SEDAR 68 Commercial Discard Mortality Estimates Based on Observer Data

Jeff Pulver

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SEDAR 68 Commercial Discard Mortality Estimates Based on Observer Data

Jeff Pulver

Southeast Regional Office, 263 13th Avenue South, St. Petersburg, FL 33701

Introduction

A literature review and at-sea observer data were used to estimate commercial discard mortality for SEDAR 68. Fishery-dependent catch information collected by the National Marine Fisheries Service (NMFS) Southeast Fisheries Science Center (SEFSC) Galveston Lab Reef Fish Observer Program (RFOP) on board commercial vessels in the Gulf of Mexico (Gulf) from July 2006 through December 2019 (accessed June 1, 2020) using standardized data protocols (NMFS, 2018) were used for all commercial estimates since no mandatory at-sea observer program is currently in place in the South Atlantic. Similar to other studies, the RFOP currently determines immediate discard mortality through surface observations of individual fish after discard (Patterson et al., 2002; Stephen and Harris, 2010). Short-term survival was assumed if the fish was able to descend rapidly or slowly and immediate mortality was classified when the fish floated on the surface or floated on the surface then slowly descended (not swimming). Although submergence ability as a proxy for discard mortality is problematic since it does not account for any long-term effects (delayed mortality), similar studies have shown that when other factors, such as hook trauma or barotrauma, are included, it can be used as a reasonably accurate method for inferring total discard mortality rates (Patterson et al., 2002; Rudershausen et al., 2014).

Methods

For the Gulf RFOP, each year vessels were randomly selected quarterly to carry an observer. Sampling effort was stratified by season and gear in the eastern and western Gulf based on annually updated vessel logbook data (Scott-Denton et al., 2011). Beginning in February 2009, increased observer coverage levels were directed at the bottom longline fishery in the eastern Gulf due to concerns regarding sea turtle interactions. Additionally, in 2011, increased funding allowed enhanced coverage of both the vertical line and bottom longline fisheries through 2014. Because of these actions, observer coverage levels did not remain consistent throughout the years (1% to 5% based on the number of days at sea), but varied depending on funding levels. Despite these variations in coverage levels, catch data were collected from vessels using multiple gear types across broad spatial and temporal scales. For this study, discard mortality was estimated for both hook-and-line (vertical line) and bottom longline gear.

Fishery observers on reef fish vessels assigned one of the following dispositions to each fish captured by the vessel: kept, used for bait, discarded alive, discarded dead, discarded unknown if dead or alive, and unknown if kept or discarded. For discarded fish, the disposition determination of alive or dead was based on surface observation of individual fish. If the fish rapidly or slowly descended, even with barotraumatic stress indicators, it was recorded as alive. It was considered dead if it floated on the surface or floated on the surface then slowly descended (not swimming). Some fish were recorded with an unknown discarded disposition due to the difficulty of observing discards attributed to poor lighting, high seas, or other factors. In this study, only individual fish that were discarded as either alive or dead were used to examine immediate discard mortality. Individual fish recorded as dead upon arrival were included in the analyses since the goal was to examine total discard mortality.

Onboard reef fish vessels, observers also recorded if the fish was vented (air bladder punctured) prior to release; however, no distinction on the quality of the observed technique was recorded. Bottom depths were recorded in feet using fishing vessel equipment, typically depth sounders, and a fishing depth was estimated by monitoring gear deployment at each fishing site. All depths were converted to meters for the analyses.

A logistic regression model was fit to determine if fishing depth, gear, or venting affected the immediate mortality observed. Stepwise backwards selection removed non-significant ($P > 0.05$) covariates using the likelihood ratio χ^2 P-Value to determine significance at each step. The initial model fit to the binary response of immediate discard mortality (alive or dead) was modeled as:

$$Logit(Y_i) = \alpha + \beta Depth_i + \beta Gear_i + \beta Vented_i$$

where α is the intercept and β are the estimated model coefficients, depth of capture, gear (e.g. bottom longline or vertical line), and whether venting occurred. For the significant variables remaining in the model, the predicted odds ratios with profile likelihood 95% confidence intervals were calculated using the ‘confint’ function in R. For each final model, the overall χ^2 significance compared to an intercept only model, percent of deviance explained, and area under the receiver operating characteristic curve (AUC) were also reported. The AUC is a measure of overall model predictive accuracy, with 0.5 considered random and 1.0 a perfect fit (Agresti, 2013). A Hosmer-Lemeshow test statistic was used to assess the goodness of fit for the final logistic regression model (Agresti, 2013).

The final logistic model was used to predict immediate mortality in the Gulf and South Atlantic commercial fisheries. In the Gulf, estimates were made for bottom longline and vertical line gear, but in the South Atlantic only a vertical line estimate was produced. The immediate mortality estimates were made on depths obtained from the SEFSC Supplemental Discard Logbook (accessed May 2020) from trips that had scamp or yellowmouth grouper recorded as discarded from 2010 through 2019. The SEFSC Supplemental Discard Logbook is filled out on a subset of commercial trips with the vessel recording the bottom capture depth where the majority of discards occurred by species. The weighted mean (weighted by the number of fish discarded per trip) for immediate mortality was estimated for each region and gear combination. In addition, both vented and unvented estimates were produced. Analyses were performed using R statistical software (version 3.6.1; R Core Team 2019).

Results

There were 963 fish (955 scamp and 8 yellowmouth grouper) with a discard disposition of either alive or dead and depth recorded by the RFOP from July 2006 through 2019 (Table 1). The RFOP nominal immediate discard mortality rate based on the surface estimates was 40.3% for gears combined with a 95% confidence interval (CI) of 37.2 – 43.5% (Wilson score interval with continuity correction). The immediate discard mortality rate for vertical line gear of 28.4% (95% CI 25.0 – 32.1%) was lower than the bottom longline rate of 65.3% (95% CI 59.7 – 70.6%). The majority of discards observed by the RFOP were captured between 20 m and 90 m with bottom longline having discards at deeper depths compared to vertical line (Figure 1).

Depth, gear, and venting were significant variables in predicting immediate mortality for scamp and yellowmouth grouper discards observed by the RFOP (Table 2). The final logistic regression model was significant ($P < 0.001$) and explained 23.3% of the deviance. The AUC value of 0.82 was acceptable indicating good predictive accuracy. In the final model, the predicted immediate discard mortality increased with capture depth, vertical line had substantially lower mortality compared to bottom longline gear, and air bladder venting had a positive effect, decreasing predicted mortality (Figure 2).

The SEFSC Supplemental Discard Logbook had the shallowest depths recorded for discard in the South Atlantic vertical line fishery, with deeper depths for discards being reported from the Gulf (Figure 3). The predicted immediate mortality estimates in the South Atlantic commercial vertical line fishery were the lowest with an estimate of 21% for scamp and yellowmouth grouper not vented and 16% for vented fish (Table 3). The highest estimates were for the Gulf bottom longline fishery of 53% for fish not vented and 47% for fish vented. The predicted Gulf vertical line estimate of 29% for fish not vented was very similar to the nominal RFOP immediate mortality rate of 28%, but the predicted Gulf bottom longline estimates were lower than the nominal RFOP bottom longline rate of 65%.

Discussion

In addition to immediate mortality, post-release (delayed) mortality, and predation should be considered for a total discard mortality estimate. Based on the available literature, post-release (delayed) mortality estimates between 0 and 75% were available from four studies (Table 4). It should also be noted that discarded scamp generally had higher mortality compared to other reef species observed by the RFOP (Pulver, 2017).

In conclusion, the RFOP estimates for scamp and yellowmouth grouper captured and discarded in the commercial Gulf of Mexico fishery may differ from the South Atlantic due to differences in gears used, depth of capture, water temperatures, or differences in other variables not specified that could affect discard mortality. The reliability of this analysis is dependent upon the accuracy of the underlying data and input assumptions.

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Table 1. The total number of discarded captures with an alive or dead disposition with the mean depth of capture and proportion vented prior to release recorded by the RFOP from July 2006 through December 2019.

Gear	Disposition Category	Number Observed	Mean Depth (m)	Vented
Bottom Longline	Alive	107	76.2	0.61
Bottom Longline	Dead	202	77.3	0.47
Bottom Longline	Total	309	76.9	0.51
Vertical Line	Alive	468	47.6	0.41
Vertical Line	Dead	186	91.9	0.58
Vertical Line	Total	654	60.2	0.46
Combined	Alive	575	52.9	0.45
Combined	Dead	388	84.3	0.52
Combined	Total	963	65.6	0.48

Source: SEFSC RFOP (June 2020)

Table 2. Logistic regression model odds ratios with profile likelihood 95% confidence intervals and the likelihood ratio χ^2 P-Value for the intercept, depth (m), vertical line compared to bottom longline gear, and whether the fish was vented prior to release compared to not vented.

Variable	Odds Ratio	χ^2 Significance
Intercept	0.18 (0.12, 0.29)	—
Depth (m)	1.03 (1.03, 1.04)	< 0.0001
Gear (Vertical Line)	0.27 (0.20, 0.37)	< 0.0001
Vented (True)	0.69 (0.50, 0.96)	0.0458

Table 3. Scamp and yellowmouth grouper commercial immediate mortality (IM) estimates predicted from depths obtained from trips with discards recorded in the SEFSC Supplemental Discard Logbook from 2010 through 2019. Estimates are provided with the air bladders vented or not vented.

Region	**Gear**	**Discard Logbook Mean Depth (m)**	**IM – Not Vented**	**IM - Vented**
Gulf of Mexico	Bottom Longline	72.1	53%	47%
Gulf of Mexico	Vertical Line	54.1	29%	23%
South Atlantic	Vertical Line	46.5	21%	16%

Table 4. Scamp delayed mortality estimates based on the literature reviewed.

Publication	**Type of Study**	**Location**	**Depth (m)**	**Sample Size**	**Delayed Mortality**
Collins (1996)	Cage	South Carolina	36	2	0%
Collins (1996)	Cage	South Carolina	46-54	7	0%
Wilson & Burns (1996)	Cage	West FL Shelf	44	3	0%
Wilson & Burns (1996)	Cage	West FL Shelf	54	2	50%
Wilson & Burns (1996)	Cage	West FL Shelf	75	12	75%
Overton et al. (2008)	Cage (2 hour)	North Carolina	15-45	11	28%
Overton et al. (2008)	Cage (48 hour)	North Carolina	15-45	23	22%
Runde et al. (2020)	Desc.Device/Acoustic	North Carolina	60-116	15	53%

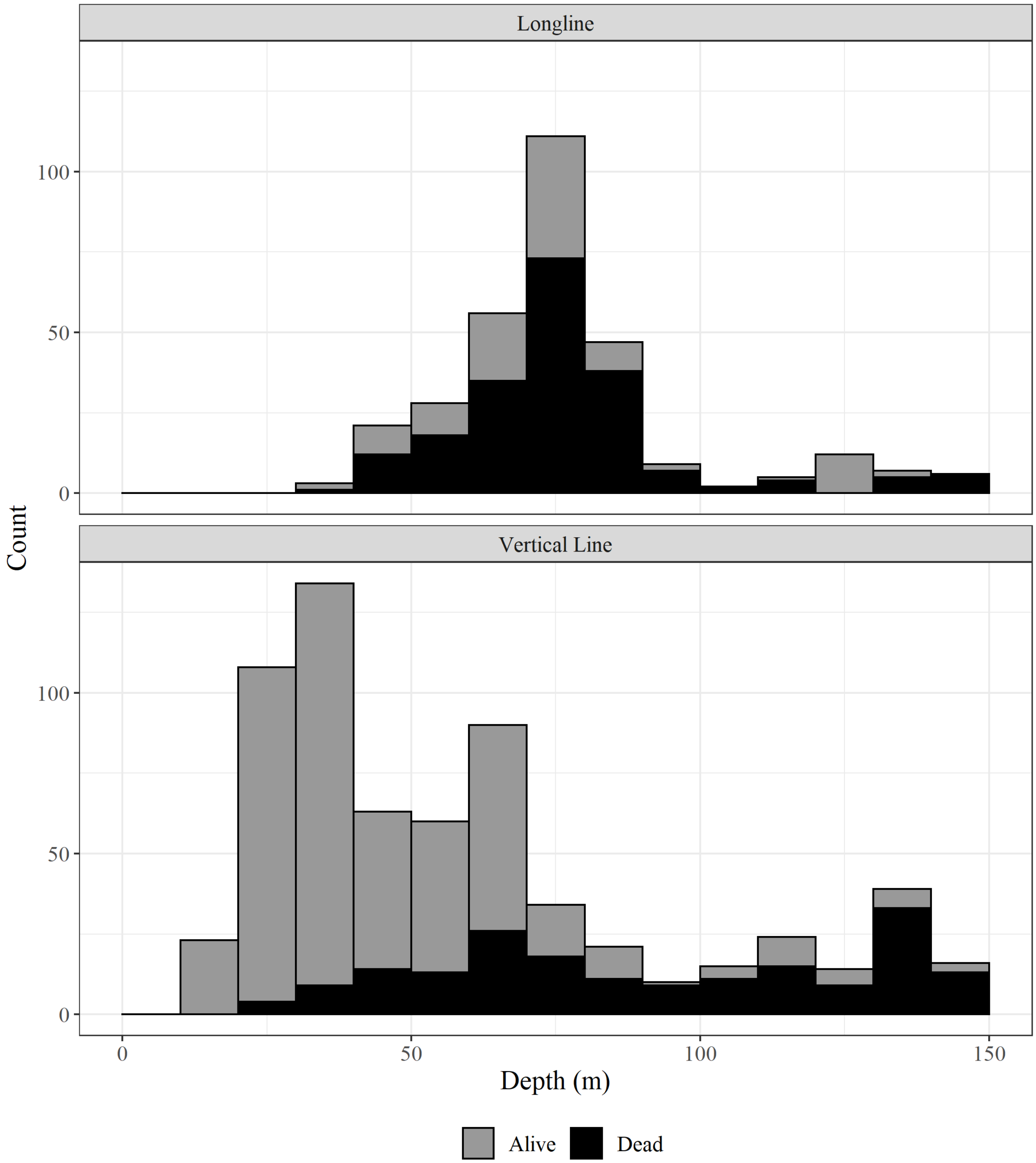

Figure 1. Histogram of capture depths for scamp and yellowmouth grouper (n=963) discarded by vessels using bottom longline and vertical line gear observed by the RFOP from July 2006 through December 2019.
Source: SEFSC RFOP (June 2020).

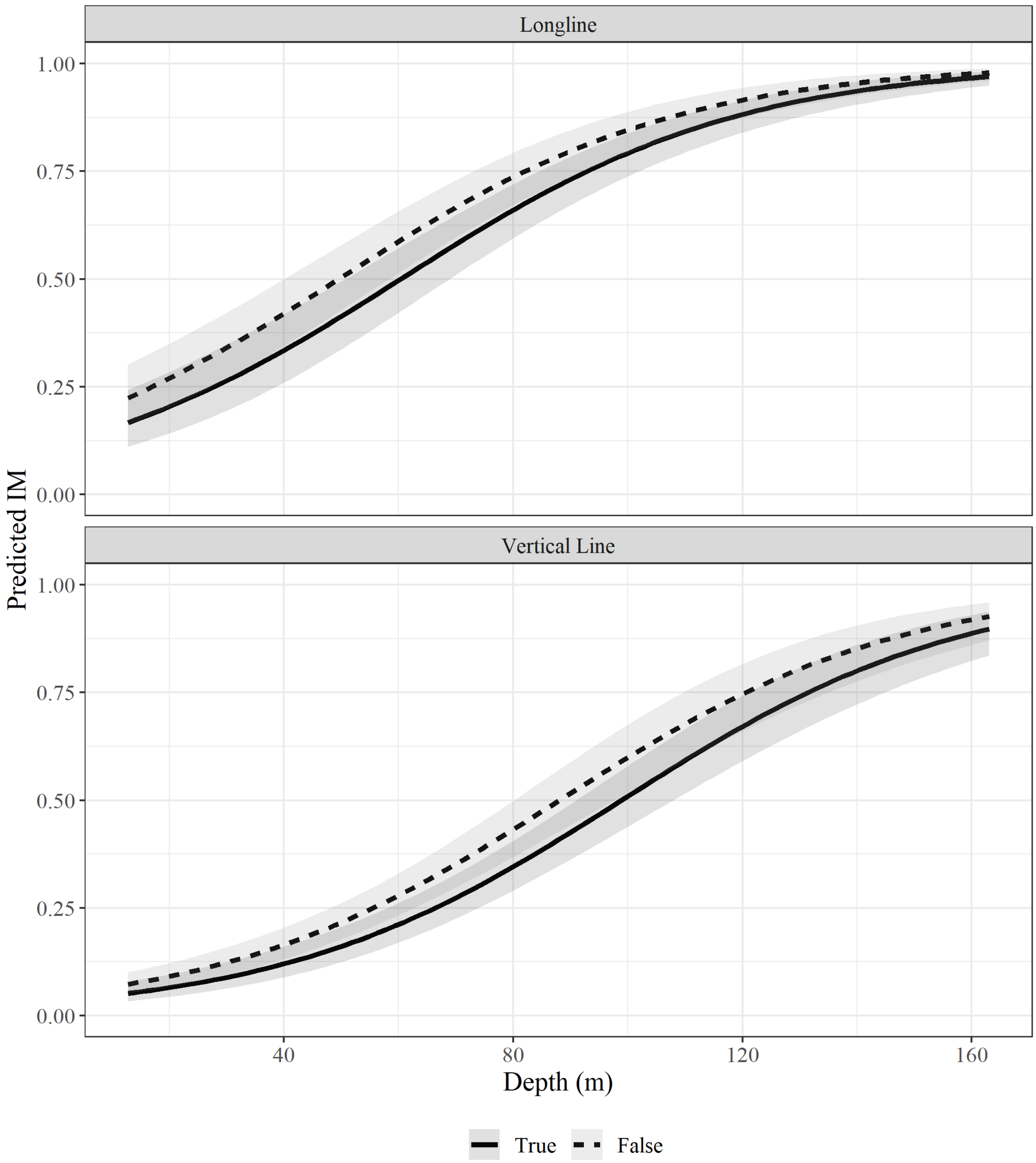

Figure 2. The predicted immediate mortality (IM) logistic regression probabilities with 95% confidence intervals by gear (longline or vertical line), depth (meters), and whether the fish was vented prior to release (True=vented) based on RFOP from July 2006 through December 2019. Source: SEFSC RFOP (June 2020).

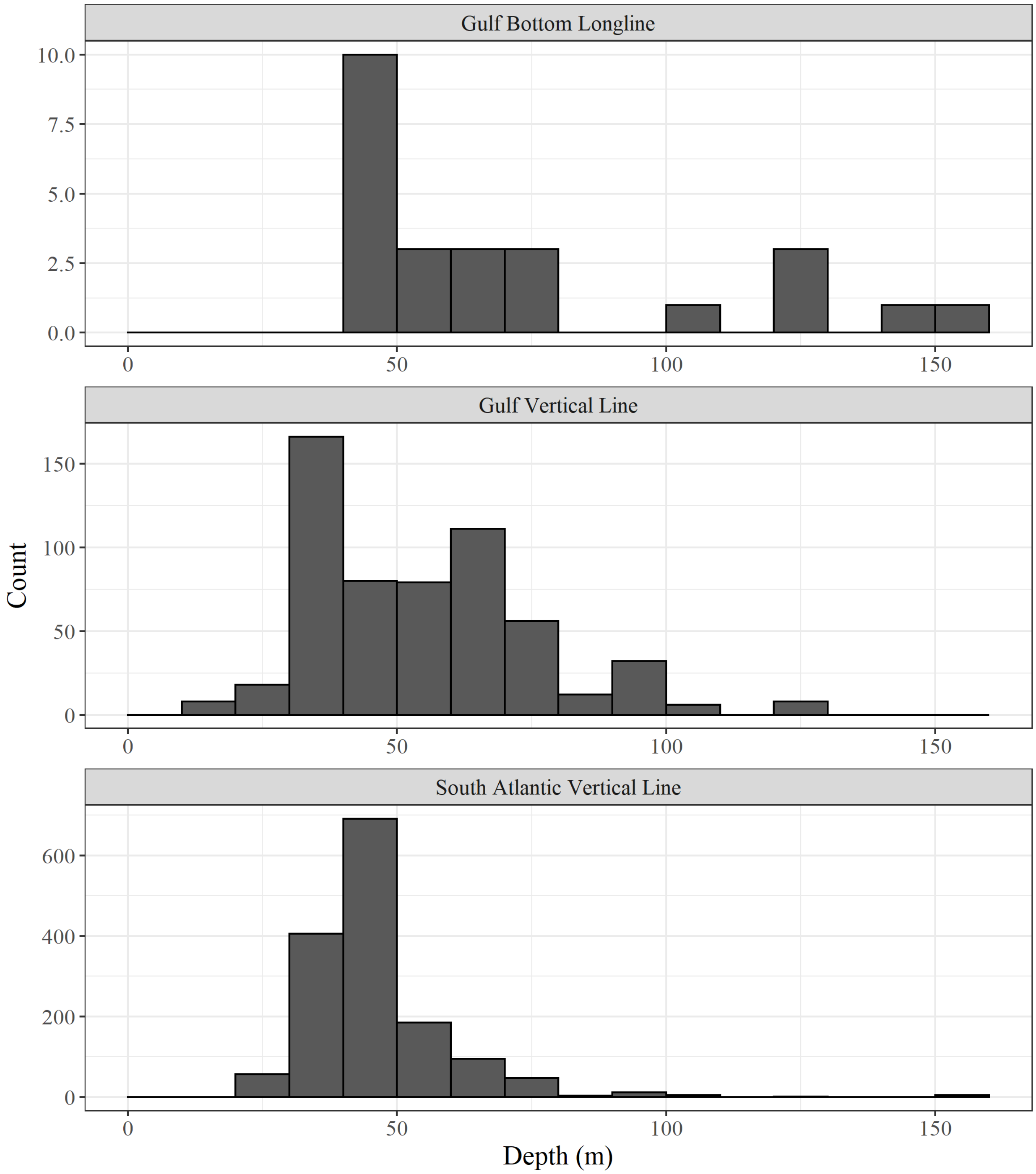

Figure 3. Histogram of depths for trips reporting scamp and yellowmouth grouper discarded by bottom longline and vertical line gear by region from the SEFSC Supplemental Discard Logbook from 2010 through 2019.
Source: SEFSC Supplemental Discard Logbook (May 2020).