

A TRIAL EVALUATION OF THE EFFECTIVENESS OF THE USE OF CIRCLE HOOKS TO REDUCE MORTALITY OF SHORTFIN MAKO SHARK IN PELAGIC LONGLINE FISHERIES

MORTALITY OF SHORTFIN MAKO SHARK ON CIRCLE HOOKS VS J-HOOKS

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SUMMARY

The recommendation by ICCAT on the conservation of North Atlantic stock of shortfin mako shark caught in association with ICCAT fisheries contemplated in ICCAT Rec. 17-08 includes that the SCRS shall take into its account the effectiveness of the use of circle hooks as a mitigation measure to reduce mortality in conducting review the effectiveness of the measures. In this study, the total mortality of shortfin mako shark was estimated and consists of at-vessel releases and post-release mortalities by hook types, i.e. circle hooks versus J-hooks, with 5 different combinations of at-vessel and post-release mortality rates of shortfin mako shark in pelagic long line fisheries based on the literatures. In conclusion, the estimated total mortality with circle hooks was more than 1.6 times higher than that with J-hooks in every combination. From this result, it was considered that the use of circle hooks may cause substantial increases of overall mortality of shortfin mako shark.

RÉSUMÉ

La recommandation de l'ICCAT sur la conservation du stock de requin-taupe bleu de l'Atlantique Nord capturé en association avec les pêcheries de l'ICCAT envisagée dans la Rec. 17-08 indique que le SCRS doit tenir compte de l'efficacité de l'utilisation des hameçons circulaires en tant que mesure d'atténuation pour réduire la mortalité lors de l'examen de l'efficacité des mesures. Dans cette étude, nous avons estimé, sur la base des publications, que la mortalité totale du requin-taupe bleu se composait de mortalités sur le navire et après la libération par type d'hameçon, c'est-à-dire hameçons circulaires par opposition à hameçons en forme de J, avec cinq combinaisons différentes de taux de mortalité du requin-taupe bleu au navire et après sa remise à l'eau dans les pêcheries pélagiques à la palangre. En conclusion, la mortalité totale estimée avec les hameçons circulaires était plus de 1,6 fois supérieure à celle avec les hameçons en forme de J dans chaque combinaison. À partir de ce résultat, on a estimé que l'utilisation des hameçons circulaires pouvait entraîner une augmentation substantielle de la mortalité globale du requin-taupe bleu.

RESUMEN

La recomendación de ICCAT sobre la conservación del stock de marrajo dientuso del Atlántico norte capturado en asociación con pesquerías de ICCAT contemplada en la Rec. 17-08 de ICCAT establece que el SCRS tenga en cuenta la eficacia del uso de los anzuelos circulares como medida de mitigación para reducir la mortalidad al llevar a cabo la revisión de la eficacia de las medidas. En este estudio, se estima que la mortalidad total de marrajo dientuso está compuesta por la mortalidad en el buque y la mortalidad tras la liberación por tipo de anzuelo, a saber, anzuelos circulares versus anzuelos en forma de J, con cinco combinaciones diferentes de tasas de mortalidad en el buque y tras la liberación de marrajo dientuso en las pesquerías de palangre pelágico, basándose en la bibliografía. En conclusión, la mortalidad total estimada con anzuelos circulares fue 1,6 veces superior a la mortalidad con anzuelos en forma de J en cada combinación. A partir de este resultado, se ha considerado que el uso de anzuelos circulares puede causar incrementos importantes de la mortalidad total de marrajo dientuso.

KEYWORDS

*Atlantic shortfin mako, Longline fishery,
Circle hook, J-hook, Mortality, Catch rate, Mitigation*

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1. Introduction

The recommendation by ICCAT on the conservation of North Atlantic shortfin mako shark caught in association with ICCAT fisheries contemplated in ICCAT Rec. 17-08 includes that the SCRS shall take into its account the effectiveness of the use of circle hooks as a mitigation measure to reduce mortality in conducting review the effectiveness of the measures contained in this recommendation. This study attempted to evaluate the effectiveness of the use in circle hooks to reduce the mortality of shortfin mako shark caught by pelagic long line fisheries. The estimated total mortality of shortfin mako shark consist of at-vessel and post-release mortality of circle hooks was compared with that of J-hooks using information of the following literatures: (1) Catch rate and at-vessel mortality rate of circle hooks versus J-hooks in the pelagic long line fisheries in a global meta-analysis (Reinhardt et al., 2017); (2) post-release mortality rate of shortfin mako shark in the Canadian pelagic long line fishery in the North Atlantic (Campana et al., 2016).

2. Materials and Methods

2.1 Catch rate and at-vessel mortality rate

In Reinhardt et al. (2017), the relative risk (RR) on catch rate with circle hooks was 1.71 times higher than that with J-hooks, and the RR on at-vessel mortality rate caught on circle hooks was 0.89 times lower than that of J-hooks for shortfin mako shark. Based on the above, we assumed 1,000 fish caught on J-hooks, and 1,710 fish caught on circle hooks that was calculated through 1,000 (assumed catch in number of J-hooks) was multiplied by 1.71. In Campana et al. (2016), the mean at-vessel (hooking or capture) mortality rate for shortfin mako shark caught on circle hooks (partially J-hooks were used but almost all consist of circle hooks) was 0.26 with a range 0.12-0.32. However, the catch rate and at-vessel mortality rate frequently vary due to various factors regarding fishing operations such as gear soak times at sea and environmental conditions. In consideration for these unknown factors and information of the above literatures, we changed the at-vessel mortality rate of J-hooks ranged from 0.1 to 0.5 at 0.1 intervals and we gave a 0.89 times lower values for those of circle hooks. This assumption covers the range of the at-vessel mortality rate of shortfin mako shark in pelagic long line fisheries shown in a recent review paper by Ellis et al. (2017).

2.2 Post-release mortality rate

Based on Campana et al. (2016), we used a single value 0.313 for the post-release mortality rate of shortfin mako shark caught on both of circle hooks and J-hooks that was given for the overall post-release mortality rate of live healthy and injured shortfin mako shark caught on circle hooks (almost all consist of circle hooks same as the above section 2.1).

2.3 Estimation of total mortality of circle hooks versus J-hooks

The estimated total mortality of shortfin mako shark consist of at-vessel and post-release mortality. The total mortality of shortfin mako shark associated with circle hooks and J-hooks in 5 different at-vessel (hooking or capture) mortality rates was calculated using the above figures. To compare the total mortality of circle hooks and that of J-hooks, the relative value of total mortality by hook type was calculated by dividing the total mortality of J-hooks into that of circle hooks.

3. Results

The results on the estimation of mortality of circle hooks versus J-hooks were shown in **Table 1**. Based on the relative value of total mortality by hook type in **Table 1**, the estimated total mortality of shortfin mako shark associated with circle hooks was more than 1.6 times higher than that of J-hooks in every case with different at-vessel (hooking or capture) mortality rate of J-hooks ranged 0.1-0.5.

4. Discussion

In this study, we calculated the total mortality of shortfin mako shark based on the best-available estimates on the catch rate, at-vessel mortality of each hook type and empirical estimates on the post-release mortality of this species. Regarding the at-vessel mortality, a variety of studies analyzing onboard observation of mortality and blood biochemical status (e.g. Coelho et al. 2013, Butcher et al. 2015) suggest that the mortality is affected by various factors including the sex and size of specimen, region of operation of the fleet, and the interaction between species with capture depth and the elapsed time spent on the line after hooking, without mentioning of species.

Taking this uncertainty into consideration, we calculated the mortality with varying at-vessel mortality from 0.1 to 0.5. This range of sensitivity is suggested to be reasonable from the review of capture and post-release mortality of elasmobranchs by Ellis et al. (2017) as mentioned in the section 2.1. From the evaluation in this work, it was considered that the use of circle hooks substantially increased the total mortality, especially for the post-release mortality, caused by relatively larger increase of catch rate rather than relatively small reduction of at-vessel (hooking or capture) mortality rate. From this result, it was suggested that the use of circle hooks may cause substantial increases of total mortality of shortfin mako shark, comprising the at-vessel and the post-release mortality, in pelagic long line fisheries. Therefore, the use of circle hooks might be an inappropriate mitigation measure to reduce mortality of shortfin mako shark in pelagic long line fisheries particularly, however, further studies will be necessary to analyze the detailed mechanisms and improve uncertainty of this result.

Also, it was recognized that the meta-analysis by Reinhardt et al. (2017) is a useful information to evaluate the effectiveness of the use of circle hooks as mitigation measures to reduce the by-catch and its mortality in pelagic long line fisheries because their study covered a wide variety of animals including tunas, sharks and a lot of by-catch species and incorporated uncertainty and variability included in each experiment in their modelling approach using whole comprehensive data world-wide. However, the effect of circle hook in terms of catch rate and at-vessel mortality could be changed by species. Therefore, it is an important approach to examine the data thoroughly including trends of changing catch rate, at-vessel mortality rate, and post-release mortality rate by hook and gear type of each fleet and operation type without rough-and-ready steps and to avoid coarse analysis and conclusion to consider the practical implementation of the conservation measures closely.

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Table 1. Estimation of at-vessel, post-release, and total mortality of J-hooks, and circle hooks, and relative value of total mortality of circle hooks versus J-hooks for shortfin mako shark in pelagic long line fisheries.

Hook Type	Catch in Number of Fish (A)	At-vessel Mortality Rate (B)	At-vessel Mortality (C) (C=A*B)	Post- release Mortality Rate (D)	Post-release Mortality (E) (E=(A-C) *D)	Total Mortality (F) (F=C+E)	Relative Value of Total Mortality (G) (G= F of C-hooks / F of J-hooks)
J-hook	1000	0.1	100	0.313	282	382	-
J-hook	1000	0.2	200	0.313	250	450	-
J-hook	1000	0.3	300	0.313	219	519	-
J-hook	1000	0.4	400	0.313	188	588	-
J-hook	1000	0.5	500	0.313	157	657	-
Circle hook	1710	0.089	152	0.313	488	640	1.68
Circle hook	1710	0.178	304	0.313	440	744	1.65
Circle hook	1710	0.267	457	0.313	392	849	1.64
Circle hook	1710	0.356	609	0.313	345	953	1.62
Circle hook	1710	0.445	761	0.313	297	1058	1.61

Footnotes: An assumption of catch in number of J-hooks is 1,000 fish, and an assumption of catch in number of circle hooks is 1,710 multiplied 1,000 (assumed catch in number of J-hooks) by 1.71. An assumption of at-vessel mortality rate of J-hooks ranged 0.1-0.5 at 0.1 intervals, and an assumption of at-vessel mortality rate of circle hooks is multiplied at-vessel mortality rate of J-hooks by 0.89.