Electronic Monitoring Documentation of Gag Grouper (*Mycteroperca microlepis*) in the Eastern Gulf Commercial Reef Fish Fishery

Katie Harrington, Max Lee, Carole Neidig, and Ryan Schloesser

SEDAR105-WP-10

21 May 2026

Please cite this document as:

Harrington, Katie, Max Lee, Carole Neidig, and Ryan Schloesser. 2026. Electronic Monitoring Documentation of Gag Grouper (*Mycteroperca microlepis*) in the Eastern Gulf Commercial Reef Fish Fishery. SEDAR105-WP-10. SEDAR, North Charleston, SC. 17 pp.

Electronic Monitoring Documentation of Gag Grouper (*Mycteroperca microlepis*) in the Eastern Gulf Commercial Reef Fish Fishery

Katie Harrington, Max Lee, Carole Neidig, and Ryan Schloesser, Ph.D.

Mote Marine Laboratory
Center for Fisheries Electronic Monitoring (CFEMM)
1600 Ken Thompson Parkway, Sarasota, FL 34236

knharrington@mote.org

Research Grant Support
National Fish and Wildlife Foundation
National Oceanic and Atmospheric Administration
Sea Pact
Sustainable Ocean Alliance
Net Gains Alliance
Environmental Defense Fund

Industry Partners
Gulf of America Reef Fish Shareholders' Alliance
Independent Commercial Reef Fish Industry Participants

SEDAR 105 - Gulf Gag Grouper

May 21, 2026

MML Tech. Rpt. No. 2904

Introduction

The Eastern Gulf of America (EGoA) commercial bottom longline (BLL) reef fish fishery primarily targets red grouper (*Epinephelus morio*), red snapper (*Lutjanus campechanus*), yellowedge grouper (*Hyporthodus flavolimbatus*), golden tilefish (*Lopholatilus chamaeleonticeps*), and gag grouper (*Mycteroperca microlepis*) across the West Florida Shelf from The Edges to the Dry Tortugas. The Center for Fisheries Electronic Monitoring at Mote (CFEMM) has been pioneering electronic monitoring (EM) in this fishery since 2016. A thorough review of the program history and data summaries can be found in Neidig et al., 2023. Industry volunteer participation has included collaborations with 24 BLL and vertical line (VL) vessels. The data reported for gag grouper in this paper were generated from 16 BLL vessels fishing out of ports along Florida's west coast, from Cortez to Inglis, in the EGoA, defined here as federal waters east of 88°W, from July 2016 to December 2024.

Methods

Video Review Protocol

Saltwater Inc. (SWI) (Anchorage, AK) Electronic Monitoring Unit hard drives from participating vessels were collected during dockside visits or mailed by the respective captains or vessel owners. These drives were loaded to workstations, where CFEMM staff used SWI review software to annotate the collected video footage. Sets and hauls were marked along a timeline by reading associated sensor data (hydraulic pressure and rotation). Twenty-five percent of complete set/haul events from each BLL trip were randomly selected to be reviewed. Each recorded catch event was assigned characteristics based on a series of custom dropdown menus for the reviewer to select. These variables included species identification, handling, condition on arrival, and fate. Detailed descriptions of CFEMM review protocols are included in Neidig et al., 2023.

Post-Review Processing

The resulting data navigated a CFEMM-established QA/QC process in which all annotated events and sensor data anomalies were reviewed by experienced staff to screen for species identification errors or missing catch. Aggregated groupings of trips were further screened using R (version 4.2.1; R Core Team, 2024), applying a series of over 75 error checks to flag abnormalities. Once approved, the final data was appended to the master database in Microsoft Access™. Depth was associated with events by spatially joining locations to the raster of a digital elevation model with a resolution of 0.01 meters (National Geophysical Data Center, 2011).

Electronic Monitoring Data Analysis

A generalized additive model (GAM) was used to depict potential annual and seasonal changes in catch per unit effort (CPUE) and was generated using the default k-values calculated by the mgcv and ggplot2 packages (Wood, 2011; Wickham, 2016) within R. The plots incorporate data up to October 2025 to provide visual guidance while avoiding the inference of trends during the terminal year of data collection. The CPUE for BLL vessels was calculated at the set/haul-level as the number of individuals caught per 1000 hook-hours:

$$CPUE = 1000n/ht$$

where n is the number of individuals caught in the haul, h is estimated to be 750 hooks, and t is the soak time in hours from the start of the set to the end of the associated haul. Following the Stephens-MacCall approach (2004) with improvements (Dettloff, 2021), only hauls classified as targeted were retained for calculating CPUE in Figure 1. Specific improvements implemented in the Bernoulli generalized linear model to increase fit were, at the haul-level, the addition of the depth at the centroid of the haul, the National Marine Fisheries Service Gulf of America statistical sampling zone (2-9) the haul occurred in, the month of the haul, the interaction of depth and zone, and the interaction of zone and month.

Spatial analyses were conducted in ArcGIS Pro (version 3.4.2; Esri Inc., 2024) using the Kernel Density and Optimized Hot Spot Analysis tools. Catch locations for conducting the kernel density analysis were determined by using the locations of each individual projected from WGS84 to UTM Zone 17N to convert angular degrees to linear meters. The hot spot analysis was performed at the set/haul-level on CPUE (for all hauls), with the locations represented as the centroid of the haul. Resulting points were then spatially joined to a 10 min x 10 min grid with the average confidence level bin (Gi Bin) score used per grid cell.

Depredation Analysis

Depredation patterns among species were evaluated using a chi-square test of independence. Animals documented by an EM reviewer as caught in a damaged condition, whether alive or dead, were classified as depredated. Observed damage included retrieval of heads only, bodies with “rake” teeth marks, and chunks of missing flesh. Damaged gear (e.g., bent hooks), presumed “bite-offs” where the hook was removed before retrieval, and scavenging, where predators consumed fish post-release, were not included in the analyses. The counts of damaged fish and non-damaged fish for the ten most frequently caught species, excluding sharks, were arranged into a 2 x k contingency table (damaged status x species). Expected counts under the null hypothesis of independence were calculated based on marginal totals. Standardized residuals were extracted from the chi-square test to quantify deviations between observed and expected counts, where residuals exceeding ±1.96 were considered statistically significant at the 95% level.

Discard Mortality Based on Surface Observations

In an unpublished study, cameras were mounted on the stern of a subset of vessels to document the proportion of discarded fish that either floated away or were scavenged upon. The number of gag discards, as viewed with a stern camera, during this time period (February 2021 through November 2024) was low (*n* = 101) with most of the trips occurring prior to the commencement of commercial quota reductions. Post-release classifications were defined as either swam down, floated off, eaten by a predator (marine mammal, shark, or unknown), or unknown.

NOAA Reef Fish Observer Data Comparative Analysis

The resulting EM data were compared to NOAA Reef Fish Observer Program data from September 2016 through December 2025. Note that in 2020, only two observer trips were conducted in the EGoA, and therefore, the data from those trips were not included in subsequent analyses due to vessel confidentiality. During this time period, 13 BLL trips from seven vessels had overlapping EM and observer coverage. From these 13 trips, 253 sets were identified as corresponding to one another, with the recorded difference in the set start times being less than 30 minutes. Data were examined at the set/haul level to avoid differences in effort calculations, and catch and fate (discarded or retained) counts were compared to assess agreement rates across overlapping trips. Analyses were also conducted at the fleet-wide level to compare average catch and discard rates of gag grouper and Wilcoxon rank-sum tests were used to identify significant differences.

Results and Discussion

Catch and Effort Distribution

From July 2016 through December 2024, 542 fishing trips were recorded by the EM systems, covering 4,978 sea days (Table 1). These trips, focused in the EGoA, represent approximately 8.5% coverage of the total Gulf-wide fleet and involved the review of 3,010 hauls, documenting 157,795 catch events, including 1,855 gag grouper. These captures occurred on 822 of the reviewed hauls (27%). Gag grouper are the fifth most frequently caught species on this gear type in the EGoA.

Gag grouper CPUE was variable, showing distinct interannual variability (Figure 1) with a cyclical pattern of lower catch rates seemingly appearing every three years. Recent increases in catches align with the commercial industry's claims of increased abundance. Anecdotal reports from fishers indicate catches of gag in areas where they were historically absent or minimal, as well as an increase in overall size. Notably, the 2019 terminal year used for the previous gag grouper assessment (SEDAR 72) coincided with the lowest average catch rate observed within the CFEMM dataset. Red grouper and scamp (*Mycteroperca phenax*) were also caught at lower rates in 2019.

Gag groupers were recorded from 24.5° latitude to 28.95° latitude and as far west as -85.61° longitude. Catch density was highest around The Edges fishery management area, and west of Tampa Bay (Figure 2). These individuals were encountered in depths from 37m to 163m, with an average capture depth of about 69m. A hotspot analysis resulted in multiple large and significant clusters of high catches per haul that coincided with high catch densities in the northern portion of the fishing area near the Middle Grounds and the Edges, off of Tampa Bay, and a few smaller clusters off of Naples, FL (Figure 3).

Discards and Depredation

Of the 1,855 gag grouper caught, 18.8% were discarded across all years (Table 2). The highest discard rates occurred following substantial reductions in the commercial quota, with management measures increasing discard rates by 434% in 2023 and 1,162% in 2024 compared to pre-management levels in 2022.

The immediate discard mortality rate was 0.43% (Table 2), with the rate per depth bin shown in Table 3. The short-term post-release discard mortality rate as determined from stern camera footage where the fish floated off was 31.7% (32/101), including one instance of marine mammal scavenging (Table 4). The total discard mortality rate as reported by at-sea observers from October 2016 to December 2024 in the EGoA was 31.9% (66/207).

The depredation rate for gag, where individuals arrived at the vessel with damage, was 0.65% (n = 12). Results from the chi-square test of independence indicated that depredation of gag grouper was significantly lower than expected (standardized residual = −2.63) and that depredation is not independent of species (Figure 4). The expected number of damaged gag grouper was 26, indicating that they are depredated at roughly half of the rate predicted by overall catch proportions.

Observer Data Comparisons

For the 13 BLL trips with overlapping EM and at-sea observer coverage, gag grouper were recorded on 91 (36%) hauls via EM systems and 91 hauls by observers. On average, EM and observers documented nearly the same amount of gag grouper when at least one gag grouper was identified as captured during the haul (mean bias = -0.011; Figure 5). Additionally, the number of fish discarded exhibited high levels of agreement (mean bias = 0.022; Figure 6). On an annual basis, there were no significant differences found between the average catch ($W = 30$, $p > 0.05$) and discard ($W = 34$, $p > 0.05$) rates of gag grouper for EM vs observer-recorded data (Figure 7).

Given the high levels of agreement between EM and observer-generated data, there exists potential for combining these data sources into a joint index of abundance for future stock assessments considering fishery-dependent data. The EM data, in this scenario, could assist with filling in gaps in observer coverage, especially for years in which coverage is low, such as in 2020 and 2021 where the COVID-19 pandemic impacted the number of observer trips taken. It is therefore recommended that research should be conducted investigating methods to combine EM and observer data to form indices with the goal of determining appropriate standardization and scaling techniques.

Literature Cited

Dettloff, K. (2021). Improvements to the Stephens-MacCall approach for calculating CPUE from multispecies fisheries logbook data. *Fisheries Research*. *242*(106038). https://doi.org/10.1016/j.fishres.2021.106038

Esri Inc. (2024). *ArcGIS Pro* (Version 3.4.2). Esri Inc. https://www.esri.com/en-us/arcgis/products/arcgis-pro/overview

National Geophysical Data Center, NESDIS, NOAA, U.S. Department of Commerce. (2011). *Digital Elevation Model of the Gulf of Mexico, Integrating Bathymetric and Topographic Datasets*. NOAA National Centers for Environmental Information.

Neidig, C., Lee, M., Roberts, D. E., & Schloesser, R. (2023). Characterization of the U.S. Eastern Gulf of Mexico Reef Fish Bottom Longline Catch through Fishery Collaboration with Electronic Monitoring. *Marine Fisheries Review. 85*(1-4). https://doi.org/10.7755/MFR.85.1-4.5

R Core Team. (2024). R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/.

Stephens, A. & MacCall, A. (2004). A multispecies approach to subsetting logbook data for purposes of estimating CPUE. *Fisheries Research*. *70*(2-3), 299-310. https://doi.org/10.1016/j.fishres.2004.08.009

Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

Wood, S.N. (2011). Fast stable restricted maximum likelihood and marginal likelihood estimation of semiparametric generalized linear models. *Journal of the Royal Statistical Society (B)*. *73*(1):3-36. https://doi.org/10.1111/j.1467-9868.2010.00749.x

Tables and Figures

Table 1. Effort metrics by year for bottom longline vessels fishing in the eastern Gulf of America reef fish fishery, 7/2016 - 12/2024.

Year	Participating Vessels	Trips	Hauls Reviewed	Sea Days
2016	5	32	191	271
2017	5	42	242	392
2018	5	49	217	427
2019	7	48	457	495
2020	8	67	344	618
2021	11	83	400	758
2022	12	72	286	545
2023	11	80	468	779
2024	10	71	405	721

Table 2. Fate by year for gag grouper caught on bottom longline gear in the eastern Gulf of America reef fish fishery, 7/2016 - 12/2024.

Year	Number of Hauls	Total Number Caught	Total Number Discarded	Discarded Alive	Discarded Alive - Damaged	Discarded Dead	Discarded Unknown	Unknown Fate	Discard Rate
2016	191	210	8	7	0	1	0	0	3.81%
2017	242	143	2	1	0	1	0	0	1.40%
2018	217	205	2	1	0	1	0	0	0.98%
2019	457	95	7	5	1	1	0	0	7.37%
2020	344	70	6	6	0	0	0	1	8.57%
2021	400	287	6	5	0	1	0	0	2.09%
2022	286	256	14	13	0	1	0	0	5.49%
2023	468	263	77	41	0	1	35	1	29.3%
2024	405	326	226	223	0	1	2	0	69.3%
All Years	3,010	1,855	348	302	1	8	37	2	18.8%

Table 3. Fate by depth range for gag grouper caught on bottom longline gear in the eastern Gulf of America reef fish fishery, 7/2016 - 12/2024.

Depth Range (m)	30-39.99	40-49.99	50-59.99	60-69.99	70-79.99	80-89.99	90-99.99	100-109.99	110-119.99	>120
Total Number Caught	39	347	394	364	298	123	48	56	101	85
Total Number Discarded	15	79	82	70	73	17	11	0	1	0
Discarded Alive	15	57	67	64	71	17	11	0	0	0
Discarded Alive - Damaged	0	0	0	1	0	0	0	0	0	0
Discarded Dead	0	3	2	0	2	0	0	0	1	0
Discarded Unknown	0	19	13	5	0	0	0	0	0	0
Unknown Fate	0	1	0	0	0	1	0	0	0	0
Discard Rate	38.5%	22.8%	21.6%	19.2%	24.5%	13.8%	22.9%	0%	0.99%	0%

Table 4. Short-term post-release status of discarded gag grouper as viewed from bottom longline vessel stern camera footage, 2/2021 - 11/2024.

Year	Number of Hauls	Number Discarded	Floated Off	Swam Down	Unknown	Eaten by Marine Mammal	Mortality Rate
2021	1	1	1	0	0	0	100%
2022	5	5	1	3	1	0	20%
2023	19	35	14	20	1	0	40%
2024	27	60	15	36	8	1	26.7%
All Years	52	101	31	59	10	1	31.7%

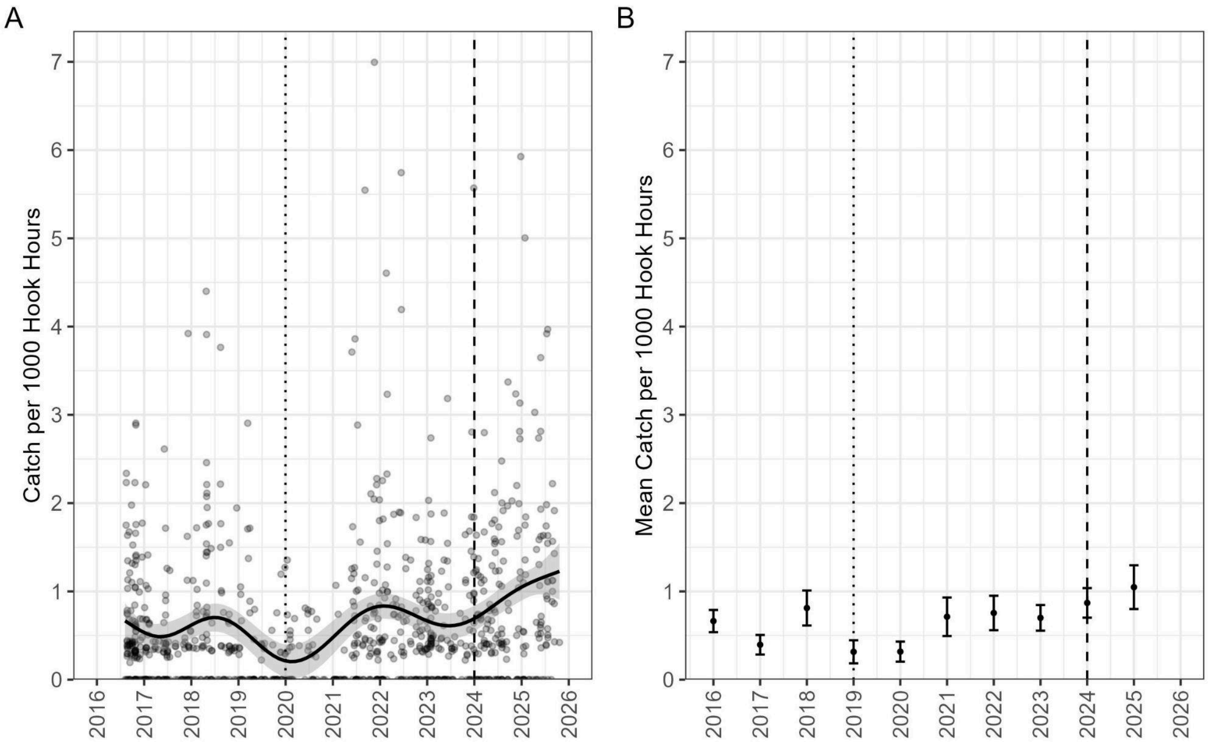

Figure 1. A) Gag grouper catch per unit effort GAM, where each point represents one haul, the dotted line at December 31, 2019 represents the terminal date for data inclusion in the previous stock assessment, SEDAR 72, and the dashed line represents the commencement of quota reductions under the stock rebuilding plan. B) Average catch per unit effort per year with 95% confidence intervals for the eastern Gulf reef fish bottom longline fishery, 7/2016 - 10/2025.

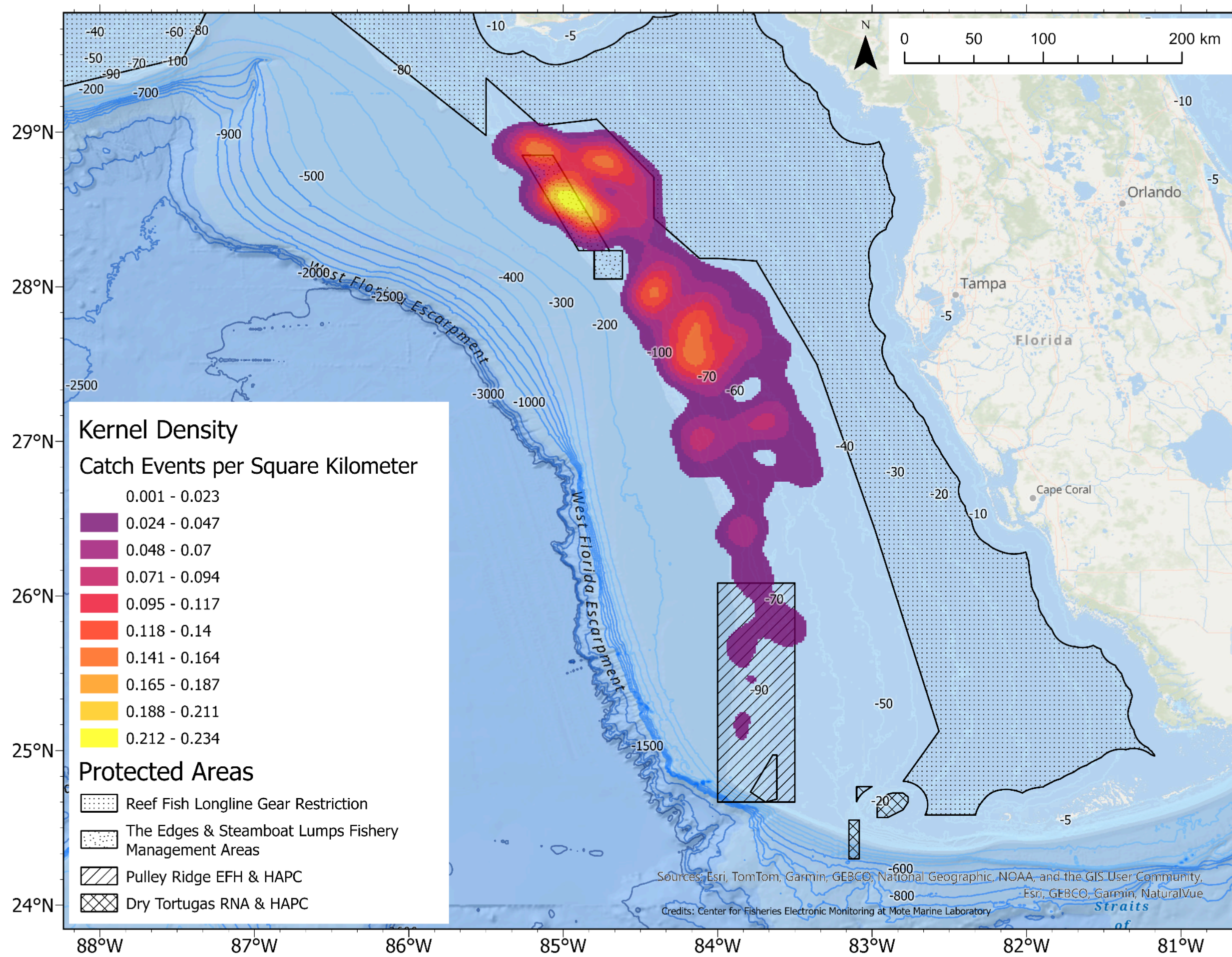

Figure 2. Kernel density of gag grouper bottom longline catch events recorded in the eastern Gulf, 7/2016 - 12/2024.

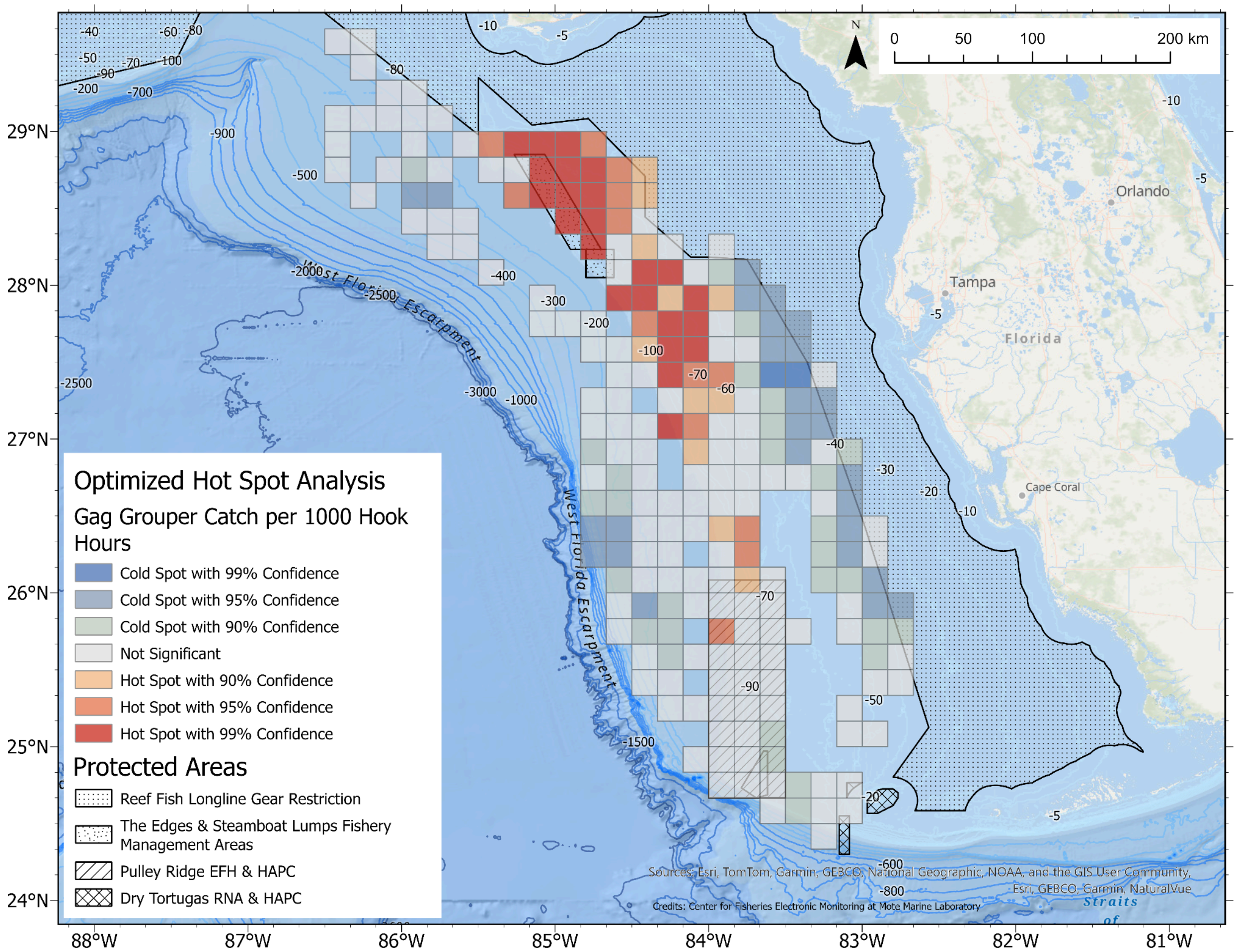

Figure 3. Hotspot analysis for gag grouper catch per 1000 hook hours in the eastern Gulf bottom longline fishery with a grid cell size of 10 x 10 min, 7/2016 - 12/2024.

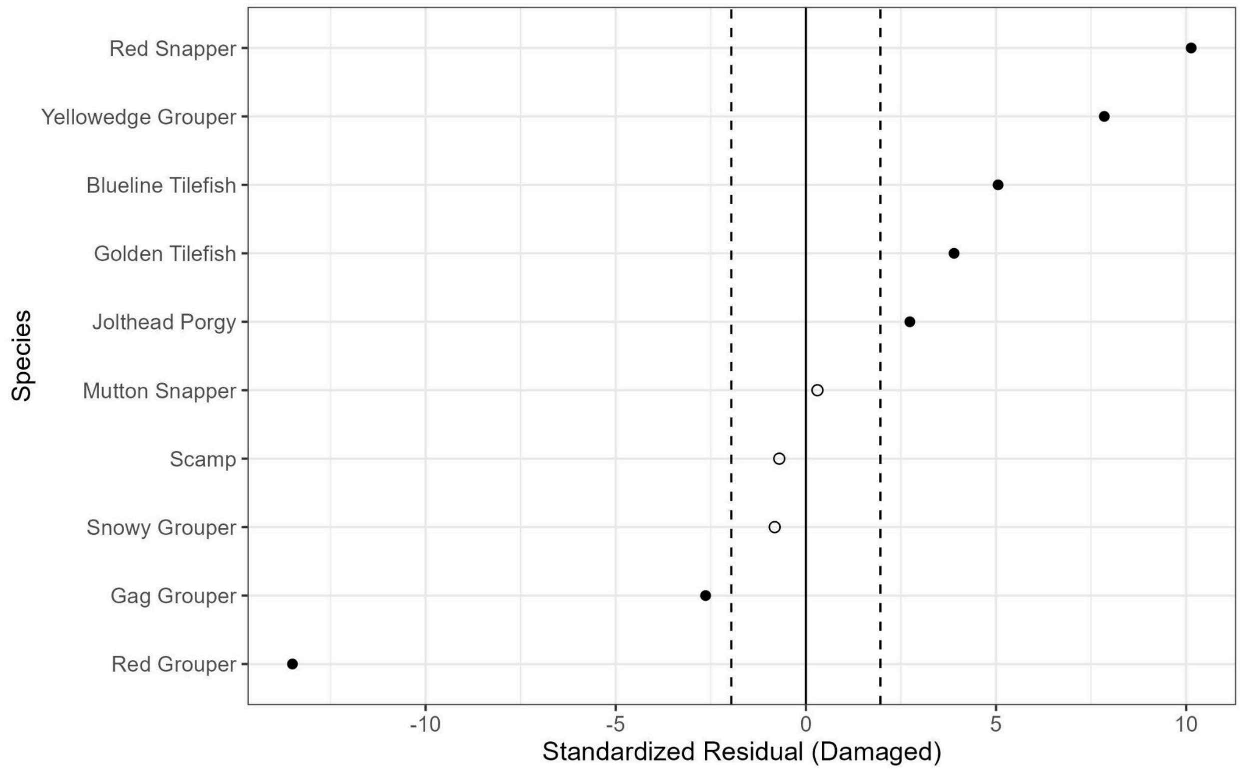

Figure 4. Standardized residuals of damaged catch per species where the open circles represent non-significant points within the 95% threshold (dashed lines). Positive values indicate higher than expected depredation and negative values indicate lower than expected depredation.

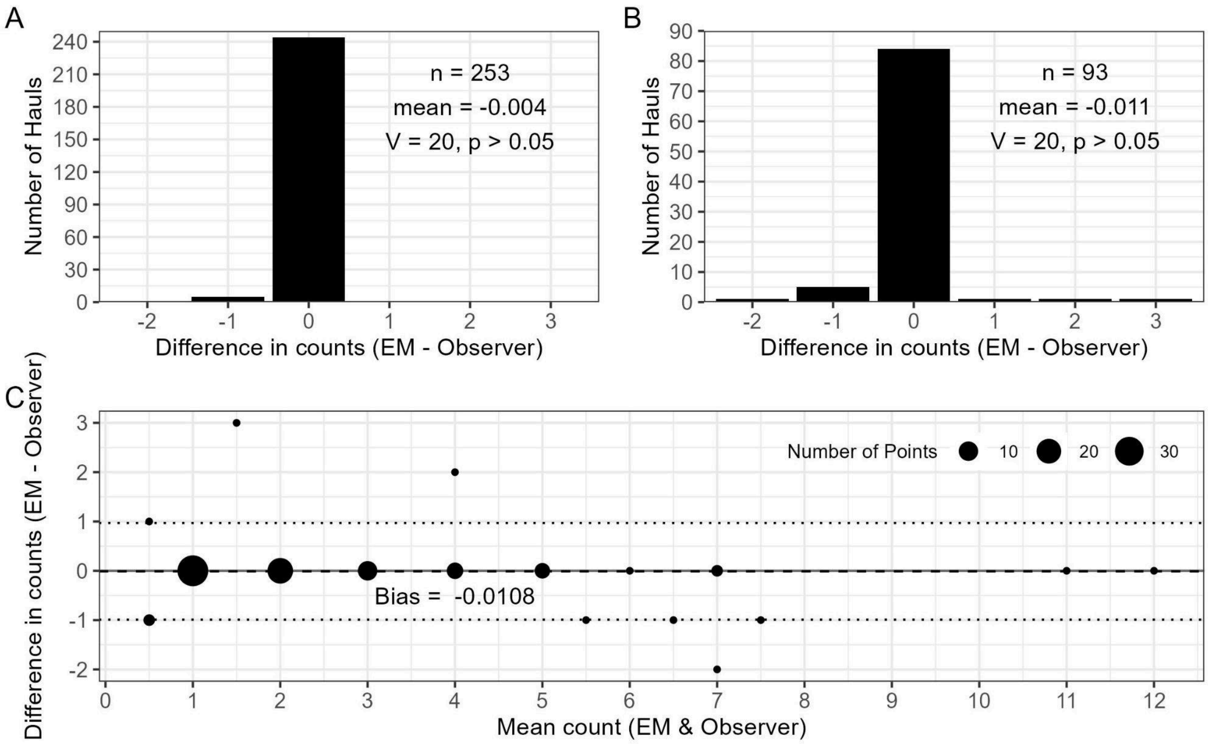

Figure 5. A) Frequency plot of the difference (EM - Observer) in number of gag grouper counted per haul for matched bottom longline hauls where the annotations denote Wilcoxon signed-rank test results. B) Frequency plot of the difference (EM - Observer) in number of gag grouper counted per haul for matched bottom longline hauls where at least one gag grouper was identified by either EM or an Observer. C) Bland-Altman agreement plot of the difference in counts and mean count for electronic monitoring and observer data, where the number of points represents the number of hauls in the instances where at least one gag grouper was identified by either EM or an Observer (n = 93), the dashed line represents the average bias, and the dotted lines represent the limits of agreement.

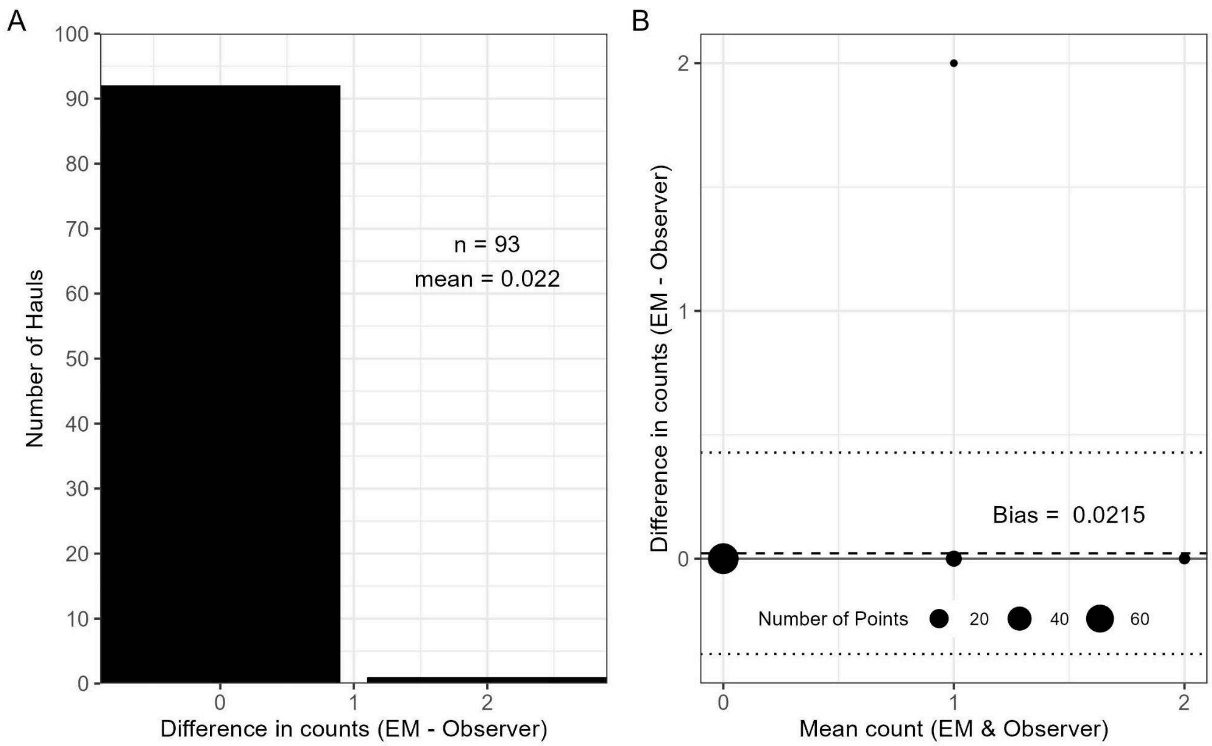

Figure 6. A) Frequency plot of the difference (EM - Observer) in number of discarded gag grouper counted per haul for matched bottom longline hauls. B) Bland-Altman agreement plot of the difference in counts and mean count for electronic monitoring and observer data, where the number of points represents the number of hauls in the instances where at least one gag grouper was identified by either EM or an Observer (*n* = 93), the dashed line represents the average bias, and the dotted lines represent the limits of agreement.

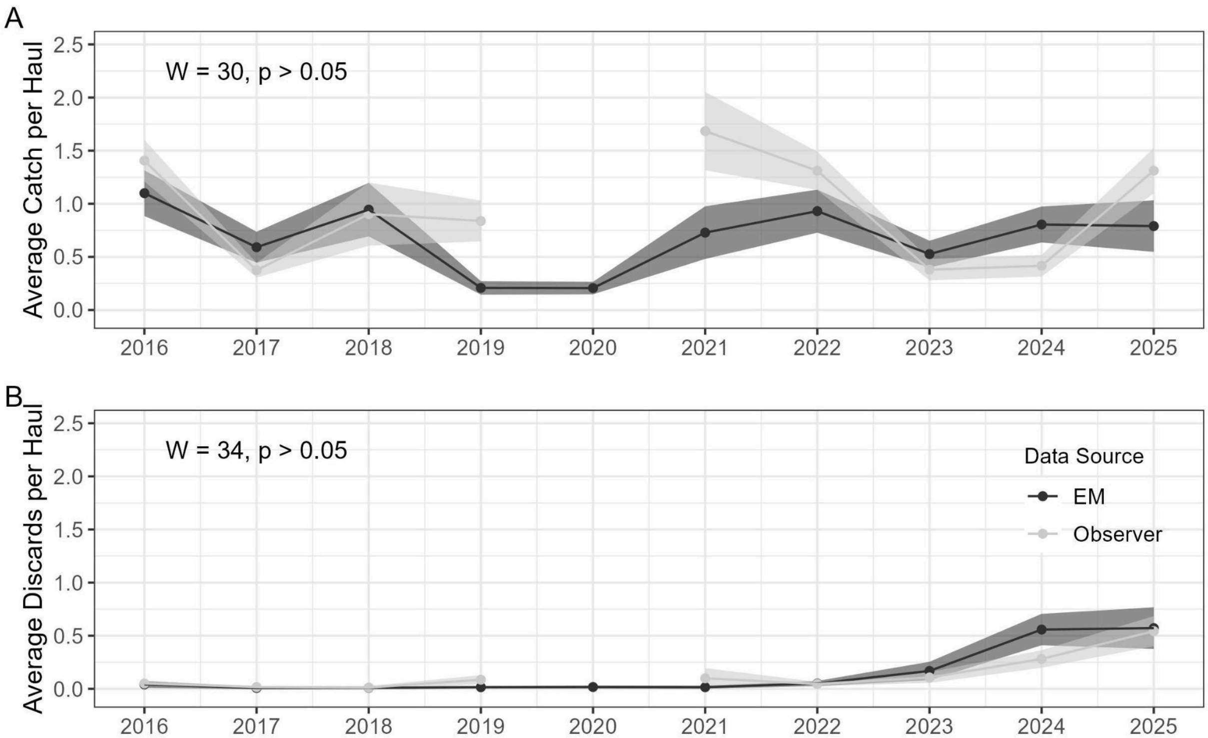

Figure 7. A) Average annual gag grouper catch per haul and B) average annual gag grouper discards per haul for bottom longline vessels fishing in the eastern Gulf, as documented through electronic monitoring or an at-sea observer, where the ribbons denote the 95% confidence intervals and the annotations denote Wilcoxon rank-sum test results.