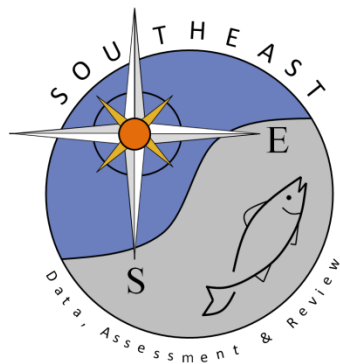


Proxy Discard Estimates of King Mackerel (*Scomberomorus cavalla*)  
from the US Gulf of America Headboat Fishery

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SEDAR99-WP-09

1 April 2026



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Please cite this document as:

Nuttall, Matthew A. 2026. Proxy Discard Estimates of King Mackerel (*Scomberomorus cavalla*) from the US Gulf of America Headboat Fishery. SEDAR99-WP-09. SEDAR, North Charleston, SC. 12 pp.

## Proxy Discard Estimates of King Mackerel (*Scomberomorus cavalla*) from the US Gulf of America Headboat Fishery

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04-01-2026

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### Abstract

Discard data from the Southeast Region Headboat Survey (SRHS) were not routinely collected until 2004, prior to which SRHS discard estimates are not available. These data are self-reported and not currently validated within the SRHS program. Proxy discards are estimated for years prior to 2004, when discard data were not routinely collected in the SRHS, and for years when discard data were collected but not deemed reliable. Following concerns of underreporting in the initial years of data collection, SRHS discard estimates for 2004-2007 were excluded from this analysis. The decision for SEDAR 99 was to retain SRHS discard estimates between 2008-2024 and to calculate proxy discard estimates for those years prior (1981-2007) using the SRHS-Mean approach, with annual calculations conducted at the state (equivalent) level.

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## 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 America, 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 America 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., 1981-2003) 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 99 and the associated justifications for any required decisions (e.g., selection of method and years to include in the estimation).

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## Methods

### *Exclusion of Initial SRHS Discard Estimates*

For SEDAR 99, the decision is to retain SRHS discard estimates for years 2008 - 2024 and to impute proxy discard estimates for any years prior (1981-2007). Given concerns with underreporting in the first few years of discard data collection in the SRHS, and no evidence to the contrary, the SRHS discard estimates for 2004 - 2007 are excluded from this analysis and will be imputed along with those proxy discards needed for years before discard data collection started. Note that this differs from the decision made in SEDAR 38 and which was followed during the SEDAR 38 Update (SEDAR 2014, 2020), where the SRHS discard timeseries started with the first year of data collection (i.e., in 2004) and proxy discards were imputed for 1981-2003.

### *Discard proxy*

Several sources of proxy SRHS discard estimates have been considered in past SEDAR stock assessments, including the preferred Super-Ratio approach (SEDAR-PW-07). All of these methods are based on scaling historic SRHS landings estimates (e.g., 1981-2007) by some assumed discard rate(s), but what differs between the approaches is how these discard rate(s) are estimated, with most being derived from some subset of MRIP catch data (described in SEDAR 99-WP-08). Headboat landings in Texas for years 1981-1985, for which neither MRIP nor SRHS provide estimates, were imputed from the average of SRHS-Texas catch between 1986-1990.

Of those methods considered in SEDAR 99:

- Super-Ratio (charterboat) approach rescales past (e.g., 1981-2007) discard rates of the MRIP charterboat mode (discards:landings) by a superratio scalar, calculated as the ratio of mean discard rates between the MRIP charterboat mode and SRHS headboat mode from recent years (e.g., 2008-2024, 2008-2012). This approach is the current “Best Practice” method for calculating discard proxies as 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. This is the method assessment analysts applied in SEDAR 38U to estimate proxy discards for SRHS headboats.
- MRIP-Charterboat approach applies (unaltered) discard rates of MRIP charterboat anglers from past years (e.g., 1981-2007). This method allows for changes in management and year class effects to be incorporated into the estimation, but does not account for any differences in the magnitude of MRIP vs. SRHS discards.

Additionally, 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. This is the method assessment analysts applied in SEDAR 38 (SEDAR 2014) to estimate proxy discards for SRHS headboats.

- SRHS-Mean approach applies an average SRHS discard rate from recent years (e.g., 2008-2024, 2008-2012). This approach is limited to (native) estimates from the SRHS and not influenced by any inherent differences in the magnitude (of discards) between the MRIP and SRHS. However, this approach relies on (average) SRHS discard rates calculated from years that differ from those for which discard proxies are being calculated, and so does not account for any changes in management or year class effects. The SRHS-Mean proxy method has been applied in past SEDAR stock assessments, offering an alternative when MRIP discard rates are highly variable and/or do not agree with SRHS discard rates (e.g., SEDAR 68, 96).

To determine the most appropriate set of proxy estimates for SEDAR 99 Gulf of America King Mackerel, 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 (2008-2024) (Figure 1). This comparison includes visual inspection of the resultant time series, both between methods and with actual SRHS discard estimates.

As further evaluation of the chosen proxy method, the combined discard timeseries (i.e., proxies from 1981-2007 added to SRHS estimates from 2008-2024) is rescaled to that representative of dead discards using the assumed discard mortality rate (of 20%) from SEDAR 38 and 38U (SEDAR 2014, 2020), facilitating comparisons of actual removals from the population (i.e., landings vs. dead discards, Figure 2). A comparison of proxy discards estimated between SEDAR 99 and the previous stock assessment is also shown (Figure 3).

All proxy discards considered for SEDAR 99 were calculated at the state (equivalent) level, splitting the Gulf of America into four spatial areas: Texas (~80% of regional headboat landings and ~45% of discards), Louisiana (~3% and ~2%), Mississippi (<1% and ~2%), and a combined stratum for Florida-Alabama (~17% and ~51%).

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):

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

GenRec estimates of catch and associated uncertainties are provided in SEDAR 99-WP-08. For those methods that require an average discard rate (e.g., Super-Ratio, SRHS-Mean), the

associated variance is calculated as  $\frac{\Sigma \text{variance}}{n^2}$ . 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

### *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 99 wherein any static ratios used in the imputation of proxy discards (e.g., SRHS:MRIP superratios, mean SRHS discard rates) 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. This approach differs from that applied in the SEDAR 38 Update, which calculated superratios from all years with available SRHS discard estimates (i.e., 2004-2018).

Both the general trends and overall magnitude of proxy estimates (Figure 1) from the preferred Super-Ratio approach were fairly similar to those from the SRHS for years where SRHS discard estimates were available, considered reliable, and retained for use in SEDAR 99 (2008-2024). For those areas comprising the majority of regional headboat discards, the estimated superratio for the combined FLW-AL stratum was 0.226 and for Texas was 0.032, the latter largely suppressed by the negligible discards from Texas headboats relative to SRHS landings (SEDAR 99-DW-02). However, proxy discard estimates from the Super-Ratio approach were also highly variable for Gulf King Mackerel, both over these years of overlap (2008-2024) and historically (1981-2007).

As an alternative to the preferred Super-Ratio approach, we also evaluated proxy discard estimates from the SRHS-Mean and MRIP-Charterboat approaches (Figure 1). The general trends in proxy estimates from the MRIP-Charterboat approach follow those from the Super-Ratio approach, but the overall magnitude differed substantially in some stratum, particularly in Texas for which the applied superratio was relatively small (0.032). Conversely, both the general trends and overall magnitude of proxy estimates from the SRHS-Mean approach were fairly similar to the retained SRHS discard estimates (2008-2024) and proxy discards from the Super-Ratio approach across the time series (1981-2024). However, the SRHS-Mean approach also produced proxy discard estimates with less variability (Figure 1).

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## Discussion

For SEDAR 99, the SRHS-Mean approach is recommended to provide proxy SRHS discard estimates for years 1981-2007 (Table 1, Figure 2). The Super-Ratio approach is the preferred proxy method according to SEDAR Best Practices, with alternative methods considered when this approach fails (SEDAR-PW-07). Of the two methods that produce discard proxies (1981-2007) at a scale comparable to actual SRHS discard estimates (2008+), namely the Super-Ratio and SRHS-Mean approaches, the variability in the Super-Ratio approach seems to better reflect that in SRHS discard estimates (i.e., 2008+) as compared to the relatively flat trends in proxies from the SRHS-Mean approach (Figure 1). However, it is unclear whether this variability in proxy discards from the Super-Ratio approach represents true trends in historical headboat discards. In particular, the Super-Ratio approach produces proxies with a fairly large spike in 1988-Texas (of 1153, which is >7 times larger than the next highest proxy in Texas) and in 1987 FLW (of 360, which is >2 times larger than the next highest proxy in FLW), a highly variable proxy time series for Louisiana, and a large number of years with proxies = zero in Louisiana and Mississippi. In this, the decision for SEDAR 99 was to apply the SRHS-Mean approach, with the understanding that we might be underestimating the true inter-annual variability in headboat discards but while also avoiding suspect fluctuations in proxy discards from the Super-Ratio approach. This is the first assessment for Gulf King Mackerel for which the SRHS-Mean approach has been recommended.

As compared to those provided for the last assessment of Gulf King Mackerel (SEDAR 38 Update) (Figure 3), the proxy discards of SEDAR 99 are a function of a number of changes to the data and estimation. The underlying GenRec data in SEDAR 99 include data updates and improved methodologies described in SEDAR 99-WP-08. The applied method has also been updated, applying a less variable SRHS-Mean approach than the Super-Ratio approach applied in S38U, and with proxy discards calculated from MRIP-CBT and SRHS-HBT estimates based on fishing year in SEDAR 99, vs. calendar year as it was in SEDAR 38U.

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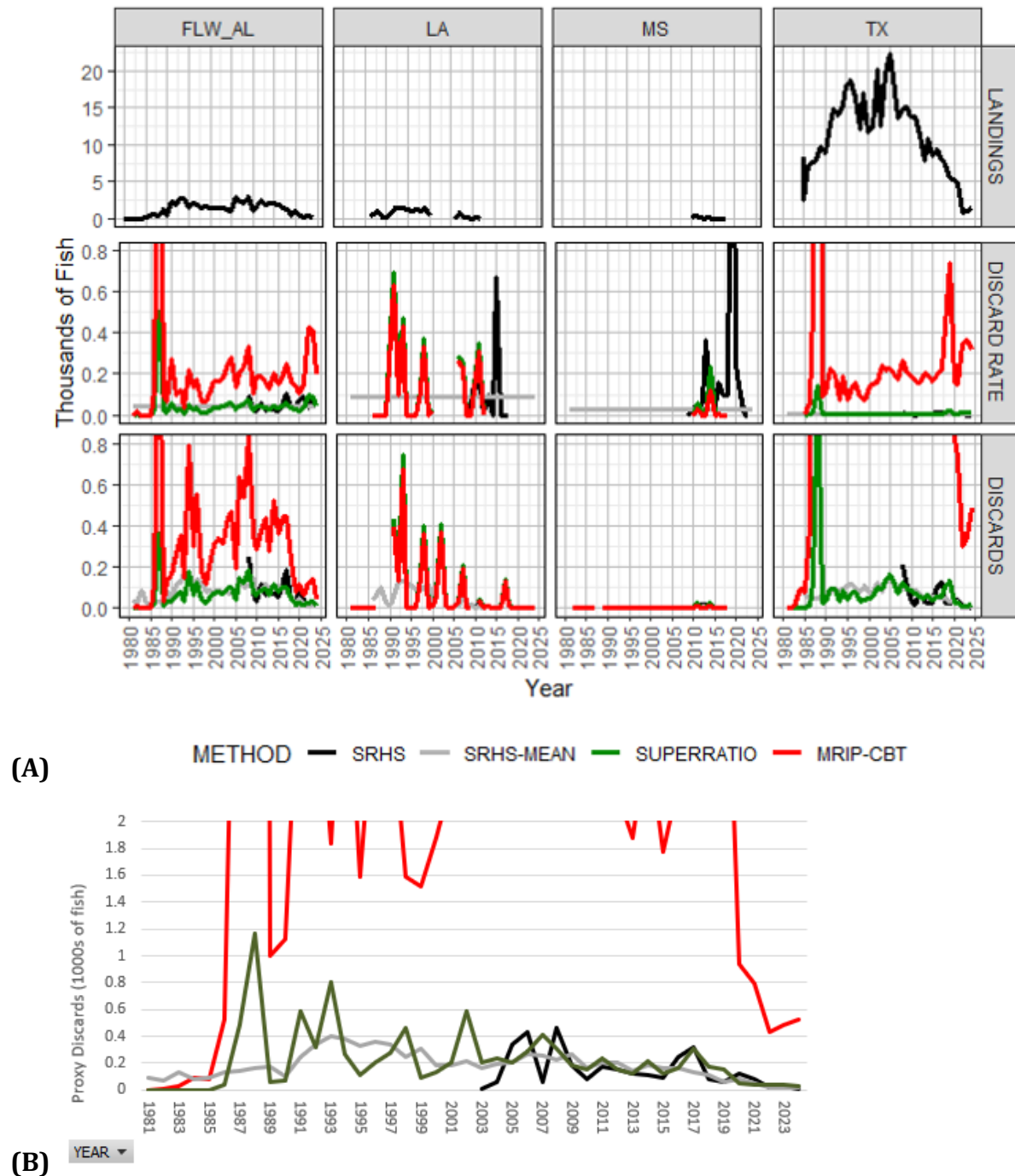
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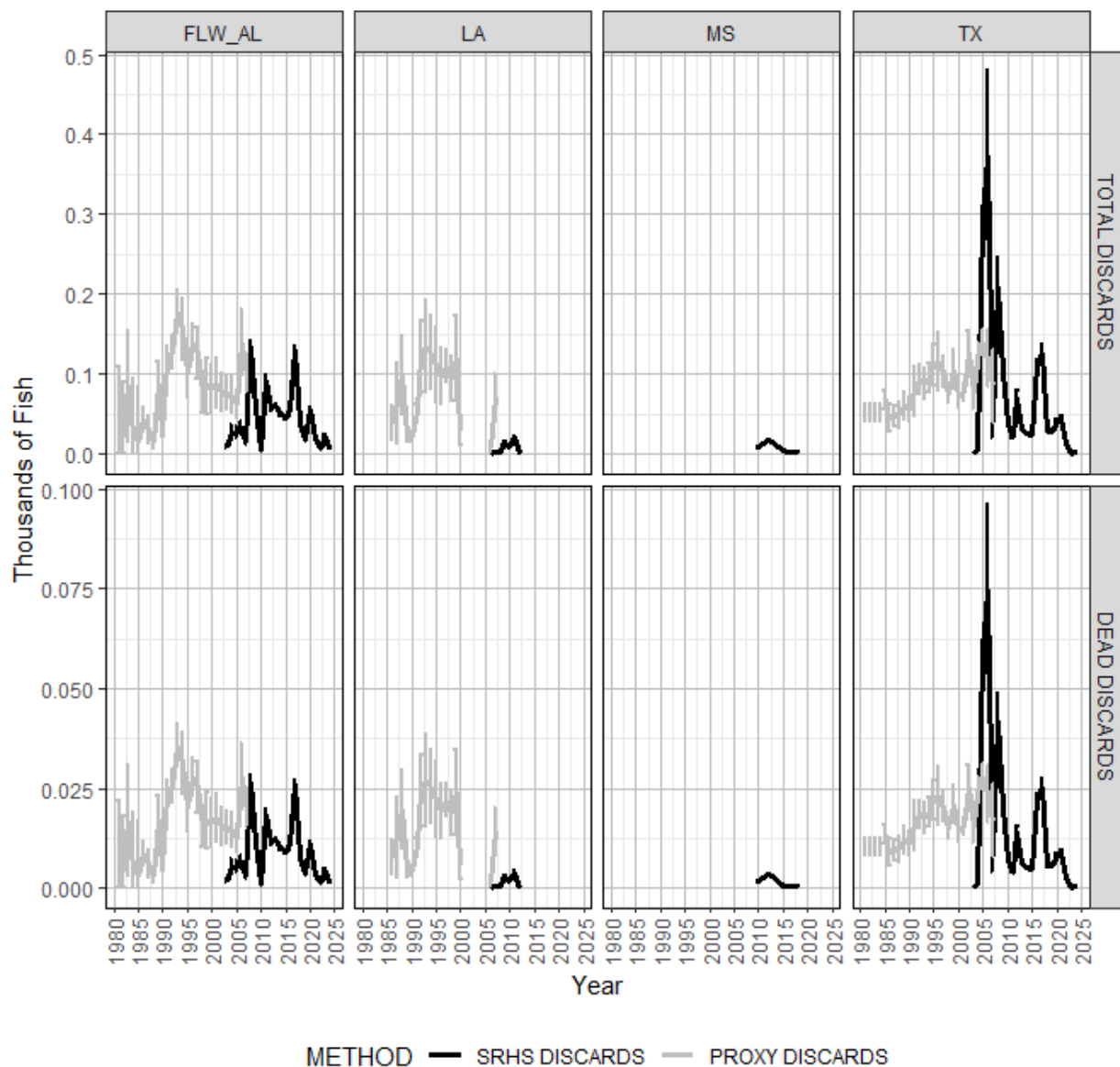
**Table 1.** Timeseries of SRHS Proxy Discard Estimates and associated Coefficients of Variation (1981-2007) for SEDAR 99 Gulf of America King Mackerel. Proxy discards were calculated using the SRHS-MEAN approach, with annual calculations conducted at the state (equivalent) level. Proxies for 1981-1985 were calculated from Texas headboat landings imputed from the average of SRHS-Texas catch between 1986-1990.

Year	FLW_AL		LA		MS		TX	
	Proxy	CV	Proxy	CV	Proxy	CV	Proxy	CV
1981	41	1.67	0	0.00	0	0.00	52	0.21
1982	22	3.10	0	0.00	0	0.00	52	0.21
1983	85	0.80	0	0.00	0	0.00	52	0.21
1984	27	2.53	0	0.00	0	0.00	52	0.21
1985	15	4.55	4	22.27	0	0.00	68	0.17
1986	43	0.35	39	0.55	0	0.00	45	0.38
1987	31	0.55	64	0.78	0	0.00	48	0.27
1988	15	0.50	99	0.49	0	0.00	49	0.32
1989	87	0.32	24	0.39	0	0.00	60	0.28
1990	27	0.18	22	0.29	0	0.00	56	0.27
1991	116	0.16	54	0.17	0	0.00	79	0.39
1992	128	0.16	122	0.37	0	0.00	93	0.19
1993	178	0.15	135	0.42	0	0.00	88	0.22
1994	156	0.24	127	0.36	0	0.00	95	0.19
1995	100	0.29	111	0.42	0	0.00	111	0.23
1996	140	0.17	97	0.36	0	0.00	116	0.31
1997	126	0.25	110	0.18	0	0.00	102	0.19
1998	77	0.34	94	0.29	0	0.00	76	0.16
1999	85	0.40	120	0.45	0	0.00	106	0.22
2000	82	0.36	29	0.58	0	0.00	73	0.21
2001	89	0.34	16	0.56	0	0.00	77	0.14
2002	77	0.30	14	0.92	0	0.00	126	0.23
2003	76	0.27	12	1.13	0	0.00	78	0.29
2004	74	0.29	0	0.00	0	0.00	122	0.15
2005	63	0.27	0	0.00	0	0.00	139	0.13
2006	139	0.31	8	1.00	0	0.00	119	0.30

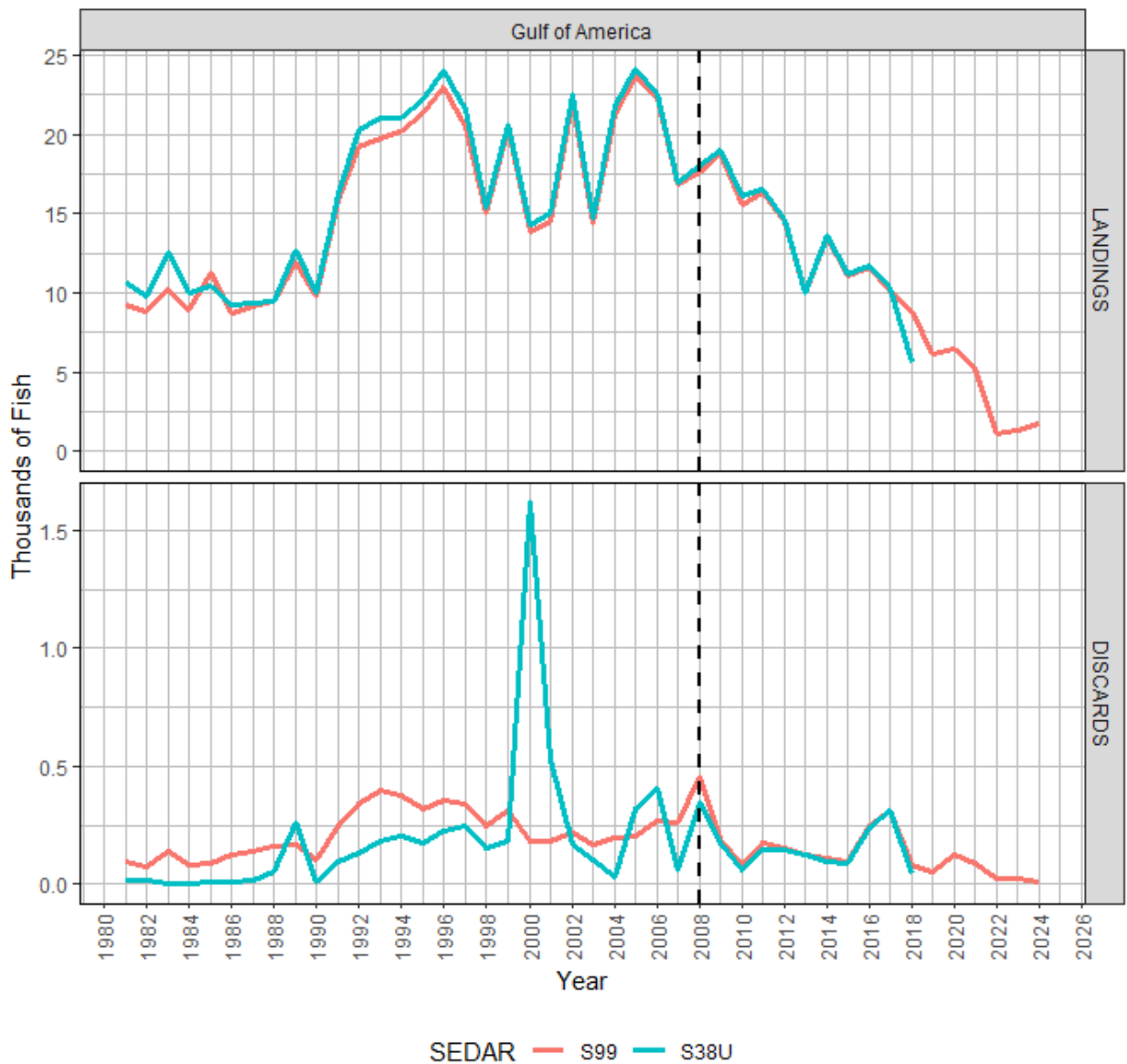
Year	FLW_AL		LA		MS		TX	
	Proxy	CV	Proxy	CV	Proxy	CV	Proxy	CV
2007	102	0.24	72	0.40	0	0.00	85	0.53



**Figure 1.** Comparison of SRHS discard proxies for Gulf of America King Mackerel from various approaches (METHOD) applied in past SEDAR stock assessments, shown both (A) at the resolution of estimation and (B) as applied in the assessment. Proxy estimates are needed for years 1981-2007 in SEDAR 99, but shown through 2024 to compare proxies to actual SRHS estimates (black lines). Each method calculates (panel A) discard proxies (third row) as the product of annual SRHS landings estimates (first row) and discard rates from other surveys or years (second row). The panels for discard rates and discard estimates are zoomed-in to facilitated comparisons between the Super-Ratio and SRHS-Mean approaches.



**Figure 2.** Timeseries of SRHS landings (1980-2024), SRHS discards (2008-2024), and proxy discard estimates (1981-2007) for SEDAR 99 Gulf of America King Mackerel with associated estimates of uncertainty. Proxy discard estimates were provided by the SRHS-MEAN approach, with annual calculations conducted at the State (equivalent) level. Dead discards (lower panel) were calculated by applying an assumed discard mortality rate of 20% from the previous assessment.



**Figure 3.** Comparison of total SRHS landings and discard estimates provided for Gulf of America King Mackerel between SEDAR 99 and SEDAR 38U, the terminal years of which are 2024 and 2018 respectively. A dashed black line is drawn in 2008 to separate years where SRHS discard estimates were retained for use in SEDAR 99 (2008-2024) versus those where proxy discard estimates are needed (1981-2007).