0.946	0.938
West	Third (2014-2023)	Catch	L	36	0.778	0.813
West	Third (2014-2023)	Catch	M	15	1	1
West	Third (2014-2023)	Catch	H	79	1	1

Table 8. Annual time-series of vertical line logbook trips (number) and effort (hours) by catch level strata for Gulf of Mexico Red Snapper.

Zone (East)

					Logbook Trips	Logbook Effort
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2007	Catch	L	145	435	7,260	22,881
2007	Catch	H	109	109	6,784	6,784
2008	Catch	L	87	182	3,405	6,743
2008	Catch	M	58	58	2,966	2,966
2008	Catch	H	111	111	6,672	6,672
2009	Catch	L	121	253	6,583	13,036
2009	Catch	M	81	81	4,089	4,089
2009	Catch	H	145	145	7,871	7,871
2010	Catch	L	166	347	7,855	15,555
2010	Catch	M	117	117	6,504	6,504
2010	Catch	H	273	273	17,321	17,321
2011	Catch	L	180	376	7,157	14,173
2011	Catch	M	141	141	6,327	6,327
2011	Catch	H	438	438	24,421	24,421
2012	Catch	L	186	389	7,289	14,435
2012	Catch	M	162	162	7,154	7,154
2012	Catch	H	422	422	22,062	22,062
2013	Catch	L	194	405	6,404	12,683
2013	Catch	M	176	176	7,137	7,137
2013	Catch	H	530	530	31,048	31,048
2014	Catch	L	365	510	13,730	19,693
2014	Catch	M	305	305	14,038	14,038
2014	Catch	H	373	373	21,515	21,515
2015	Catch	L	385	538	16,230	23,279
2015	Catch	M	296	296	12,331	12,331
2015	Catch	H	433	433	23,604	23,604
2016	Catch	L	440	615	13,907	19,947
2016	Catch	M	363	363	15,540	15,540
2016	Catch	H	466	466	26,345	26,345
2017	Catch	L	392	548	11,863	17,015
2017	Catch	M	399	399	16,084	16,084

					Logbook Trips	Logbook Effort
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2017	Catch	H	519	519	27,439	27,439
2018	Catch	L	366	511	8,948	12,834
2018	Catch	M	314	314	9,618	9,618
2018	Catch	H	599	599	27,715	27,715
2019	Catch	L	388	542	6,524	9,357
2019	Catch	M	264	264	7,437	7,437
2019	Catch	H	689	689	30,535	30,535
2020	Catch	L	298	416	6,232	8,939
2020	Catch	M	291	291	8,100	8,100
2020	Catch	H	647	647	28,341	28,341
2021	Catch	L	310	433	7,155	10,263
2021	Catch	M	272	272	8,868	8,868
2021	Catch	H	713	713	30,876	30,876
2022	Catch	L	153	214	3,450	4,948
2022	Catch	M	186	186	5,306	5,306
2022	Catch	H	751	751	31,676	31,676
2023	Catch	L	156	218	2,313	3,318
2023	Catch	M	192	192	5,090	5,090
2023	Catch	H	705	705	29,924	29,924

Zone (Central)

					Logbook Trips	Logbook Effort
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2007	All	A	1,250	1,853	44,557	57,574
2008	All	A	1,237	1,430	39,762	45,478
2009	All	A	1,345	1,555	42,007	48,046
2010	All	A	1,577	1,824	47,345	54,151
2011	All	A	1,802	2,084	58,030	66,372
2012	All	A	1,903	2,201	64,728	74,033
2013	All	A	1,743	2,016	52,914	60,520
2014	Catch	L	1,026	1,107	25,826	27,694
2014	Catch	H	713	713	26,473	26,473

					Logbook Trips	Logbook Effort
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2015	Catch	L	889	959	18,101	19,411
2015	Catch	H	940	940	29,808	29,808
2016	Catch	L	1,008	1,088	24,554	26,331
2016	Catch	H	867	867	29,438	29,438
2017	Catch	L	1,005	1,084	23,324	25,012
2017	Catch	H	1,012	1,012	32,364	32,364
2018	Catch	L	842	908	18,311	19,636
2018	Catch	H	937	937	28,076	28,076
2019	Catch	L	740	798	15,832	16,978
2019	Catch	H	1,014	1,014	29,145	29,145
2020	Catch	L	540	583	12,672	13,589
2020	Catch	H	893	893	27,883	27,883
2021	Catch	L	403	435	7,826	8,392
2021	Catch	H	867	867	28,443	28,443
2022	Catch	L	420	453	8,441	9,052
2022	Catch	H	711	711	25,306	25,306
2023	Catch	L	429	463	10,047	10,774
2023	Catch	H	710	710	26,875	26,875

Zone (West)

					Logbook Trips	Logbook Effort
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2007	Catch	L	434	470	12,546	13,000
2007	Catch	H	433	433	24,756	24,756
2008	All	A	607	642	26,462	28,211
2009	All	A	515	544	22,728	24,229
2010	All	A	482	510	19,137	20,402
2011	All	A	499	528	18,400	19,616
2012	All	A	518	548	21,042	22,432
2013	All	A	457	483	21,382	22,794
2014	Catch	L	134	172	1,680	2,065

					Logbook Trips	Logbook Effort
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2014	Catch	M	96	96	2,715	2,715
2014	Catch	H	341	341	14,844	14,844
2015	Catch	L	186	239	1,244	1,530
2015	Catch	M	114	114	2,371	2,371
2015	Catch	H	402	402	16,680	16,680
2016	Catch	L	234	301	1,540	1,894
2016	Catch	M	101	101	1,917	1,917
2016	Catch	H	388	388	15,930	15,930
2017	Catch	L	231	297	1,732	2,131
2017	Catch	M	114	114	1,943	1,943
2017	Catch	H	394	394	15,392	15,392
2018	Catch	L	221	284	2,198	2,703
2018	Catch	M	134	134	2,864	2,864
2018	Catch	H	334	334	12,654	12,654
2019	Catch	L	200	257	2,280	2,805
2019	Catch	M	154	154	3,848	3,848
2019	Catch	H	354	354	13,453	13,453
2020	Catch	L	135	174	1,169	1,438
2020	Catch	M	161	161	3,050	3,050
2020	Catch	H	345	345	11,620	11,620
2021	Catch	L	169	217	1,175	1,445
2021	Catch	M	163	163	2,093	2,093
2021	Catch	H	281	281	10,067	10,067
2022	Catch	L	132	170	1,030	1,266
2022	Catch	M	151	151	2,069	2,069
2022	Catch	H	306	306	11,188	11,188
2023	Catch	L	89	114	894	1,099
2023	Catch	M	140	140	2,065	2,065
2023	Catch	H	360	360	14,120	14,120

Table 9. Estimated observer mean CPUE in weight by management regime and catch level strata for expansion estimates of vertical line Gulf of Mexico Red Snapper catch and discards.

					Observer CPUE	
Zone	Management Regime	Strata Type	Strata Level	Logbook CPUE	Kept	Discard
East	First (2007)	Catch	L	0.411	0.374	0.781
East	First (2007)	Catch	H	6.393	6.214	1.717
East	Second (2008-2013)	Catch	L	0.325	0.156	2.809
East	Second (2008-2013)	Catch	M	1.926	1.711	3.052
East	Second (2008-2013)	Catch	H	8.838	7.244	2.188
East	Third (2014-2023)	Catch	L	0.828	0.399	1.253
East	Third (2014-2023)	Catch	M	4.313	3.623	0.920
East	Third (2014-2023)	Catch	H	19.147	15.104	1.586
Central	First (2007)	All	A	12.948	14.142	1.975
Central	Second (2008-2013)	All	A	21.005	21.163	3.095
Central	Third (2014-2023)	Catch	L	11.780	10.603	2.159
Central	Third (2014-2023)	Catch	H	63.713	58.551	2.421
West	First (2007)	Catch	L	21.221	18.206	0.981
West	First (2007)	Catch	H	61.875	72.262	27.088
West	Second (2008-2013)	All	A	73.633	70.795	9.970
West	Third (2014-2023)	Catch	L	32.972	19.787	4.481
West	Third (2014-2023)	Catch	M	73.018	45.700	1.314
West	Third (2014-2023)	Catch	H	161.214	137.106	3.991

Table 10. Average calibration ratio and associated variance used to adjust discard logbook-derived estimates from 1996-2006. These ratios were used using overlapping discard logbook and observer discard estimates from 2007-2023. Variance estimates were used to derive the adjusted SE for the final annual estimates.

Average Ratio

Gear	East	Central	West
Bottom Longline	0.3858	0.1433	0.1177
Vertical Line	0.3544	0.1795	0.8386

Variance

Gear	East	Central	West
Bottom Longline	0.0259	0.0038	0.0032
Vertical Line	0.0339	0.0040	0.3881

Table 11. Commercial Gulf of Mexico Red Snapper vertical line discards in weight (lbs.) and number (with associated standard errors). Season is only applicable for pre-IFQ years. From 1996-2006, discard estimates are only provided in number using calibrated discard logbook data. Discard estimates during the IFQ era are estimated using observer data and provided in number and weight.

Zone (East)

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
1996	Open			2,634	3,174
1996	Closed			25,672	30,557
1997	Open			1,964	2,366
1997	Closed			27,086	32,239
1998	Open			2,219	2,674
1998	Closed			26,451	31,483
1999	Open			2,180	2,626
1999	Closed			30,840	36,708
2000	Open			2,968	3,575
2000	Closed			32,661	38,875
2001	Open			2,622	3,159
2001	Closed			28,379	33,778
2002	Open			2,637	3,177
2002	Closed			23,318	27,754
2003	Open			2,362	2,846
2003	Closed			20,935	24,917
2004	Open			2,296	2,766

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2004	Closed			16,770	19,961
2005	Open			2,073	2,498
2005	Closed			16,335	19,442
2006	Open			2,454	2,956
2006	Closed			17,960	21,377
2007	Open	29,525	7,344	8,037	1,873
2008	Open	42,597	4,205	7,990	834
2009	Open	66,330	6,548	12,393	1,293
2010	Open	101,458	10,015	19,080	1,991
2011	Open	112,571	11,112	21,323	2,225
2012	Open	110,667	10,925	20,889	2,180
2013	Open	125,359	12,375	23,839	2,488
2014	Open	71,717	9,859	24,126	3,581
2015	Open	77,954	10,716	25,760	3,823
2016	Open	81,079	11,146	27,834	4,131
2017	Open	79,641	10,948	27,967	4,151
2018	Open	68,894	9,471	24,631	3,656
2019	Open	67,005	9,211	24,702	3,666
2020	Open	63,610	8,744	23,442	3,479
2021	Open	69,997	9,622	25,692	3,813
2022	Open	61,332	8,431	23,479	3,485
2023	Open	56,309	7,741	21,853	3,243

Zone (Central)

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
1996	Open			30,901	43,183
1996	Closed			130,017	181,142
1997	Open			30,433	42,529
1997	Closed			109,229	152,181
1998	Open			33,241	46,455
1998	Closed			109,699	152,835
1999	Open			37,317	52,150
1999	Closed			124,443	173,377
2000	Open			48,952	68,410
2000	Closed			102,018	142,133
2001	Open			55,732	77,884
2001	Closed			97,940	136,453

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2002	Open			61,423	85,838
2002	Closed			92,380	128,706
2003	Open			82,161	114,820
2003	Closed			106,473	148,340
2004	Open			77,328	108,066
2004	Closed			79,439	110,677
2005	Open			66,227	92,552
2005	Closed			61,086	85,107
2006	Open			69,795	97,538
2006	Closed			70,243	97,864
2007	Open	113,682	21,610	80,169	13,296
2008	Open	140,772	15,175	49,324	4,904
2009	Open	148,720	16,031	52,109	5,181
2010	Open	167,619	18,068	58,731	5,840
2011	Open	205,446	22,146	71,985	7,158
2012	Open	229,161	24,702	80,294	7,984
2013	Open	187,333	20,194	65,639	6,527
2014	Open	123,875	16,344	79,706	8,456
2015	Open	114,065	15,049	77,486	8,220
2016	Open	128,109	16,902	83,983	8,910
2017	Open	132,343	17,461	88,230	9,360
2018	Open	110,358	14,560	74,393	7,892
2019	Open	107,208	14,144	73,679	7,816
2020	Open	96,837	12,776	67,725	7,185
2021	Open	86,972	11,475	63,387	6,725
2022	Open	80,802	10,661	58,047	6,158
2023	Open	88,318	11,652	62,856	6,668

Zone (West)

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
1996	Open			756,000	712,094
1996	Closed			405,741	382,481
1997	Open			855,973	806,260
1997	Closed			517,006	487,368
1998	Open			945,513	890,599
1998	Closed			405,162	381,935
1999	Open			868,229	817,805

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
1999	Closed			436,787	411,748
2000	Open			853,132	803,584
2000	Closed			420,384	396,285
2001	Open			1,062,244	1,000,551
2001	Closed			401,854	378,818
2002	Open			916,488	863,261
2002	Closed			429,826	405,186
2003	Open			993,762	936,047
2003	Closed			417,277	393,356
2004	Open			1,095,110	1,031,508
2004	Closed			363,947	343,084
2005	Open			946,639	891,661
2005	Closed			361,285	340,574
2006	Open			1,069,062	1,006,973
2006	Closed			263,230	248,140
2007	Open	683,331	404,544	448,309	255,768
2008	Open	281,261	44,033	131,783	25,742
2009	Open	241,568	37,819	113,185	22,109
2010	Open	203,405	31,844	95,304	18,616
2011	Open	195,574	30,618	91,635	17,899
2012	Open	223,653	35,014	104,791	20,469
2013	Open	227,261	35,579	106,482	20,799
2014	Open	72,071	13,111	33,968	5,708
2015	Open	76,545	13,925	36,799	6,184
2016	Open	74,587	13,569	35,595	5,982
2017	Open	73,532	13,377	34,843	5,855
2018	Open	66,380	12,076	30,479	5,122
2019	Open	71,318	12,974	32,642	5,486
2020	Open	56,831	10,339	26,728	4,492
2021	Open	49,404	8,988	23,201	3,899
2022	Open	53,048	9,651	25,212	4,237
2023	Open	63,994	11,642	30,905	5,194

Table 12. Number of total and Red Snapper coastal observer bottom longline trips by year for the Gulf of Mexico.

	East Zone		Central Zone		West Zone	
Year	Total Observer Trips	Red Snapper Observer Trips	Total Observer Trips	Red Snapper Observer Trips	Total Observer Trips	Red Snapper Observer Trips
2007	27	14	2	0	2	0
2008	3	2	9	0	4	2
2009	27	22	14	2	7	4
2010	58	53	8	1	5	4
2011	78	77	13	2	6	4
2012	39	31	9	2	3	2
2013	70	65	3	3	1	2
2014	23	21	5	1	3	1
2015	22	21	11	0	9	2
2016	51	45	4	1	6	7
2017	24	14	16	1	4	2
2018	17	5	7	0	1	0
2019	13	6	2	0	1	0
2020	2	0	17	2	7	1
2021	7	6	1	1	1	0
2022	25	24	4	0	2	4
2023	20	18	2	1	4	0

Table 13. Definition of trip catch level strata for Gulf of Mexico Red Snapper, and corresponding percentages of logbook and observer bottom longline trips for each zone and management regime.

Zone	Management Regime	Strata Level	Stratum Code	% Trips	
				Logbook	Observer
East & Central	First (2007-2014)	Low, Catch <= 192 lbs	L	44	72.6
East & Central	First (2007-2014)	High, Catch > 192 lbs	H	56	27.4
East & Central	Second (2015-2023)	Low, Catch <= 464 lbs	L	50.5	64.1
East & Central	Second (2015-2023)	High, Catch > 464 lbs	H	49.5	35.9
West	Second (2015-2023)	Low, Catch <= 1860 lbs	L	49.7	75
West	Second (2015-2023)	High, Catch > 1860 lbs	H	50.3	25

Table 14. Red Snapper bottom longline trip and effort adjustment factors by management regime and catch level strata in Gulf of Mexico. Catch level strata are defined in Table 13; catch level stratum 'All' is all levels (i.e., no stratification) for the management regime. The proportions of Red Snapper observer trips and effort with kept Red Snapper were used to respectively adjust annual logbook total trips and effort (Table 15) to account for logbook trips that only had discarded fish.

Zone	Management Regime	Strata Type	Strata Level	Number of Observer Trips (n)	Proportion of Observer Data with Kept Red Snapper	
					Trips	Effort
East & Central	First (2007-2014)	Catch	L	215	0.512	0.547
East & Central	First (2007-2014)	Catch	H	81	1	1
East & Central	Second (2015-2023)	Catch	L	93	0.806	0.808
East & Central	Second (2015-2023)	Catch	H	52	1	1
West	First (2007-2014)	All	A	19	0.632	0.684
West	Second (2015-2023)	Catch	L	12	0.5	0.465
West	Second (2015-2023)	Catch	H	4	1	1

Table 15. Annual time-series of bottom longline logbook trips (number) and effort (sets) by catch level strata for Gulf of Mexico Red Snapper.

Zone (East)

			Logbook Trips		Logbook Effort	
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2007	Catch	L	39	76	1,073	1,961
2007	Catch	H	5	5	113	113
2008	Catch	L	43	84	1,103	2,016
2008	Catch	H	23	23	619	619
2009	Catch	L	15	29	317	579
2009	Catch	H	10	10	372	372
2010	Catch	L	59	115	1,595	2,915
2010	Catch	H	95	95	2,862	2,862
2011	Catch	L	83	162	2,750	5,025
2011	Catch	H	110	110	3,129	3,129
2012	Catch	L	65	127	1,539	2,812
2012	Catch	H	82	82	2,230	2,230
2013	Catch	L	93	182	2,529	4,621
2013	Catch	H	136	136	3,787	3,787
2014	Catch	L	102	199	3,149	5,754
2014	Catch	H	142	142	4,639	4,639
2015	Catch	L	184	228	5,697	7,052
2015	Catch	H	167	167	5,719	5,719
2016	Catch	L	250	310	7,956	9,848
2016	Catch	H	119	119	3,935	3,935
2017	Catch	L	231	286	8,347	10,332
2017	Catch	H	116	116	3,889	3,889
2018	Catch	L	206	255	6,753	8,359
2018	Catch	H	146	146	5,187	5,187
2019	Catch	L	229	284	6,637	8,216
2019	Catch	H	231	231	8,225	8,225
2020	Catch	L	234	290	5,493	6,799
2020	Catch	H	262	262	8,061	8,061
2021	Catch	L	199	247	4,815	5,960
2021	Catch	H	265	265	7,375	7,375
2022	Catch	L	164	203	3,457	4,279
2022	Catch	H	286	286	7,350	7,350

			Logbook Trips		Logbook Effort	
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2023	Catch	L	197	244	4,379	5,420
2023	Catch	H	272	272	8,284	8,284

Zone (Central)

			Logbook Trips		Logbook Effort	
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2007	Catch	L	12	23	250	457
2007	Catch	H	21	21	485	485
2008	Catch	L	6	12	121	221
2008	Catch	H	20	20	561	561
2009	Catch	L	4	8	108	197
2009	Catch	H	8	8	282	282
2010	Catch	L	4	8	123	225
2010	Catch	H	7	7	169	169
2011	Catch	L	2	4	40	73
2011	Catch	H	9	9	260	260
2012	Catch	L	5	10	123	225
2012	Catch	H	1	1	22	22
2013	Catch	L	3	6	129	236
2013	Catch	H	5	5	169	169
2014	Catch	L	3	6	81	148
2014	Catch	H	12	12	374	374
2015	Catch	L	20	25	581	719
2015	Catch	H	18	18	763	763
2016	Catch	L	16	20	679	840
2016	Catch	H	8	8	358	358
2017	Catch	L	14	17	635	786
2017	Catch	H	2	2	70	70
2018	Catch	L	14	17	499	618
2018	Catch	H	20	20	1,030	1,030
2019	Catch	L	7	9	182	225
2019	Catch	H	15	15	464	464
2020	Catch	L	13	16	371	459
2020	Catch	H	15	15	485	485

			Logbook Trips		Logbook Effort	
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2021	Catch	L	20	25	679	840
2021	Catch	H	15	15	479	479
2022	Catch	L	26	32	861	1,066
2022	Catch	H	18	18	506	506
2023	Catch	L	13	16	442	547
2023	Catch	H	22	22	755	755

Zone (West)

			Logbook Trips		Logbook Effort	
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2007	All	A	32	51	903	1,321
2008	All	A	34	54	1,198	1,752
2009	All	A	41	65	1,639	2,397
2010	All	A	22	35	571	835
2011	All	A	10	16	242	354
2012	All	A	19	30	379	554
2013	All	A	33	52	1,464	2,141
2014	All	A	15	24	813	1,189
2015	Catch	L	12	24	531	1,143
2015	Catch	H	8	8	238	238
2016	Catch	L	15	30	697	1,500
2016	Catch	H	6	6	248	248
2017	Catch	L	16	32	547	1,177
2017	Catch	H	8	8	207	207
2018	Catch	L	11	22	492	1,059
2018	Catch	H	8	8	177	177
2019	Catch	L	20	40	850	1,829
2019	Catch	H	27	27	1,042	1,042
2020	Catch	L	11	22	269	579
2020	Catch	H	18	18	582	582
2021	Catch	L	7	14	245	527
2021	Catch	H	12	12	291	291
2022	Catch	L	1	2	16	34
2022	Catch	H	8	8	212	212

			Logbook Trips		Logbook Effort	
Year	Strata Type	Strata Level	Reported	Adjusted (N)	Reported	Adjusted ($\hat{X}$)
2023	Catch	L	4	8	153	329
2023	Catch	H	3	3	137	137

Table 16. Estimated observer mean CPUE in weight by management regime and catch level strata for expansion estimates of bottom longline Gulf Of Mexico Red Snapper catch and discards.

					Observer CPUE	
Zone	Management Regime	Strata Type	Strata Level	Logbook CPUE	Kept	Discard
East & Central	First (2007-2014)	Catch	L	1.630	1.160	14.698
East & Central	First (2007-2014)	Catch	H	21.619	21.211	8.945
East & Central	Second (2015-2023)	Catch	L	5.466	5.262	8.957
East & Central	Second (2015-2023)	Catch	H	43.098	44.881	4.702
West	First (2007-2014)	All	A	29.549	20.798	9.477
West	Second (2015-2023)	Catch	L	9.742	1.738	13.838
West	Second (2015-2023)	Catch	H	107.116	88.154	2.711

Table 17. Commercial Gulf of Mexico Red Snapper bottom longline discards in weight (lbs.) and number (with associated standard errors). Season is only applicable for pre-IFQ years. From 1996-2006, discard estimates are only provided in number using calibrated discard logbook data. Discard estimates during the IFQ era are estimated using observer data and provided in number and weight.

Zone (East)

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
1996	Open			500	518
1996	Closed			4,199	4,354
1997	Open			462	478
1997	Closed			5,027	5,214
1998	Open			366	379
1998	Closed			5,096	5,285
1999	Open			436	452
1999	Closed			5,624	5,833
2000	Open			425	441
2000	Closed			4,750	4,926
2001	Open			325	337
2001	Closed			4,798	4,975
2002	Open			375	389
2002	Closed			3,964	4,111
2003	Open			354	367
2003	Closed			4,361	4,522
2004	Open			479	496
2004	Closed			3,865	4,009
2005	Open			407	422
2005	Closed			2,661	2,760
2006	Open			419	434
2006	Closed			3,511	3,641
2007	Open	29,830	1,974	4,216	283
2008	Open	35,162	2,327	4,973	333
2009	Open	11,842	784	1,676	112
2010	Open	68,439	4,529	9,690	650
2011	Open	101,849	6,740	14,413	967
2012	Open	61,282	4,056	8,675	582
2013	Open	101,799	6,737	14,411	966
2014	Open	126,073	8,344	17,846	1,197
2015	Open	90,054	12,408	13,897	1,604
2016	Open	106,713	14,704	15,986	1,845
2017	Open	110,832	15,271	16,569	1,912
2018	Open	99,261	13,677	15,129	1,746

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2019	Open	112,259	15,468	17,510	2,021
2020	Open	98,803	13,614	15,551	1,795
2021	Open	88,061	12,133	13,892	1,604
2022	Open	72,886	10,043	11,710	1,352
2023	Open	87,500	12,056	13,966	1,612

Zone (Central)

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
1996	Open			14	14
1996	Closed			64	102
1997	Open			10	10
1997	Closed			79	125
1998	Open			9	9
1998	Closed			56	88
1999	Open			8	8
1999	Closed			44	70
2000	Open			10	10
2000	Closed			87	138
2001	Open			10	10
2001	Closed			80	126
2002	Open			14	14
2002	Closed			79	125
2003	Open			14	14
2003	Closed			96	151
2004	Open			19	19
2004	Closed			67	106
2005	Open			14	14
2005	Closed			69	109
2006	Open			16	16
2006	Closed			69	109
2007	Open	11,053	731	1,565	105
2008	Open	8,268	547	1,172	79
2009	Open	5,423	359	768	52
2010	Open	4,815	319	682	46
2011	Open	3,400	225	482	32
2012	Open	3,500	232	495	33

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2013	Open	4,976	329	704	47
2014	Open	5,521	365	783	52
2015	Open	10,029	1,382	1,569	181
2016	Open	9,212	1,269	1,383	160
2017	Open	7,370	1,015	1,070	123
2018	Open	10,375	1,430	1,664	192
2019	Open	4,199	579	682	79
2020	Open	6,394	881	1,000	115
2021	Open	9,781	1,348	1,485	171
2022	Open	11,925	1,643	1,798	207
2023	Open	8,450	1,164	1,341	155

Zone (West)

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
1996	Open			140	279
1996	Closed			91	174
1997	Open			73	144
1997	Closed			57	110
1998	Open			67	133
1998	Closed			66	126
1999	Open			234	464
1999	Closed			118	226
2000	Open			164	326
2000	Closed			103	198
2001	Open			102	204
2001	Closed			62	118
2002	Open			189	375
2002	Closed			82	157
2003	Open			310	616
2003	Closed			117	224
2004	Open			498	990
2004	Closed			103	196
2005	Open			399	794
2005	Closed			90	172
2006	Open			390	776
2006	Closed			66	125
2007	Open	12,518	5,748	1,266	574

Year	Season	Estimated Discards in Weight	SE of Estimated Discards in Weight	Estimated Discards in Number	SE of Estimated Discards in Number
2008	Open	16,608	7,626	1,680	761
2009	Open	22,721	10,433	2,298	1,041
2010	Open	7,916	3,635	801	363
2011	Open	3,355	1,540	339	154
2012	Open	5,254	2,412	531	241
2013	Open	20,295	9,319	2,053	930
2014	Open	11,270	5,175	1,140	516
2015	Open	16,459	6,258	1,522	484
2016	Open	21,429	8,148	1,982	631
2017	Open	16,851	6,407	1,559	496
2018	Open	15,132	5,753	1,400	445
2019	Open	28,138	10,699	2,595	826
2020	Open	9,589	3,646	882	281
2021	Open	8,085	3,074	746	237
2022	Open	1,051	400	95	30
2023	Open	4,928	1,874	455	145

Figures

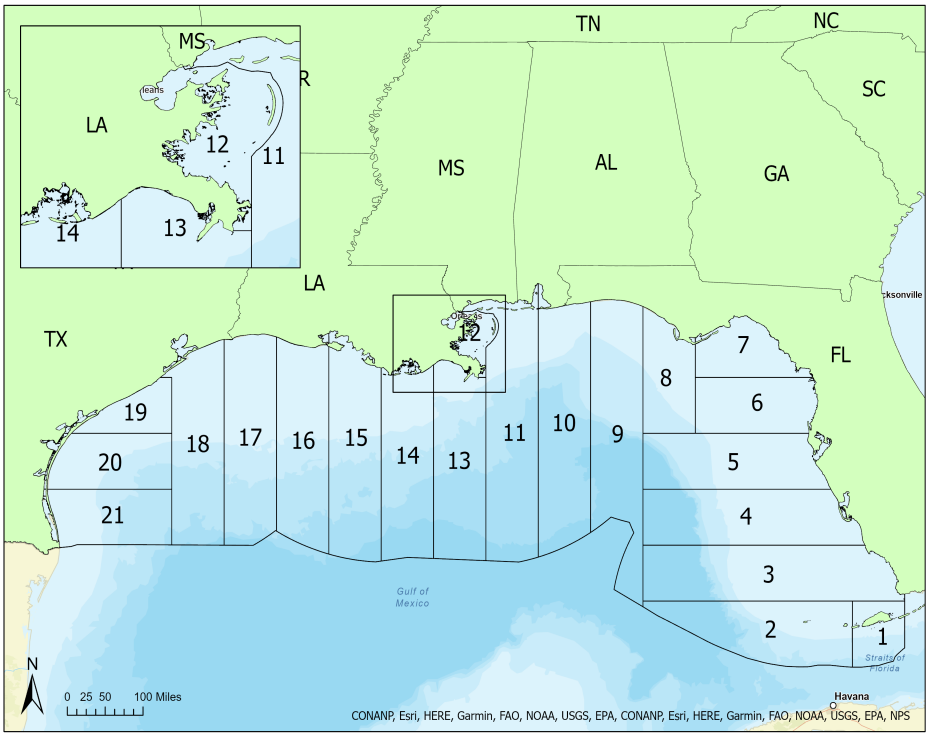


Figure 1. Map of Gulf of Mexico fishing areas. Areas 1-6 are assigned the eastern zone, 7-12 the central zone, and 13-21 the western zone.

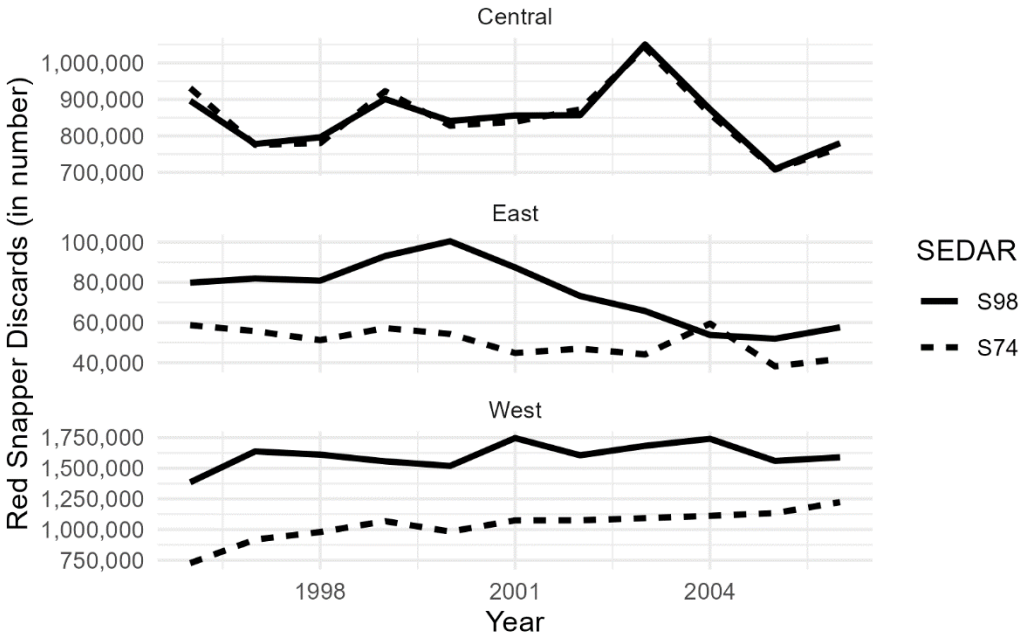


Figure 2. Commercial vertical line discard logbook discard estimates of Red Snapper (1996-2006) for SEDAR 98 compared to SEDAR 74.

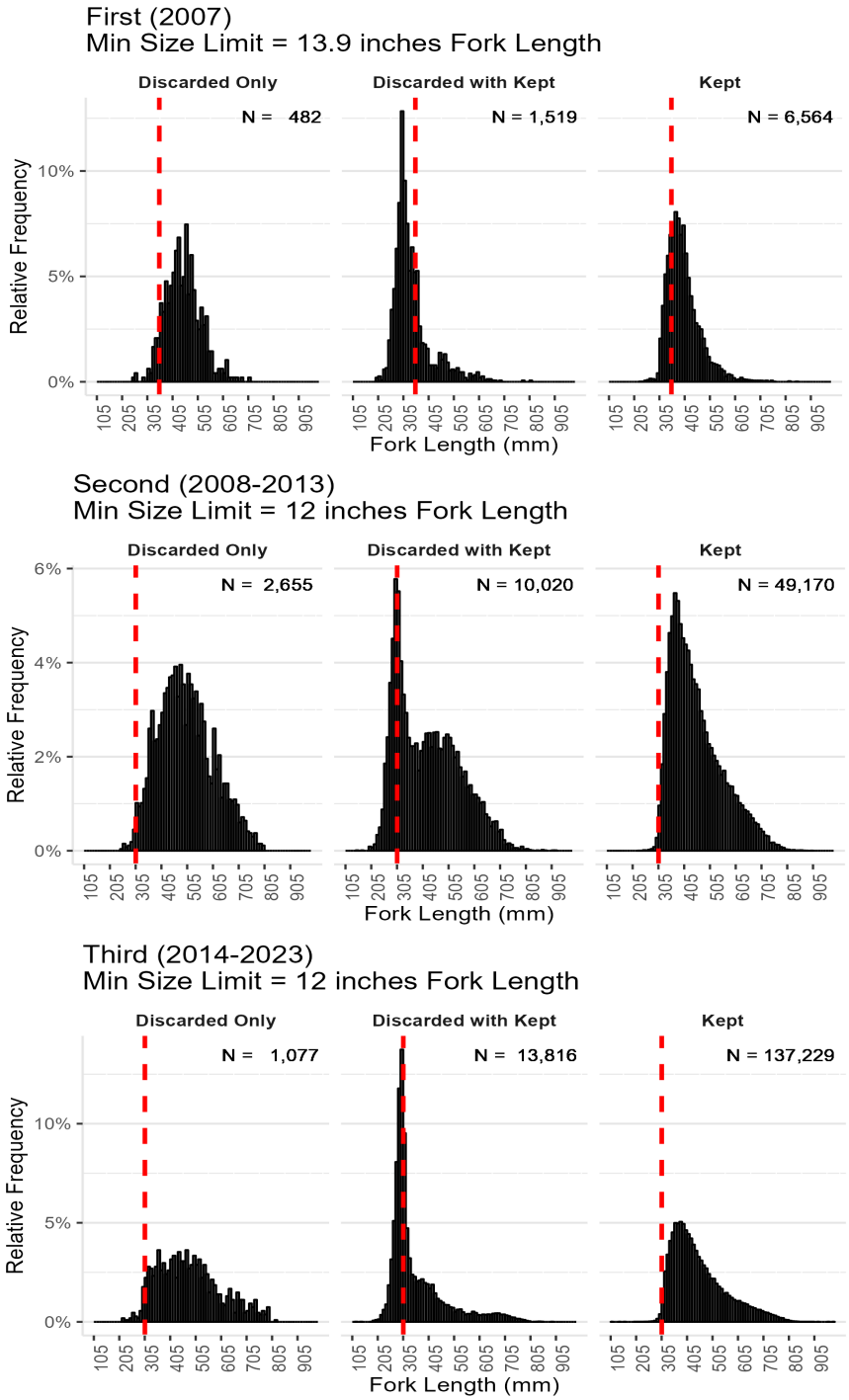


Figure 3. Length-frequency plots of observer vertical line Gulf of Mexico Red Snapper by disposition (Kept or Discard) and management regime. "Discarded Only" were discards from trips with no kept Red Snapper; "Discarded with Kept" were discards from trips with kept and discarded Red Snapper. All trips that kept Red Snapper are included in the "Kept" plot. Vertical dashed line denotes the minimum size limit in fork length (FL); N is the number of measured fish.

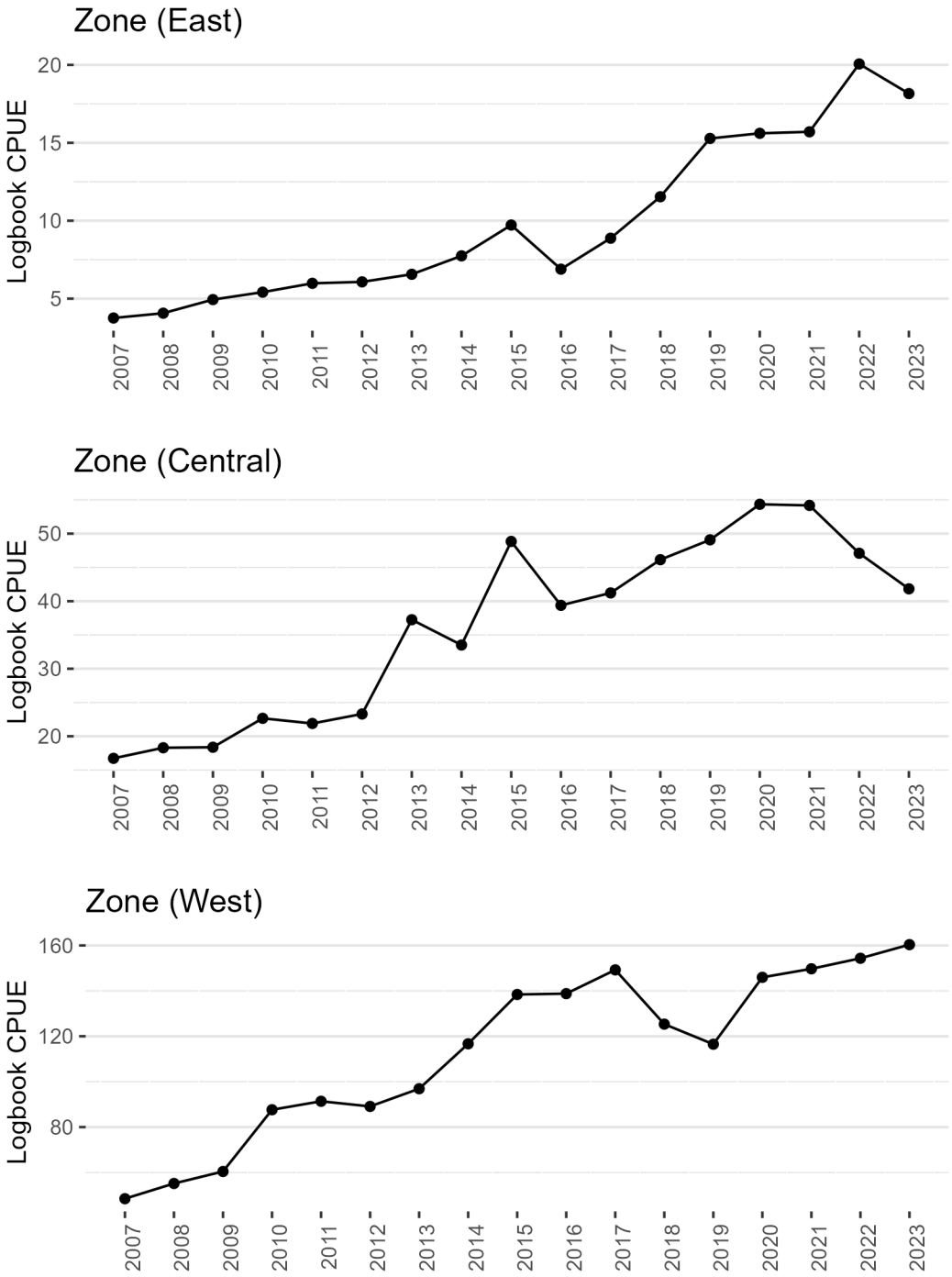


Figure 4. CPUE (catch in whole pounds per hour) time-series for logbook data from 2007 - 2023 for vertical line trips landing Gulf of Mexico Red Snapper.

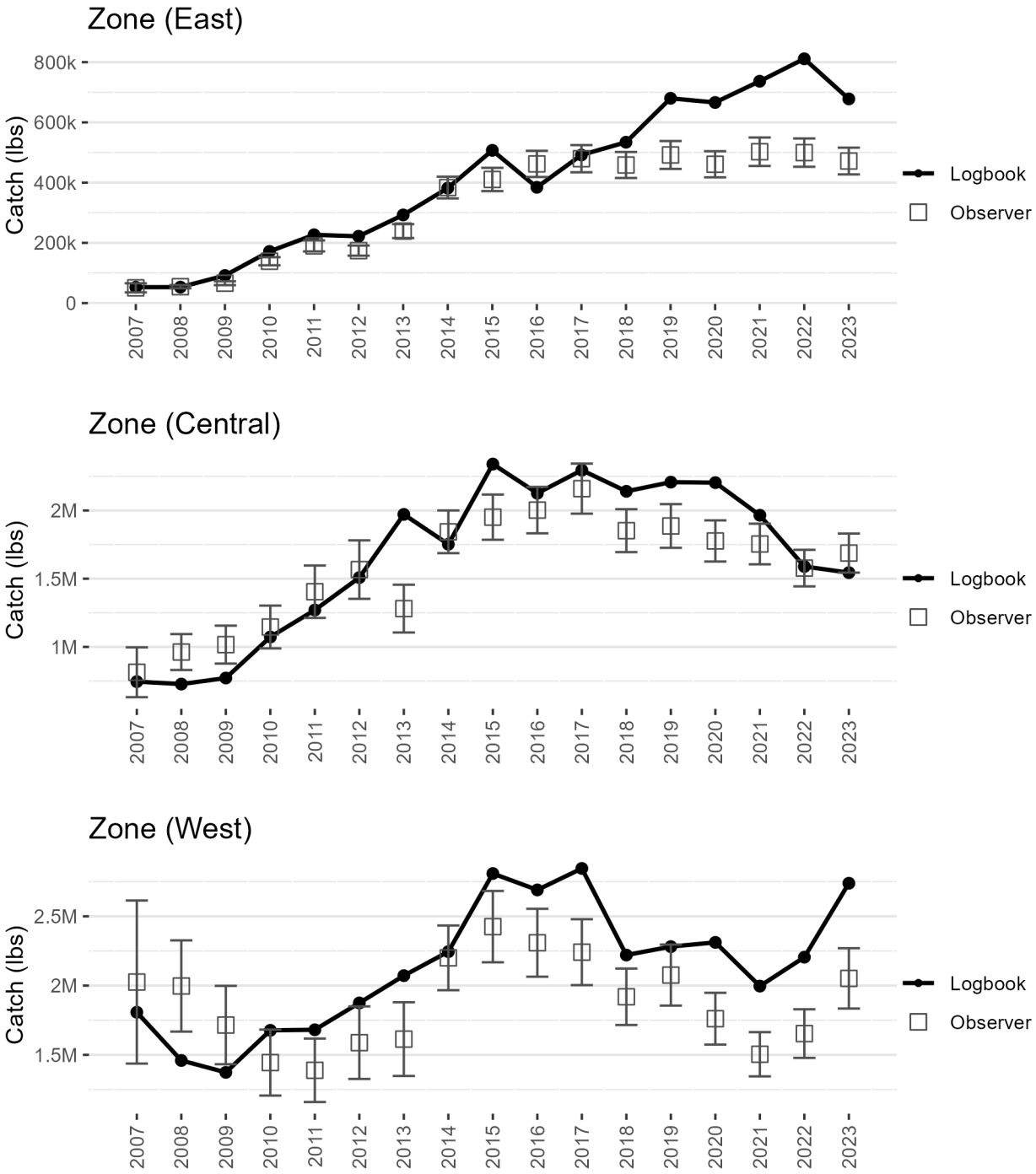
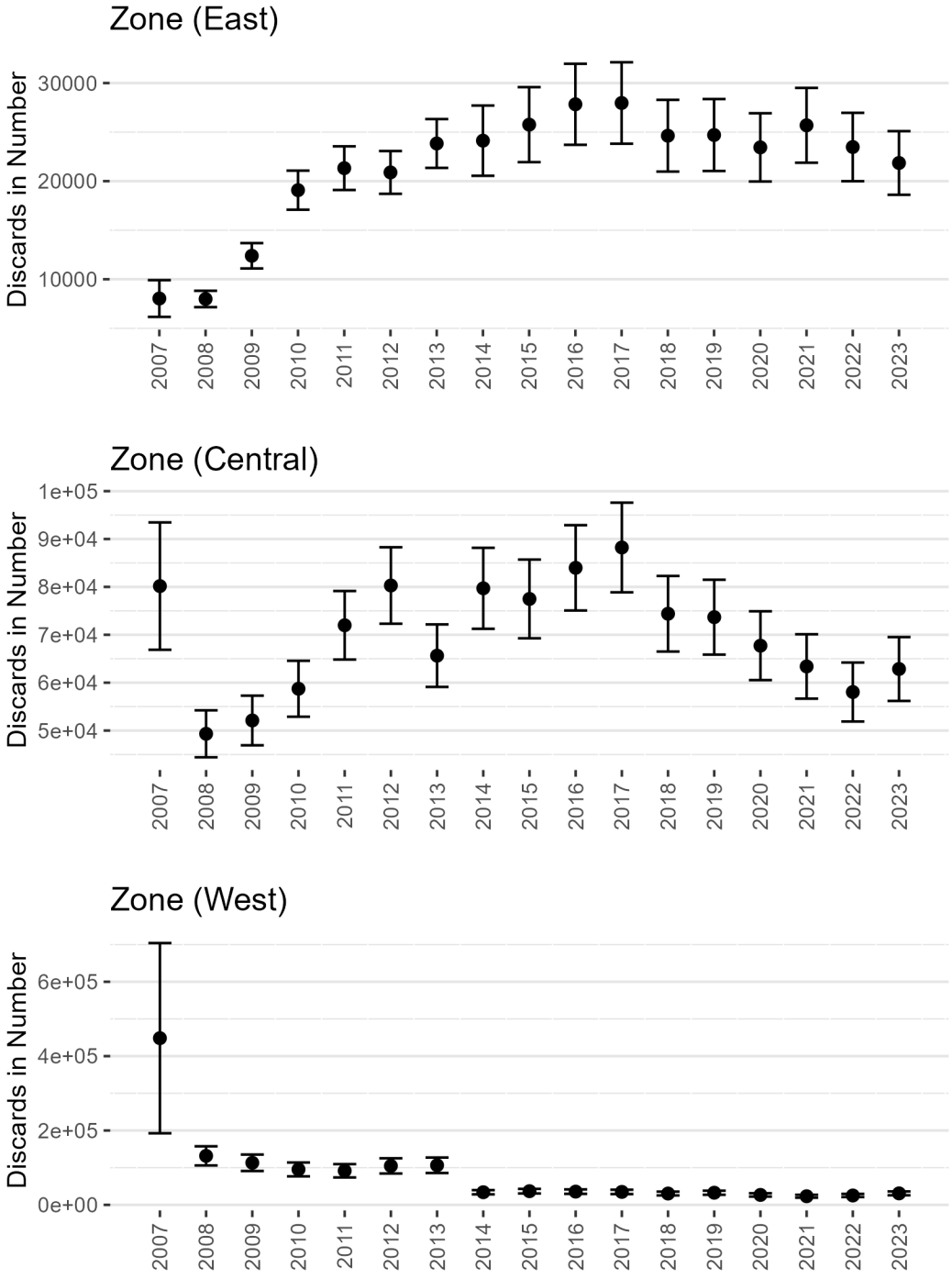


Figure 5. Comparison of vertical line reported annual logbook landings of Gulf of Mexico Red Snapper (solid black line) with CPUE expansion estimates from observer data (open squares). Error bars (SE) are shown for observer estimates.

(A) Discards in Number



(B) Discards in Weight, Percentage of Total Catch

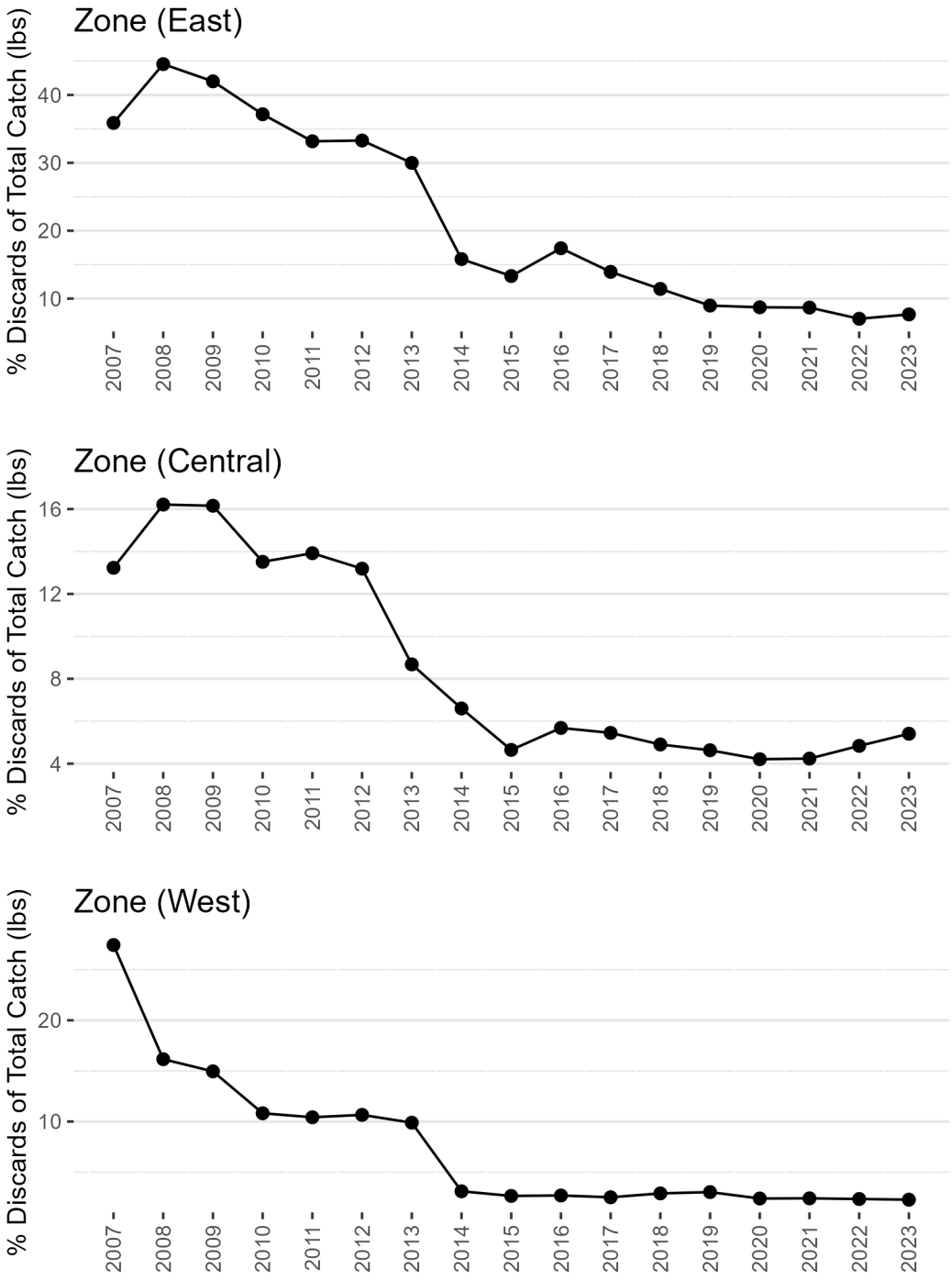


Figure 6. Observer CPUE expansion estimates of Gulf of Mexico Red Snapper commercial vertical line annual discards (+/-SE) in (A) number and (B) weight expressed as percentage of total catch (kept + discards) for 2007 - 2023.

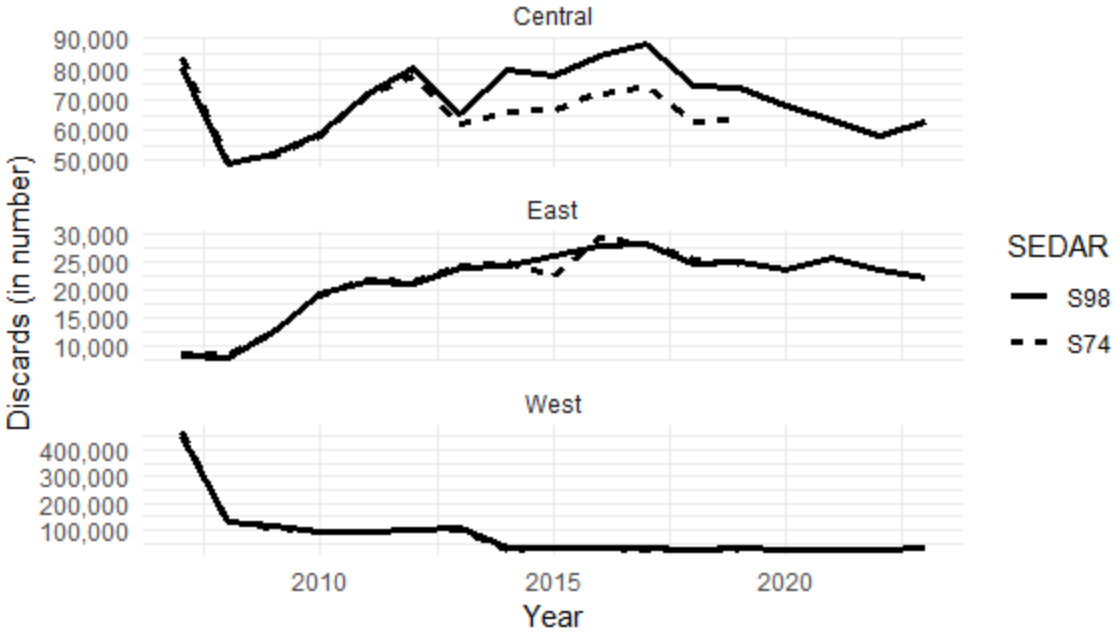
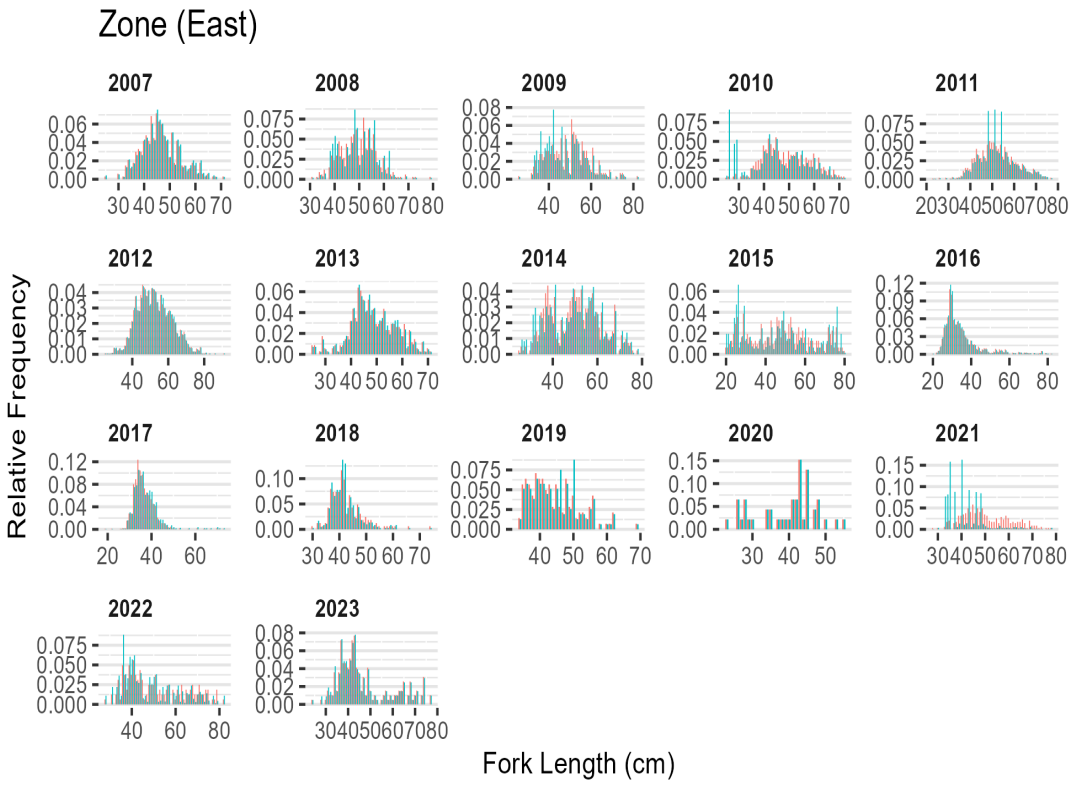


Figure 7. Commercial vertical line observer discard estimates of Red Snapper (2007-2023) for SEDAR 98 compared to SEDAR 74.



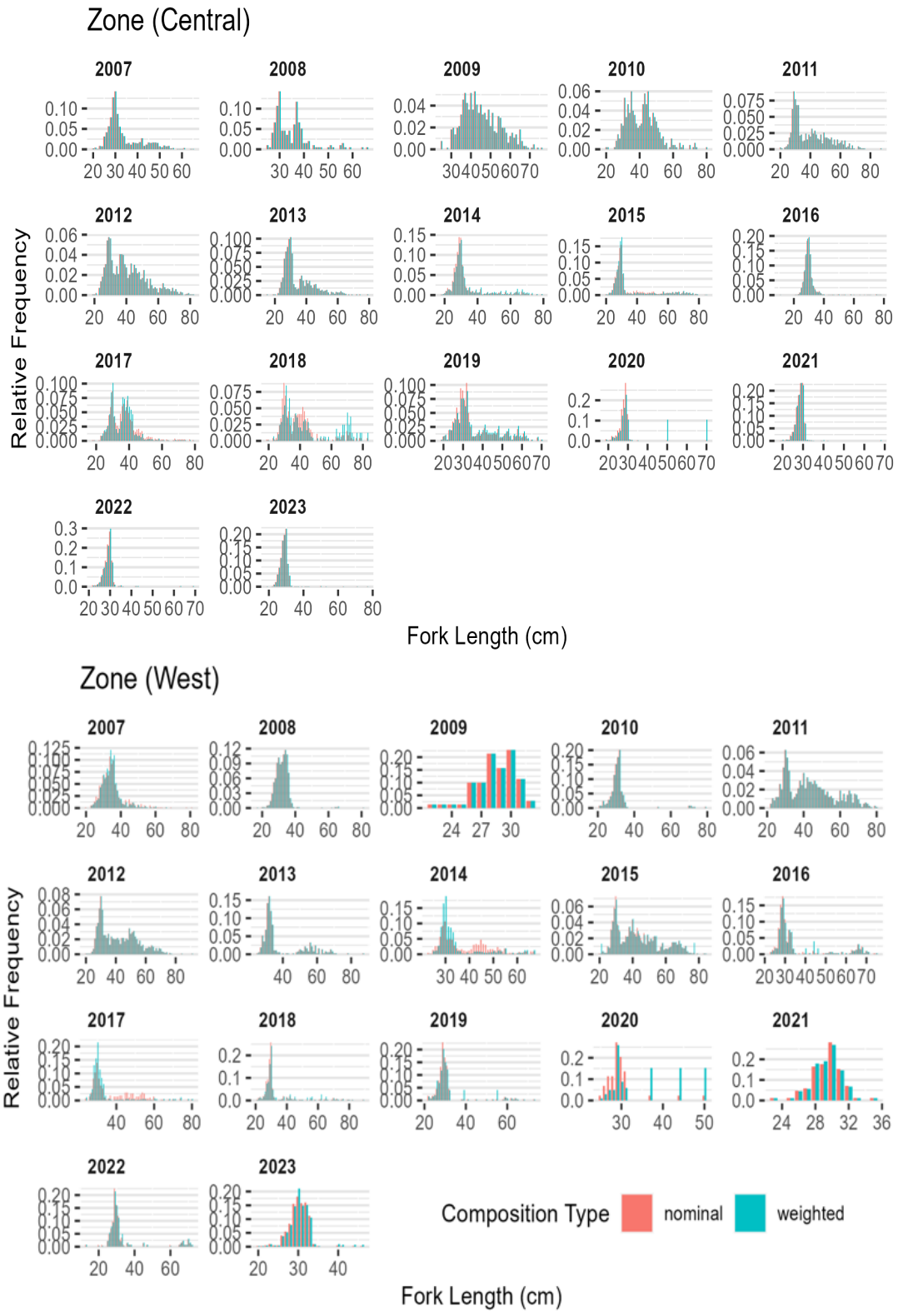


Figure 8. Commercial vertical line annual discard length compositions for Gulf of Mexico Red Snapper, accounting for catch and effort level stratification by management period.

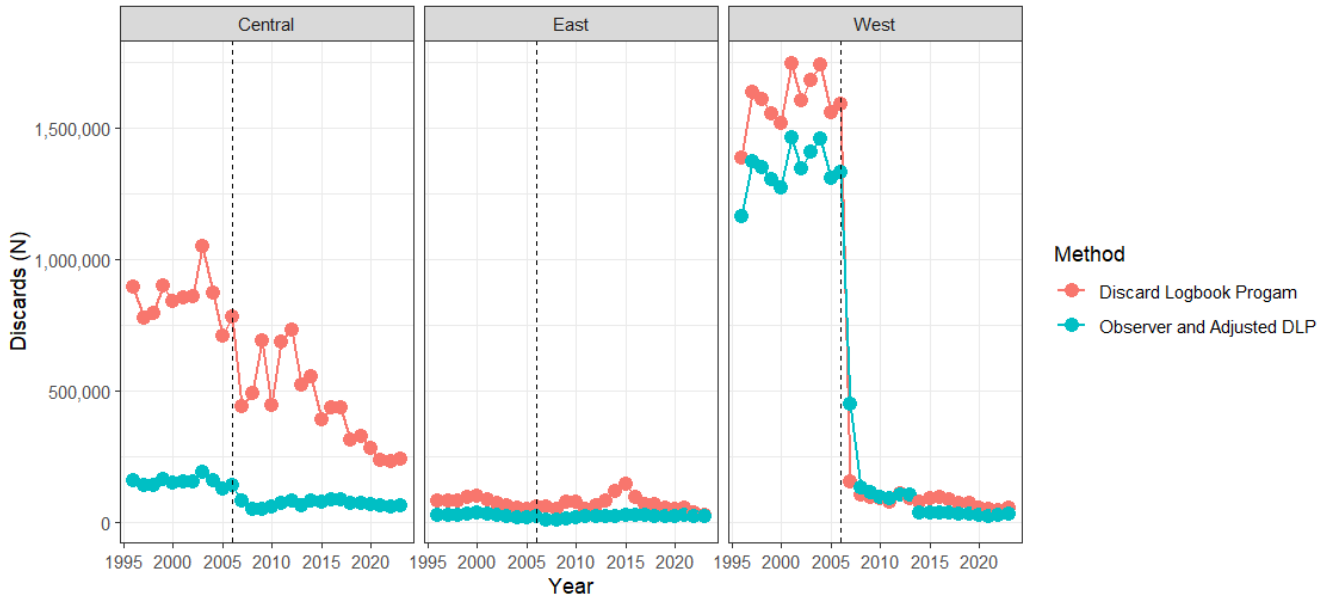


Figure 9. Commercial vertical line discard estimates of Gulf of Mexico Red Snapper from 1996-2023 with calibrated discard logbook estimates from 1996-2006.

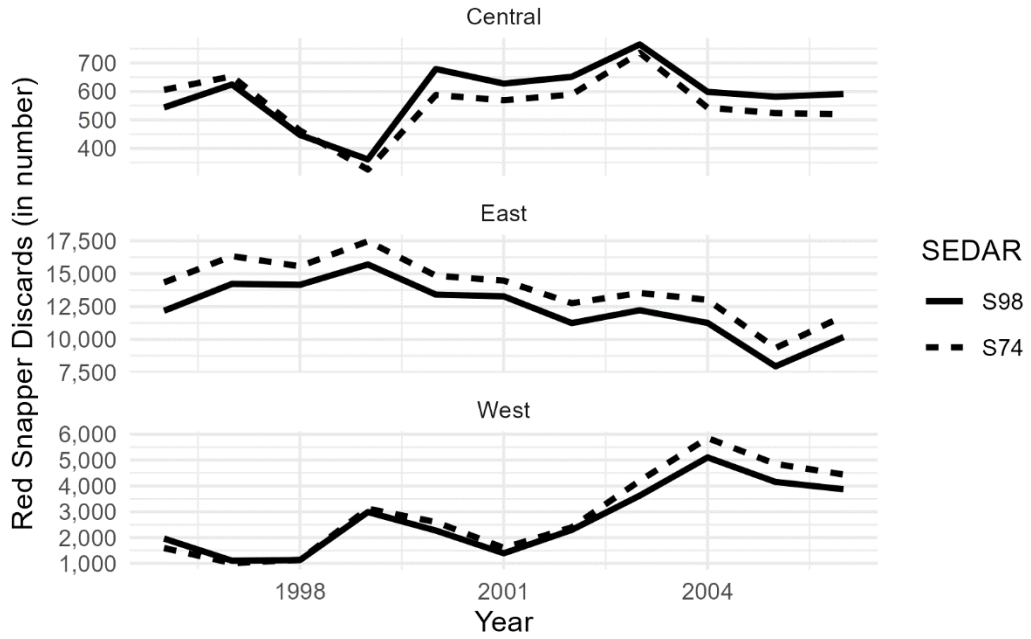


Figure 10. Commercial bottom longline discard logbook discard estimates of Red Snapper (1996-2006) for SEDAR 98 compared to SEDAR 74.

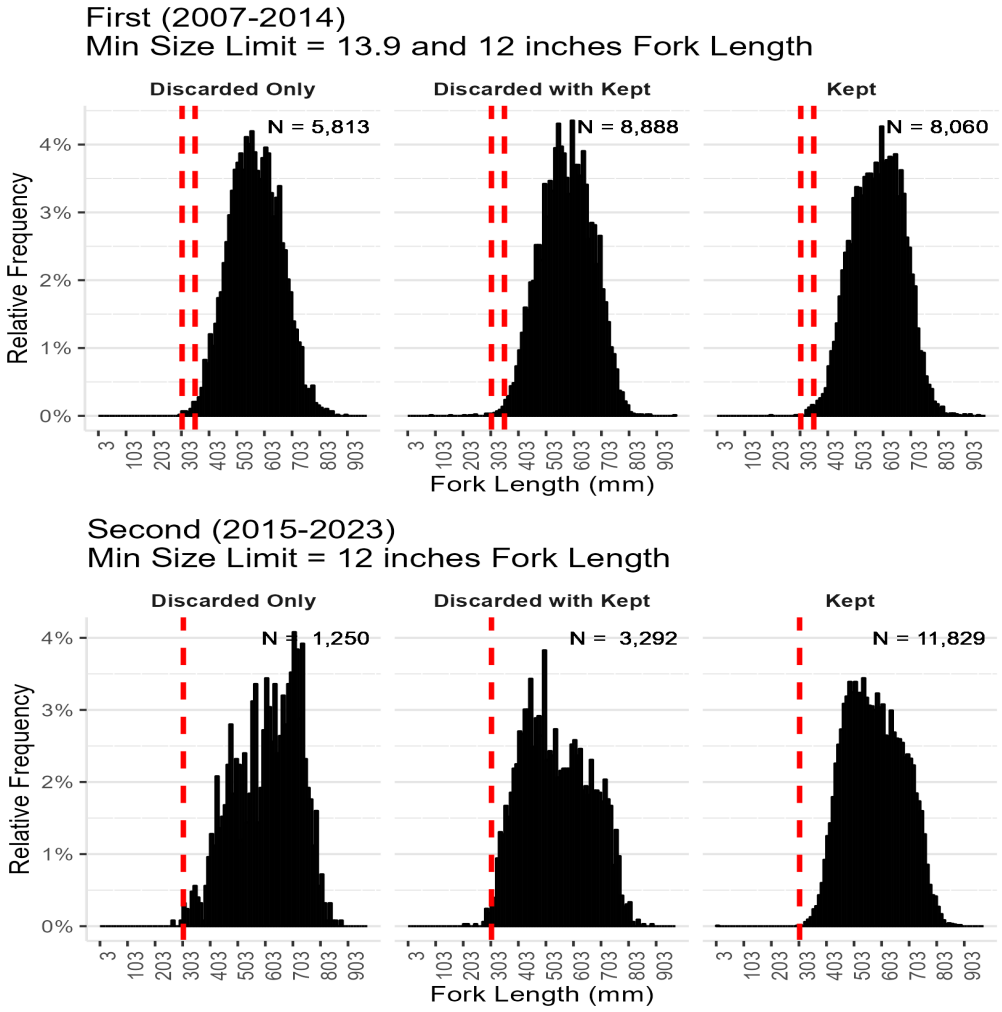


Figure 11. Length-frequency plots of observer bottom longline Gulf of Mexico Red Snapper by disposition (Kept or Discard) and management regime. "Discarded Only" were discards from trips with no kept Red Snapper; "Discarded with Kept" were discards from trips with kept and discarded Red Snapper. All trips that kept Red Snapper are included in the "Kept" plot. Vertical dashed lines denote the minimum size limit in fork length (FL); N is the number of measured fish.

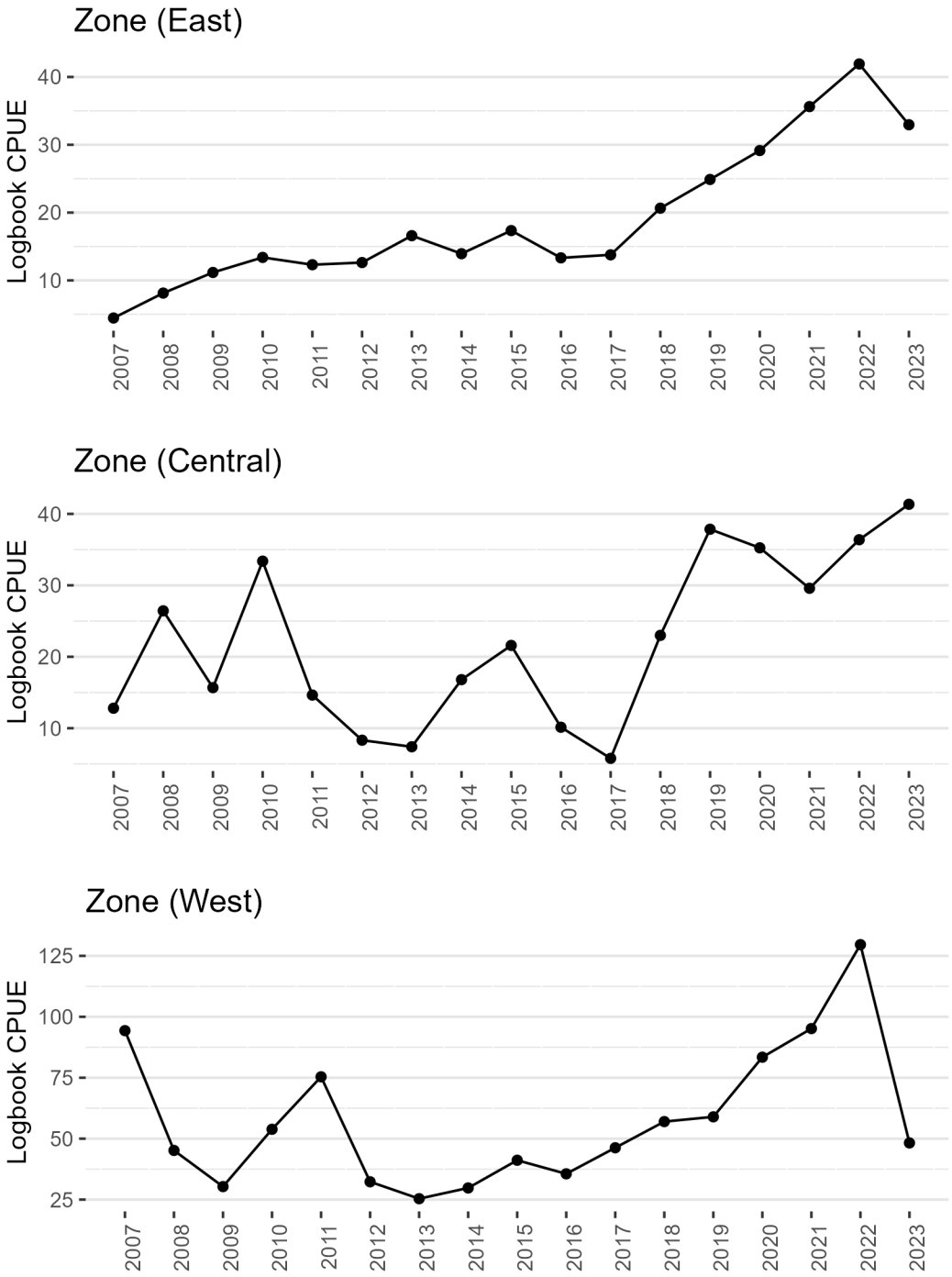


Figure 12. CPUE (catch in whole pounds per hour) time-series for logbook data from 2007 - 2023 for bottom longline trips landing Gulf of Mexico Red Snapper.

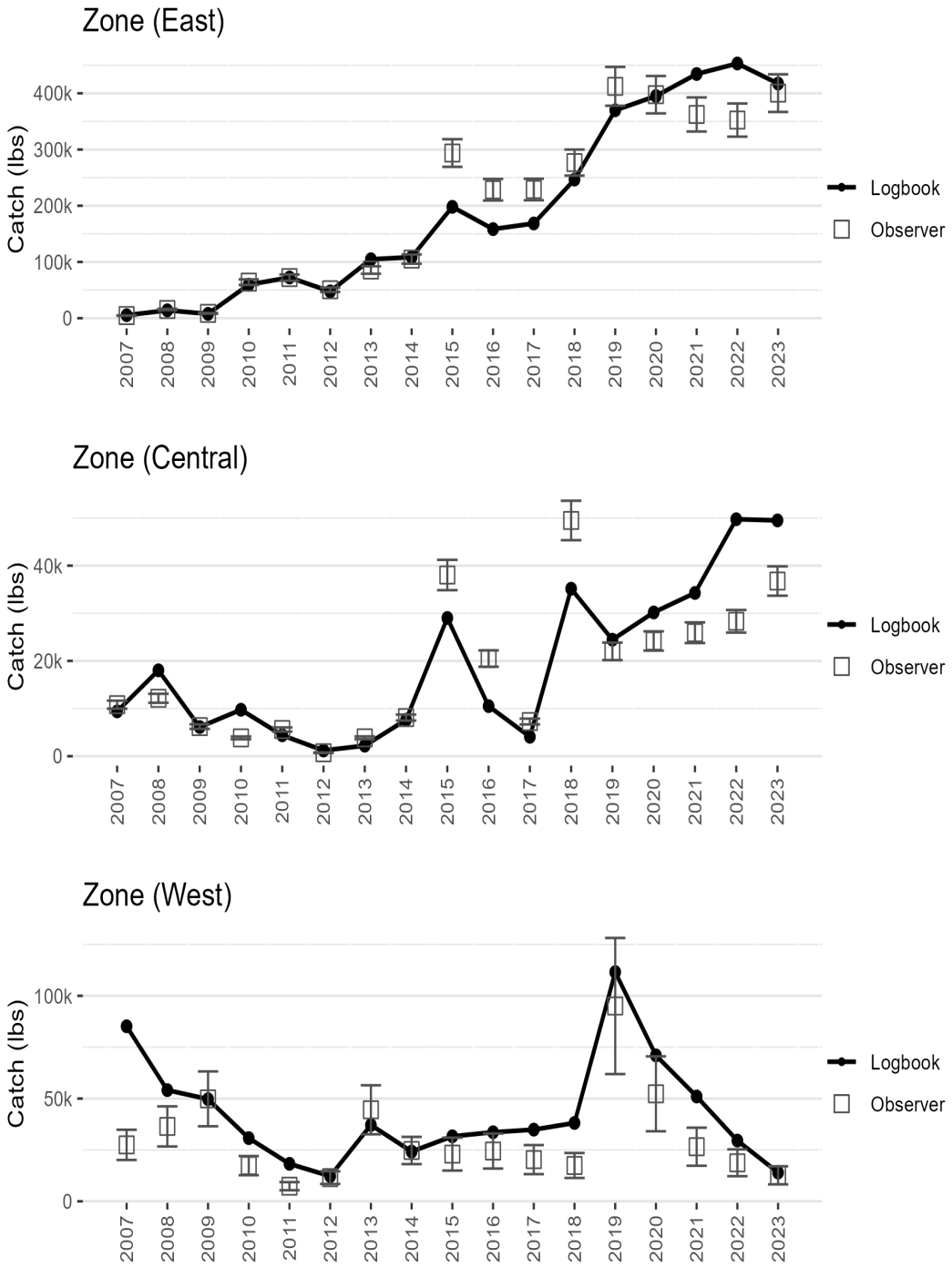
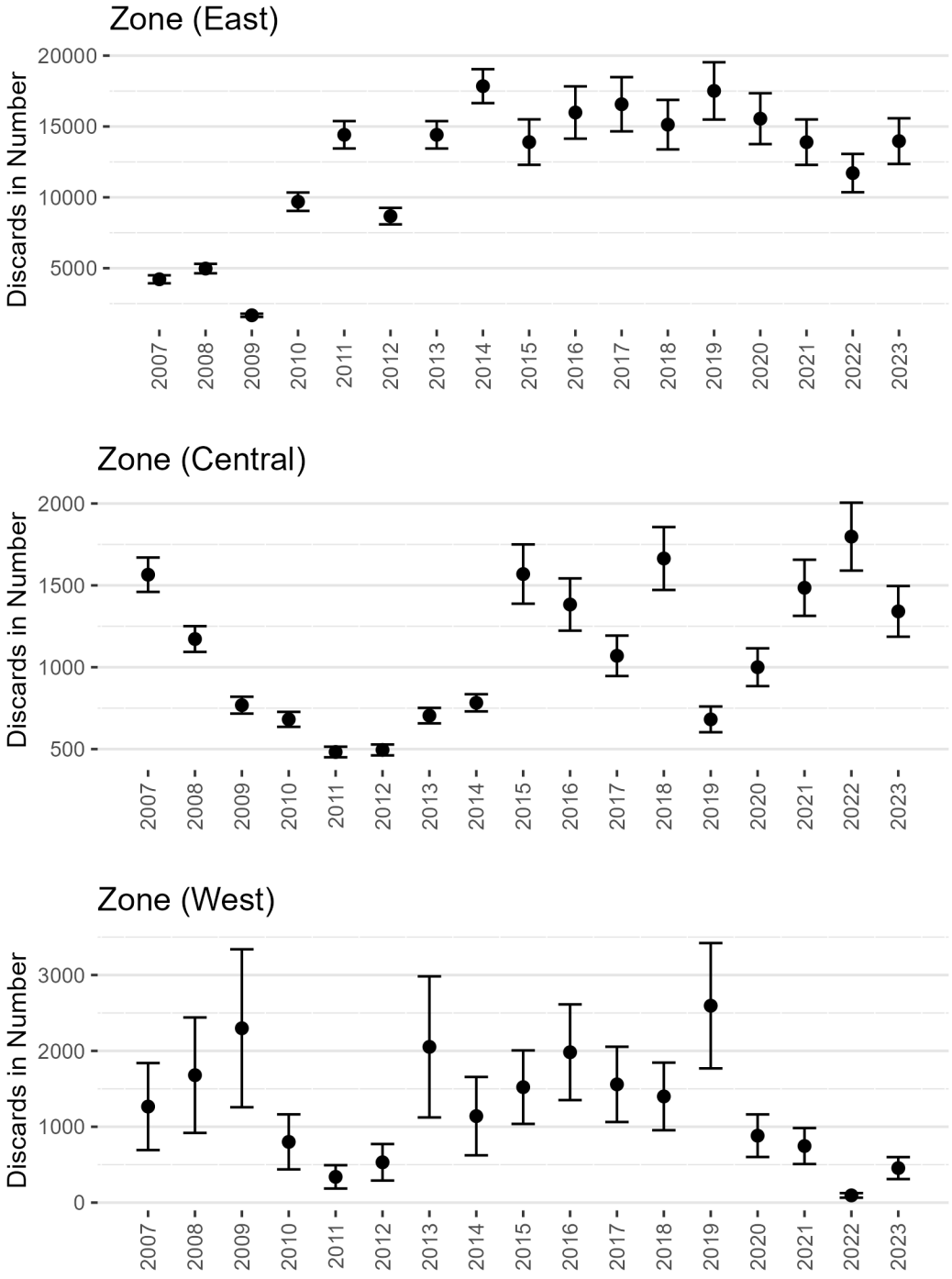


Figure 13. Comparison of bottom longline reported annual logbook landings of Gulf of Mexico Red Snapper (solid black line) with CPUE expansion estimates from observer data (open squares). Error bars (SE) are shown for observer estimates.

(A) Discards in Number



(B) Discards in Weight, Percentage of Total Catch

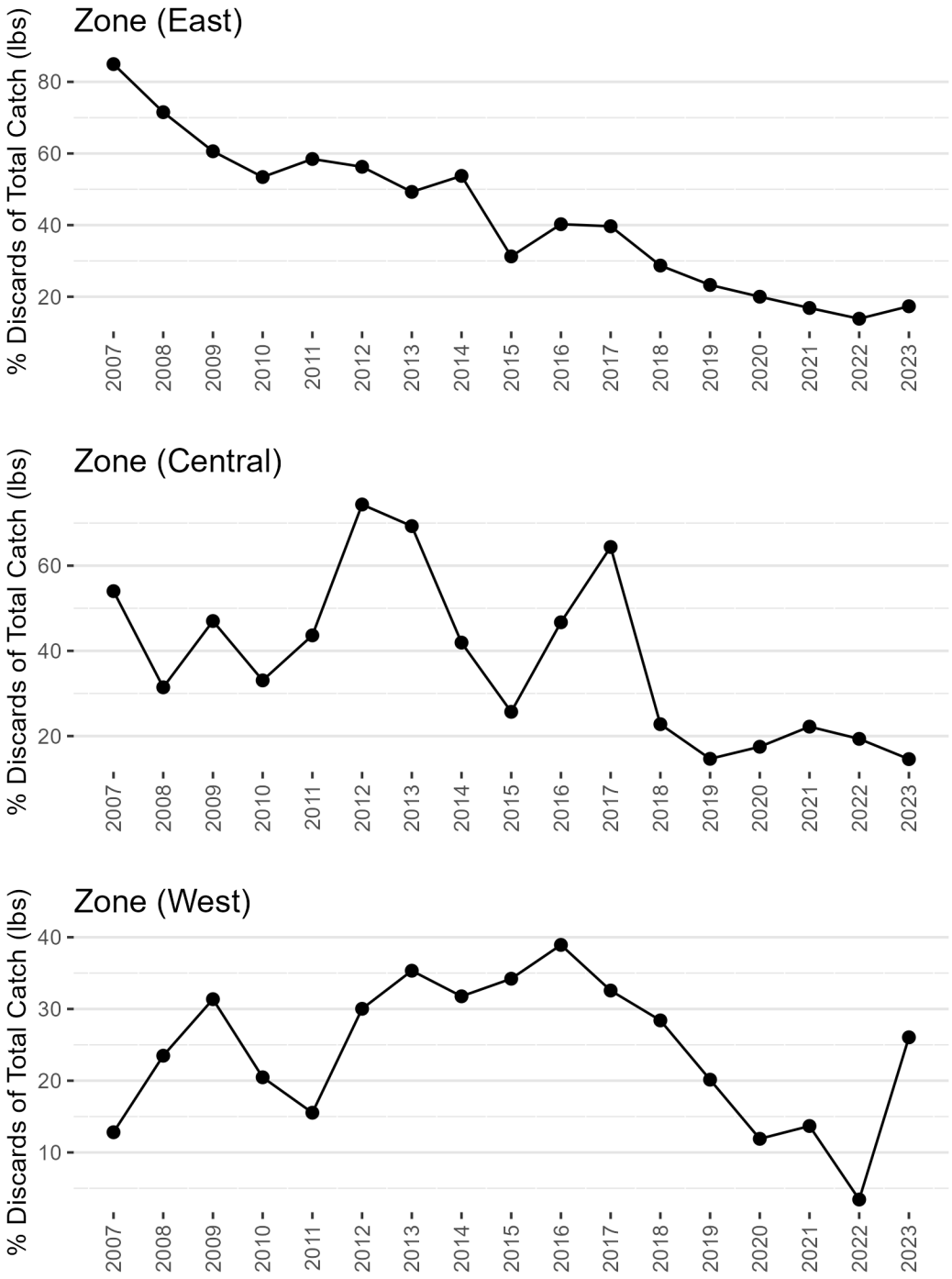


Figure 14. Observer CPUE expansion estimates of Gulf of Mexico Red Snapper bottom longline annual discards (+/-SE) in (A) number and (B) weight expressed as percentage of total catch (kept + discards) for 2007 - 2023.

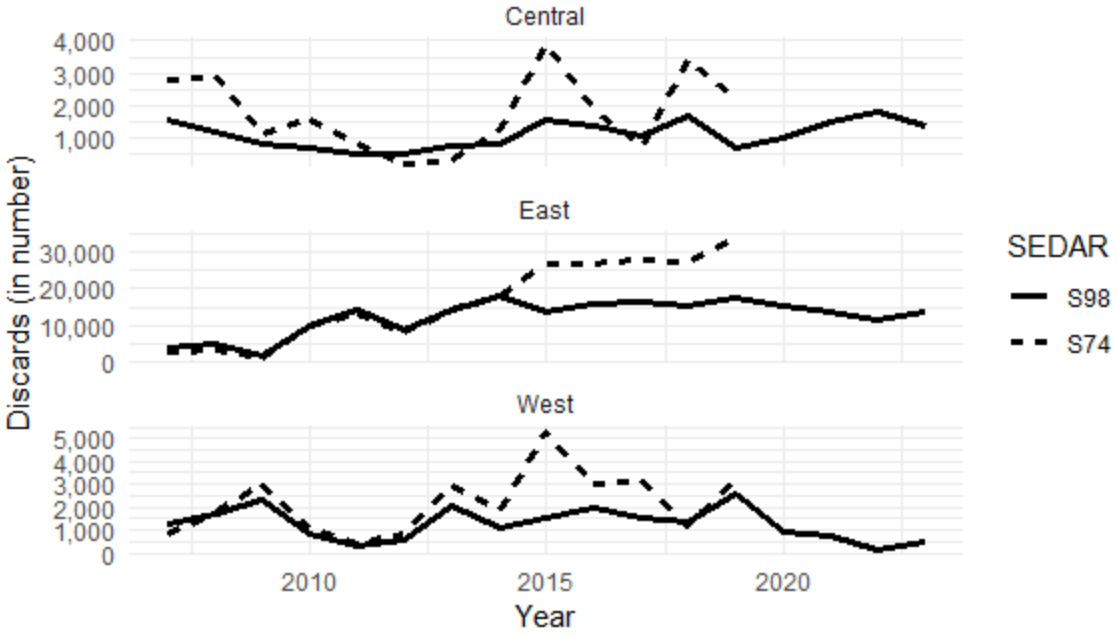
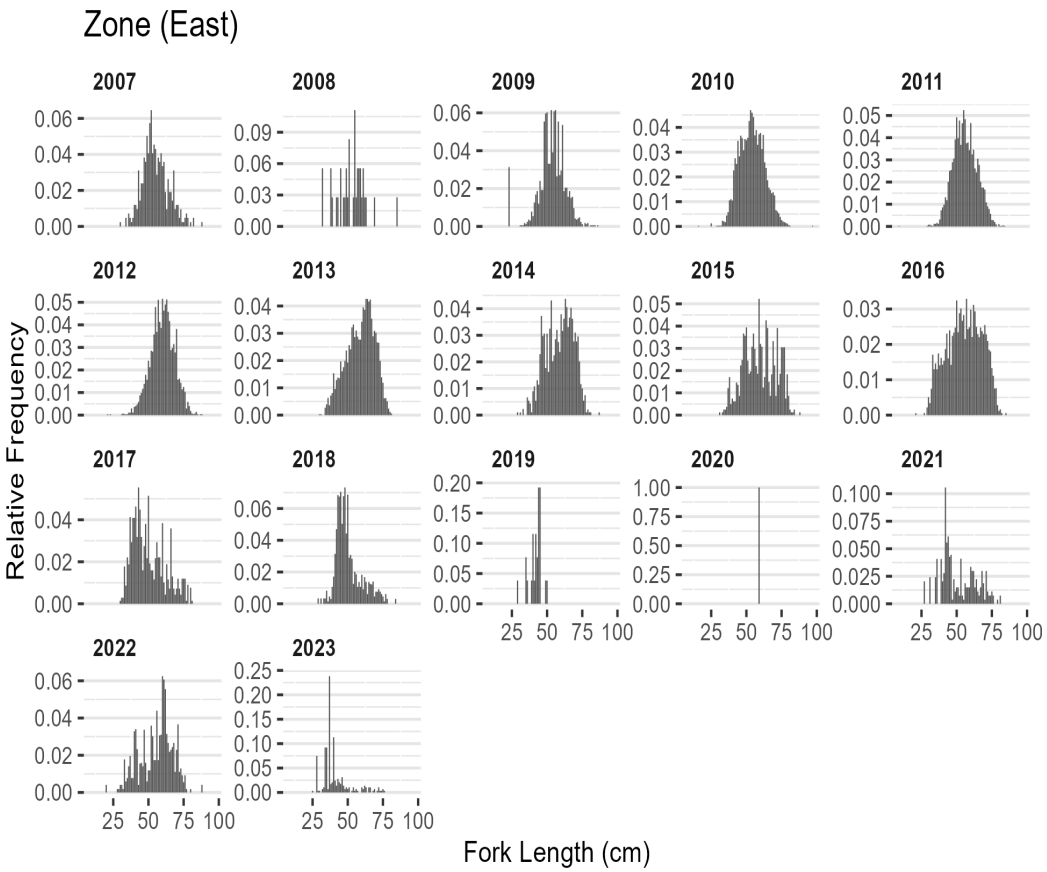


Figure 15. Commercial bottom longline observer discard estimates of Red Snapper (2007-2023) for SEDAR 98 compared to SEDAR 74.



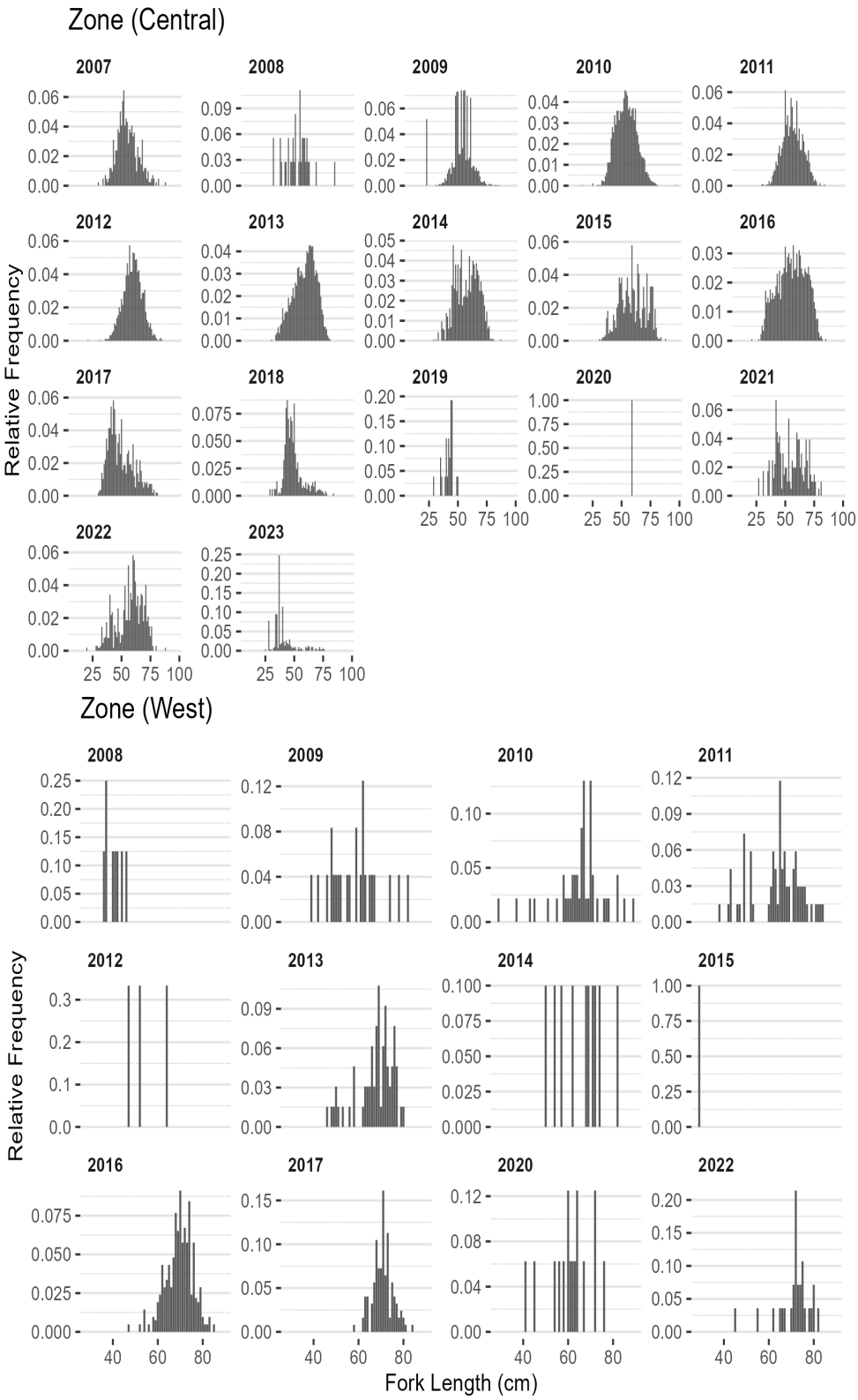


Figure 16. Commercial bottom longline annual weighted discard length compositions for Gulf of Mexico Red Snapper, accounting for catch and effort level stratification by management period. Due to low sample sizes in some years, the distribution will not be representative.

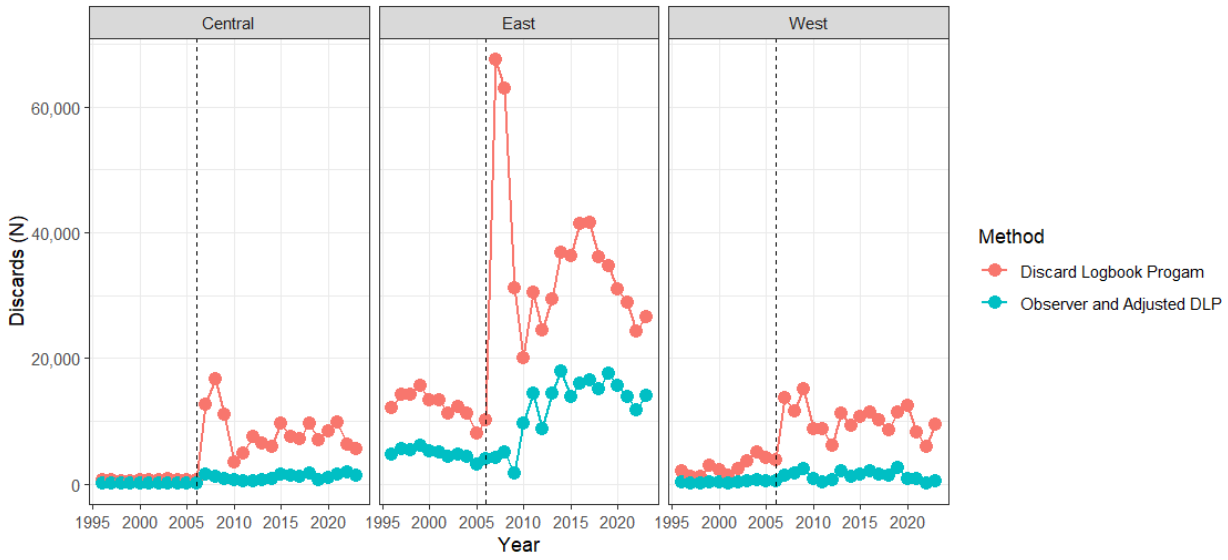


Figure 17. Commercial bottom longline discard estimates of Gulf of Mexico Red Snapper from 1996-2023 with calibrated discard logbook estimates from 1996-2006.