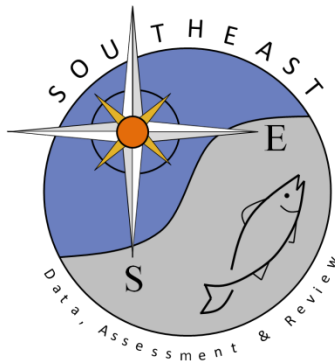# Hammerhead Shark (*Sphyrna spp.*) Electronic Monitoring Data Review from the Gulf of Mexico Bottom Longline Reef Fish Fishery

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Hammerhead Shark (*Sphyrna spp.*) Electronic Monitoring Data Review from the Gulf of Mexico Bottom Longline Reef Fish Fishery

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

The Center for Fisheries Electronic Monitoring (CFEMM) has been pioneering electronic monitoring (EM) in the Gulf of Mexico (GoM) commercial reef fish fishery since 2016, utilizing Saltwater Inc. hardware and software. Industry volunteer participation has included collaborations with 18 commercial vessels, with 16 of those deploying bottom longline (BLL) gear.   The BLL vessels fished out of ports along Florida's west coast and Galveston, Texas (Figure 1). From July 2016 to October 2021, through these partnerships, the CFEMM has gathered BLL data representative of the following:

- Catch Events Recorded = 93,997
- Trips = 307
- Hauls Reviewed = 2,033 (Represents 25% of all potentially analyzable set-haul events)
- Sea Days = 3,034
- Unique species/species groupings annotated = 137

Video Review Protocol

Saltwater Inc. (SI) (Anchorage, AK) Electronic Monitoring Unit (EMU) hard drives from participating vessels are collected during dockside visits or mailed by the respective captains or vessel owners. These drives are loaded to workstations, where SI review software is used to review the collected video footage. Sets and hauls are marked along a timeline by reading associated sensor data (hydraulic pressure and rotation). Subsamples of 25% of complete set/haul events from each trip are reviewed. Each recorded catch event is assigned characteristics based on a series of dropdown menus for the reviewer to select from. These variables include:

- **Species**
- **Handling**
    - Brought onboard,
    - Not handled (dropped off),
    - Cutoff at rail (no entanglement),
    - Cutoff at rail (entanglement), or
    - Unknown handling.
- **Condition**
    - Live healthy,
    - Live stomach and/or eyes protruding,
    - Live damaged,
    - Dead on arrival damaged,
    - Dead on arrival undamaged, and
    - Unknown condition.

- **Fate**
    - Retained,
    - Retained as bait,
    - Discarded live healthy (vented),
    - Discarded live healthy (not vented),
    - Discarded live damaged (not vented),
    - Discarded live damaged (vented),
    - Discarded dead,
    - Discarded unknown, and
    - Unknown fate.
- **Shark Specific Attributes**
    - Sex - Male/Female
    - Maturity - Juvenile/Known Adult
    - Size Estimate - Small (>1m), Medium (1.1 to 2.9m), and Large (>3m)

Post-Review Processing

Resulting data navigates a CFEMM established QA/QC process where all annotated events and sensor data anomalies are reviewed by experienced staff to screen for identification errors or missing catch. Aggregated groupings of trips are further screened using "R", applying a series of over 50 error checks to flag any abnormalities. Once approved, final data is appended to the master database in Access™. For reporting purposes, additional automatic calculations and environmental metadata are linked to the Access™ database through an export routine in "R", allowing for key variables to be associated to catch events such as depth, average temperature, and bottom type, with over 200 variables recorded.

Great Hammerhead (*Sphyrna mokarran*)

Catch and Mortality

The CFEMM documented 11 confirmed captures of Great Hammerheads on BLL gear targeting reef fish from 2,033 reviewed hauls, with all occurrences in the EGoM (Figure 2). Great hammerheads were encountered most often in shallower depths from 41.8 to 77.5 m, with an average depth of capture of 50 m. At vessel mortality for this species was 27.27% (Table 1), though interactions were not sufficient for other inferences when compared to Scalloped Hammerheads. Catches of this species were not recorded during summer months (July-September), and no captures were documented in 2018.

Biological Characteristics

All great hammerheads had associated size estimates of greater than 2m. Two of the eleven hammerheads were recorded as known adults. Sex of sharks was not obtained during these interactions, as all captures were cut off at the side of the vessel.

Scalloped Hammerhead (*Sphyrna lewini*)

Catch and Mortality (EGOM)

From the 1,684 hauls reviewed, EM data documented 47 Scalloped Hammerhead interactions in the EGoM on reef fish BLL gear since 2016. In this region, the depth of capture ranged from 43 to 281m, with an average depth of capture of 115 m. The majority of scalloped hammerhead interactions occurred during or surrounding the red grouper closure from June through August, when fishing effort is restricted to outside of 35 fathoms. Over 72% of the scalloped hammerhead interactions were outside of the seasonal closed area (Figure 2). Capture locations showed a southerly distribution, with few interactions recorded north of Sarasota, FL.

Scalloped Hammerheads showed the second highest rate of mortality in the EGoM, with 38.30% of catches arriving dead to the vessel (Table 1). The primary factors influencing catches included a positive effect of depth and gravel bottom as identified by the 3 step model selection process.

Biological Characteristics (EGOM)

Two scalloped hammerheads were recorded as known adults, one was a juvenile, and one was recorded as a male. The remainder (91.49%) had unknown maturity and/or sex. Medium (1 m-2 m) size estimates accounted for 61.70% of catches, and 38.30% were recorded as large (>3 m). No specimens less than 1m in length were documented.

Catch and Mortality (WGOM)

From 349 reviewed hauls since 2019, EM data documented 112 scalloped hammerheads in the WGoM (Table 2). Scalloped hammerhead catches in the region ranged in depths from 100 to 339 m with an average depth of occurrence of 135 m. Due to inshore waters closed to longlining, all fishing effort targeted the deep-water grouper complex. Fishing effort spanned from the US/Mexico border to Louisiana. Mortality for this species in the WGoM was 72.32%, nearly double the mortality rate in the EGoM. Qualitatively speaking, longer soak times could be considered a primary driver for elevated mortalities in this region.

Biological Characteristics (WGOM)

Sex determination for scalloped hammerheads on WGoM vessels was difficult, with the majority of catches cut off at the side of the vessel and vessels hauling gear at night

more regularly than in the EGoM. Juveniles represented 10.71% of catch and adults made up 8.93% overall. Unknown sex and or maturity were recorded by reviewers 77.68% of the time. A shark size of medium (1-2 m) and large (>3 m) were recorded at 50.89% and 49.11%, respectively. No specimens were documented under 1 m in length.

Catch per Unit Effort (CPUE)

Species specific CPUE for scalloped hammerheads was calculated based on the average CPUE within 10 x 10 minute grid cells. Results showed high CPUE in offshore areas of Louisiana and relatively widespread low catch rates throughout the fishing area (Figure 3). CPUE was based on the EGoM limit of 750 hooks, taking the average species specific CPUE within each grid cell. Calculating CPUE using other methods such as catch per kilometer (due to the absence of hook counts) showed similar trends of high-CPUE areas.

Management Implications

Potential negative impacts to scalloped hammerheads may occur in the EGoM with reduced availability or accessibility to red grouper quota, pushing fishing effort into depths where scalloped hammerheads are more abundant. As fishers rely on the deep-water grouper complex more in the EGoM, there is potential for an increase in these interactions.
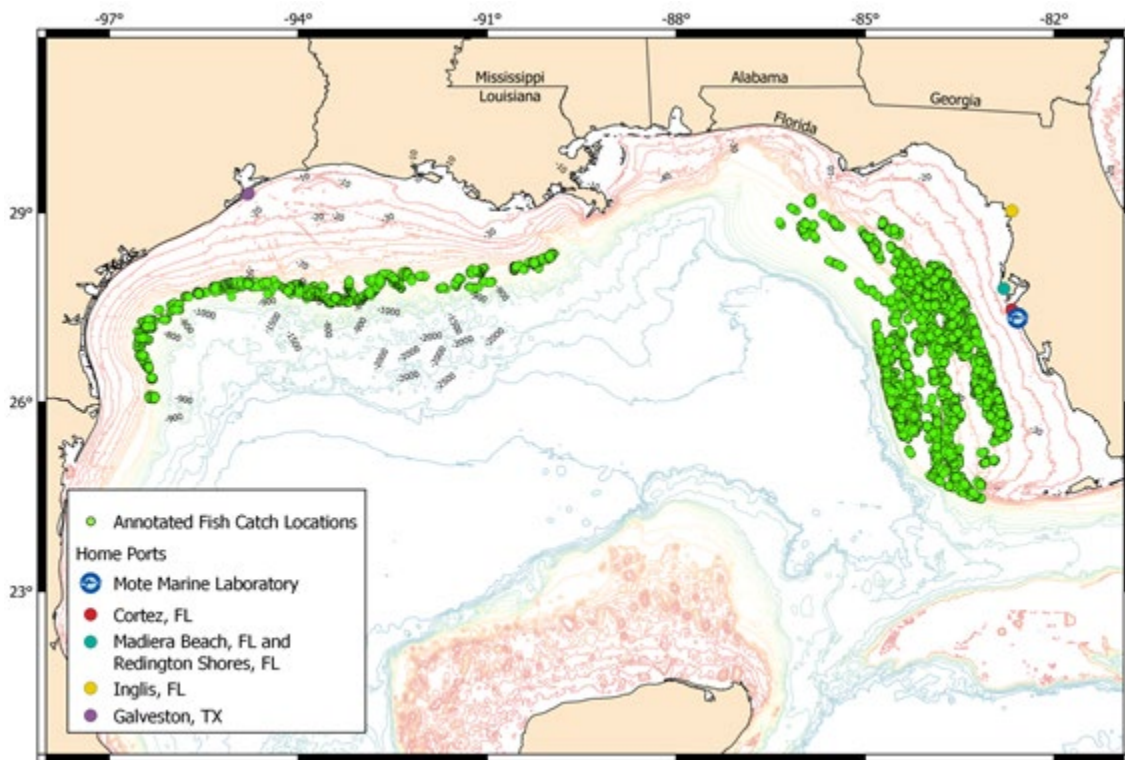

Figure 1. Distribution map of all catch events (*n* = 93,997) from bottom longline vessels recorded through EM from July 2016 to October 2021.
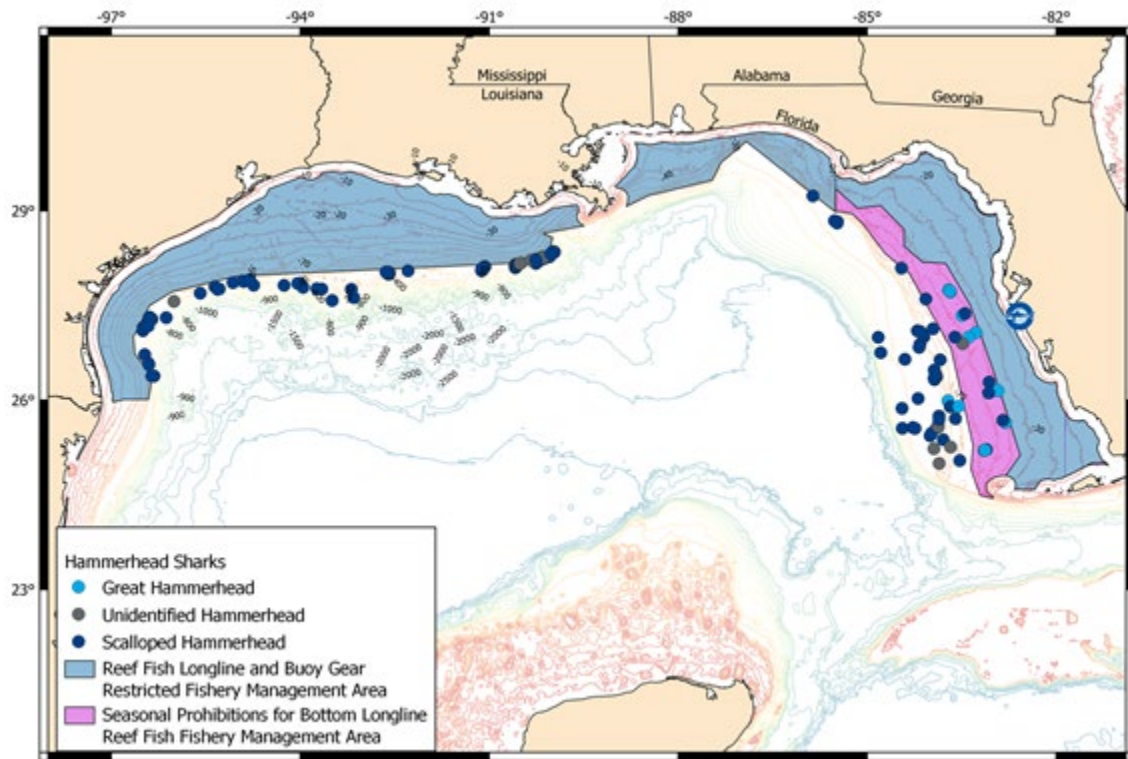
Figure 2. Distribution map of hammerhead shark (*Sphyrna spp.*) interactions (*n* = 181) on bottom longline gear in relation to gear restricted areas.

Table 1. Shark frequency and mortality from bottom longline data in the eastern Gulf of Mexico.

Common Name	Number Caught	Number Dead	% Dead on Arrival
Dusky Shark	7	3	42.86
Scalloped Hammerhead	47	18	38.30
Silky Shark	135	47	34.81
Great Hammerhead	11	3	27.27
Spinner Shark	14	2	14.29
Night Shark	71	8	11.27
Carcharhinid, Unidentified	38	3	7.89
Shark, Unidentified	174	11	6.32
Atlantic Sharpnose Shark	871	55	6.31
Blacknose Shark	487	12	2.46
Dogfish, Smooth (Florida)	379	4	1.06
Dogfish, Spiny (Cuban)	362	2	0.55
Sandbar Shark	532	2	0.38
Sharpnose Sevengill Shark	2	0	0.00
Angel Shark	1	0	0.00
Blacktip Shark	6	0	0.00
Bull Shark	3	0	0.00
Chain Catshark	3	0	0.00
Hammerhead, Unidentified	6	0	0.00
Lemon Shark	10	0	0.00
Nurse Shark	184	0	0.00
Sixgill Shark (all)	17	0	0.00
Tiger Shark	274	0	0.00
Total	3634	170	-

Table 2. Shark frequency and mortality from bottom longline data in the western Gulf of Mexico.

| Common Name	Number Caught	Number Dead	% Dead on Arrival
Common Thresher Shark	1	1	100.00
Silky Shark	78	63	80.77
Blacktip Shark	4	3	75.00
Scalloped Hammerhead	112	81	72.32
Night Shark	41	25	60.98
Atlantic Sharpnose Shark	248	151	60.89
Shortfin Mako	10	5	50.00
Spinner Shark	2	1	50.00
Carcharhinid, Unidentified	51	21	41.18
Blacknose Shark	11	4	36.36
Sixgill Shark (all)	23	8	34.78
Shark, Unidentified	117	35	29.91
Sharpnose Sevengill Shark	39	10	25.64
Hammerhead, Unidentified	5	1	20.00
Tiger Shark	30	3	10.00
Sandbar Shark	73	6	8.22
Dogfish, Smooth (Florida)	1659	91	5.49
Dogfish, Spiny (Cuban)	767	5	0.65
Angel Shark	8	0	0.00
Bull Shark	3	0	0.00
Chain Catshark	8	0	0.00
Dusky Shark	3	0	0.00
Total	3293	514	-
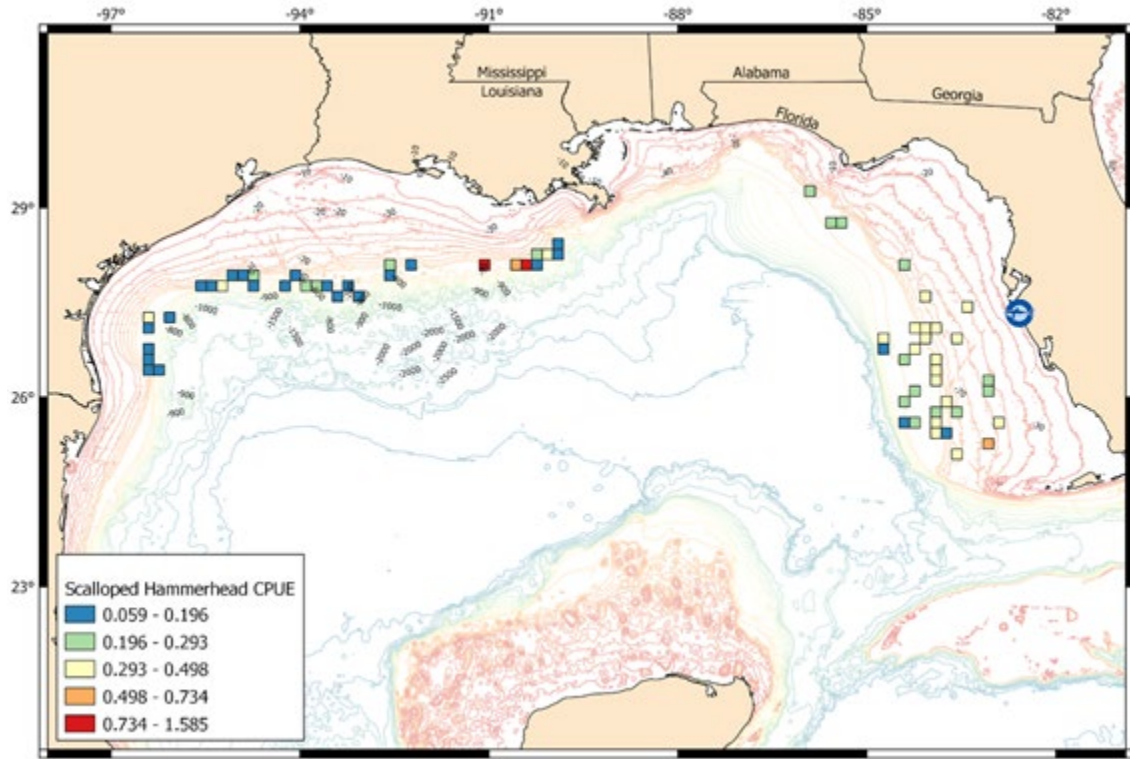
Figure 3. Catch per unit effort of scalloped hammerheads on bottom longline gear. Grid size 10 x 10 minute.