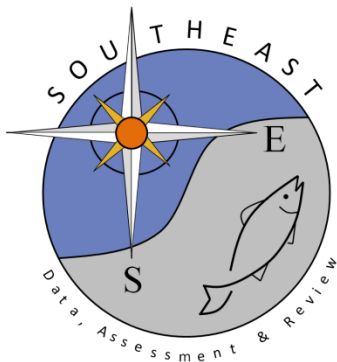


Proxy Discard Estimates of Red Snapper (*Lutjanus campechanus*) from the US Gulf of Mexico Headboat Fishery

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Proxy Discard Estimates of Red Snapper (*Lutjanus campechanus*) from the US Gulf of Mexico Headboat Fishery

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Abstract

Discard data were not routinely collected as part of the Southeast Region Headboat Survey (SRHS) until 2004, prior to which SRHS discard estimates are not available. These data are self-reported and not currently validated within the SRHS program. As a form of validation, SRHS discard rates were compared to those from the Headboat At-Sea Observer Program to determine those years for which SRHS discard estimates should be used (SEDAR 52-WP-21), from which the decision was to retain SRHS discard estimates between 2008-2023. For those years prior (1986-2007), proxy discard estimates were calculated using the superratio approach, with annual calculations conducted at the StockID (SID) level.

Introduction

The Southeast Region Headboat Survey (SRHS) logbook form was modified in 2004 to standardize collection of discard data for each reported trip (Fitzpatrick et al. 2017, SEDAR 79-DW-06). Some logbooks prior to 2004 allowed for discards to be reported, but these had to be handwritten (by species) and were rarely reported. Between 2004-2012, discard information was collected from logbook forms as the number of fish (by species) and their discard condition (i.e., released alive or released dead). Port agents instructed each captain on criteria for determining the condition of discarded fish, in that a fish was considered “released alive” if it was able to swim away on its own and “released dead” if it was unable to swim, floated off, or was obviously dead. As of Jan 1, 2013, the SRHS began collecting logbook data electronically. Changes to the required reporting were also made at this time, one of which was the removal of the condition category for discards. Current forms only require information on the total number of fish released, regardless of condition, due to the subjectivity in determining the condition of released fish. Live and dead releases for 2004 to 2012 are typically combined as total discards for consistency with SRHS data collection in later years.

Underreporting of discard information on SRHS logbooks was a concern in the initial years of data collection (e.g., 2004-2007) (SEDAR PW-07) as many headboat captains expressed confusion with the new data fields. Because logbook data are self-reported, discard data are not currently validated within the SRHS program. To assess the validity of annual SRHS discard estimates, discard rates from SRHS logbooks can be compared to those from Headboat At-Sea Observer Programs. These programs were implemented to collect more detailed information on headboat catch, particularly for discarded fish. In the Gulf of Mexico, headboat observers operate mainly in western Florida (beginning in 2005), with limited coverage in Alabama in certain years (beginning in 2004) (SEDAR 61-WP-13) and Texas in 2011 (Donaldson et al. 2013). Inconsistent funding and natural phenomenon (e.g., 2020 COVID-19 pandemic) have led to short breaks in the sampling for some of these surveys (e.g., no observer coverage of Gulf of Mexico headboats in 2008). Within these programs, headboat vessels are randomly selected throughout the year in each state, with the west coast of Florida further stratified into three sample regions (i.e., panhandle, western peninsula, and the FL Keys). Biologists board selected vessels with permission from the captain and observe a subset of anglers as they fish on the recreational trip. Data collected include the number of fish landed and discarded by species.

Because discards were not added to the SRHS logbook form until 2004, a proxy method is needed to provide headboat discard estimates for prior years (e.g., 1986-2003) and for any years for which SRHS discard estimates are considered inaccurate (e.g., 2004-2007). This working paper identifies how SRHS proxy discards were estimated in SEDAR 98 and the associated justifications for any required decisions (e.g., selection of method and years to include in the estimation).

Methods

Validation of SRHS Catch Rates

Discard rates of Gulf of Mexico red snapper (ratio of discards to total catch) from SRHS logbooks were compared to those from Headboat At-Sea Observer Programs to validate SRHS discard estimates. This comparison is used to identify the appropriate start year for SRHS discard estimates (e.g., 2004 or 2008) and any calibrations needed to offset potential misreporting of SRHS discard rates. This analysis was done as part of SEDAR 52 (SEDAR 52-WP-21) and was not repeated for SEDAR 98. However, the associated decisions from the previous comparison were reevaluated for this assessment. Note that the recommended start year for SRHS discards (from SEDAR 52-WP-21), for which proxies are required for all years prior, was also applied in SEDAR 74 (Final Assessment Report).

Discard proxy

Several sources of proxy SRHS discard estimates have been considered in past SEDAR stock assessments, including the preferred superratio approach (SEDAR-PW-07). All of these methods are based on scaling historic SRHS landings estimates (e.g., 1986-2007) by some assumed discard rate(s), but what differs between the approaches is how these discard rate(s) are estimated, most being derived from some subset of MRIP catch data (described in SEDAR 98-DW-05). SRHS catch estimates are provided in SEDAR 98-DW-01.

For SEDAR 98 Gulf of Mexico red snapper, the preferred superratio approach was evaluated as a suitable proxy method for SRHS discards, which rescales past (e.g., 1986-2007) discard rates of the MRIP charterboat mode (discards:landings) by the ratio of mean discard rates between the MRIP charterboat mode and SRHS headboat mode from recent years (e.g., 2008-2012, 2008-2023). This approach is the current “Best Practice” method for calculating discard proxies and is the same method applied in the SEDAR 74 stock assessment for Gulf of Mexico red snapper. It allows for changes in management and year class effects to be incorporated into the estimation (annual discard proxies estimated from SRHS landings and discard rates for the same year) and accounts for potential differences in the magnitude of MRIP vs. SRHS discards (i.e., rescaling with superratios) (SEDAR-PW-07, Issue #11). Additionally, the discard rates for this method are estimated from those of charterboat anglers, who are generally assumed to fish in areas and use fishing methods most similar to headboat anglers.

To evaluate the suitability of the superratio method in its application for SEDAR 98 Gulf of Mexico red snapper, discard rates and the associated proxy estimates were compared to the corresponding SRHS estimates for those years where SRHS estimates were considered reliable and retained for use in this assessment (2008-2023) (Figure 1).

All proxy discards considered for SEDAR 98 were:

- Geographically, calculated at the SID-level, splitting the Gulf of Mexico into three spatial areas: a WEST region composed of Texas and Louisiana (~79% of Gulf-wide landings and ~17% of discards), a CENTRAL region that includes Mississippi, Alabama, and the Florida panhandle (~19% of Gulf-wide landings and ~77% of discards), and an EAST region that includes western Florida (~1% of Gulf-wide landings and ~6% of discards).
- Temporally, calculated at the total (annual) level. At the request of assessment analysts, the proxy discards provided for SEDAR 98 are specific to (open vs. closed) fishing season (Table 1). However, the methods discussed in this working paper were applied to produce annual proxies, which were subsequently partitioned between fishing seasons using the associated %days-open in any given year. This is the same method assessment analysts applied in SEDAR 74 to partition recreational catches between open and closed fishing seasons.

Uncertainty estimates for SRHS proxy discards are provided as coefficients of variation, with associated variances calculated using standard statistical equations. Variances of annual discard rates ($var(r_{B2:AB1})$) are approximated using a Taylor Series expansion ignoring covariance terms (SEDAR 74-DW-10, Equation 2):

$$var(r_{B2:AB1}) = \frac{var(B2)}{AB1^2} + \frac{B2^2 * var(AB1)}{AB1^4}$$

SRHS estimates of catch and associated uncertainties are provided in SEDAR 98-DW-01. GenRec estimates of catch and associated uncertainties are provided in SEDAR 98-DW-05. For those methods that require an average discard rate (e.g., superratios), the associated variance is calculated as $\frac{\Sigma variance}{n^2}$. With variances available for discard rates ($r_{B2:AB1}$) and SRHS landings estimates ($AB1$), variances of the associated proxies ($var(\widehat{B2})$) are approximated using Goodman's Formula (SEDAR 74-DW-10, Equation 5):

$$var(\widehat{B2}) = (AB1^2 * var(r_{B2:AB1})) + (r_{B2:AB1}^2 * var(AB1)) - (var(r_{B2:AB1}) * var(AB1))$$

Results

Validation of SRHS Catch Rates

As decided in previous SEDARs (SEDAR 52-WP-21, SEDAR 74), SRHS discard estimates for SEDAR 98 are retained for years 2008-2023, requiring proxy discard estimates to be imputed for any years prior (1986-2007). As justification for this decision:

- Discard rates from the observer programs were almost an order of magnitude larger than that from SRHS logbooks in the early years of discard data collection (2004-2007, SEDAR 52-WP-21).

- Discard rates from these two data sources in subsequent years (2008+) followed a very similar pattern, with slight differences in magnitude attributed to relatively low sample sizes from the regional at-sea observer programs.
- Similarly, the corresponding SRHS discard estimates in the early years of discard data collection (2004-2007) were relatively low when compared to estimates from the rest of the timeseries (SEDAR 52-WP-21).

Taken together, these results suggest SRHS discard estimates of Gulf of Mexico red snapper were being underreported by the SRHS logbooks in the early years of data collection, and so the decision for SEDAR 98 is to replace SRHS discard estimates from 2004-2007 with the associated proxy estimates.

Discard proxy

Fishing behavior can change for any number of reasons, including management actions, ecosystem drivers, and the relative productivity or availability of the stock or any populations with which it interacts. Because data sources are often lacking for many of these potential drivers, a more precautionary approach was applied in SEDAR 98 wherein any static ratios used in the imputation of proxy discards (e.g., SRHS:MRIP superratios) were constrained to the first few years of valid SRHS discard estimates (2008-2012). The number of years selected in this estimation (i.e., five) is a trade-off between minimizing the potential for bias from inclusion of years over which an undetected change in discarding behavior may have occurred while also retaining an adequate sample size to account for the inter-annual variability inherent in discard rates. As support for this decision, recreational discard rates from SRHS appear relatively stable over these five years (2008-2012), but may have changed in subsequent years in the WEST (decline) and CENTRAL regions (increase), which support the vast majority of regional headboat catch of Red Snapper (Figure 1). Similar trends are also seen in the GenRec data (Figure 8 in S98-DW-01). This approach differs from that applied in SEDAR 74, for which all years with valid SRHS discard estimates were retained in this estimation (i.e., 2008+), resulting in smaller estimates for proxy discards (Figure 3).

Discussion

For SEDAR 98, the superratio approach is recommended to provide proxy SRHS discard estimates for years 1986-2007 (Table 1). The relative agreement between actual SRHS discard estimates and these proxies (2008-2023) provides support for their use in other years (1986-2007) (Figure 1). The superratio approach is the preferred proxy method according to SEDAR Best Practices (SEDAR-PW-07) because it applies historic (rescaled) discard rates of MRIP charterboat anglers, who are generally assumed to fish in areas and use fishing methods most similar to headboat anglers, while accounting for potential differences in magnitude between MRIP vs. SRHS discards and any year-specific effects of management regulations and/or year-class strength on angler behavior. Alternative methods are therefore only considered when the preferred approach fails (SEDAR-PW-07)

and given no clear indication of failure, the superratio approach was chosen for this assessment. This decision to apply the superratio method agrees with past SEDAR stock assessments for Gulf of Mexico red snapper (i.e., SEDAR 52 and 74).

Although this approach produced a relatively high discard estimate in 1994 for the WEST domain, the same spike in proxy discards is also seen in the corresponding SRHS landings timeseries (Figure 1). Additionally, the associated discard rate ($r_{1994} = 0.79$) is similar in magnitude to other discard rates observed during that time period (e.g., $r_{1990} = 0.95$, $r_{1996} = 0.67$). The high proxy discard estimated for the WEST region in 1994 is therefore assumed representative of the true catch in that year. A relatively high proxy discard estimate was also provided for 1994 in SEDAR 52 and 74.

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Table 1. Timeseries of SRHS Proxy Discard Estimates and associated Coefficients of Variation (1986-2007) for SEDAR 98 Gulf of Mexico red snapper by fishing season (open vs. closed). Proxy discards were calculated using the SUPERRATIO approach, with annual calculations conducted at the SID level.

Year	SID	OPEN		CLOSED	
		Proxy	CV	Proxy	CV
1986	CENTRAL	128	0.95		
1986	EAST	175	0.82		
1986	WEST	4,338	0.77		
1987	CENTRAL	514	0.80		
1987	EAST	88	1.16		
1987	WEST	3,761	0.94		
1988	CENTRAL	1,393	0.93		
1988	EAST				
1988	WEST	14,355	1.10		
1989	CENTRAL	1,064	0.61		
1989	EAST				
1989	WEST	11,382	1.13		
1990	CENTRAL	5,165	0.59		
1990	EAST				
1990	WEST	176,989	0.94		
1991	CENTRAL	9,473	0.50		
1991	EAST				
1991	WEST	135,399	0.74		
1992	CENTRAL	18,196	0.42		
1992	EAST	6	1.07		
1992	WEST	157,824	0.74		
1993	CENTRAL	6,820	0.62		
1993	EAST				
1993	WEST	158,411	0.73		
1994	CENTRAL	12,572	0.45		
1994	EAST	98	1.38		
1994	WEST	393,427	0.72		

Year	SID	OPEN		CLOSED	
		Proxy	CV	Proxy	CV
1995	CENTRAL	18,548	0.58		
1995	EAST				
1995	WEST	180,040	0.84		
1996	CENTRAL	19,433	0.50		
1996	EAST				
1996	WEST	233,200	0.84		
1997	CENTRAL	40,622	0.42	4,445	0.42
1997	EAST	4	1.31	0	1.31
1997	WEST	118,558	0.73	12,973	0.73
1998	CENTRAL	26,320	0.34	9,129	0.34
1998	EAST	37	0.91	12	0.91
1998	WEST	34,532	0.78	11,978	0.78
1999	CENTRAL	34,337	0.35	18,102	0.35
1999	EAST	1,828	0.90	964	0.90
1999	WEST	6,153	0.83	3,244	0.83
2000	CENTRAL	23,872	0.32	21,274	0.32
2000	EAST	184	0.93	164	0.93
2000	WEST	12,070	0.72	10,756	0.72
2001	CENTRAL	22,930	0.33	20,435	0.33
2001	EAST	392	0.93	350	0.93
2001	WEST	20,247	0.81	18,043	0.81
2002	CENTRAL	23,611	0.34	21,042	0.34
2002	EAST				
2002	WEST	21,303	0.71	18,985	0.71
2003	CENTRAL	24,261	0.39	21,621	0.39
2003	EAST	197	0.92	176	0.92
2003	WEST	36,930	0.75	32,912	0.75
2004	CENTRAL	22,589	0.39	20,131	0.39
2004	EAST	525	0.69	467	0.69
2004	WEST	53,457	0.70	47,640	0.70

Year	SID	OPEN		CLOSED	
		Proxy	CV	Proxy	CV
2005	CENTRAL	19,482	0.39	17,363	0.39
2005	EAST	1,062	0.62	946	0.62
2005	WEST	58,972	0.71	52,556	0.71
2006	CENTRAL	30,505	0.48	27,186	0.48
2006	EAST	419	0.91	373	0.91
2006	WEST	57,318	0.69	51,081	0.69
2007	CENTRAL	28,559	0.51	25,452	0.51
2007	EAST	461	0.90	411	0.90
2007	WEST	47,886	0.79	42,675	0.79

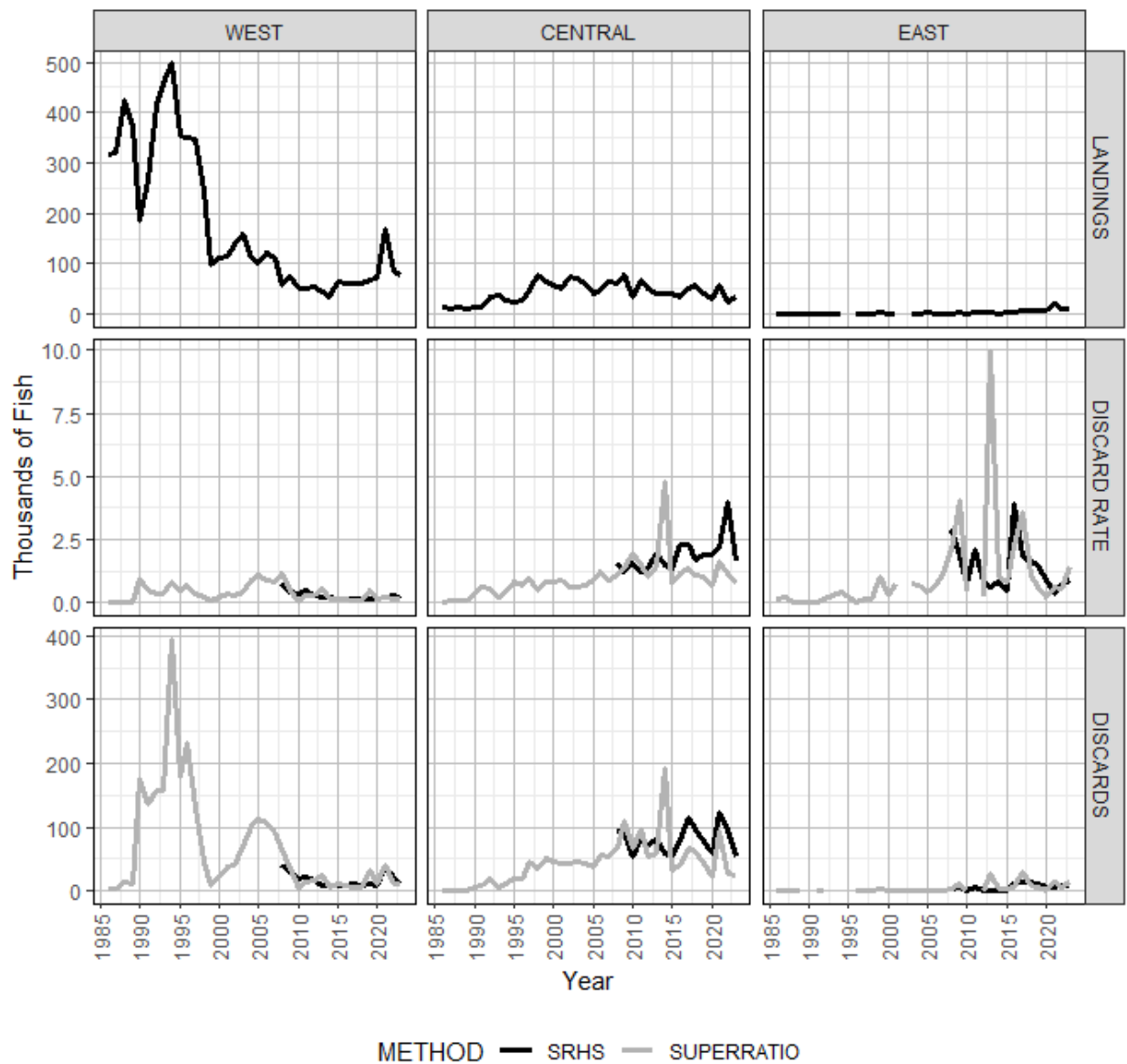


Figure 1. Estimates of SRHS discard proxies for Gulf of Mexico red snapper from the SUPERRATIO approach. Proxy estimates are needed for years 1986-2007 in SEDAR 98, but shown through 2023 to compare proxies to actual SRHS estimates (black lines). Each method calculates discard proxies (third row) as the product of annual SRHS landings estimates (first row) and discard rates from other surveys or years (second row).

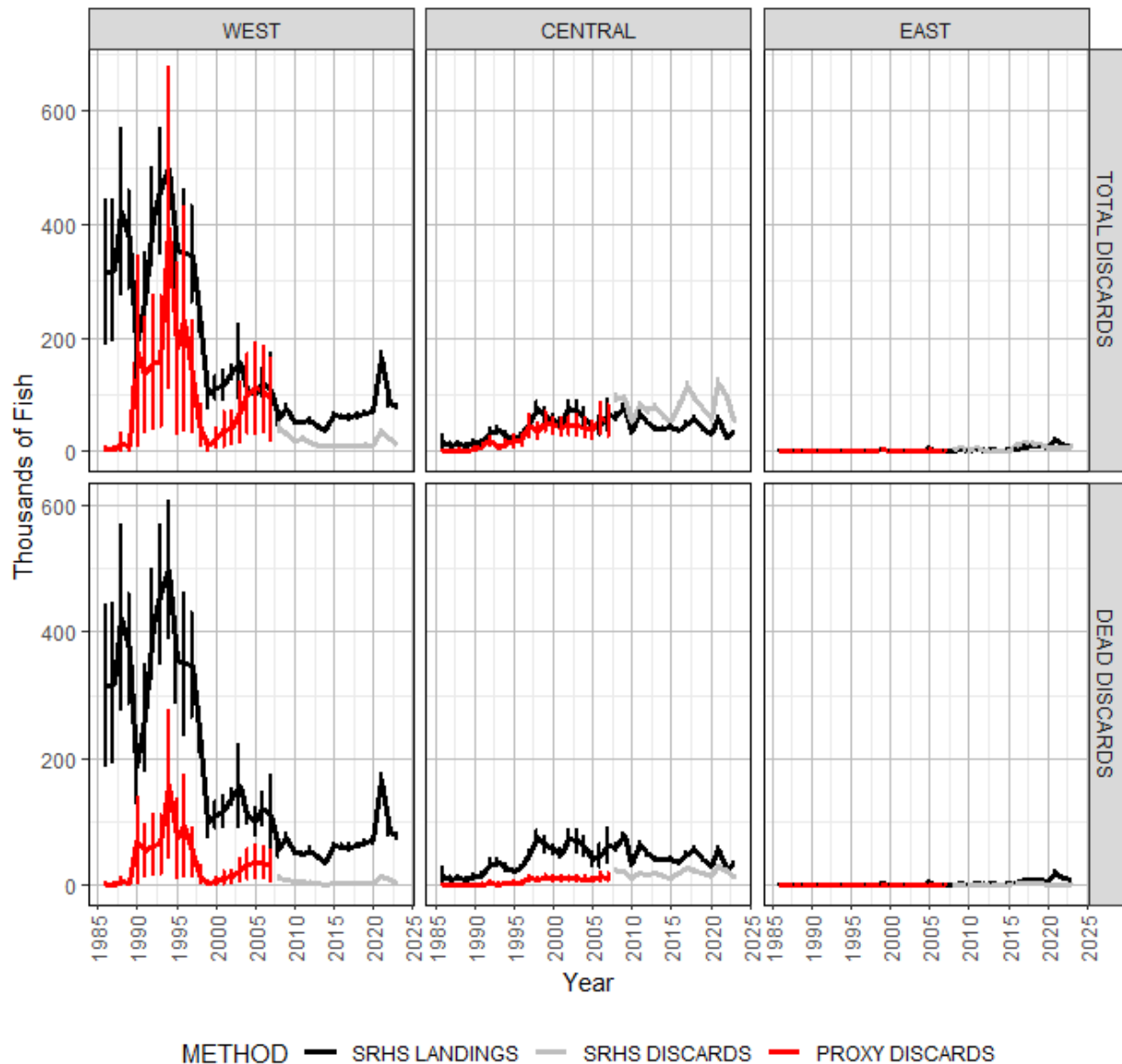


Figure 2. Timeseries of SRHS landings (1986-2023), SRHS discards (2008-2023), and proxy discard estimates (1986-2007) for SEDAR 98 Gulf of Mexico red snapper with associated estimates of uncertainty. Proxy discard estimates were provided by the SUPERRATIO approach, with annual calculations conducted at the SID level. Dead discards (lower panel) were calculated by applying the assumed discard mortality rates from the previous assessment.



Figure 3. Comparison of total SRHS landings and discard estimates provided for Gulf of Mexico red snapper between SEDAR 98 and SEDAR 74, the terminal years of which are 2023 and 2019 respectively. A dashed black line is drawn in 2008 to separate years where SRHS discard estimates were retained for use in SEDAR 98 (2008-2023) versus those where proxy discard estimates are needed (1986-2007).