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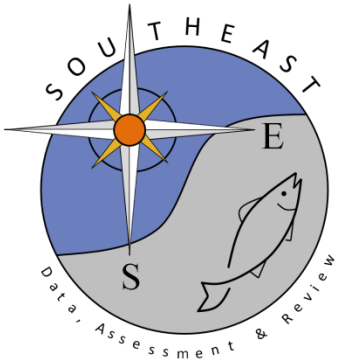

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Hook Selectivity in Gulf of Mexico Gray Triggerfish when using circle or 'J' Hooks.

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I. Introduction

The US Gulf of Mexico supports a year-round recreational fishery that constitutes a large portion of total removals for many fish stocks. Harvest control measures for gray triggerfish include size limits, bag limits and in recent years, seasonal closures. Additional measures have been adopted, including regulating hook type and offset (GMFMC, 2007; Florida Administrative Code § 68B-14.005), to reduce hook related injuries to individuals that are released. Florida Administrative Code § 68B-14.005 states that recreational anglers fishing in federal waters must use non-stainless steel circle hooks when catching reef fishes with natural bait. A circle hook is defined by this regulation as "a fishing hook designed and manufactured to form a generally circular, or oval, shape." This analysis seeks to better understand how hook size and hook type might influence the size of fish caught. Data for this analysis were collected after the circle hook requirement was implemented; however, there were enough observations of gray triggerfish caught with J hooks to offer some insight into potential changes in selectivity since circle hooks were required. Size selectivity of hooks is considered separately for circle hooks and 'J' hooks.

II. Methods

Data were collected as part of a cooperative research project with operators of for-hire fishing vessels that offer recreational fishing trips in the Gulf of Mexico. Biologists were assigned to randomly selected vessels to observe recreational anglers during hook and line fishing. Further details of the study are described in Sauls and Ayala (2012). Variables collected for individual gray triggerfish include region and depth of capture, fork length, hook size, hook type and anatomical location where the hook embedded. Hook size was determined in the field by laying them onto a standardized sizing chart (Figure 1). The smallest circle hook on the chart was size 5; therefore, smaller hooks that could not be assigned a size in the field were assigned to one overall "small" size category (size 3). Three regions were sampled on the Gulf coast of Florida, including the Northwest panhandle, the Big Bend, and greater Tampa Bay. Only greater Tampa bay (TB) and the northwest panhandle (NW) were used for this analysis, due to low sample sizes in the Big Bend.

We constructed a generalized linear model to test the significance of hook type and size on the fork length of gray triggerfish caught by recreational anglers. Covariates were also tested for inclusion to explain variability in the model.

III. Results

Of the total number of Gray Triggerfish observed, 3,680 fish, or nearly 90%, were caught with a circle hook, while 416, or roughly 10%, were caught with a 'J' hook. Differences were seen in hook type use in the different regions (Table 1). The NW had a nearly 10:1 ratio of circle hook to 'J' hook use, while TB had a 2:1 ratio. The NW also tended to use a smaller sized circle hook, with 71% of gray triggerfish observed from this region caught on small circle hooks (size 3), versus only 33% in greater TB. Additionally, almost all 'J' hooks used in the NW were small, which was not the case in TB. Both regions, however, produced similarly sized fish (Figure 2), with the most common size being in the 30 cm length bin (between 25cm and 35cm).

The average fork length of fish caught on circle hooks (regardless of hook size) was 6 mm larger than fish caught on 'J' hooks (Table 2), which was statistically significant but does not represent a large effect. Factors tested for inclusion in the GLM model include hook size, hook type, depth of capture, and possible interaction terms. Region was not included in the model because it was potentially correlated with the selective use of circle hooks versus J hooks (Table 1). We first tested each variable in a single factor model, then used forward selection methods to enter additional factors. Factors were selected based on amount of influence on sums of squares. Hook size alone explained the highest percentage of variability among the single factor models, but the R square was very low (Table 3). As other factors were entered into the model, the R squared value was only slightly improved (Table 3). Results for the final model are shown in Table 4.

Figures 3 and 4 illustrate how fork length varies with increased size of circle hooks and J hooks in each region. Small circle hooks capture a wide size range of fish; however, smaller fish disappear with increasing circle hook size (Figure 3). The NW has far fewer 'J' hook observations (Figure 4), but of those that were observed, nearly all were small hook sizes. The only significant interaction was between hook size and depth. Gray triggerfish observations by hook size and depth are shown in Table 5, with depths binned into shallow (<30m), moderate (30m-35m) and deep (>35m) categories. Interaction terms for hook size * hook type and hook type * depth were not significant.

Table 1. Gray triggerfish observations by hook type and region (NW=northwest, TB=greater Tampa Bay).

Hook Type	NW	TB
C	3356	92
J	324	54
Total	3680	146

Table 2. Least Squares Mean of fork length of fish caught using circle and 'J'.

Hook Type	FL LS mean	Pr > [t]
C	348.99	0.0346
J	342.59	

Table 3. GLM comparisons for the response variable, fork length. The final model selected is highlighted in gray.

Sum of Squares	R-square	P-value	Model
13499.06	0.0014	0.0208	Hook Type
131712.92	0.0137	<0.0001	Depth
698360.53	0.0723	<0.0001	Hook Size
698360.96	0.0723	<0.0001	Hook Size, Hook Type
802663.76	0.0832	<0.0001	Hook Size, Depth
923381.90	0.0957	<0.0001	Hook Size, Depth, Hook size * Depth
804665.00	0.0833	<0.0001	Hook Size, Depth, Hook Type
927656.43	0.0961	<0.0001	Hook Size, Depth, Hook Type, Hook size * Depth

Table 4. Results for the final model.

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Hook Size	8	195500.5240	24437.5655	10.64	<.0001
Depth	1	2544.3935	2544.3935	1.11	0.2927
Depth*Hook Size	8	122991.4223	15373.9278	6.69	<.0001
Hook Type	1	4274.5229	4274.5229	1.86	0.1726

Table 5. Hook size use at each depth bin. Depth 1 includes all depths below 30m, depth 2 includes all depths between 30m and 35m, and depth 3 includes all depths above 35m.

		HookSize									
		3	5	6	7	8	9	10	11	12	Total
Depth											
1	Frequency	847	163	75	88	26	14	22	3	0	1238
	Percent	22.14	4.26	1.96	2.30	0.68	0.37	0.58	0.08	0	32.36
	Row Pct	68.42	13.17	6.06	7.11	2.10	1.13	1.78	0.24	0	
2	Frequency	977	157	57	63	28	3	15	2	1	1303
	Percent	25.54	4.10	1.49	1.65	0.73	0.08	0.39	0.05	0.03	34.06
	Row Pct	74.98	12.05	4.37	4.83	2.15	0.23	1.15	0.15	0.08	
3	Frequency	849	207	75	65	44	21	21	1	2	1285
	Percent	22.19	5.41	1.96	1.70	1.15	0.55	0.55	0.03	0.05	33.59
	Row Pct	66.07	16.11	5.84	5.06	3.42	1.63	1.63	0.08	0.16	
Total	Frequency	2673	527	207	216	98	38	58	6	3	3826
	Percent	69.86	13.77	5.41	5.65	2.56	0.99	1.52	0.16	0.08	100

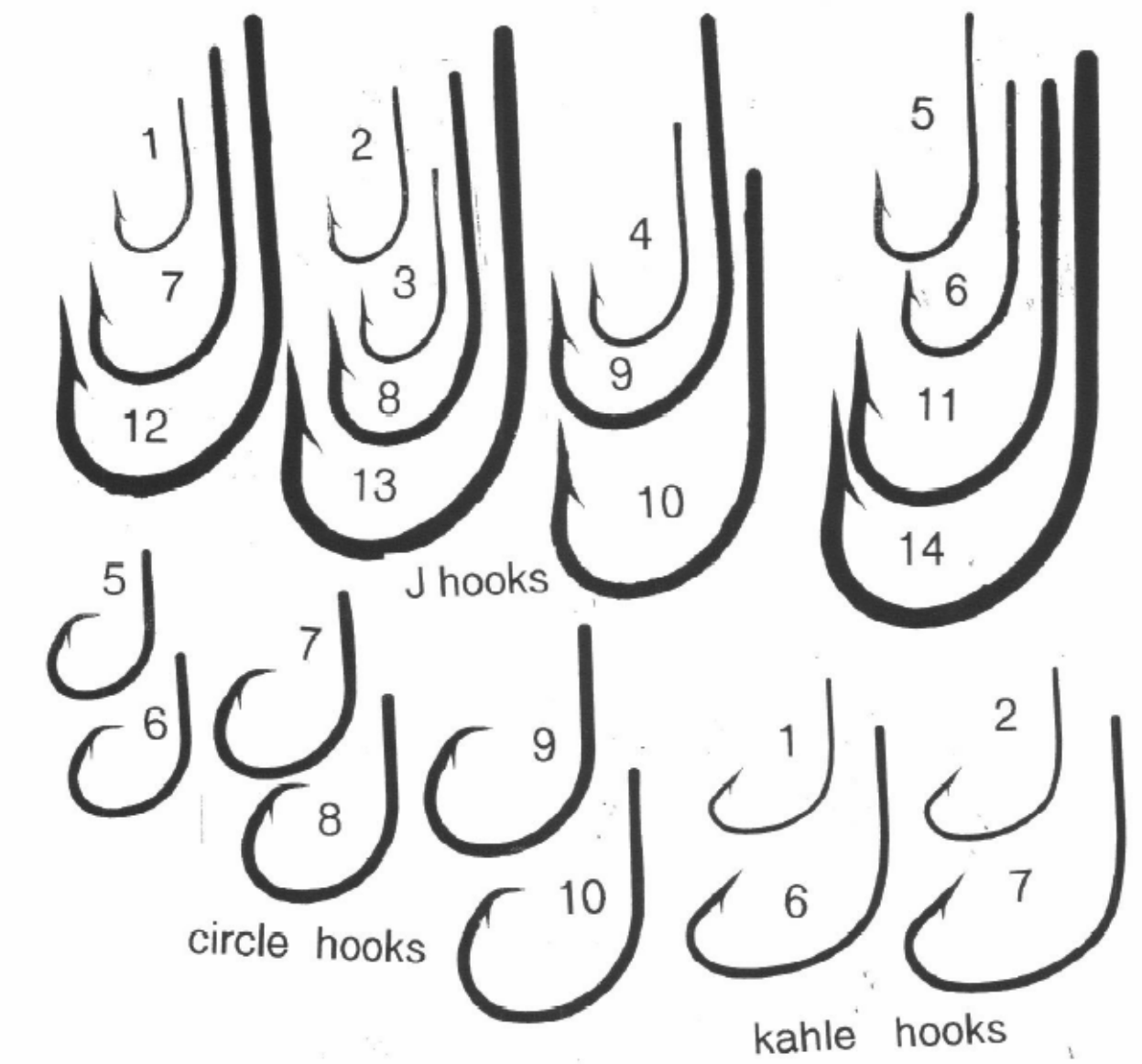

Figure 1. Hook sizing chart used in the field.

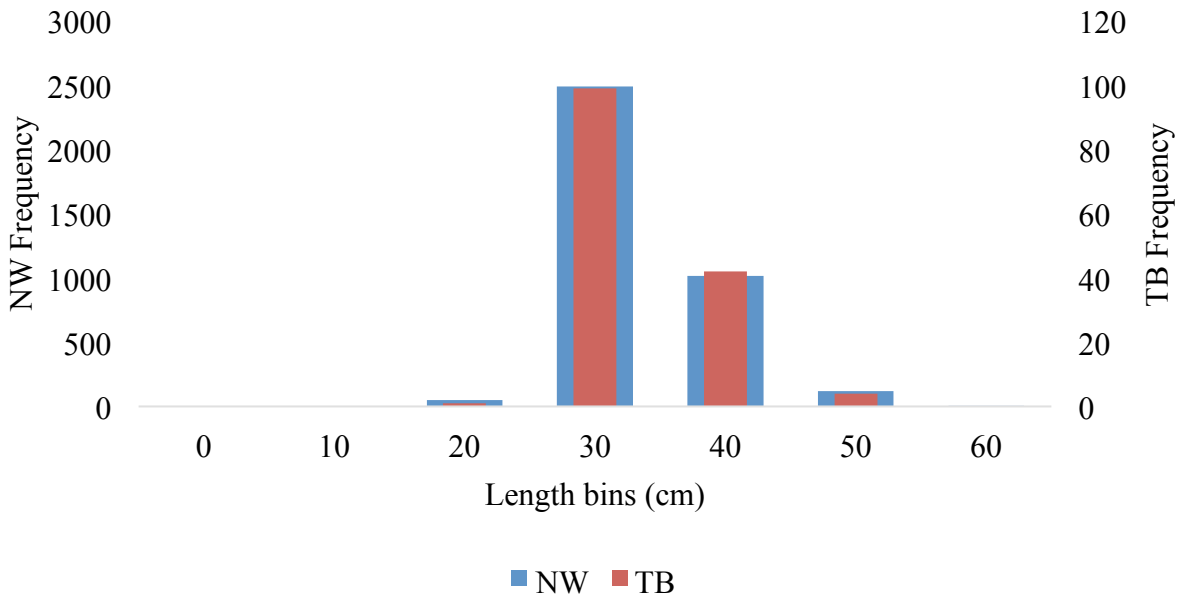

Figure 2. Size frequency of gray triggerfish in the Northwest Panhandle and in greater Tampa Bay. Fish are lumped into 10 cm fork length bins. Northwest panhandle (n=3680) is shown in blue and greater Tampa Bay (n=146) is shown in red.

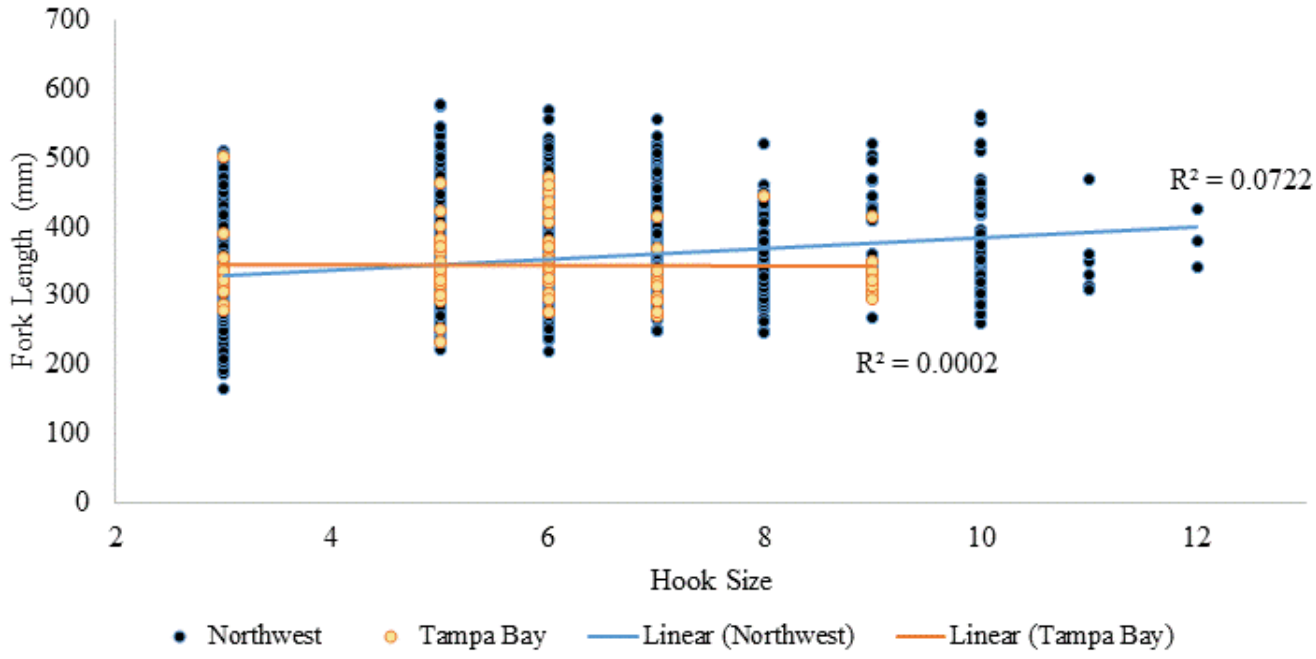

Figure 3. Fork length of gray triggerfish caught on circle hooks by hook size and region. All small hooks below size 5 were combined into the size 3 category.

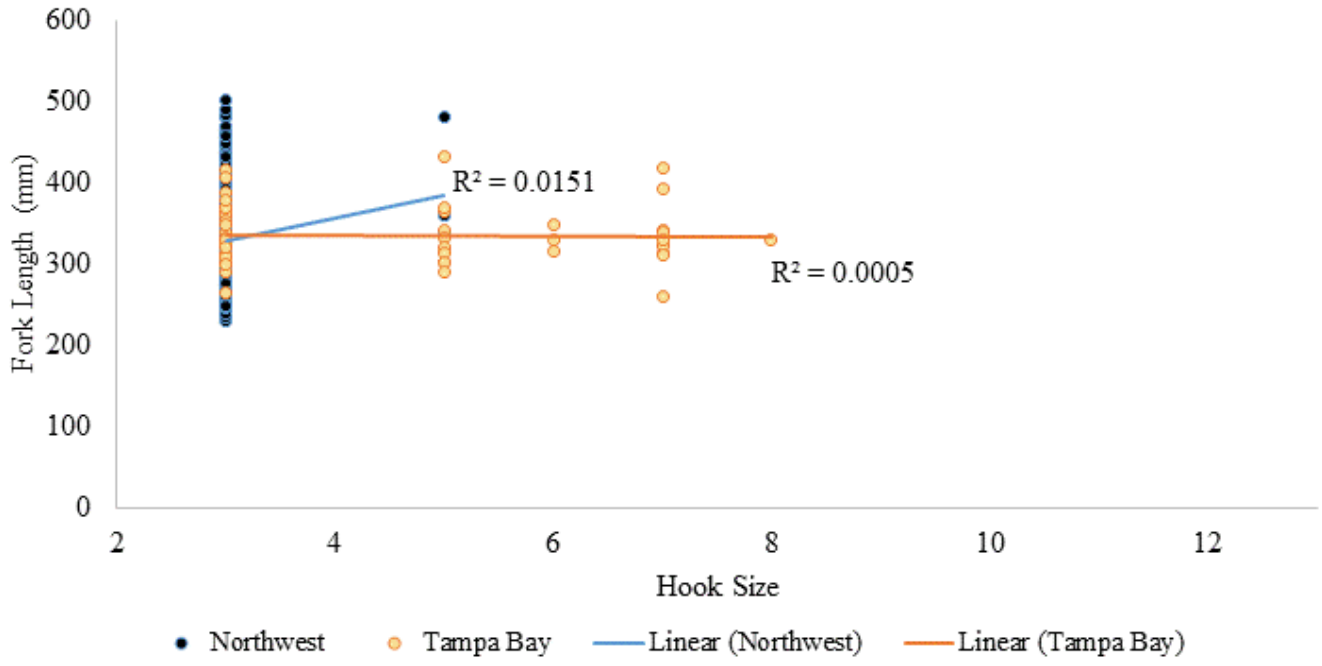

Figure 4. Fork length of gray triggerfish caught on 'J' hooks by hook size and region. All small hooks below size 5 were combined into the size 3 category.

IV. Conclusion

In fishery dependent observations, a high degree of variability is expected. Terminal tackle used on for-hire fishing vessels have a wide variety of configurations, vessel operators may choose from a variety of hook brands and fish with a variety of baits, and skill levels vary among anglers. However, observational studies that measure conditions within a fishery are important for understanding the true degree of impact, given all of the inherent variability.

The lack of a significant interaction between hook size and hook type suggests that there are no significant differences in the sizes of fish caught with circle hooks compared to J hooks within the same hook size category. The overall conclusion from this analysis is that circle hooks do not select for substantially larger or older fish compared to J hooks, and the limited selectivity that was accounted for in the model was primarily attributed to hook size. Gray triggerfish size increased only slightly with increased hook size. Smaller size classes of fish disappear with increasing hook size; however, a wide size range of fish are observed across the range of hook sizes.

References

Sauls B, Ayala O. 2012. Circle hook requirements in the Gulf of Mexico: Application in recreational fisheries and effectiveness for conservation of reef fishes. B Mar Sci. 88(3):667-679.