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The Effects of Hook Type on Gray Triggerfish Catch-Per-Unit-Effort

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I. Introduction

The gray triggerfish fisheries in the Gulf of Mexico and the Atlantic Coast of Florida have adopted various regulations to better control harvests, discards and hook-related injuries (GMFMC, 2007; Florida Administrative Code § 68B-14.005). Since 2008, recreational anglers fishing in Gulf of Mexico waters (including state waters in Florida and the EEZ) have been required to use non-stainless steel circle hooks when catching reef fishes with natural bait. A similar regulation has been effective in Atlantic federal waters north of latitude 28°N since 2011.

The Florida Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute's Fisheries Dependent Monitoring (FWRI-FDM) At-Sea Observer Program has been operating since 2009. Biologists are assigned to randomly selected headboat and charter vessels to observe recreational anglers during hook-and-line fishing. The methods are more fully described in Sauls and Ayala (2012). The program began after the circle hook requirement was put into place in the Gulf of Mexico in 2007; however, some
J-hook usage continues to occur.

A preliminary analysis using a generalized linear model was performed to better understand the relationship between hourly catch-per-unit-effort (CPUE) and hook-type (circle vs. j hook).

II. Methods

Headboats and charter boats were sampled from the Gulf and Atlantic coasts of Florida, including three regions where gray triggerfish are frequently encountered: Northwest panhandle (fishing areas 8-10), Southwest Peninsula, Southeast and Keys combined (areas 736, 741, 744, 748, 1 and 2) and Northeast (areas 722, 728, and 732) regions. Figure 1 provides a map of the fishing area codes used by the Florida Fish and Wildlife Conservation Commission.

Only sampled trips that either targeted or caught a gray triggerfish were included in this analysis, and the catch-per-unit effort (CPUE) of gray triggerfish was calculated at the individual rod-level during each fishing station. The amount of time a rod was fished, in hours, was calculated by subtracting the fishing start time of the rod from the fishing end time, then subtracting break time, if any. The number of gray triggerfish caught on each rod was divided by the time fished to compute CPUE, which was then log-transformed to better meet the assumptions of the generalized linear model. Only rods that caught at least one gray triggerfish were used in the analysis (untransformed CPUE > 0).

Other variables collected at the individual rod-level include hook type, hook size and whether the hook was offset. Only J-hooks and circle hooks were examined in this analysis. The Offset variable is a binary variable that takes the form of a 0 (not offset) or 1 (offset). Hook size was determined in the field using a standardized sizing chart (Figure 2); however, during analysis, it was realized that the corresponding hook sizes for circle and J-hooks sometimes have different hook widths. For example, a size 6 circle hook measures 18 mm at its largest width, whereas a size 6 J-hook measures 21 mm. The authors were concerned that the difference in hook width for the different sizes of circle vs. J-hooks would affect the results, so the width of each hook size on the standardized sizing chart was measured using a ruler. The length in millimeters of each hook size (henceforth known as "hook width") was used in place of hook size. When At-Sea samplers observe a circle hook that is smaller or larger than the circle hook sizing chart, they measure it on the sizing chart against the J-hook size; therefore, for any circle hooks smaller than 5 or larger than 10 (Figure 2), the relevant J-hook width was used.

III. Results

Of the 47,724 rods on vessels that targeted or caught gray triggerfish, roughly 65% used circle hooks and 35% used J-hooks. Circle hook use varied by region (Table 1). The Northwest Panhandle used the most circle hooks (71% of all circle hooks used) and the Southeast used the most J-hooks (67% of all J-hooks used).

Of the 7,301 rods that caught at least one gray triggerfish, roughly 74% used circle hooks, and 26% used J-hooks. Circle hook use by region was similar to the previous paragraph (Table 2), wherein the Northwest Panhandle used the most circle hooks (85%) and the Southeast used the most J-hooks (76%).

Of the 13,101 gray triggerfish caught, 75% were caught on circle hooks and roughly 25% were caught on J-hooks. In the Northwest Panhandle, 66% of all gray triggerfish were caught on circle hooks (Table 3), and gray triggerfish were most often caught on J-hooks in the Southeast, with 18% of the total.

A generalized linear model was created using the SAS "Proc GLMSelect" command with a backward selection method, using AIC criterion minimums as a selection factor. Factors tested in the GLM model were hook type, hook width, offset, and region, with a log-transformed CPUE value as the dependent variable. All of the variables were retained in the final model (p-value <.0001, AIC 3380.89, and R-square 0.1686; Table 3). Hook type was significant with a p-value of 0.0223, and hook width, offset and region were significant with p-values of <.0001 (Table 4). The mean hourly CPUE was also calculated using the LSMeans statement in SAS (Table 5). The mean CPUE for circle hooks was 1.35 and the mean CPUE for J-hooks was 1.44, with a difference of 0.09 in mean CPUE.

IV. Conclusion

Variability is expected in fishery-dependent observations, and many factors can confound the analyses, including angler skill level, rod configuration, and differing bait types. Only 16.9% of the total variation was explained by the model; therefore, unknown or untested factors may have much more effect on the catch-per-unit effort of gray triggerfish. A more sophisticated model, such as a two-part model that includes "zero-catch" rods, could also be explored in future analyses.

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.

V. Tables & Figures

Table 1. Numbers and percentages of rods outfitted by hook-type that were observed during trips that targeted or caught gray triggerfish in each region.

	Northwest		Southeast		Northeast		Total	
Hook Type	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Circle Hook	22,268	95.7%	1,682	13.2%	7,293	62.5%	**31,243**	**65.5%**
J-Hook	997	4.3%	11,106	86.8%	4,378	37.5%	**16,481**	**34.5%**
Total	**23,265**	**100%**	**12,788**	**100%**	**11,671**	**100%**	**47,724**	**100%**

Table 2. Numbers and percentages of rods outfitted by hook-type, for rods that caught one or more gray triggerfish in each region.

	Northwest		Southeast		Northeast		Total	
Hook Type	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Circle Hook	4,599	94.4%	281	16.2%	509	73.8%	**5,389**	**73.8%**
J-Hook	274	5.6%	1,457	83.8%	181	26.2%	**1,912**	**26.2%**
Column Total	**4,873**	**100%**	**1,738**	**100%**	**690**	**100%**	**7,301**	**100%**

Table 3. Numbers and percentages of gray triggerfish caught by hook-type in each region.

	Northwest		Southeast		Northeast		Total	
Hook Type	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Circle Hook	8,701	93.2%	417	14.8%	723	76%	**9,841**	**75.1%**
J-Hook	629	6.8%	2,403	85.2%	228	24%	**3,260**	**24.9%**
Column Total	**9,330**	**100%**	**2,820**	**100%**	**951**	**100%**	**13,101**	**100%**

Table 4. Final Model.

Sum of Squares	R-Square	P-value	Model
863.70	0.1686	<.0001	Hook Type, Offset, Hook Width, Region

Table 5. Parameter estimates.

Parameter	DF	Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	0.266	0.043	6.13	<.0001
HookType (Circle)	1	-0.071	0.031	-2.29	0.0223
HookType (J-Hook)	0	0	.	.	.
Hook Width	1	-0.026	0.002	-11.19	<.0001
Offset (No)	1	0.105	0.022	4.79	<.0001
Offset (Yes)	0	0	.	.	.
Region (Northeast)	1	0.585	0.0397	14.7	<.0001
Region (Northwest)	1	0.854	0.032	26.51	<.0001
Region (Southeast)	0	0	.	.	.

Table 6. Least square means.

Hook Type	Mean CPUE	Lower 95% CI	Upper 95% CI
C	1.345	1.301	1.391
J	1.444	1.381	1.510

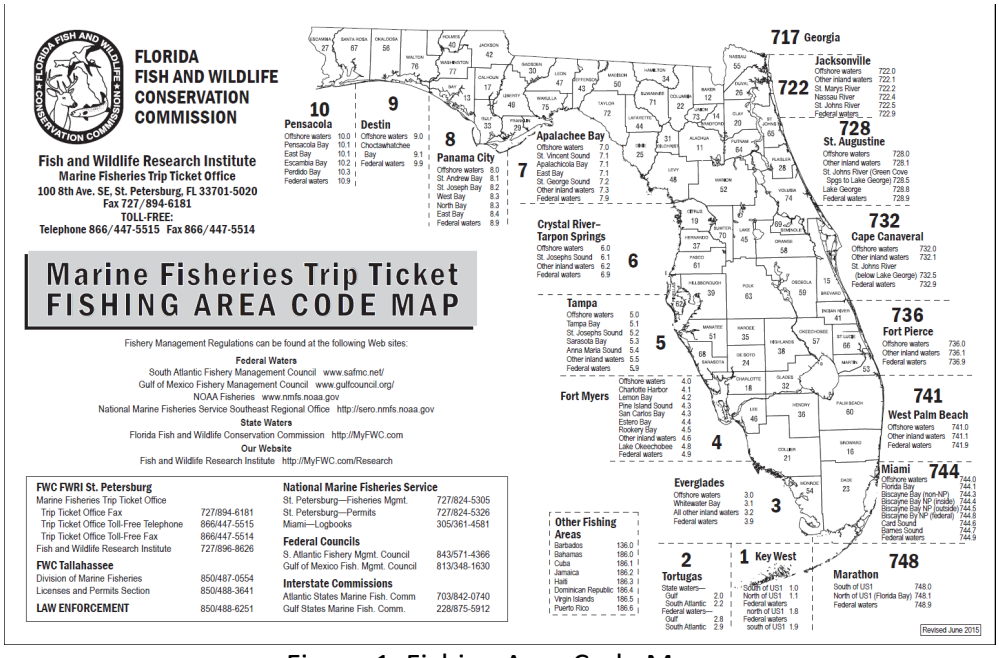

Figure 1. Fishing Area Code Map.

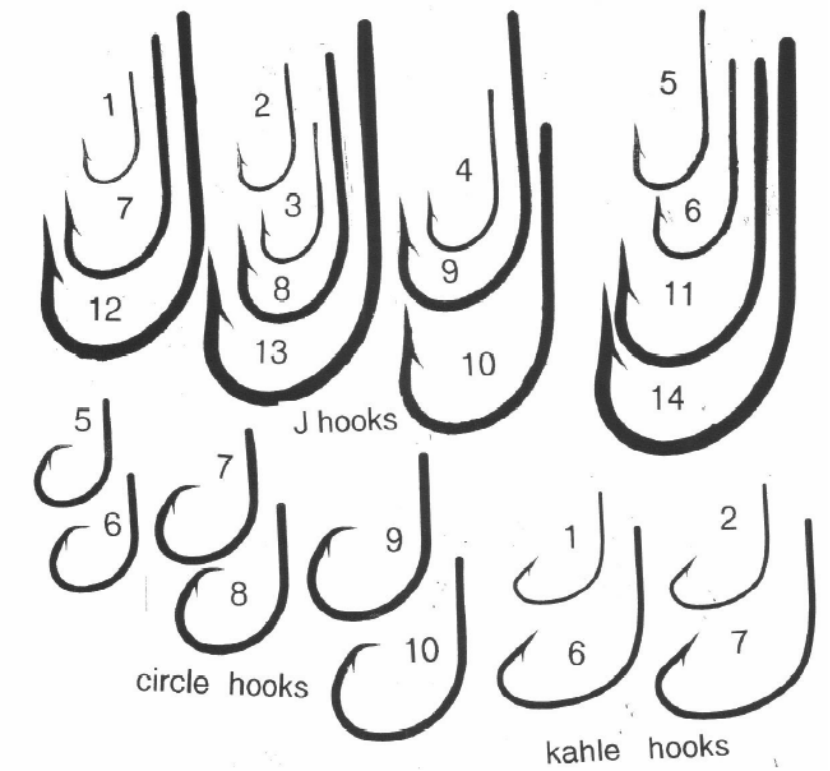

Figure 2. Hook sizing chart used in the field.