

Factors Affecting the Loggerhead Take Rate in the Reef-Fish Longline Fishery

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Introduction

In September 2008, NMFS Southeast Fisheries Science Center produced an analysis of observed turtle takes in the longline sector of the reef-fish fishery of the Gulf of Mexico, using data from two observer programs (respectively: SBLOP and RFOP) over the period July 2006 through December 2007 (NMFS 2008). That analysis extrapolated from the 18 observed takes to an estimate of fleet-wide captures of hard-shell turtles (predominantly and perhaps exclusively loggerheads) totalling 902 in the eastern Gulf during the 18 months of observation. While NMFS (2008) presented some specific information on each observed take, no analysis of the factors that influence take rate (i.e. takes per unit fishing effort) was offered. Yet it is only by examining take rates that ways may be found to alter fishing gears or practices to reduce turtle takes while maintaining the optimal yield of the target species.

This brief paper offers an initial analysis of the take rates represented by the 18 observed takes, relative to the universe of reef-fish longline trips observed during the July 2006 through December 2007 period. The data available to the author are, in some cases, far from ideal for the present purpose. Hence, the results presented here should be seen as preliminary, pending further work by the staff of SEFSC, who have access to the original observer data. It is also preliminary in the sense that a mere 18 observed takes do not provide an adequate database to support any definitive conclusions. Those must await the collection of far more data.

It should also be noted that this paper considers only the take rate relative to fishing effort. The reef-fish fishery of the Gulf of Mexico is, however, controlled by TACs and the longline sector is expected to soon be under IFQ management. The important consideration in reducing turtle takes is therefore the number of takes per unit weight of directed catch (predominantly red and gag groupers). Management measures that restrict the efficiency of longlining more than they reduce the turtle take rate will actually serve

to increase the number of takes. The relative efficiencies of different longline gears and fishing practices are matters for another analysis.

Methods

Data on the observed takes were drawn from Table 1 and Appendix B of NMFS (2008), from an accompanying PowerPoint presentation delivered to the Gulf of Mexico Fishery Management Council, and from a one-page tabulation and illustration of depth distributions provided to SOFA by the NMFS SERO. Parallel data on the universe of observed trips and sets were drawn from the latter page and from tabulations provided to Southeastern Fisheries Association by NMFS SEFSC.

The available data on observed takes and observed trips are not always as comparable as would be desired. Specific problems and the steps taken to moderate them are outlined in the Results section below.

The two kinds of data were compared using Kolmogorov-Smirnov tests, which have an advantage over the more familiar χ^2 tests in that K-S tests recognize rank-order relationships among the various data classes. That is, they recognize, for example, that a 40–45 fathom depth bin lies between the 35–40 and 45–50 fathom bins.

Results

Seasons

The data on numbers of observed reef-fish trips and numbers of turtle takes by month are shown in Table 1 below. The seasonal distribution of observed trips provided by SEFSC included both shallow-and deep-water grouper trips observed by either the SBLOP or the RFOP. It included all such trips from January 2006 until May 2008, whereas the data on turtle takes provided by NMFS (2008) were confined to the period July 2006 until December 2007. In consequence, Table 1 lists 47 observed trips, whereas NMFS (2008) recognized only 33.48 – the decimal arising because individual sets within a trip observed by the SBLOP were classified as directed for reef-fish, shark or a mixture and only the data from reef-fish directed sets were used.

To make the data comparable and suited to analysis by K-S test, it was here assumed that Table 1 lists 14 trips not considered by NMFS (2008) and that all 14 were conducted during January through June 2006 or January through May 2008. The results of the K-S test did not differ depending on which months of the first half of the year each the 14 were assumed to have been made in. It is possible that some of the 14 trips were actually directed for deep-water grouper during July to December, though that fishery tends to be concentrated into the winter months. It is also possible that the 47 trips included all that had at least one set directed towards reef fish, whereas the 33.48 were exclusively reef-fish-directed sets. Thus, the assumption used here was far from ideal. However, deletion of 14 trips from the first half of the year is the only immediately-available option for reconciling the two data sets. Since the two data sets differed in

seasonality, an analysis of the seasonal distribution of the takes could not simply ignore the issue.

Once the data were reconciled, the Kolmogorov-Smirnov K statistic was $K = 1.051$, which is not significant (relative to $\alpha = 0.05$) – meaning that the seasonal distribution of turtle takes did not differ from that of observer deployments by more than can be accounted for by chance alone.

Depths

The data on depths fished and the depths at which turtles were taken are shown in Table 2. Those do not pose all of the complications seen in the seasonal data, though the tabulated observed sets include ones made between July 2006 and July 2008, whereas the turtle takes are only those from July 2006 to December 2007. Only three turtles were observed to be taken by reef-fish longliners during 2008 but it is not currently known whether any of those were seen before July. If not, the difference in dates of coverage would be immaterial.

The result of the K-S test was $K = 1.157$, which is not significant. The depth distribution of turtle takes did not differ from that of observed sets by more than can be accounted for by chance alone.

Areas

The bathymetric contours west of Florida run generally North Northwest to South Southeast, while the seabed slopes steadily downwards away from the coast. With no detectable variations in take rate with depth, any remaining spatial variation can therefore be represented by a latitudinal trend. Table 3 shows the data on observed sets and observed takes grouped into one-degree latitudinal bins. The locations of the observed takes were read from Figure 2 in NMFS (2008). That map shows discernable marks for 14 of the 18 takes. To maximize the opportunity for finding a significant association between latitude and take rate, the other 4 takes are here assigned to the 27°–28° N bin.

The sets in Table 3 cover the same 29 months as the trips shown in Table 1 and, like those trips, include fishing directed towards deep-water groupers. Table 3 nevertheless notes only 940 sets, compared to the 952 in Table 2. Lacking any way to correct for the sets made on the 14 surplus trips, the data were analyzed as tabulated. Unless there is a major latitudinal difference in where the fleet fishes at different times, the statistical result should not be much affected.

The result of the K-S test was $K = 0.934$, which is not even close to being significant. The latitudinal distribution of turtle takes did not differ from that of observed sets by more than can be accounted for by chance alone.

Gangion Lengths

The data on gangion lengths and the corresponding turtle takes are shown in Table 4. The trips are the same 47 shown in Table 1 but no information are currently available to allow elimination of the excess 14 trips and the data were analyzed as tabulated.

The result of the K-S test was $K = 1.543$, which is significant at $P < 0.02$. Hence, there is a relationship between turtle take rate and gangion length which is more than can readily be explained by chance alone, with higher take rates on longer gangions. That result was unchanged if the gangion lengths were binned into 2 ft increments instead of the 1 ft shown in Table 4. However, 7 of the 18 observed takes came from a single, extraordinary trip which used 9 ft gangions. If 6 of those 7 were dropped from the analysis, the K-S test result would drop to the very-insignificant $K = 0.634$. Thus, it is unclear whether the apparent link to gangion length is anything more than an artifact of the one exceptional trip, which may have taken so many turtles for quite other reasons.

Hook Sizes

All observed reef-fish trips used circle hooks but their reported sizes ranged from 12/0 to 15/0. It is not certain what those data really mean, since the nominal sizes of hooks of similar dimensions differ among manufacturers and among the designs (or “quality numbers”) of the same manufacturer. It will here be supposed for present purposes that the reported sizes all correspond to the size designations of Mustad “tuna circle” hooks.

The data are shown in Table 5. The same 47 trips that appear in Table 1 are represented in the data set, though no hook-size information is available for 9 of them and those were dropped from the analysis. The data were otherwise analyzed as tabulated.

The result of the K-S test was $K = 0.552$, which is not even close to being significant. Thus, the distribution of turtle takes across hook sizes did not differ from that of the observed trips by more than can be accounted for by chance alone.

The available data on 14 of the 18 observed turtle takes also include information on the hook offset. However, 11 of those 14 were recorded as zero offset, which seems unlikely considering the normal designs of circle hooks. The other three were offset by 10° . No attempt has been made here to compare those offsets to the ones in the universe of observed trips.

Bait Type

The data provided by SEFSC on the dominant bait types used on the 47 observed trips were defective – a column of “percentages” totalling on 32.1, rather than 100%. It is not possible to re-create the correct numbers from available data. Of the 18 observed turtle takes, 7 were taken on squid bait but those were all taken on the one exceptional trip. Of the remaining 11 takes, one turtle was taken on each of mackerel, shark and skate baits, while the bait types of the other 8 takes were unknown. With such data, it is most unlikely that any convincing conclusions could be drawn.

Discussion and Conclusion

Most of the Kolmogorov-Smirnov tests reported here returned non-significant results. That does not mean that turtle take rates are not influenced by season, depth, latitude and hook size, only that those influences are too weak to be detected with the very limited amount of data yet available. As more observed takes are recorded, relationships will begin to emerge, though they may remain too weak to serve as a basis for practicable measures to reduce takes. Even with the presently-extant data, more might be learnt from analyses using better datasets, without the complications outlined above. The SEFSC, which alone has unrestricted access to the numbers, should be encouraged to undertake a more thorough exploration that has been possible here.

The only significant result found concerned gangion length. While that is not above suspicion, due to its reliance on the data from a single, aberrant trip, it does suggest that extensive trials of take rates with different lengths of gangions would be worthwhile.

The existing observer data might be used to show which variant longline gears and fishing practices gave the highest grouper catch rates – which may equate to the gears and practices that would give the lowest turtle takes within the caps of the grouper IFQ. However, it is likely that each gear and practice is, to some degree, optimised for the fishing of the captain who uses it. During future studies, however, attention should be given to grouper catch rates as well as turtle take rates, since the two together will determine future numbers of takes.

Reference

National Marine Fisheries Service (NMFS) (2008) Estimated takes of sea turtles in the bottom longline portion of the Gulf of Mexico reef fish fishery July 2006 through 2007 based on observer data. *NMFS Southeast Fisheries Science Center Contribution PRD-07/08-15*.

TABLES

Table 1 : Observed Reef-Fish Trips and Turtle Takes by Reef-Fish Longliners by Calendar Month (see text for explanation)

Month	Observed Trips	Turtle Takes
January	3	0
February	5	0
March	6	0
April	3	1
May	4	0
June	3	3
July	4	9
August	7	4
September	5	1
October	3	0
November	3	0
December	1*	0

*: Actual number of observed trips withheld by NMFS to protect confidentiality. It was either one or two.

Table 2 : Observed Reef-Fish Sets and Turtle Takes by Reef-Fish Longliners by 5-Fathom Depth Bin

Upper Limit of Depth Bin	Observed Sets	Turtle Takes
20	24	1
25	277	11
30	192	3
35	88	3
40	99	2
45	26	0
50	16	0
55	18	1
60	8	0
65	7	0
70	12	0
75	7	0
80	12	0
85	20	0
90	10	0
95	11	0
100	8	0
105	20	0
110	15	0
115	7	0
120	28	0
125	6	0
>125	41	0

Table 3 : Observed Reef-Fish Sets and Turtle Takes by Reef-Fish Longliners by Latitude Bin (see text for explanation)

Latitude	Observed Sets	Turtle Takes
30–31° N	1*	0
29–30° N	1*	0
28–29° N	175	2
27–28° N	345	12
26–27° N	211	2
25–26° N	145	0
24–25° N	62	2

*: Actual number of observed trips withheld by NMFS to protect confidentiality. It was either one or two.

Table 4 : Observed Reef-Fish Trips and Turtle Takes by Reef-Fish Longliners by the Length of the Gangions Used

Gangion Length (ft)	Observed Trips	Turtle Takes
3 to <4	6	2
4 to <5	11	0
5 to <6	2	2
6 to <7	10	2
7 to <8	3	0
8 to <9	9	2
9 to <10	1	7
10 to <11	4	3
11 to <12	0	0
12 to <13	1	0

Table 5 : Observed Reef-Fish Trips and Turtle Takes by Reef-Fish Longliners by the Size of the Hooks Used

Hook Size	Observed Trips	Turtle Takes
12/0	2	0
13/0	11	9
14/0	20	9
15/0	5	0
Unknown	9	–