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

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SEDAR90-DW-14

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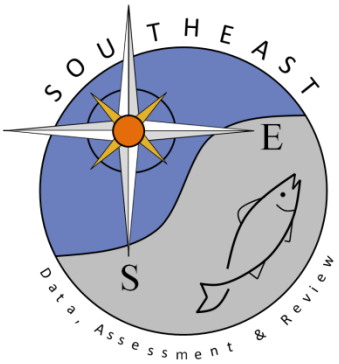

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SEDAR 90-DW-14

Proxy Discard Estimates of Red Snapper (*Lutjanus campechanus*) from the US South Atlantic 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. To validate SRHS discards, the discard rates from self-reported SRHS data were compared to those from the Headboat At-Sea Observer Program. Proxy discards are estimated for years prior to 2004, when discard data were not routinely collected by the SRHS, and for years when discard data were collected but not deemed reliable when validated against the Headboat At-Sea Observer data. The decision for SEDAR 90 was to retain SRHS discard estimates between 2007-2024 and to calculate proxy discard estimates for those years prior (1984-2006) using the SRHS-Bio approach, with annual calculations conducted at the subregional level (i.e., South, North).

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 South Atlantic, headboat observers began sampling in North and South Carolina in 2004 and in Georgia and Florida in 2005 (SEDAR 68-DW-23). Inconsistent funding and natural phenomenon (e.g., 2020 COVID-19 pandemic) have led to short breaks in the sampling for some of these surveys. Within these programs, headboat vessels are randomly selected throughout the year in each state, with the east coast of Florida further stratified into two sample regions (i.e., north vs. south). 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 90 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 South Atlantic red snapper, calculated as total discards per unit fishing effort (i.e., number anglers x hours fished), from SRHS logbooks were compared to those from Headboat At-Sea Observer Programs to validate SRHS discard estimates (Figure 1). This comparison is used to identify the appropriate start year for SRHS discard estimates (e.g., 2004, 2008) and any calibrations needed to offset potential misreporting of SRHS discard rates. SRHS discard estimates in the early years of data collection (i.e., 2004-2007) were also compared to those in subsequent years to further evaluate the likelihood of under-reporting.

This analysis was done at an annual level, comparing median discard rates from trip-level data across all trips reported by SRHS logbooks versus those observed by at-sea observers, and across only those trips sampled by both programs (i.e., matching trips). The number of observed trips from the observer programs was also compared to that from SRHS logbooks to evaluate the adequacy of coverage by the At-Sea Observer Programs (Table 1).

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., 1984-2006) 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 90-DW-03). SRHS catch estimates are provided in SEDAR 90-DW-02.

Of those methods considered in SEDAR 90:

- Super-Ratio (charterboat) approach rescales past (e.g., 1984-2006) 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., 2007-2024, 2007-2012). 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.
- SRHS-Bio approach was developed for South Atlantic red snapper in SEDAR 41 (SEDAR 2017) and uses size compositions of biologically sampled fish from SRHS dockside intercepts to quantify the discards expected after a size limit has been implemented on a fishery. This approach uses the discard rate, calculated as the ratio of undersized fish below a given size limit to those legal-sized fish above it,

within a time block not under that size limit as a measure of the discards (relative to landings) expected in the time block under that size limit. To account for the potential harvest of undersized fish, this baseline discard rate from the time block without the size limit is subtracted from that with the size limit, which is then multiplied by historic SRHS landings estimates as a proxy for historic SRHS discards. For SEDAR 90, time blocks with size limits were defined as 1984-1991 and 1992-2010, which restricted red snapper harvest to 12" (48 FR 39463) and 20" total length (56 FR 56016), respectively. The baseline time period was set at 1981-1983, when no size limits were in place for South Atlantic red snapper. The SRHS-Bio approach is the same selected and applied in SEDARs 41 and 73. It is limited to (native) data and estimates from the SRHS and not influenced by any inherent differences in the magnitude (of discards) between the MRIP and SRHS. However, this approach assumes discarding by regional headboats is largely a function of size limits and may produce biased estimates if other factors with potential effect on angler behavior have not remained static (e.g., cohort strength, other management actions).

To determine the most appropriate set of proxy estimates for SEDAR 90 South Atlantic 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 (2007-2024) (Figure 2). 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 1984-2006 added to SRHS estimates from 2007-2024) is rescaled to that representative of dead discards using the assumed discard mortality rates from the previous stock assessment for South Atlantic red snapper (SEDAR 2021, Table 2), facilitating comparisons of actual removals from the population (i.e., landings vs. dead discards, Figure 3). A comparison of proxy discards estimated between SEDAR 90 and the previous stock assessment is also provided (Figure 4).

All proxy discards considered for SEDAR 90 were calculated at the subregional level, splitting the South Atlantic into two spatial areas: a NORTH region that includes North Carolina and South Carolina (~10% of regional landings and ~7% of discards) and a SOUTH region that includes Georgia and eastern Florida (~90% of regional landings and ~93% of discards).

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 90-DW-02. GenRec estimates of catch and associated uncertainties are provided in SEDAR 90-DW-03. For those methods that require an average discard rate (e.g., superratios, SRHS-Mean, MRIP-Smoothing Methods), the associated variance is calculated as $\frac{\sum variance}{n^2}$. 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

The last time this validation was done (SEDAR 41-DW-29) the, SRHS program collected 18,348 logbook records with South Atlantic red snapper catch between 2004-2013 (Table 1), ~80% of which reported discards of red snapper. The At-Sea Observer Program, conversely, only observed South Atlantic red snapper catch on 524 trips, ~3% of that sampled by the SRHS.

Due to the differences in magnitude of the number of trips sampled between the two programs, low percentage of matched trips (~2%), and low numbers of positive trips from regional observer programs (Table 1), the discard rates used in this validation analysis were calculated from all observed trips. Matched and positive trips were not compared. Similarly, the low sample sizes from those observer programs outside of Florida (~10 trips/year) necessitated a focus on Florida discard rates in this analysis. This approach is further justified by the relatively large amount of regional headboat catch originating from this state (~90% of landings and discards, SEDAR 90-DW-02).

Discard rates of Florida red snapper from SRHS logbooks tend to be lower than those from At-Sea Observer data, suggesting a consistent underreporting of discards in the SRHS logbooks (Figure 1). However, based on the relative overlap in distributions of discard rates between these two datasets, these differences appear insignificant from 2007 through 2015. These discard rates are also of the same general magnitude and show the same general trend, suggesting SRHS discard rates were accurately reported over these years.

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 90 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 (2007-2012). The number of years selected in this estimation (i.e., six) 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 decision is in-line with the conclusions from the analysis above, which validated use of SRHS discard estimates from 2007-2015. This approach differs from that applied in SEDARs 41 and 73, for which all years with valid SRHS discard estimates were retained in this estimation (i.e., 2007+).

Despite differences in the magnitude of recreational discard rates and associated estimates (Figure 2), the general trends in proxy estimates 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 90 (2007-2024). However, across these years of overlap, proxy discard estimates from the Super-Ratio approach were also highly variable for South Atlantic red snapper, particularly in those years where MRIP-charter landings estimates are relatively negligible (2010-2011, 2015-2016; Figure 8 in SEDAR 90-DW-03). The historical proxy estimates from this approach (1984-2006) were also relatively small compared to those from the SRHS in subsequent years (2007+), suggesting the Super-Ratio approach may be underestimating historical headboat discards.

As an alternative to the preferred Super-Ratio approach, we also evaluated proxy discard estimates from the SRHS-Bio approach, which is the same approach ultimately selected and applied in SEDARs 41 and 73. This approach produced proxy discard estimates with less variability and that were more in-line with subsequent SRHS discard estimates than from the Super-Ratio approach (Figures 2 and 3).

Discussion

Validation of SRHS Catch Rates

Discard rates from the SRHS and At-Sea Observer programs in Florida exhibit a similar magnitude and pattern from 2007-2012 (Figure 1). This validates the SRHS discard estimates in those years. Analyses of discard rates in other South Atlantic states (i.e., NC, SC, and GA) were impeded by very low sample sizes in the At-Sea Observer programs.

Discard Proxy

For SEDAR 90, the SRHS-Bio approach is recommended to provide proxy SRHS discard estimates for years 1984-2006 (Table 3, Figure 3). 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). For South Atlantic red snapper, the Super-Ratio approach produced proxy discards that were highly variable and suspect in some years. In particular, the high proxy discard estimate for 2016 in the South region was a function of a relatively high discard rate from MRIP charterboats (Figure 2) and not believed to be representative of a true trend in SRHS headboat catch (i.e., it is not seen in the corresponding landings timeseries). This 2016 proxy estimate is also more than six times larger than any annual discard estimate from the SRHS (i.e., ~72k fish in 2008). There is similar concern with the proxy discard estimate for 2012 in the South region, which is over three times larger than the (2008) maximum of SRHS discard estimates. Although the same variability is not seen in the historical proxy discards (1984-2006) estimated by the Super-Ratio approach, the variability in the overlap period (2007+) is of a magnitude sufficient to question the validity of historical proxy discards estimated by the Best Practice approach. Building on these concern, the historical proxy discards estimated by the Super-Ratio approach tended to be quite a bit smaller than those estimated by SRHS, with average annual proxy discards (from 2000-2006) being ~30% of those estimated by SRHS in subsequent years (2007-2015). This difference in scale can pose problems for assessment models, which have to explain such patterns even if not reflective of real catch trends.

Given these concerns with the preferred Super-Ratio approach, the SRHS-Bio approach is recommended as an alternative for SEDAR 90. This approach produced proxy discards that are less variable than those from the Super-Ratio approach (Figure 2) and of a more similar magnitude to those SRHS discard estimates retained for use in this assessment (Figure 3). This decision also agrees with those in past SEDAR stock assessments for South Atlantic red snapper (i.e., SEDARs 41 and 73).

Compared to its application in previous assessments, the SRHS-Bio approach applied in SEDAR 90 produced larger proxy discards than those provided for SEDARs 41 and 73 (Figure 4). This difference is a function of how discard rates were calculated from SRHS biological data, wherein past assessments calculated the percentage of fish below a given size threshold (i.e., #Sublegal/#TotalFish) while the approach applied in SEDAR 90 calculated a ratio of size classes (i.e., #Sublegal/#Legal). The latter approach is believed more appropriate as these discard rates are multiplied by historical SRHS landings (i.e., of legal-sized fish), which can conceivably be larger or smaller than the estimated proxy discards. In this, a percentage was considered inappropriate as it would introduce a bound on proxy discards to be no greater than the associated SRHS landings estimate. It is the removal of this bound that is driving the difference in proxy discards summarized in Figure 4.

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Table 1. Sample sizes of positive and matched red snapper trips between the SRHS and At-Sea Observer Programs. No red snapper positive trips were sampled in the At-Sea Observer program in 2004. These tables are copied from Tables 1 and 2 in SEDAR 41-DW-29.

(A) Number of red snapper positive trips reported in the SRHS and number of At-Sea Observer trips positive for red snapper by year and state, 2004-2013.

	FL		GA		NC		SC		South Atlantic	
Year	SRHS reported trips (n)	At-Sea Observer trips sampled (n)	SRHS reported trips (n)	At-Sea Observer trips sampled (n)	SRHS reported trips (n)	At-Sea Observer trips sampled (n)	SRHS reported trips (n)	At-Sea Observer trips sampled (n)	SRHS reported trips (n)	At-Sea Observer trips sampled (n)
2004	1,326		146		69		256		1,797	
2005	1,191	40	129	1	24	1	152	6	1,496	48
2006	1,202	28	99	3	70	1	115	3	1,486	35
2007	1,353	58	80	2	37	7	160	3	1,630	70
2008	1,824	55	104	3	85	9	127	2	2,140	69
2009	2,177	49	153	7	81	2	160		2,571	58
2010	1,707	42	99	2	123	11	171		2,100	55
2011	1,399	41	99	1	56	8	204		1,758	50
2012	1,472	46	54	4	87	14	95	1	1,708	65
2013	1,440	45	70	10	92	19	60		1,662	74
Total	15,091	404	1,033	33	724	72	1,500	15	18,348	524

(B) Proportion of red snapper positive At-Sea Observer trips matched to SRHS reported trips, 2005-2013.

Year	FL	GA	NC	SC	South Atlantic
2005	0.019	0.008	-	0.026	0.019
2006	0.013	0.020	-	0.017	0.013
2007	0.021	0.013	-	0.006	0.018
2008	0.021	-	0.024	0.016	0.020
2009	0.016	0.039	-	-	0.016
2010	0.020	0.020	0.024	-	0.019
2011	0.017	0.010	0.071	-	0.016
2012	0.021	0.037	0.115	0.011	0.026
2013	0.023	0.100	0.043	-	0.026

Table 2. Discard mortalities for the commercial handlines (cH), headboat (HB), and general recreational (GR) fleets assumed and applied in SEDAR 73. For HB and GR, Block 1 ends in 2010 and Block 2 going from 2011–2016, representing a reduction in discard mortality associated with the mandated transition from J-hooks to circle hooks. For all fleets, Blocks 3 and 4 account for increased use of descender devices (i.e., 25% usage and 75% usage, respectively), with Block 3 going from 2017–2020, and Block 4 being post-2020 (for projections). Shown in parentheses are the ranges used in uncertainty analyses. This table is copied from Table 6 in the SEDAR 73 final assessment report.

Fleet	Block 1	Block 2	Block 3	Block 4
cH	$0.48(0.38-0.58)$	$0.38(0.28-0.48)$	$0.36(0.26-0.46)$	$0.32(0.22-0.42)$
HB	$0.37(0.27-0.45)$	$0.26(0.18-0.34)$	$0.25(0.17-0.33)$	$0.22(0.14-0.30)$
GR	$0.37(0.27-0.45)$	$0.28(0.20-0.36)$	$0.26(0.18-0.34)$	$0.23(0.15-0.31)$

Table 3. Timeseries of SRHS Proxy Discard Estimates and associated Coefficients of Variation (1984-2006) for SEDAR 90 South Atlantic red snapper by SID domain. Proxy discards were calculated using the SRHS-BIO approach, with annual calculations conducted at the subregional level.

	NORTH		SOUTH	
Year	Proxy	CV	Proxy	CV
1984	11	0.41	62	0.61
1985	45	0.41	87	0.60
1986	8	0.37	32	0.52
1987	31	0.38	38	0.53
1988	63	0.42	47	0.58
1989	31	0.52	35	0.62
1990	18	0.50	36	0.63
1991	17	0.50	21	0.67
1992	0	0.00	12,674	0.40
1993	0	0.00	15,363	0.35
1994	0	0.00	38,347	0.49
1995	0	0.00	30,720	0.46
1996	0	0.00	20,883	0.64
1997	0	0.00	25,304	0.47
1998	0	0.00	26,527	0.49
1999	0	0.00	30,315	0.64
2000	0	0.00	49,193	0.69
2001	0	0.00	46,673	0.67
2002	0	0.00	43,836	0.72
2003	0	0.00	29,187	0.71
2004	0	0.00	58,183	0.74
2005	0	0.00	57,454	0.75
2006	0	0.00	41,331	0.74

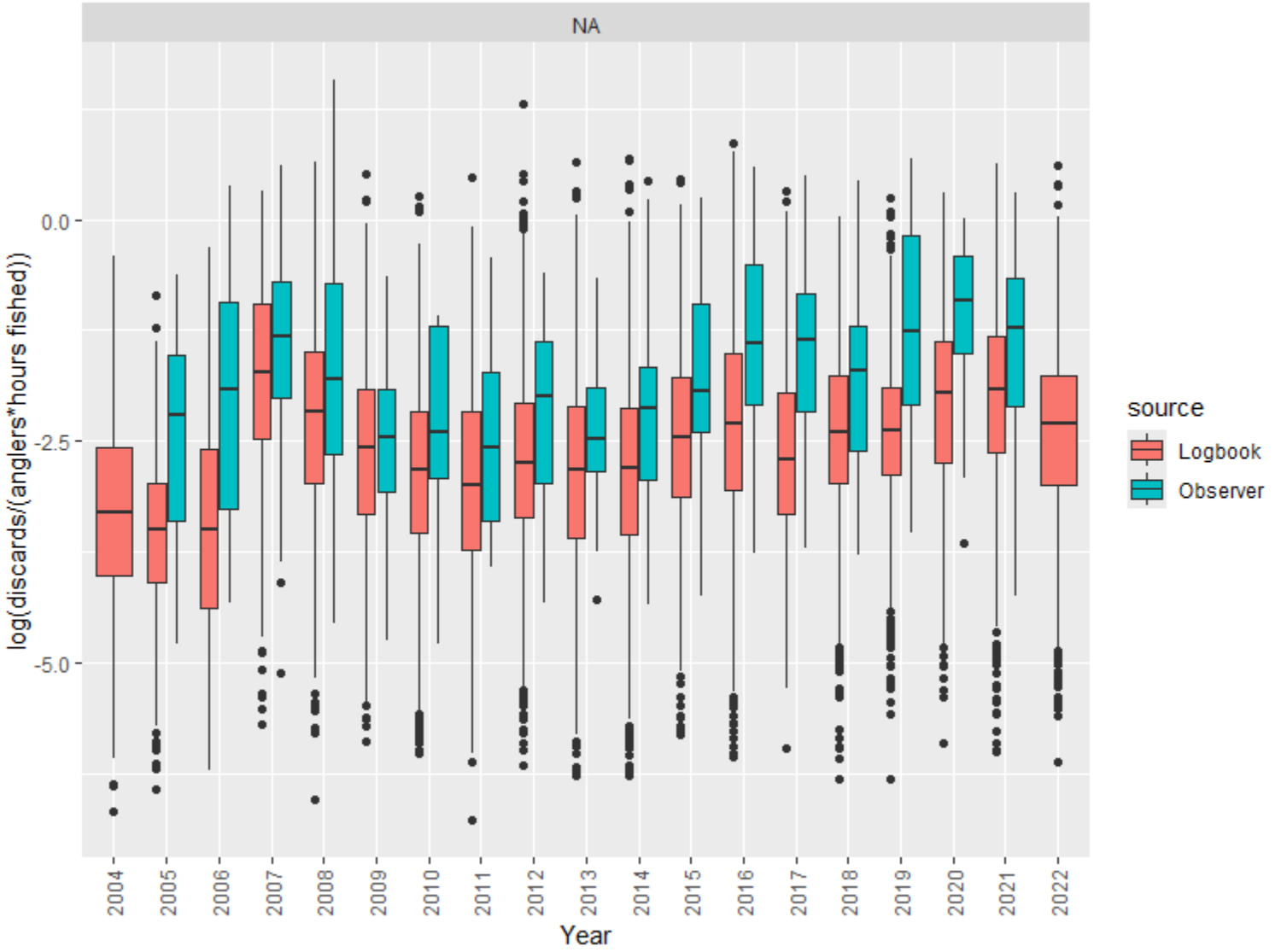

Figure 1. Comparison of the distribution of discard rates (i.e., log of total discards per angler-hour fished) of South Atlantic red snapper from Florida headboats between the SRHS and At-sea Observer programs (2004-2022).

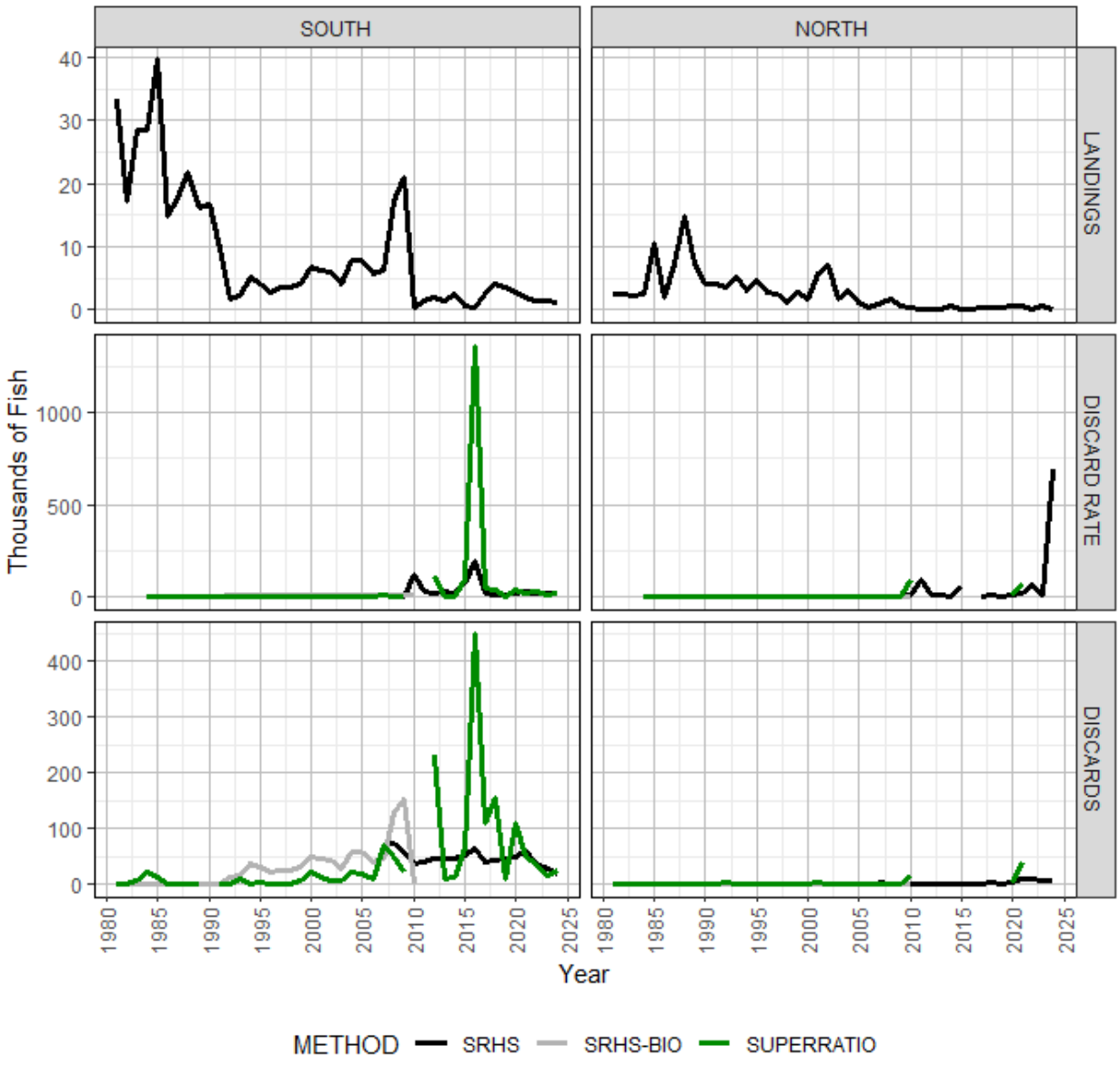

Figure 2. Comparison of SRHS discard proxies for South Atlantic red snapper from various approaches (METHOD) applied in past SEDAR stock assessments. Proxy estimates are needed for years 1984-2006 in SEDAR 90, but shown through 2024 to compare proxies to actual SRHS estimates (black lines). Each method 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).

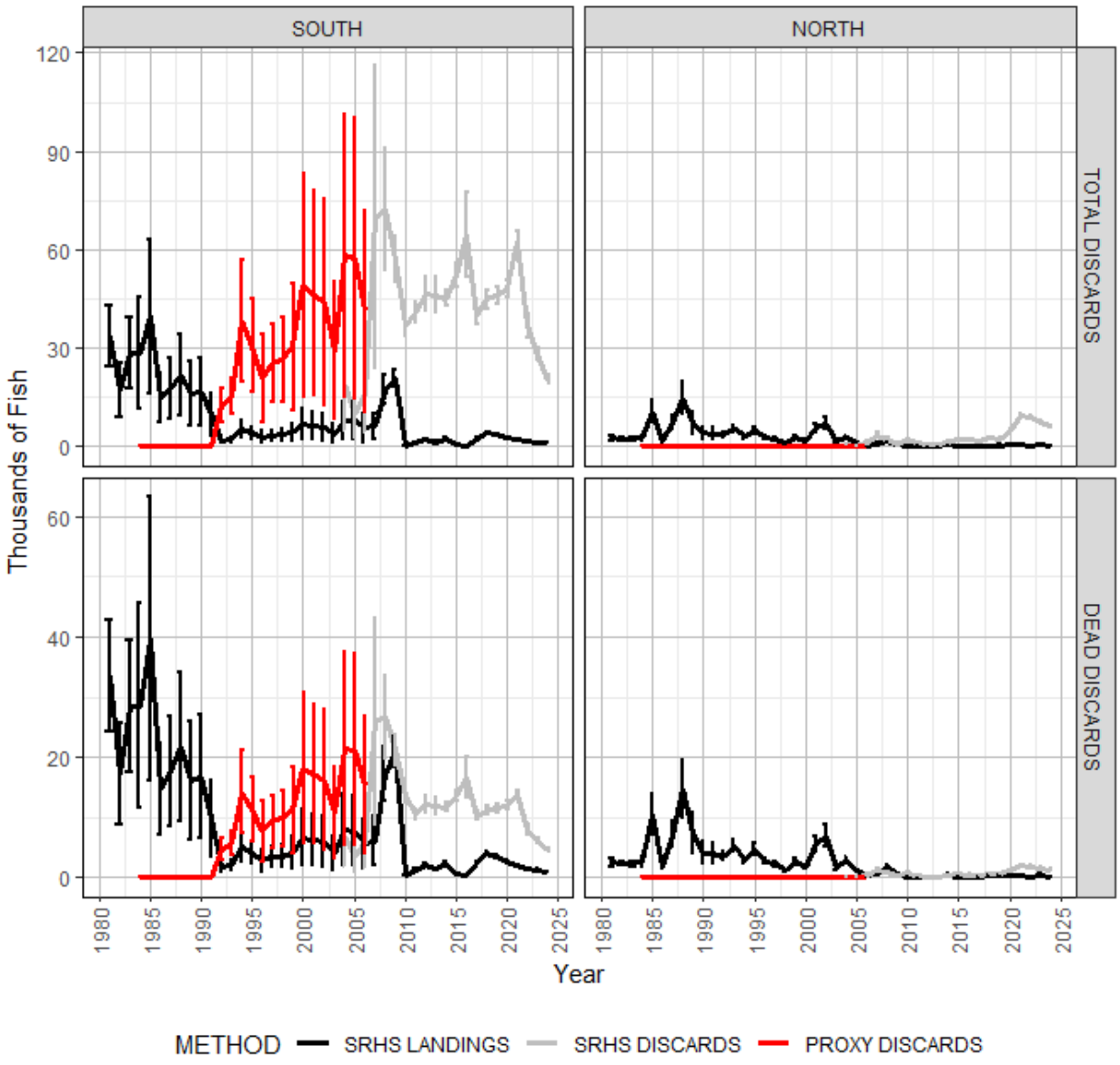

Figure 3. *Timeseries of SRHS landings (1981-2024), SRHS discards (2007-2024), and proxy discard estimates (1984-2006) for SEDAR 90 South Atlantic red snapper with associated estimates of uncertainty. Proxy discard estimates were provided by the SRHS-BIO approach, with annual calculations conducted at the subregional level. Dead discards (lower panel) were calculated by applying the assumed discard mortality rates from the previous assessment.*

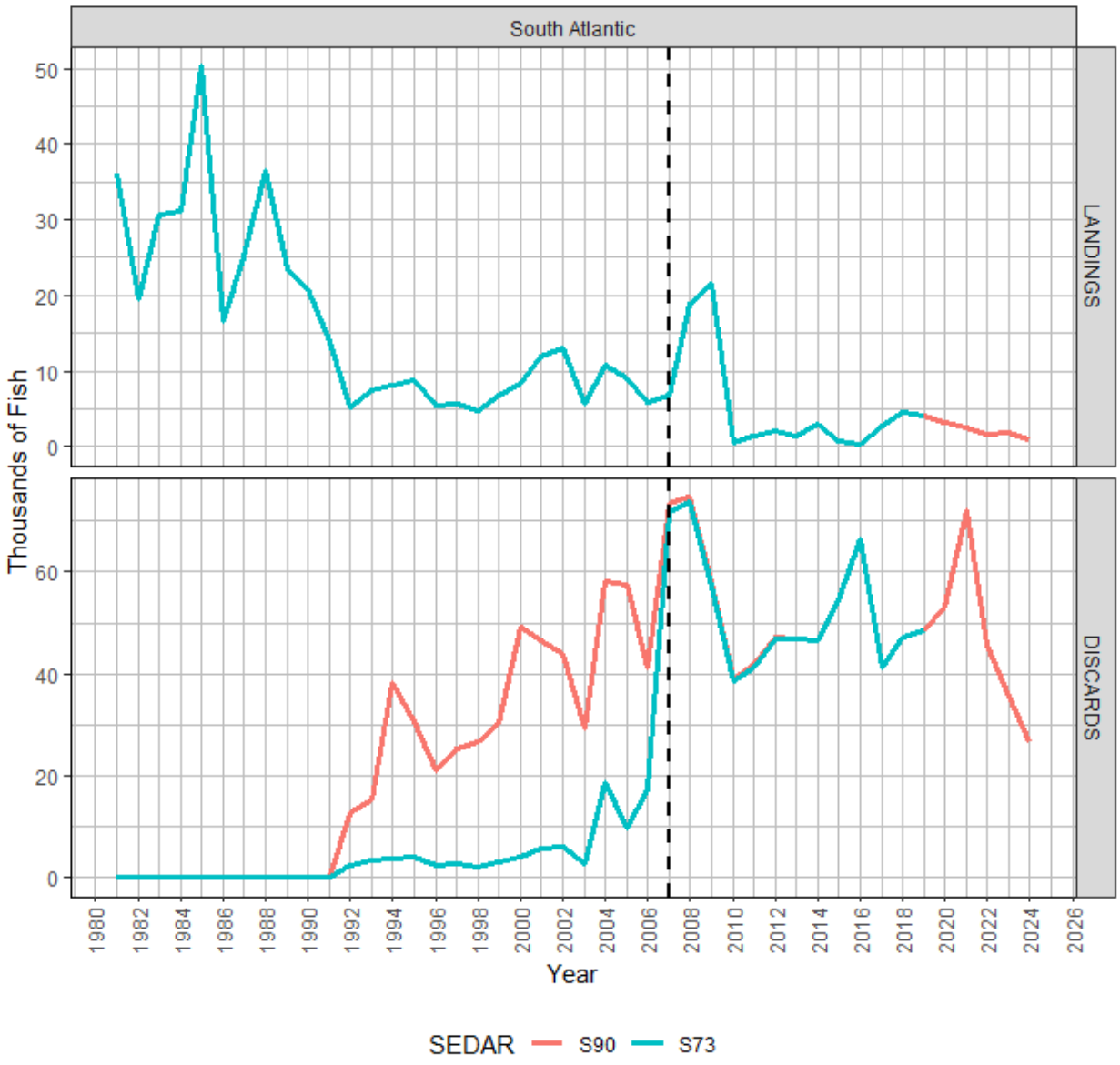

Figure 4. *Comparison of total SRHS landings and discard estimates provided for South Atlantic red snapper between SEDAR 90 and SEDAR 73, the terminal years of which are 2024 and 2019 respectively. A dashed black line is drawn in 2007 to separate years where SRHS discard estimates were retained for use in SEDAR 90 (2007-2024) versus those where proxy discard estimates are needed (1984-2006).*