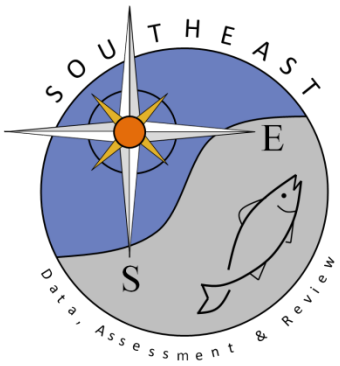
Electronic Monitoring Documentation of Red Snapper (*Lutjanus campechanus*) in the Gulf of Mexico Commercial Reef Fish Fishery

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

SEDAR98-DW-12

25 November 2024



Please cite this document as:

Harrington, Katie, Max Lee, Carole Neidig, and Ryan Schloesser. 2024. Electronic Monitoring Documentation of Red Snapper (Lutjanus campechanus) in the Gulf of Mexico Commercial Reef Fish Fishery. SEDAR98-DW-12. SEDAR, North Charleston, SC. 20 pp.

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Research Grant Support
National Fish and Wildlife Foundation, Electronic Monitoring and Recording Program
NOAA NMFS Cooperative Research Program
NOAA NMFS Bycatch Reduction Engineering Program
Sea Pact
Sustainable Ocean Alliance
Net Gains Alliance
Environmental Defense Fund

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

SEDAR 98 - Red Snapper

November 25, 2024

MML Tech. Rpt. No. 2769

Electronic Monitoring Efforts in the Gulf of Mexico Commercial Reef Fish Fishery

The Center for Fisheries Electronic Monitoring at Mote (CFEMM) has been pioneering electronic monitoring (EM) in the Gulf of Mexico (GoM) commercial reef fish fishery since 2016. Industry volunteer participation has included collaborations with 24 commercial bottom longline (BLL) and vertical line (VL) vessels. The data reported for red snapper (*Lutjanus campechanus*) in this paper were generated from 15 BLL vessels fishing out of ports along Florida's west coast, from Cortez to Inglis, in the Eastern Gulf of Mexico (EGoM), as well as three BLL vessels and four VL vessels fishing out of Galveston, Texas, in the Western Gulf of Mexico (WGoM). From July 2016 through December 2023, 593 fishing trips were recorded by the EM systems, covering 5,216 sea days. These trips involved CFEMM's detailed review of 3,502 hauls, documenting 207,246 catch events, including 62,069 red snapper.

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, while the same percentage was reviewed for VL trips using fishing location as a surrogate for hauls. 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, fate, and attributes specific to shark bycatch. 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 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 any abnormalities. Once approved, the final data was appended to the master database in Microsoft (MS) Access™. For reporting purposes, additional automatic calculations and environmental metadata were linked to the MS Access™ database through an export routine in R, allowing for more than 200 key variables, such as depth, average temperature, and bottom type to be associated to catch events.

Generalized additive models (GAMs) in this paper were generated using the default *k*-values calculated by the mgcv and ggplot2 packages (Wood, 2011; Wickham, 2016) within R. These plots incorporate data up to July 2024 to provide visual guidance while

avoiding the inference of trends during the terminal year of data collection. Spatial analyses were conducted in ArcGIS Pro using the Kernel Density and Optimized Hot Spot Analysis tools. Catch per unit effort (CPUE) for BLL vessels was calculated as catch per 1000 hook-hours where hook hours were determined based on 750 hooks per set. CPUE for VL vessels was calculated as catch per hook hour where hook hours were determined by - the total number of hooks used X the number of bandits among configurations X the total fishing duration.

Catch and Effort Distribution in the EGoM BLL Fishery

The EGoM BLL fishery primarily targets red grouper (*Epinephelus morio*), red snapper (*Lutjanus campechanus*), yellowedge grouper (*Epinephelus flavolimbatus*), and golden tilefish (*Lopholatilus chamaeleonticeps*) across the West Florida Shelf from The Edges to the Dry Tortugas. The CFEMM documented 10,482 captures of red snapper on EGoM BLL gear targeting reef fish, from 1,579 reviewed hauls. Red snapper in the region was the second most frequently caught species on this gear type and they were recorded on 60.6% of all BLL hauls reviewed.

Red snapper were recorded on BLL gear in the EGoM from 24.46° latitude to 29.54° latitude, as far west as -86.3° longitude. Catch density was highest close to major central ports (e.g., Madeira Beach) and the northeast quadrant of the Pulley Ridge HAPC (Figure 1). These individuals were encountered in depths from 36m to 168m, with an average capture depth of about 61m. The average species-specific CPUE within 10 x 10-minute grid cells is depicted in Figure 2. Results showed high CPUE in the northern portion of the fishing area close to The Edges and Steamboat Lumps. A hotspot analysis showed significant clustering of individuals coinciding with areas of high CPUE adjacent to these northern protected areas (Figure 3).

A GAM was generated based on hook-hours to depict annual and seasonal effort changes (Figure 4) that coincide with hotspot grid cells in Figure 3. Except for winter 2017, red snapper CPUE has not varied substantially and has been slowly increasing since 2019.

Catch and Effort Distribution in the WGoM BLL Fishery

The WGoM BLL fishery primarily targets golden tilefish and yellowedge grouper, though red snapper is the second most frequently caught species. The CFEMM documented 3,146 captures of red snapper on WGoM BLL gear, from 211 reviewed hauls. Red snapper were recorded on 45.6% of all BLL hauls reviewed.

Red snapper were recorded on BLL gear in the WGoM from 26.05° latitude to 28.36° latitude, and from -96.6° longitude to -89.95° longitude (Figure 5). These individuals were encountered in depths from 98m to 270m, with an average capture depth of about 120m. The average species-specific CPUE within 10 x 10-minute grid cells is depicted in Figure 6. Results showed high CPUE in the western portion of the fishing area. A hotspot analysis

showed significant clustering of individuals coinciding with areas of high CPUE adjacent to these western areas (Figure 7).

A GAM was generated based on hook-hours (Figure 8) to depict annual and seasonal effort changes that coincide with hotspot grid cells in Figure 7. Most of the catch events associated with WGoM BLL vessels occurred in 2019 and 2020, with reduced coverage in recent years due to the voluntary nature of the study fleet.

Catch and Effort Distribution in the WGoM VL Fishery

The WGoM VL fishery primarily targets red snapper and vermilion snapper with red snapper being the most frequently caught species. The CFEMM documented 48,441 captures of red snapper on WGoM VL gear from 380 reviewed fishing locations (referenced in this section as hauls). Red snapper were recorded on 87.6% of all VL hauls reviewed.

Red snapper were recorded on VL gear in the WGoM from 26.94° latitude to 28.67° latitude, and from -96.9° longitude to -91.5° longitude (Figure 9). These individuals were encountered in depths from 28m to 203m, with an average capture depth of about 51m. The average species-specific CPUE within 10 x 10-minute grid cells is depicted in Figure 10. Results showed high CPUE in the northwestern portion of the fishing area. A hotspot analysis conducted for red snapper showed significant clustering of individuals coinciding with areas of high CPUE adjacent to these northwestern areas (Figure 11).

A GAM was generated based on hook-hours (Figure 12) to depict annual and seasonal effort changes that coincide with hotspot grid cells in Figure 11. CPUE for this fishery has remained relatively constant over time.

Condition on Arrival, Discards, and Depredation

EGoM BLL fishery - At-vessel mortality for this species was 7.05%, with 2.33% showing obvious signs of depredation (Table 1). Retention rates (Table 2) were high (>77%), with discards primarily occurring due to the high cost of leasing quota based on personal communications with participating captains. Catches discarded due to size limits were nominal.

WGoM BLL fishery - At-vessel mortality for this species was 5.47%, with 0.76% showing obvious signs of depredation (Table 3). Retention rates were low (1.21%) (Table 4), though catches were predominantly well over minimum size limits.

WGoM VL fishery - At-vessel mortality for this species was 0.06%, with 0.05% showing obvious signs of depredation (Table 5), suggesting that depredation may be of lesser concern for this gear type in this region. Retention rates were high (>96%) (Table 6).

Overall, the rate of damaged red snapper caught per unit effort over time for these two regions has remained relatively low (Figure 13), even as commercial fishermen have increasingly expressed concerns about depredation during public comments at Gulf of Mexico Fishery Management Council meetings. However, in the BLL fishery, data suggests

there may be an increase in depredation over time across species which warrants further exploration (Figure 14).

Literature Cited

Neidig, C., Lee, M., Roberts, D.E., and 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

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Tables and Figures

Table 1. Condition of red snapper on arrival on BLL gear in the EGoM.

Condition on Arrival	Total	% of Red Snapper
Dead on Arrival - Damaged	226	2.16
Dead on Arrival - Undamaged	513	4.89
Live - Damaged	18	0.17
Live - Healthy	7767	74.10
Live - Stomach and/or Eyes Protruding	1941	18.52
Unknown Condition	17	0.16

Table 2. Fate of red snapper on BLL gear in the EGoM.

Catch Fate	Total	% of Red Snapper
Discarded - Dead	631	6.02
Discarded - Live and Damaged (Not Vented)	20	0.19
Discarded - Live and Damaged (Vented)	6	0.06
Discarded - Live and Healthy (Not Vented)	762	7.27
Discarded - Live and Healthy (Vented)	921	8.79
Discarded - Unknown	8	0.08
Retained	8126	77.52
Retained as Bait	1	0.01
Unknown Fate	7	0.07

Table 3. Condition of red snapper on arrival on BLL gear in the WGoM.

Condition on Arrival	Total	% of Red Snapper
Dead on Arrival - Damaged	23	0.73
Dead on Arrival - Undamaged	149	4.74
Live - Damaged	1	0.03
Live - Healthy	2220	70.57
Live - Stomach and/or Eyes Protruding	631	20.06
Unknown Condition	122	3.88

Table 4. Fate of red snapper on BLL gear in the WGoM.

Catch Fate	Total	% of Red Snapper
Discarded - Dead	190	6.04
Discarded - Live and Damaged (Not Vented)	1	0.03
Discarded - Live and Damaged (Vented)	9	0.29
Discarded - Live and Healthy (Not Vented)	1325	42.12
Discarded - Live and Healthy (Vented)	1429	45.42
Discarded - Unknown	146	4.64
Retained	38	1.21
Unknown Fate	8	0.25

Table 5. Condition of red snapper on arrival on VL gear in the WGoM.

Condition on Arrival	Total	% of Red Snapper
Dead on Arrival - Damaged	26	0.05
Dead on Arrival - Undamaged	1	0.00
Live - Damaged	4	0.01
Live - Healthy	46139	95.25
Live - Stomach and/or Eyes Protruding	2262	4.67
Unknown Condition	9	0.02

Table 6. Fate of red snapper on VL gear in the WGoM.

Catch Fate	Total	% of Red Snapper
Discarded - Dead	26	0.05
Discarded - Live and Damaged (Vented)	2	0.00
Discarded - Live and Healthy (Not Vented)	1361	2.81
Discarded - Live and Healthy (Vented)	433	0.89
Discarded - Unknown	10	0.02
Retained	46588	96.17
Retained as Bait	6	0.01
Unknown Fate	15	0.03

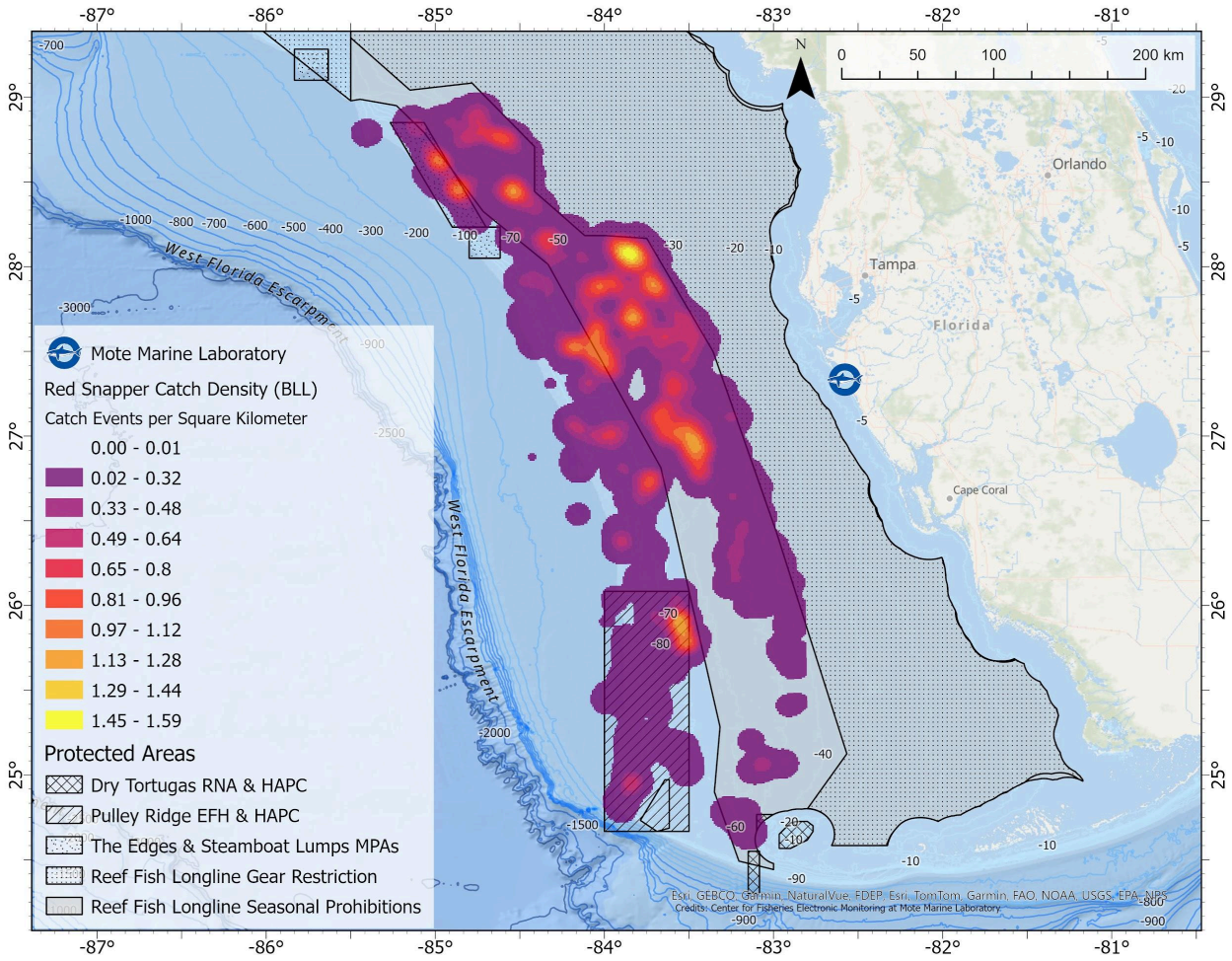

Figure 1. Kernel density of red snapper BLL catch events recorded in the EGoM.

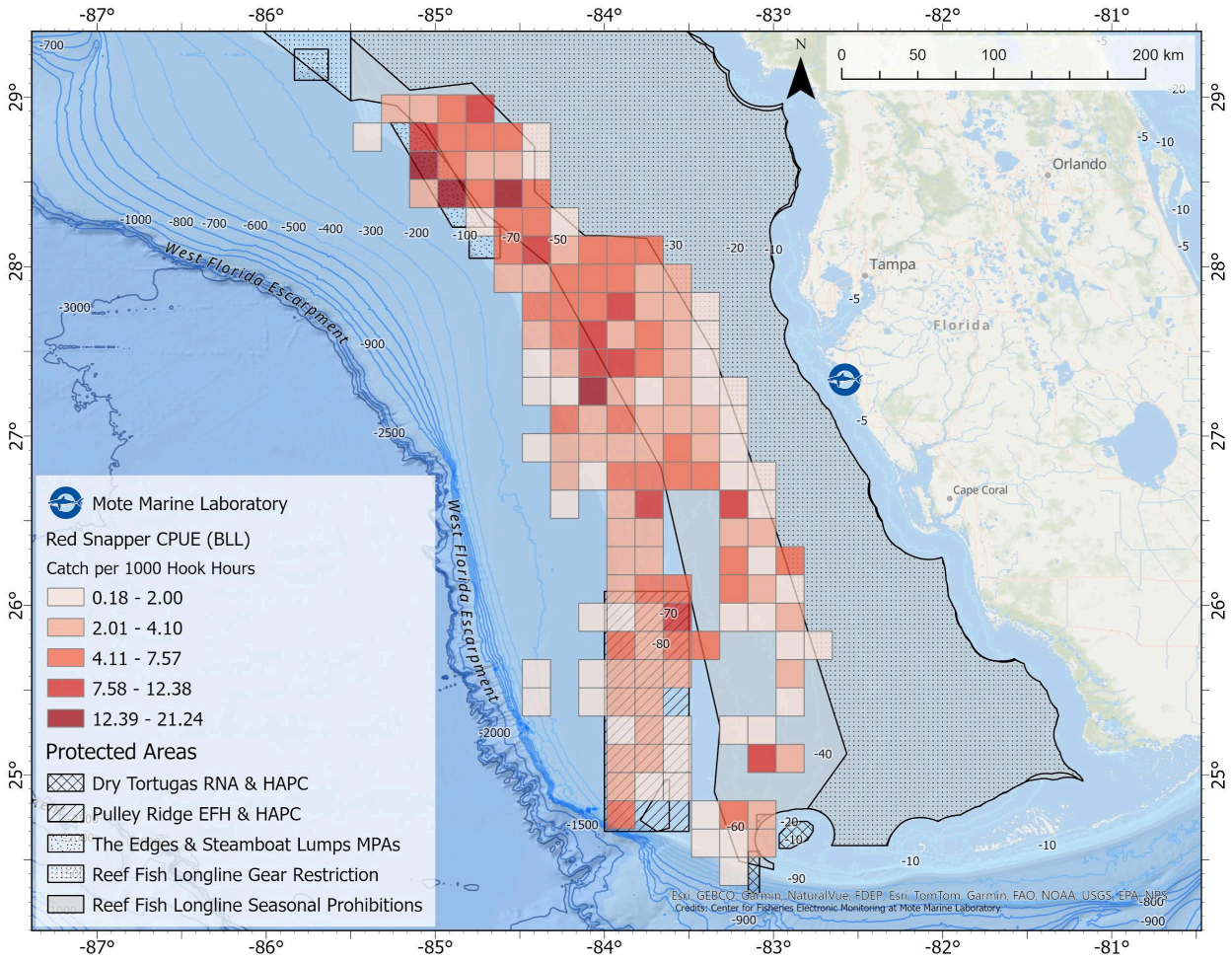

Figure 2. Catch per unit effort of red snapper in the EGoM BLL fishery with a grid cell size of 10 x 10 min.

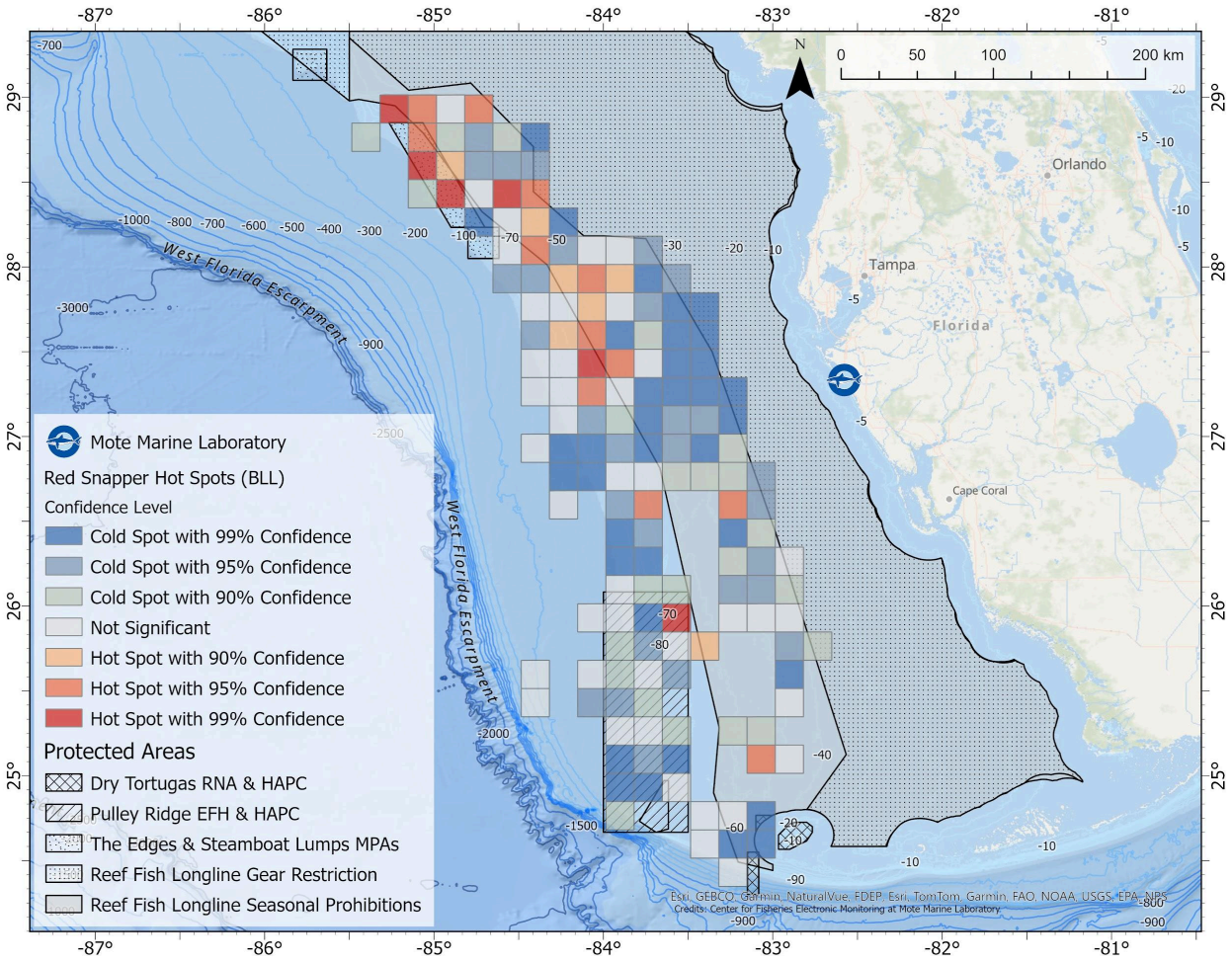

Figure 3. Hotspot analysis for red snapper in the EGoM BLL fishery.

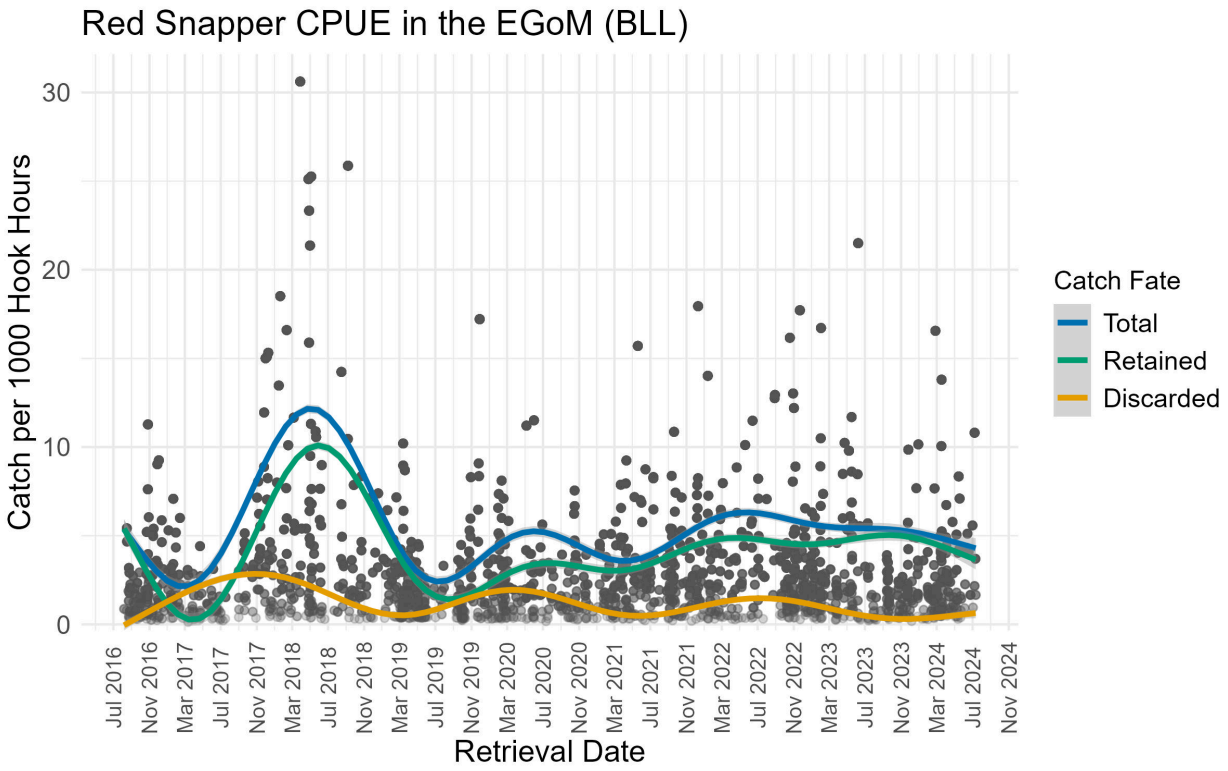

Figure 4. Red snapper catch per unit effort GAM for the EGoM BLL fishery, 7/2016 - 7/2024.

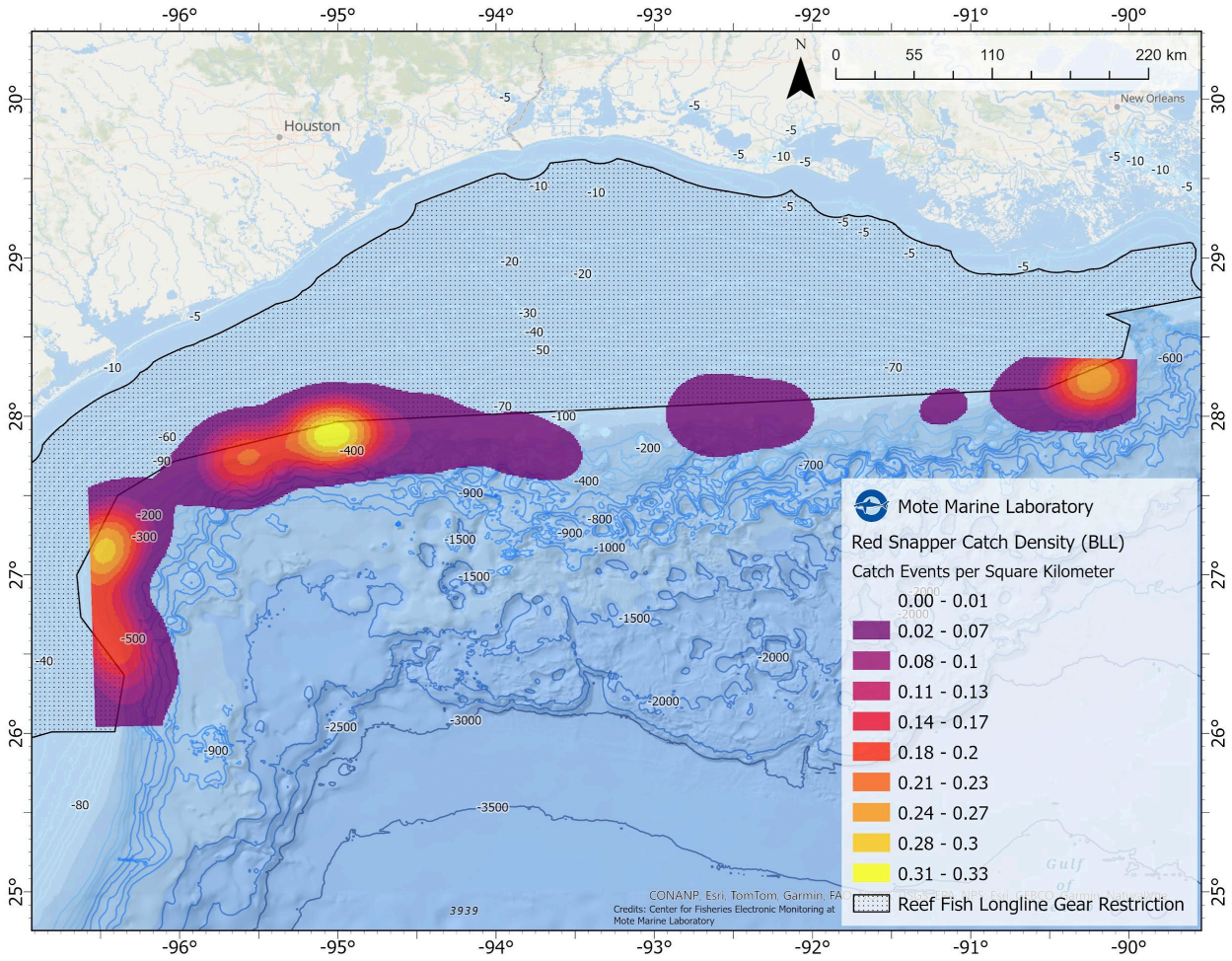

Figure 5. Kernel density of red snapper BLL catch events recorded in the WGoM.

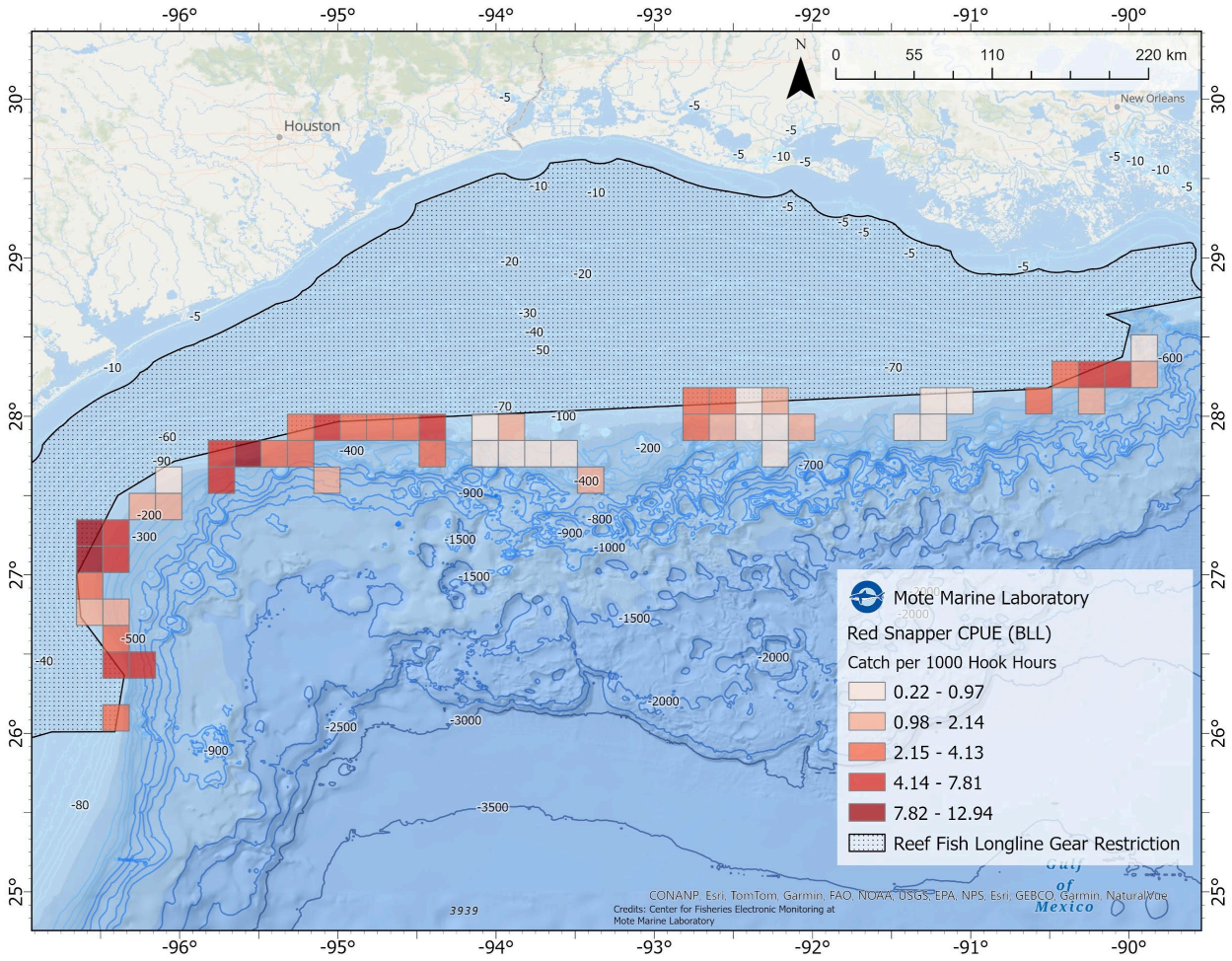

Figure 6. Catch per unit effort of red snapper in the WGoM BLL fishery with a grid cell size of 10 x 10 min

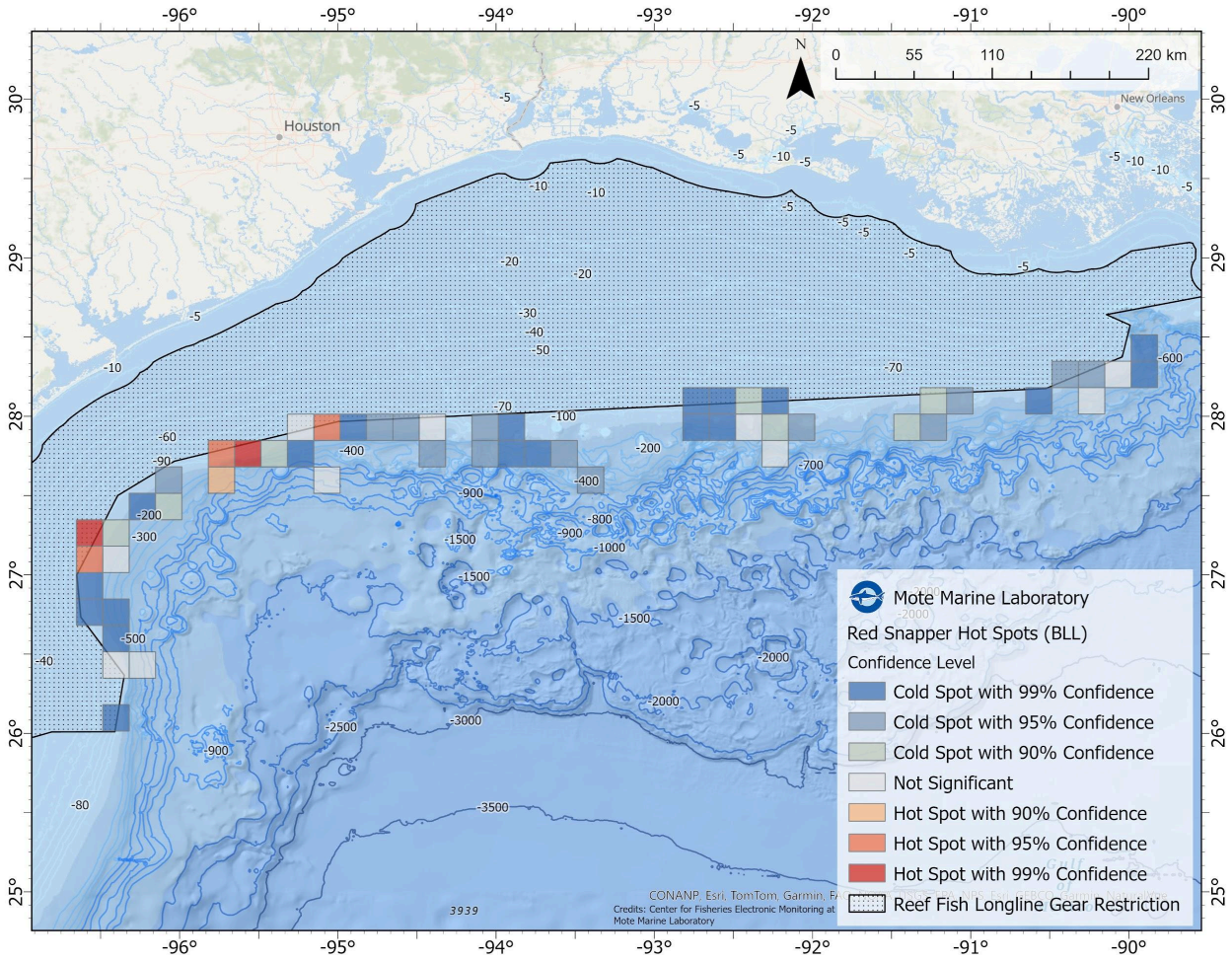

Figure 7. Hotspot analysis for red snapper in the WGoM BLL fishery.

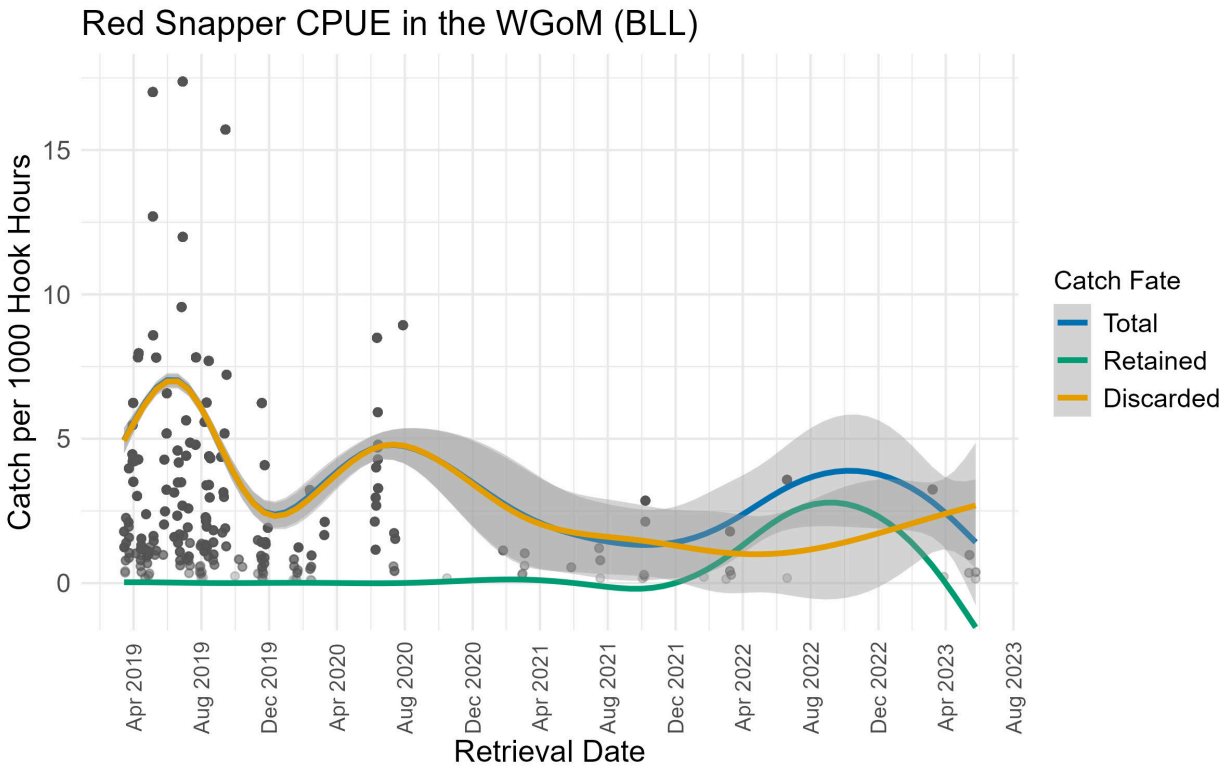

Figure 8. Red snapper catch per unit effort GAM for the WGoM BLL fishery, 4/2019 - 5/2023.

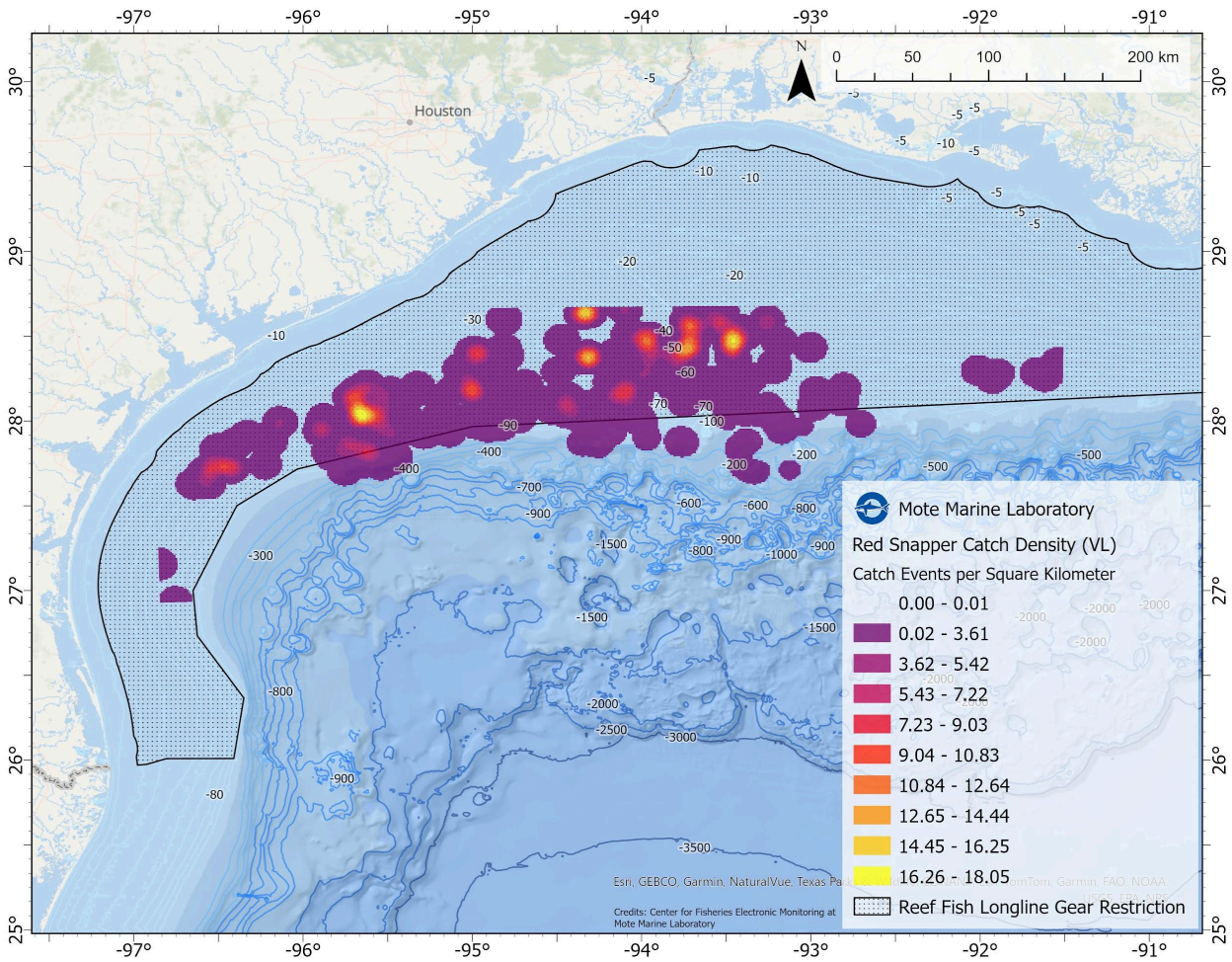

Figure 9. Kernel density of red snapper VL catch events recorded in the WGoM.

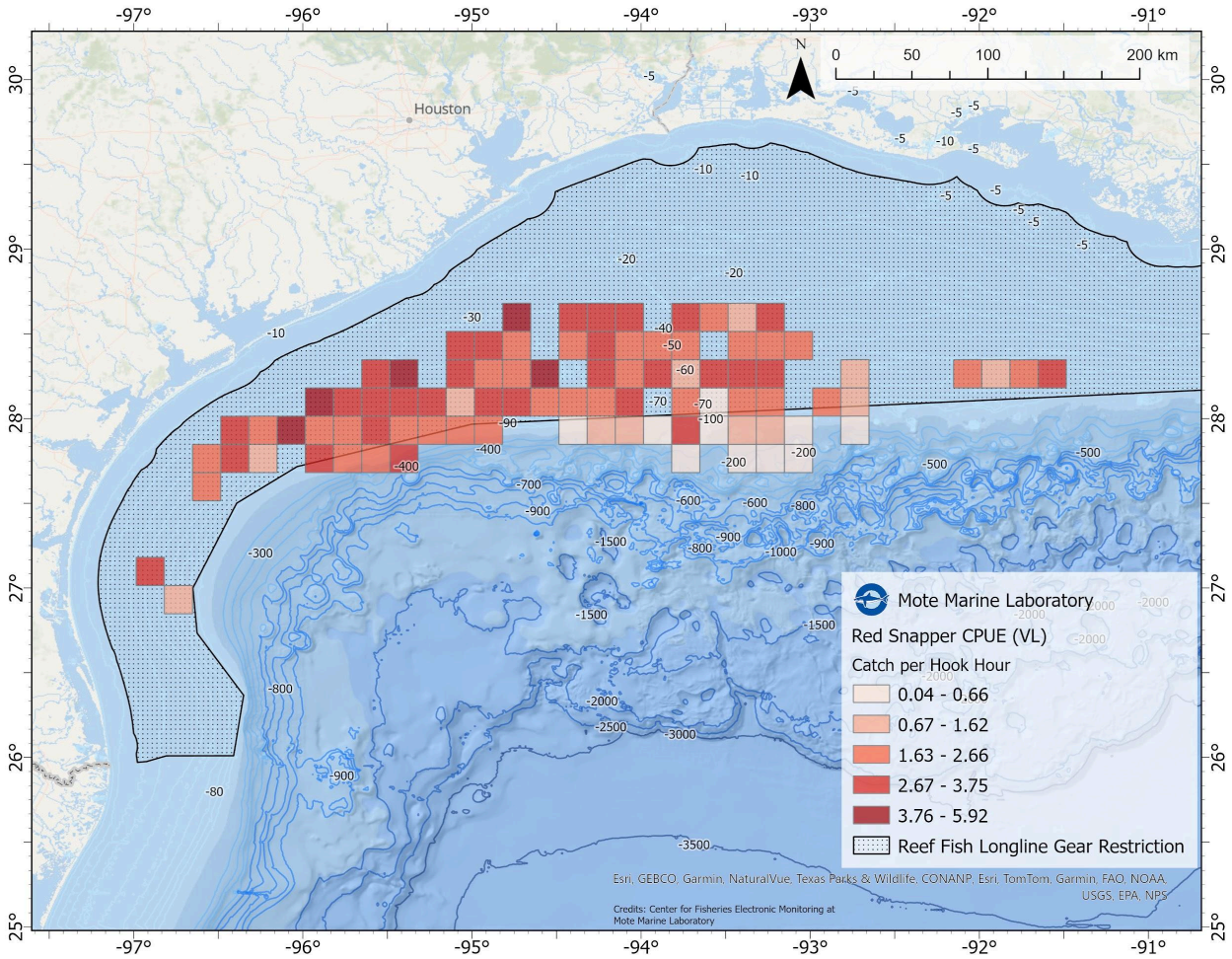

Figure 10. Catch per unit effort of red snapper in the WGoM VL fishery with a grid cell size of 10 x 10 min.

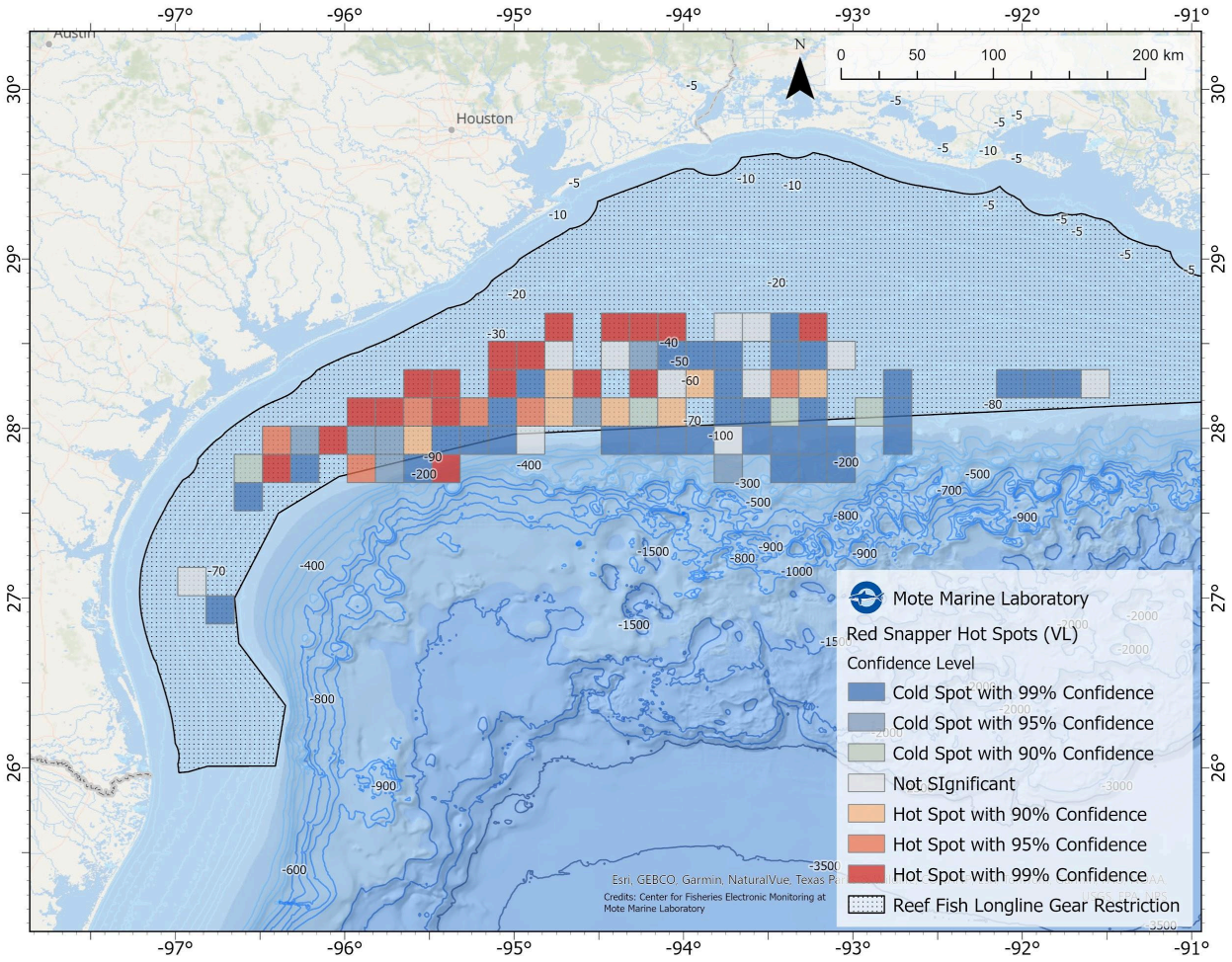

Figure 11. Hotspot analysis for red snapper in the WGoM VL fishery.

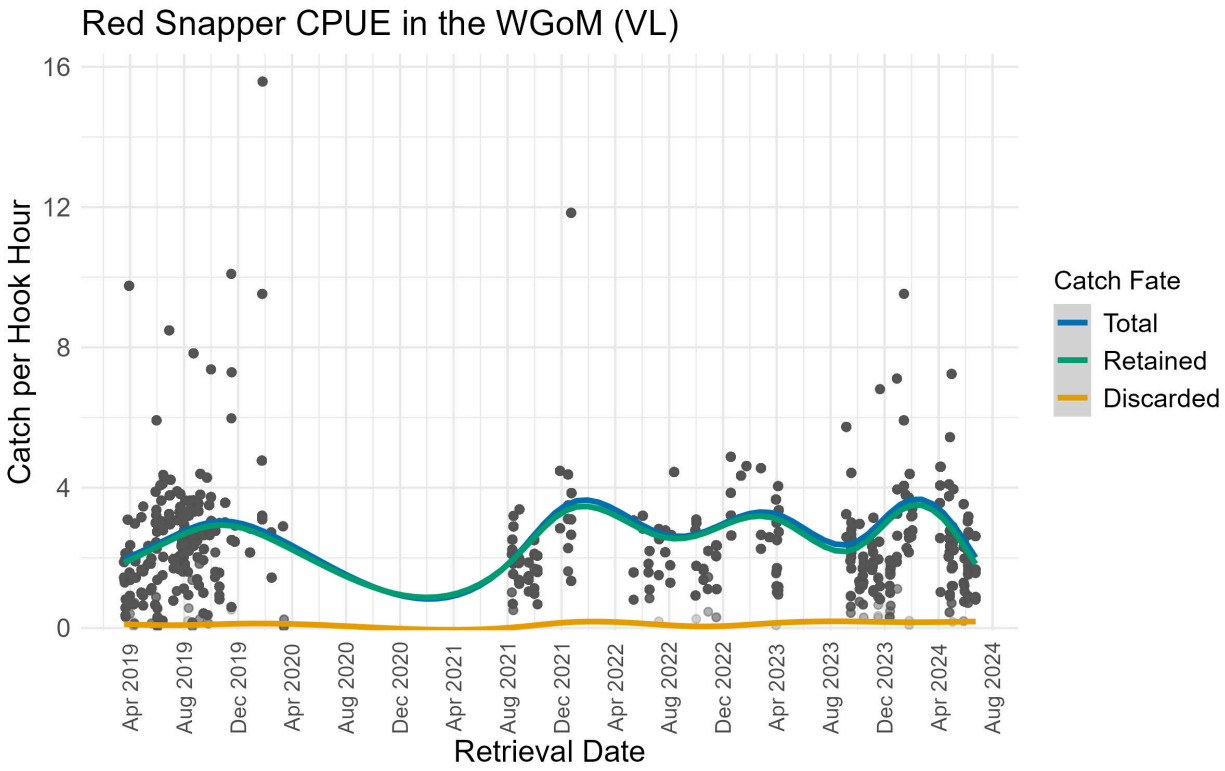

Figure 12. Red snapper catch per unit effort GAM for the WGoM VL fishery, 4/2019 - 6/2024.

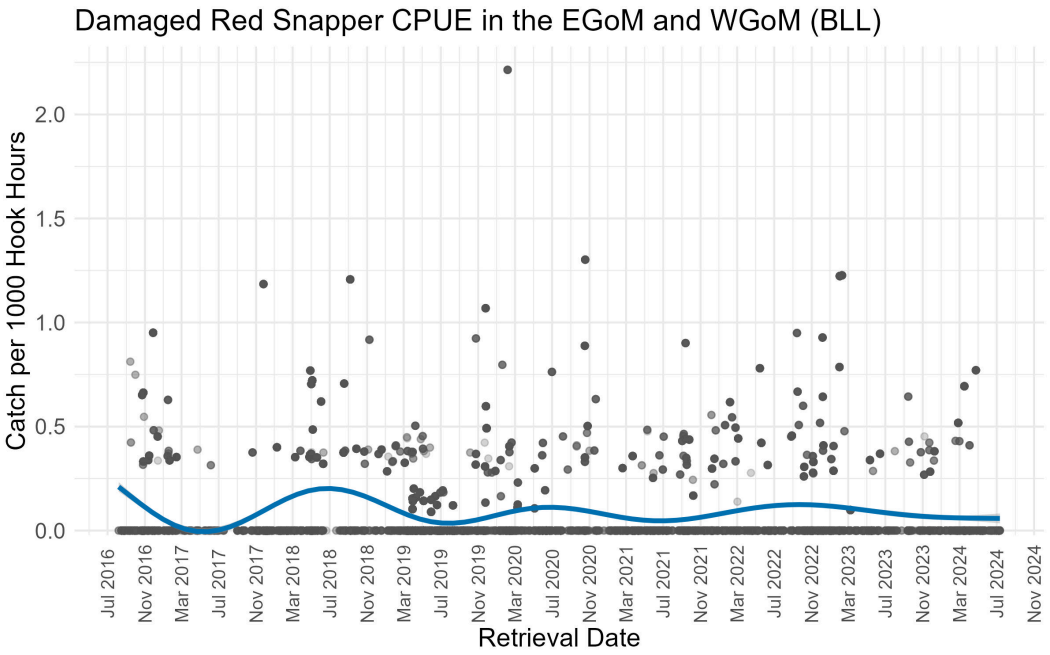

Figure 13. Damaged red snapper catch per unit effort GAM for the EGoM and WGoM BLL fisheries, 7/2016 - 7/2024.

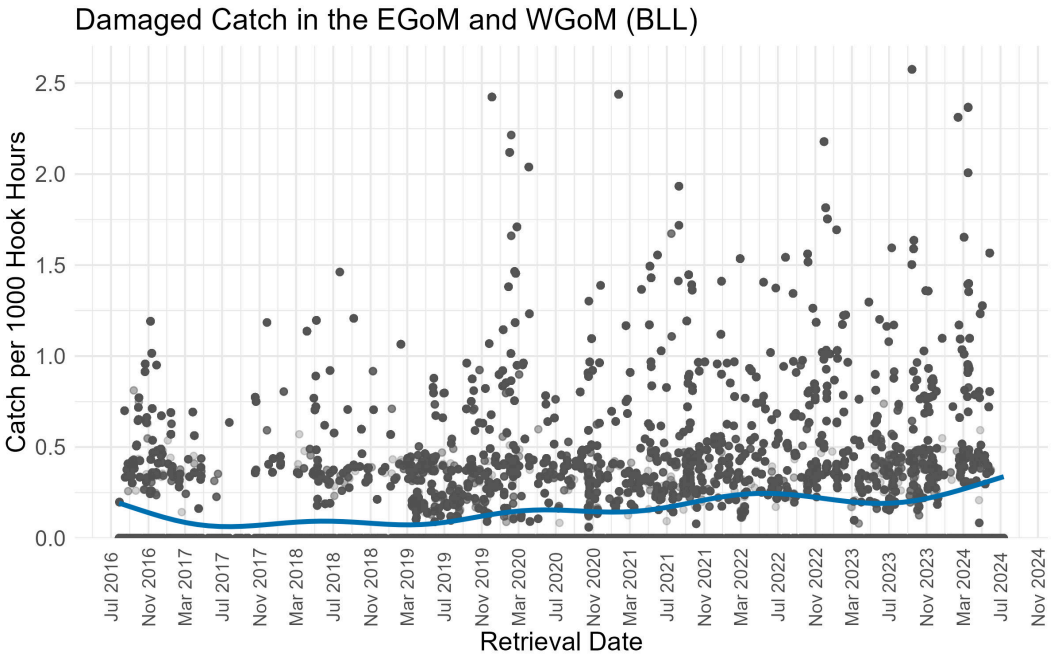

Figure 14. GAM of catch per unit effort of all damaged fish for the EGoM and WGoM BLL fisheries, 7/2016 - 7/2024.