Preliminary Non-Technical Fishery Profile and Limited Data Summary for Scamp, Mycteroperca phenax with Focus on the West Florida Shelf: Application of Electronic Monitoring on Commercial Snapper Grouper Bottom Longline Vessels

Carole L. Neidig, Daniel Roberts, Max Lee, Ryan Schloesser

SEDAR68-DW-22

12 March 2020

Please cite this document as:

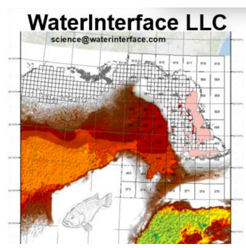
Neidig, Carole, L., Daniel Roberts, Max Lee, Ryan Schloesser. 2020. Preliminary Non-Technical Fishery Profile and Limited Data Summary for Scamp, Mycteroperca phenax with Focus on the West Florida Shelf: Application of Electronic Monitoring on Commercial Snapper Grouper Bottom Longline Vessels. SEDAR68-DW-22. SEDAR, North Charleston, SC. 15 pp.

Preliminary Non-Technical Fishery Profile and Limited Data Summary for Scamp, *Mycteroperca phenax* with Focus on the West Florida Shelf: Application of Electronic Monitoring on Commercial Snapper Grouper Bottom Longline Vessels

Mote Marine Laboratory
Center for Fisheries Electronic Monitoring (CFEMM)
Carole Neidig, M.S. and Max Lee, B.S.
Directorate for Fisheries and Aquaculture
Ryan Schloesser, Ph.D.

MOTE MARINE LABORATORY & AQUARIUM

Compiled by Daniel Roberts, B.S.
Waterinterface LLC.



Made Possible through Grant Support from:
National Fish and Wildlife Foundation Innovation Fund
Environmental Defense Fund
NOAA NMFS Cooperative Research
National Fish and Wildlife Electronic Monitoring Research
NOAA NMFS Bycatch Reduction Engineering Program
Thank You Stakeholders:
Commercial Snapper Grouper Industry Participants
Gulf of Mexico Reef Fish Shareholders' Alliance

SEDAR 68 Gulf of Mexico and Atlantic Scamp Data Workshop
16-20 March 2020

MML Tech. Rpt No. 2332

Note: Information is preliminary and is distributed solely for the purpose of pre-dissemination peer review. It does not represent and should not be construed to represent recommendations, final analysis or policy of the Center for Fisheries Electronic Monitoring at Mote (CFEMM). Please cite this information as: "CFEMM Electronic Monitoring Team".

There are two EM datasets referenced in this summary (Dataset A, and Dataset B). One contains 697 scamp individual records for the West Florida Shelf (WFS), dataset A (DSA). A later dataset contains 804 scamp records, Dataset B (DSB), a difference of 107 records. Both datasets represent approximately 25 % of all set-haul-events for the time period from for which they were annotated, from an average of five-bottom longline fishing vessels, fishing out of Madeira Beach and Bradenton, FL. The report was started prior to output of the second dataset.

Data Model Background and Review; The Annotation Dataset (Neidig et al., 2019. *Best Fishing Practices for Bycatch Reduction in the Gulf of Mexico Reef Fish Fishery: Employing Innovation Underwater Cameras and Refined Modeling to further the Use of Electronic Monitoring: Interim Report for Award Number: NA18NMF4720287, July, 2019*).

The annotation dataset was compiled by Center for Fisheries Electronic Monitoring (CFEMM) reviewers from a primary data frame originating on the fishing fleet (individual vessels). Open source software for this work designed by Saltwater Inc. (SWI) and the CFEMM was used (Figure 1).

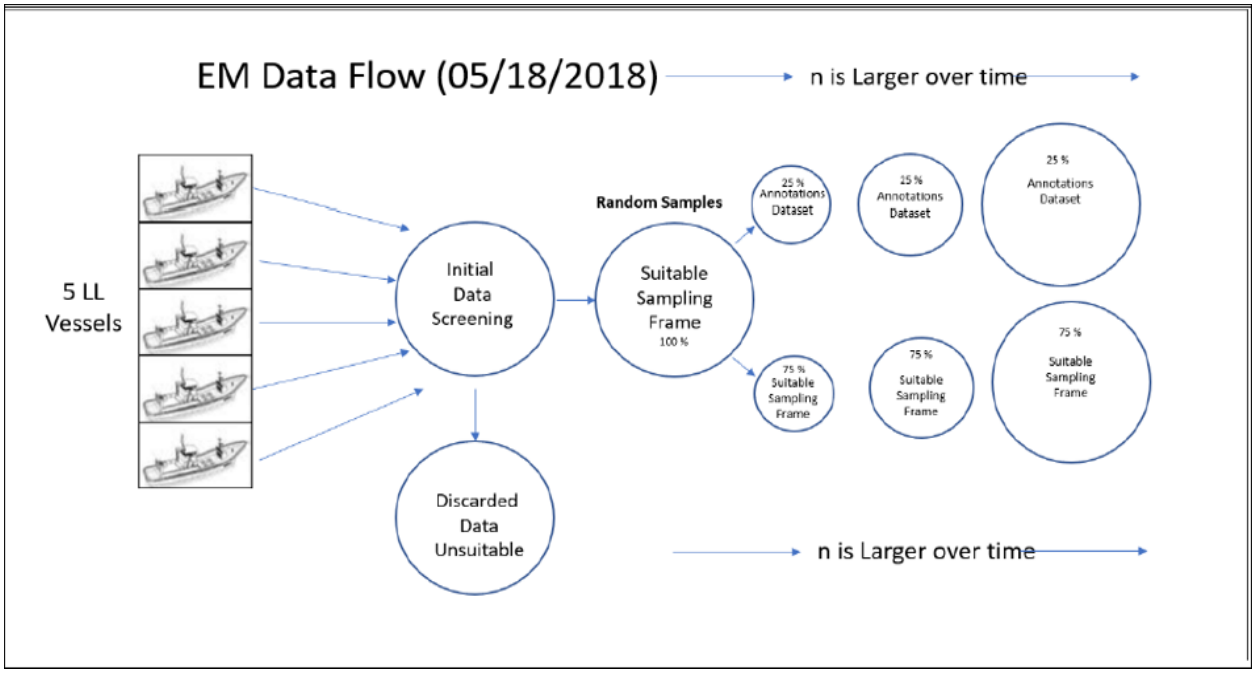


Figure 1. Origin of the EM Gulf of Mexico reef fish annotation dataset.

Vessel Trip Set-Haul-Event Annotation Sampling Frame - Available units of the sampling frame are partitioned by vessel, date and trip. Approximately 25% of the BLL and VL complete set-haul events (SHEs) are randomly sampled from each post-trip (hard drive) using a "random-sampling-without-replacement" technique. The post-trip database is developed sequentially in that it expands with project duration over time. Milestones, or waypoints, in the sampling strategy exist based on collection of EM data over time from all

fishing vessels enrolled in the project, therefore the total available sample population (data pool or sampling frame) is increasing over time.
The selected SHE consists of a population of events that had the necessary elements to evaluate and annotate; that is: not all SHEs from every trip are suitable for annotation, therefore unsuitable ones are eliminated from the initial sample frame available from each trip (prior screening to make sure SHE's were measurable and could be annotated). There are "reviewable" and "non-reviewable" SHEs (Figure 2).

Figure 2. Examples of a vessel timeline segment with set-haul-events (SHEs) that meet criteria for review and a second with incomplete SHEs, not included for review. Examples include labeled elements and definitions of catch ratio calculation elements from Scott-Denton, 2011.

Random selection of only complete SHEs comprises the initial selection annotation sample frame. This process complicates selection and is open for further consideration. The sampling process is stepwise based on the following procedure: **1)** hard drives (trips) are preliminarily reviewed to determine which sets are reviewable and which are not. Incomplete SHEs are removed from the individual trip dataset, reducing the total selectable sample frame size. Discrete variables, as a result of the screening, have two outcomes (reviewable; not reviewable). The probability distribution for this phase is hypergeometric, not binomial, due to the fact the non-reviewable set events are removed from the available remaining trip events. **2)** Once the trip data pool has only reviewable SHEs left, 25% are randomly selected without replacement for annotation and assessment. The probability distribution for phase 2, independent of phase 1, is more difficult to determine because the number of events (*n*) per trip can vary, and the number of events is decreased by n-1 as each random selection is made. If there are few total events per trip the outcome of sampling can be more statistically dramatic based on successive probabilities and can be evaluated by analysis of covariance (degree of probability linking). The probability distribution for the random selection for phase 2 may or may not be normal, based on the number of reviewable set-haul events. The sampling probability distribution follows: *Annotations dataset selection = 1/n +1/n-1 + 1/n-2 +, 1/n-3…1/n-k* until 25% of the reviewable trip sample is reached. The magnitude of a vessel trip SHE number could affect the probability distribution.

After annotation, various calculations and additional variables are added to the annotation dataset depending on the type of analysis to be performed. These additional variables primarily include environmental, oceanographic, meteorological, and geographic elements. The modified annotation dataset is used for model development, habitat assessment, GIS density and hotspot analysis, point pattern analysis, and development of fishery statistics to include disposition of all catch and bycatch.

The datasets used in this report were aggregated using an automated coding process developed by Ryan Schloesser, Ph.D., CFEMM team member. Spatial variables, and ecological variables were appended to the annotation dataset using various applications including ArcGIS™ 10.7, SAS™ 9.2, ArcGIS™ 10.3, Marine Geospatial Ecology Tools™, Geospatial Modeling Environment™, Python™, and R™.

During this period, additional BLL vessels were added to the EM Study fleet from Galveston TX. As of this dataset only six scamp have been annotated from the Texas fleet, therefore, this report includes data from only BLL vessels from the WFS from four ports in proximity to Madeira Beach, FL. The entire dataset contains almost 60,000 records (25 % of fishing events from the north and west Gulf of Mexico and the west Florida Shelf (NWGOM and WFS, respectively). The WFS portion of that dataset contains approximately 45,000 records with 697 catch records for scamp (DSA), and 804 scamp records (DSB), respectively. During the current sampling period a total of 255 SHEs caught scamp (DSB). The most numerous 15 SHEs are presented in Table 1. Mean annotated catch per set haul event for the period was 3.0.

Table 1. Top 15 set-haul-events with annotated scamp.

Set-Haul-Events with Scamp	Scamp Per SHE	Cumulative (Count)	Percent	Cumulative (Percent)
00544027_20161104_2_5	20	39	2.487562	4.8507
01057895_20160814_1_5	20	382	2.487562	47.5124
01057895_20161209_2_11	17	592	2.114428	73.6318
00559453_20170427_1_1	13	105	1.616915	13.0597
00565290_20160724_1_1	13	130	1.616915	16.1692
00623869_20160912_2_11	11	208	1.368159	25.8706
00623869_20180518_1_8	11	281	1.368159	34.9502
01057895_20161209_1_2	11	568	1.368159	70.6468
00623869_20181216_1_5	10	318	1.243781	39.5522
01057895_20160913_2_17	10	419	1.243781	52.1144
00565290_20160724_1_3	9	145	1.119403	18.0348
00565290_20160724_1_4	9	154	1.119403	19.1542
01057895_20161126_1_22	9	556	1.119403	69.1542
01057895_20180425_1_8	9	769	1.119403	95.6468
00544027_20160808_2_4	8	17	0.995025	2.1144

Scamp catch distribution within these datasets along the WFS varies from clustered to dispersed. Preliminary modeling indicates a profound influence on catch; catch per unit effort (CPUE), and other response variables by vessel operations, crew, type of vessel, and fishing schedules. Incremental spatial autocorrelation testing (Incremental Global Moran I) for scamp implies significant autocorrelation of CPUE derived abundance at WFS global scale (Figure 3; Table 2). Peak scale distance is 21,000 meters and is identical to that of the silky shark, *Carcharhinus falciformis.* This proximity of scamp and silky sharks are consistent with near neighbor analysis.

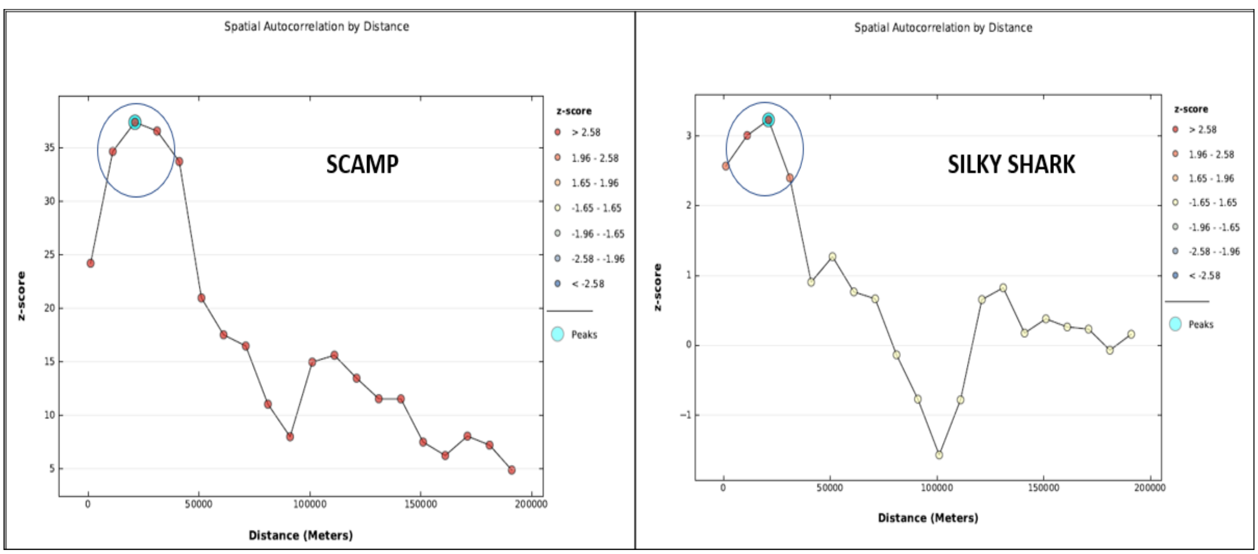


Figure 3. Spatial scale indicated by incremental autocorrelation analysis for scamp (21,000 meters) for the described BLL fishing area of the WFS. Indicated spatial scale for scamp is consistent with that of silky shark.

Table 2. Significant distance summary of scamp species CPUE X 1000 hooks globally autocorrelated neighbors.

Distance	Moran's Index	Expected Index	Variance	z-score	p-value
1000.00*	0.877026	-0.001524	0.001314	24.236062	0.000000
11000.00*	0.421362	-0.001263	0.000148	34.693119	0.000000
21000.00*	0.288713	-0.001248	0.000060	37.424369	0.000000
31000.00*	0.223246	-0.001247	0.000038	36.605322	0.000000

Scamps are caught in a fishing area (minimum convex polygon) of just over 43,000 square kilometers in this referenced fishery (Figure 4). This area ranges from approximately 28.7 degrees north to 24.7 degrees south and from -83.0 degrees west to -85.0 degrees west (Figure 4). Depths range between -49 and -165 meters; mean depth = -79 meters (Figures 5 and 7). Scamp in this fishing area were caught in the deeper range of red grouper, *Epinephelus morio* and red snapper, *Lutjanus campechanus,* the main target species (mean depth = -56 meters), but in a similar benthic habitat.

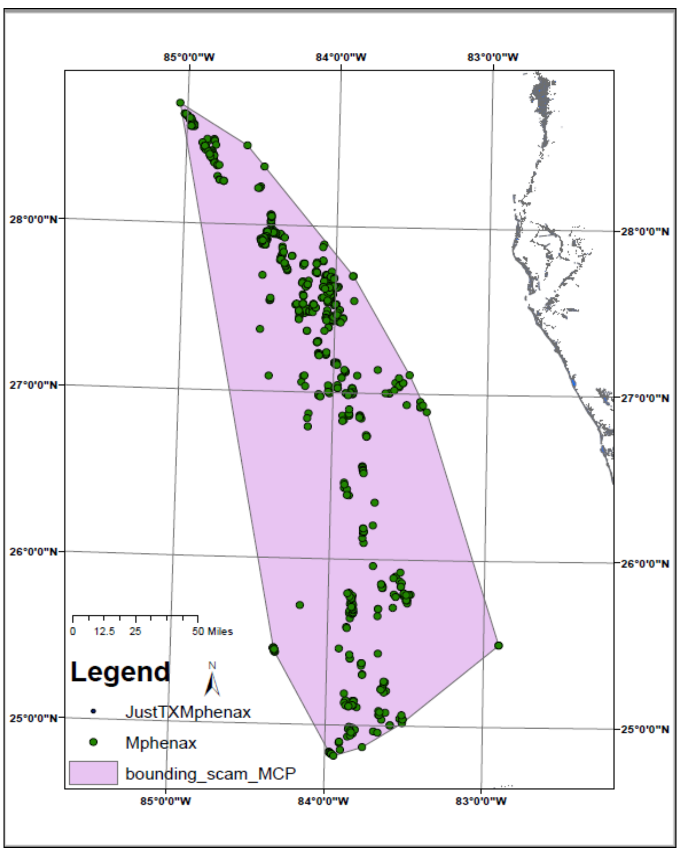


Figure 4. Fishing area with Scamp catch presented in a minimum convex polygon of just over 43,000 square kilometers in the snapper grouper fishery efforts.

Scamp are a small part of total species composition for this fishery (Table 3). They are listed fifth in frequency of occurrence and comprise a little over 2.0 % of the total annotated catch.

Table 3. Frequency of occurrence (catch) for the top 10 species listed by common name.

Common Name	Count	Cumulative (Count)	Percent	Cumulative (Percent)
Red Grouper	23766	27078	59.75260	68.0797
Red Snapper	4016	34743	10.09705	87.3510
Yellowedge Grouper	2443	3201	6.14220	8.0480
Blueline Tilefish	989	29732	2.48655	74.7524
Scamp	804	36968	2.02142	92.9451
Gag Grouper	603	35870	1.51607	90.1845
Atlantic Sharpnose Shark	521	30253	1.30990	76.0623
Mutton Snapper	469	37843	1.17916	95.1451
Jolthead Porgy	442	30727	1.11128	77.2540
Snowy Grouper	382	433	0.96043	1.0887

Total annotated catch by year, month, and vessel is presented in Tables 4 and 5, respectively. Most scamp were caught in August and October with the fewest caught in May and July. Most scamp were caught in 2016, even though data was only collected for the months of August through December that year. This may be related to the vessels and their effort in the program at that time in that year. Vessels E and F were the most productive vessels for scamp, producing 169 and 470 scamp over the period. Fishing effort and success is highly variable from vessel to vessel. Operational processes need further investigation.

Table 4. Total annotated scamp catch by vessel and month for a 3+-year period.

N=804 (Retrieval_Month)	Vessel_ID (A)	Vessel_ID (B)	Vessel_ID (C)	Vessel_ID (D)	Vessel_ID (E)	Vessel_ID (F)	Vessel_ID (G)	Row (Totals)
1	0	11	0	0	18	42	0	**71**
2	0	0	0	0	10	27	0	**37**
3	0	1	0	2	17	19	0	**39**
4	0	0	0	0	10	51	0	**61**
5	0	0	0	2	7	19	0	**28**
6	0	0	0	0	19	25	0	**44**
7	6	0	15	0	7	0	0	**28**
8	9	1	7	39	8	82	0	**146**
9	17	1	3	0	40	13	0	**74**
10	4	8	0	0	9	139	0	**160**
11	32	0	0	0	7	12	1	**52**
12	2	0	0	4	17	41	0	**64**
All Grps	**70**	**22**	**25**	**47**	**169**	**470**	**1**	**804**

Table 5. Annotated catch of scamp by month and by year from the WFS, BLL fishery.

Retrieval_Month	Retrieval_Year (2016)	Retrieval_Year (2017)	Retrieval_Year (2018)	Retrieval_Year (2019)	Row (Totals)
1	0	52	6	13	**71**
2	0	29	8	0	**37**
3	0	15	21	3	**39**
4	0	8	50	3	**61**
5	0	4	24	0	**28**
6	0	13	28	3	**44**
7	0	21	0	7	**28**
8	110	1	34	1	**146**
9	59	6	9	0	**74**
10	143	4	13	0	**160**
11	38	7	6	1	**52**
12	31	17	14	2	**64**
All Grps	**381**	**177**	**213**	**33**	**804**

The density distribution ranges for scamp were highly clustered, 2.6 – 3.0 fish/Km², to highly dispersed, 0.3 fish/Km², with clusters in depths ranging from – 60 meters to -80 meters. They were more dispersed in the deeper and shallower portions of their depth range (Figure 5).

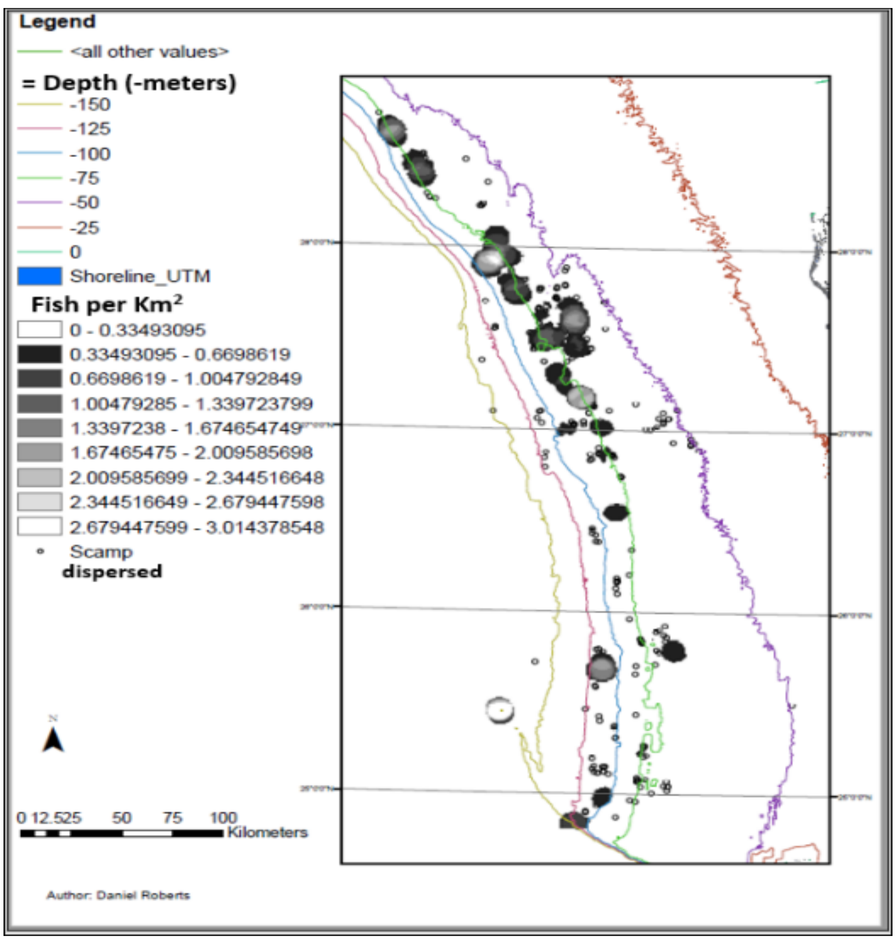


Figure 5. Scamp density distribution ranges on the West Florida Shelf.

Calculation of CPUE in this study generally follows the methods outlined in Scott-Denton, 2011. Scamp species mean CPUE X 1000 hooks (CPUE_SP_1000) is presented in Figure 6 and in Table 6.

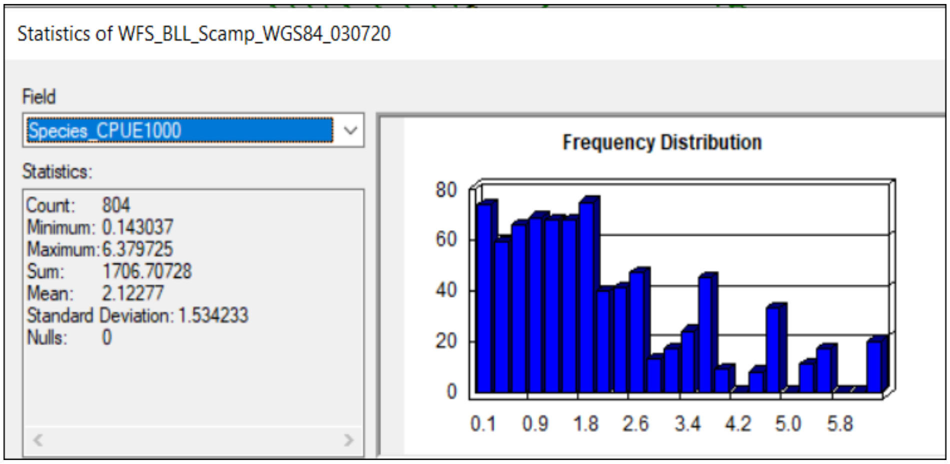


Figure 6. Summary of species CPUE x 1000 hooks for scamp over 3-plus year period from August 2016 to July 2019.

Table 6. Summary table for species CPUE X 1000 hooks by vessel (A) by year (B), and by month (C).

A

Vessel_ID	N Rows	Mean Species CPUE X 1000 Hooks	Median Species CPUE X 1000 Hooks	Std Err
A	70	2.107920143	1.536943629	0.210047413
B	22	1.275736439	0.808085709	0.218989542
C	25	2.372293984	2.779417169	0.151219171
D	47	3.141459067	3.529178216	0.241238915
E	169	1.590613461	1.141310938	0.109995274
F	1	0.298676862	0.298676862	
G	470	2.244719981	1.953548569	0.069014163

B

Retrieval Year	N Rows	Mean Species CPUE X 1000 Hooks	Median Species CPUE X 1000 Hooks	Std Err
2016	381	2.598739072	2.085193174	0.084476912
2017	177	1.686652126	1.281358582	0.112878871
2018	213	1.802809154	1.65902249	0.075134859
2019	33	1.031876286	0.700660372	0.158147711

C

Retrieval Month	N Rows	Mean Species CPUE X 1000 Hooks	Median Species CPUE X 1000 Hooks	Std Err
1	71	2.4841225	1.79768952	0.231799516
2	37	1.0479855	1.158195885	0.083948428
3	39	1.599554	1.299884184	0.198372126
4	61	1.8038856	1.458377009	0.14038222
5	28	1.1281329	1.031093926	0.123064788
6	44	1.6645664	1.589923332	0.163909615
7	28	1.7366435	1.281358582	0.193338167
8	146	2.8831882	2.337181568	0.151774362
9	74	1.9484701	1.519518692	0.187313874
10	160	2.0612665	1.954441162	0.095928025
11	52	2.65552	2.113968746	0.2449764
12	64	2.0728578	1.676402608	0.166994277

Mean CPUE_SP_1000 for scamp for the entire 3-plus year dataset was 2.1227 and ranged from 0.143037 to 6.379725. Mean CPUE_SP_1000 was highest for vessels **C** (2.372293984) and **D** (3.141459067), and lowest for vessel **F** (0.298676862), respectively. Similarly, highest mean CPUE_SP_1000 was in 2016 despite that year being only five months of recorded data. Monthly mean CPUE_SP_1000 was highest for months 10, 11, 12, and 1, respectively. When monthly mean CPUE_SP_1000 is partitioned by year this trend is fairly constant.

Fishing effort is presented by year, month and vessel (mean and median) in Table 7. Total mean fishing effort for the seven vessels fished in the dataset was 22,403.66 hook-hours. Each vessel consistently fished over 10.0 % of the total with vessels contributing in the following order: **A** (17.79 %), C (16.74 %), **B** (15.59 %), **F** (14.94 %), G (12.5 %), **E** (11.40 %), and **D** (11.02 %), respectively. Mean fishing effort was fairly consistent for all years but varied significantly monthly. In increasing order, February (2954.89 hook-hours), June (3047.47 hook-hours), November (3576.11 hook-hours) and July (3811.57 hook-hours) were the most intensively fished months over the 3-plus year period.

Table 7. Summary table for fishing effort by vessel (A), by year (B) and by month (C) for scamp 3+-year period.

A

Vessel_ID	N Rows	Mean Effort (Hook-Hours)	Median Effort (Hook-Hours)	Std Err
A	70	3986.203274	3905.097917	64.45194198
B	22	3493.147632	3104.570833	165.6226856
C	25	3750.789083	4677.239583	198.6029982
D	47	2469.779566	2550.16875	42.63420611
E	169	2554.674729	2458.908333	38.6161567
F	1	3348.1	3348.1	NA
G	470	2800.968116	2847.452083	22.66986864

B

Retrieval Year	N Rows	Mean Effort (Hook-Hours)	Median Effort (Hook-Hours)	Std Err
2016	381	2926.576323	2881.46875	38.92299258
2017	177	2953.763877	2811.595833	57.21440496
2018	213	2753.240307	2742.775	21.36109748
2019	33	2818.000505	2746.239583	99.86040969

C

Retrieval Month	N Rows	Mean Effort (Hook-Hours)	Median Effort (Hook-Hours)	Std Err
1	71	2768.884067	2811.595833	38.55006438
2	37	2954.897241	2878.870833	132.090975
3	39	2364.203632	2325.608333	43.4214943
4	61	2765.817999	2742.775	33.29597429
5	28	2671.305506	2771.420833	46.48902645
6	44	3047.479688	3053.104167	41.70625783
7	28	3811.574256	3902.108333	179.5480385
8	146	2917.737015	2830.379167	46.15506197
9	74	2783.403773	2550.6625	88.21578277
10	160	2699.759349	2984.95625	54.39422777
11	52	3576.10641	3905.097917	100.0773359
12	64	2889.764518	2794.172917	88.72530632

The spatial relationship of target species red grouper and red snapper with scamp is presented in Figure 7. Scamp in this fishery were found clustered in depths of about -60 meters to -80 meters, being more dispersed in deeper water up to about -165 meters and shallower water up to about -49 meters (Figures 5, and 7). Mean depth for the latest dataset for scamp is about -80 meters. Scamp were caught with red grouper and red snapper at the deeper end of the range for the latter two species (Figure 7).

CPUE was influenced by fishing depth (Table 8). Early models indicated depth effects on scamp CPUE to be significant over bottom current velocity, bottom current direction, bottom seawater temperature, and surface seawater temperature (Figure 8).

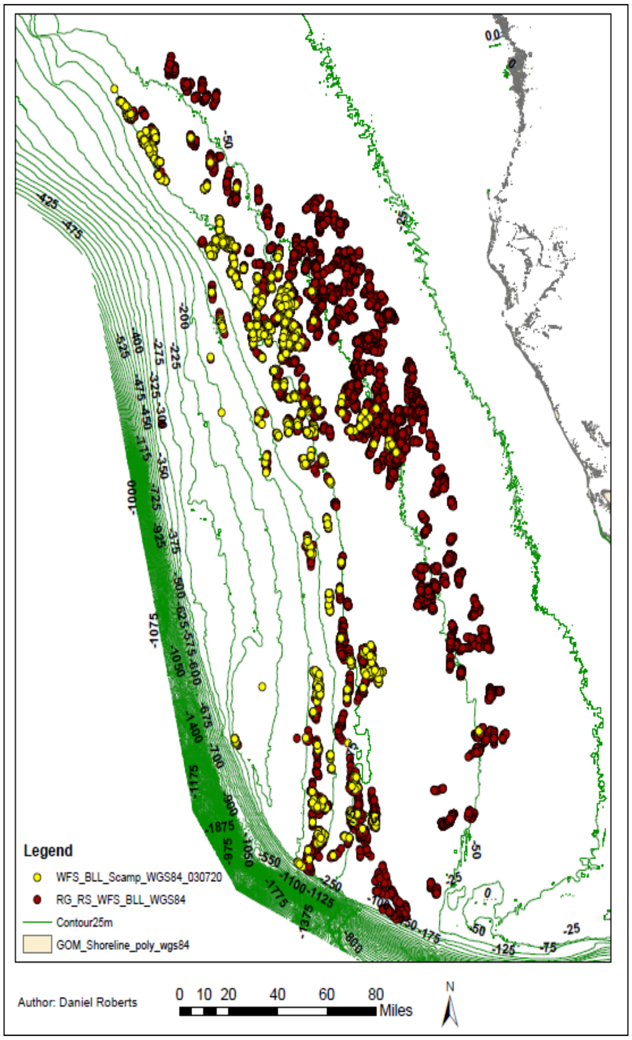


Figure 7. Spatial relationship of scamp (yellow points) and red grouper-red snapper (red points) within the 80,000 Km^2 fishing area showing depth stratification for the three species.

AICc

2859.9529

Effect Summary

Source	LogWorth	PValue
Catch_Latitude	18.304	0.00000
Depth	7.608	0.00000
Current_Velocity	1.377	0.04199
Surface_Temperature	1.209	0.06178
Bottom_Temperature	0.464	0.34346
Current_Direction	0.210	0.61594

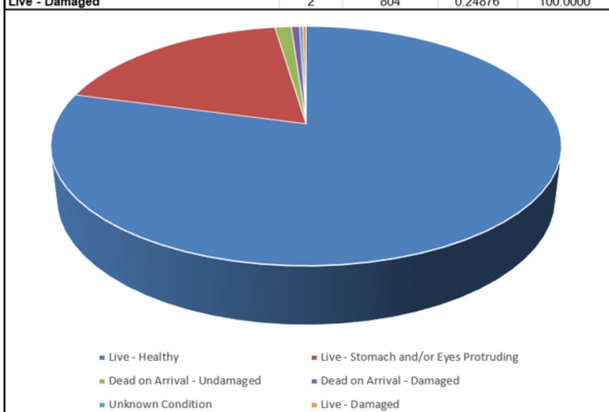
Figure 8. Effect summary for one example of generalized linear (Gaussian distribution, identity link) modeling scamp species CPUE_1000, significant response to fishing depth.

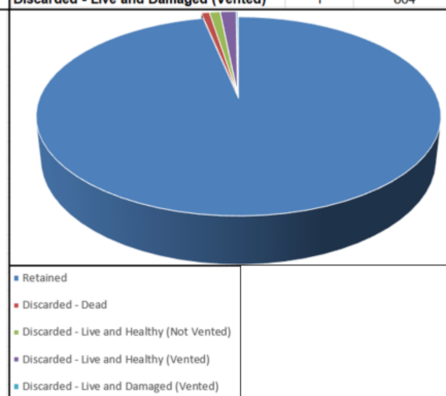
Condition of scamp upon arrival at vessels and disposition of catch are presented in Figure 9-A and 9-B for all vessels, months and years and summarized as binary classes (live and healthy, or dead or moribund) in Figure 10-A and 10-B. Approximately 24% of the scamp arrived in poor condition to dead, few scamp were discarded. These fish were partitioned by month in Figure 10-A and classified as dead or moribund, only 3.35 % were discarded.

Disposition included all categories of "discarded scamp." They were summed and given the binary classifications "retained", or "discarded". An important assumption is that if fish were not retained as catch they were discarded, however, some fish are often retained as bait. These fish and those retained as "catch" were re-coded into a binary classification for various logistic discard model development. Discarded fish are presented monthly for the 3-plus year period in Figure 10-B as potential discards, since they would not be classified as "catch." Discard rates for scamp were highest in the fall and during the early winter months. Arrival condition was poorest in the spring.

Condition of Scamp upon Arrival at Vessel	Frequency table: Condition_On_Arrival (JustScamp in			
	Count	Cumulative (Count)	Percent	Cumulative (Percent)
Live - Healthy	637	637	79.22886	79.2289
Live - Stomach and/or Eyes Protruding	148	785	18.40796	97.6368
Dead on Arrival - Undamaged	10	795	1.24378	98.8806
Dead on Arrival - Damaged	5	800	0.62189	99.5025
Unknown Condition	2	802	0.24876	99.7512
Live - Damaged	2	804	0.24876	100.0000

Disposition of Scamp (Fate)	Frequency table: Catch_Fate JustScamp			
	Count	Cumulative (Count)	Percent	Cumulative (Percent)
Retained	777	777	96.64179	96.6418
Discarded - Dead	6	783	0.74627	97.3881
Discarded - Live and Healthy (Not Vented)	8	791	0.99502	98.3831
Discarded - Live and Healthy (Vented)	12	803	1.49254	99.8756
Discarded - Live and Damaged (Vented)	1	804	0.12438	100.0000





A

B

Figure 9. Condition upon arrival at vessel (A) and ultimate disposition for scamp (B), WFS BLL fishing August 2016 through July 2019.

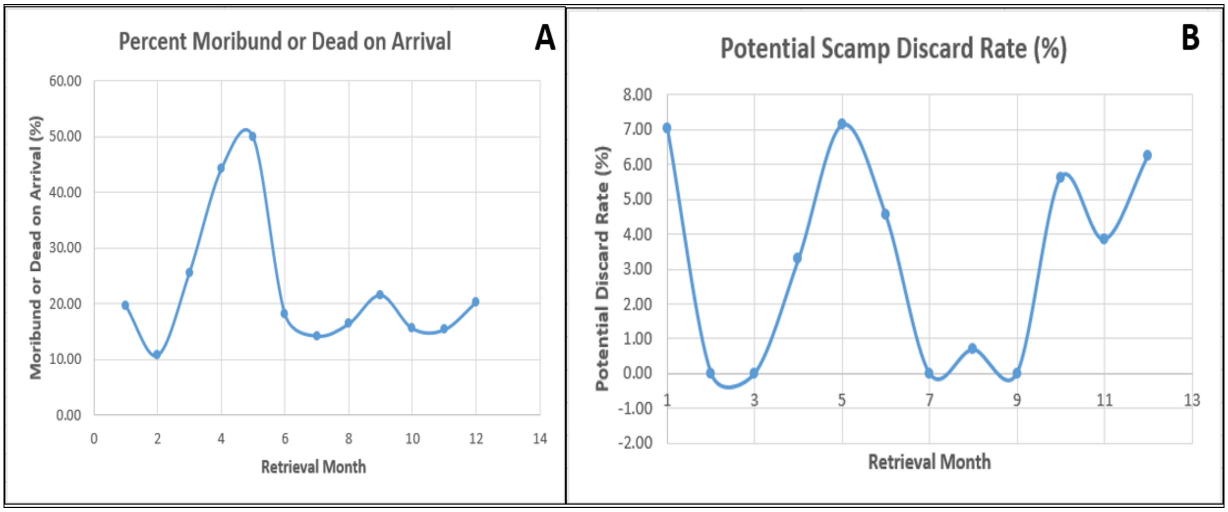


Figure 10. Binary classified condition upon arrival and binary classified discarded scamp partitioned for all vessels, all years by month.

Various statistics are presented in Figure 11. Sea Days (min = 1;max =17; mean = 10.76), CPUE for the set-haul-event (the experimental unit for BLL fishing: min = 0.439;max = 67.450; mean = 20.351), bottom current direction where scamp were caught (min = 0.221 degrees; max = 358.703 degrees; mean = 243.619 degrees), similarly bottom current velocity (min = 0.167 cm/sec; max = 6.027 cm/sec; mean = 1.896 cm/sec), bottom temperature (min = 7.0 Degrees Celsius; max = 24.0 Degrees Celsius; mean = 19.8 Degrees Celsius) and several others for general reference and unqualified inference. These and other parameters listed below are being analyzed for influence on CPUE and other response variables studied in the EM research.

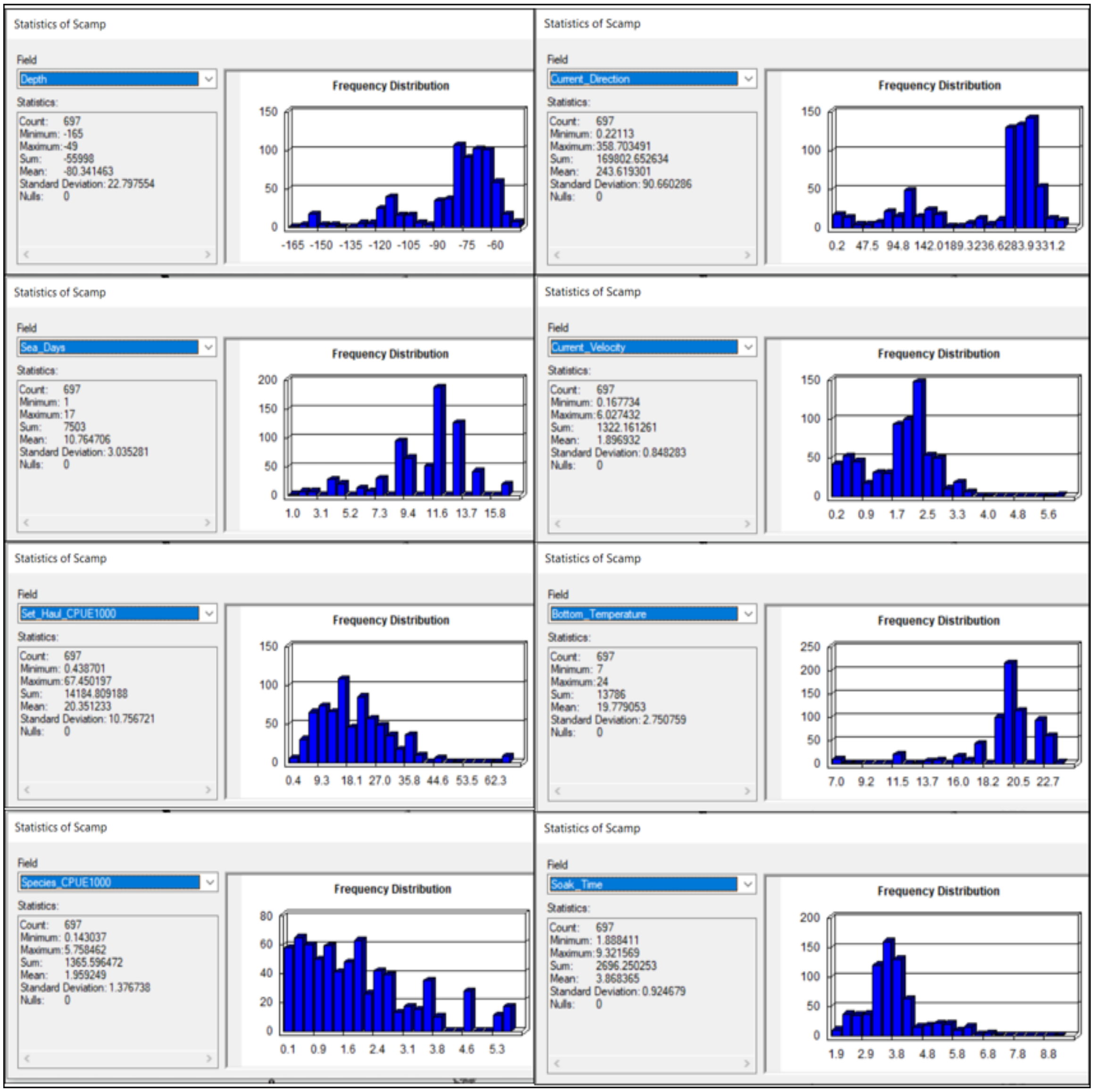


Figure 11. Summary statistics generated in ArcMAP for scamp distribution relative to depth, current direction and velocity, bottom temperature, CPUE, and limited vessel operational performance.

The CFEMM and partner Waterinterface LLC. are conducting mechanistic and ecological modeling for all target species and bycatch. Some environmental and oceanographic covariates include:

1) Geophysical and Terrain - Bathymetry, digital elevation models (various interpretations of bathymetry), Slope, Aspect, Rugosity, Sediment, Terrain (zone, reef crest, ridges, back reef, upper slopes, lower bank shelf, reef flat, open slopes, depressions, etc.)

2) Water Column - Sea surface: temperature, salinity, O2, chlorophyll-a**3) Oceanographic (mostly monthly historical) -** Sea surface wave period, sea surface wave

height, sea surface wind velocity, sea surface wind direction, bottom current velocity, bottom current direction.
4) Astronomical - Moon phase, Illumination, days post-new moon, moon distance, sun distance, moon angular diameter, and sun angular diameter**.**

Sample of Ongoing Analysis:
1) Proximity Analysis, variables (derived) - Primarily distance analysis from features (rock, hard bottom in general, terrain elements, port, other vessels, inter-species proximity).
2) Density and other spatial processes for selected species - Hotspot-coldspot analysis, kernel density, neighborhood, point pattern analysis.
3) Development of Habitat suitability models - Spatial and temporal distribution of selected species using various models with emphasis on GLZMs and Maximum Entropy (MAXENT uses presence only species locations and a suite of environmental covariates to project probabilities of species locations where no fishing has occurred).

Literature Cited

Scott-Denton, E., Cryer, P.F., Gocke, J.P., Harrelson, M.R. Kinsella, D.L. Pulver, J.R., Smith, R.C., and J.A. Williams. 2011. Descriptions of the U.S. Gulf of Mexico Reef Fish Bottom Longline and Vertical Line Fisheries Based on Observer Data. Marine Fisheries Review. 73(2), 26p.