

## DESCRIPTION FOR ESTIMATING SHORTFIN MAKO (*ISURUS OXYRINCHUS*) LIVE RELEASES AND DEAD DISCARDS FROM CHINA FISHERIES

Feng Ji<sup>1</sup>, Zhang Fan<sup>1</sup>, Zhu Jiangfeng<sup>1</sup>, Wu Feng<sup>1</sup>

### SUMMARY

*ICCAT Recommendation 21-09 is implemented that supports the conservation of the North Atlantic stock of shortfin mako (*Isurus oxyrinchus*) caught in association with ICCAT fisheries. As paragraph 13 mentioned, there is a requirement to present the statistical methodology used to estimate live releases and dead discards for CPCs with reported average catches over 1 t between 2018-2020. This document aims to describe the methodology used to estimate Shortfin Mako live releases and dead discards from China fisheries.*

### RÉSUMÉ

*La Recommandation 21-09 de l'ICCAT est mise en œuvre à l'appui de la conservation du stock de requin-taube bleu de l'Atlantique Nord (*Isurus oxyrinchus*) capturé en association avec les pêcheries de l'ICCAT. Le paragraphe 13 prévoit l'exigence que les CPC qui ont déclaré des captures moyennes supérieures à 1 t entre 2018-2020 présentent au SCRS la méthodologie statistique utilisée pour estimer les rejets morts et les remises à l'eau de spécimens vivants. Ce document vise à décrire la méthodologie utilisée pour estimer les rejets morts et les remises à l'eau de spécimens vivants de requin-taube bleu des pêcheries de la Chine.*

### RESUMEN

*La Recomendación 21-09 de ICCAT se implementa para respaldar la conservación del marrajo dientuso del Atlántico norte (*Isurus oxyrinchus*) capturado en asociación con las pesquerías de ICCAT. Tal y como se establece en el párrafo 13, es necesario presentar la metodología estadística utilizada para estimar las liberaciones de ejemplares vivos y los descartes de ejemplares muertos para las CPC con capturas medias declaradas superiores a 1 t entre 2018-2020. El objetivo de este documento es describir la metodología utilizada para estimar las liberaciones de ejemplares vivos y los descartes de ejemplares muertos de marrajo dientuso de las pesquerías de China.*

### KEYWORDS

*North Atlantic shortfin mako, live releases, dead discards, China fisheries*

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<sup>1</sup> College of Oceanography, Shanghai Ocean University, 999 Hucheng Huan Road, Shanghai, P. R. China. fengji\_shou@163.com

## 1. Background

Longline is the only fishing gear used by the Chinese tuna fleet in the ICCAT conventional area. Bigeye tuna (*Thunnus obesus*) and Bluefin tuna (*Thunnus thynnus*) are the target species of the Chinese longline fishery, while Shortfin Mako is one of the shark species of bycatch. The numbers of Shortfin Mako live releases and dead releases and other available biological information are recorded by the science observer programs. There was no Shortfin Mako bycatch data recorded by the science observer program in 2018. The annual catches (including live releases and dead discards) of Shortfin Mako between 2019 and 2021 were 27.642 t, 6.283 t and 4.581 t, respectively (Table 1).

## 2. Estimation methodology

The estimation of Shortfin Mako live releases and dead discards from China fisheries are based on the bycatch data recorded by the science observer programs. Ratio estimator (Wigley *et al.*, 2007; Stock *et al.*, 2018) is the statistical method adopted to implement the estimation of Shortfin Mako live releases and dead discards, which process is as follows.

First, the estimation of the total number of Shortfin Mako bycatch in year  $y$  ( $N_{tot, y}$ ) is based on the number of observed bycatch in year  $y$  ( $N_{obs, y}$ ) and observer coverage in year  $y$  ( $U_{obs, y}$ ). The annual catches of Shortfin Mako ( $C_y$ ) are calculated by the average weight of observed Shortfin Mako in year  $y$  ( $W_{obs, y}$ ) and the total number ( $N_{tot, y}$ ).

$$N_{tot, y} = N_{obs, y} / U_{obs, y} \quad \square \text{ 1a} \square$$

$$C_y = W_{obs, y} \times N_{tot, y} \quad \square \text{ 1b} \square$$

Second, assuming observed Shortfin Mako bycatch are representative of unobserved fishing. Based on the assumption, Shortfin Mako bycatch of unobserved fishing area (i.e.  $5^\circ \times 5^\circ$  grids) is estimated by the observed bycatch and the ratio of bycatch to fishing effort (number of hooks) of  $5^\circ \times 5^\circ$  grids.

$$C_{s, y} = (N_{s, y} / N_{tot, y}) \times C_y \quad \square \text{ 2a} \square$$

$$C_{s, y, m} = C_{s, y} \times (E_{s, y, m} / E_{s, y}) \quad \square \text{ 2b} \square$$

where  $C_{s, y}$  is the observed bycatch of area  $s$  ( $5^\circ \times 5^\circ$  grids) in year  $y$ ,  $N_{s, y}$  is the number of observed bycatch of area  $s$  ( $5^\circ \times 5^\circ$  grids) in year  $y$ ;

$C_{s, y, m}$  is Shortfin Mako bycatch of area  $s$  ( $5^\circ \times 5^\circ$  grids) of month  $m$  in year  $y$ ,  $E_{s, y, m}$  is the fishing effort (number of hooks) of area  $s$  ( $5^\circ \times 5^\circ$  grids) of month  $m$  in year  $y$ ,  $E_{s, y}$  is the total fishing effort of area  $s$  ( $5^\circ \times 5^\circ$  grids) in year  $y$ .

Third, Shortfin Mako live releases ( $C_{totDL, y}$ ) and dead discards ( $C_{totDD, y}$ ) in year  $y$  are based on the ratio of observed live releases ( $C_{obsDL, y}$ ) and observed dead discards ( $C_{obsDD, y}$ ) in year  $y$ , which is recorded by the observers.

$$C_{totDL, y} = (C_{obsDL, y} / (N_{obs, y} \times W_{obs, y})) \times C_y \quad \square \text{ 3a} \square$$

$$C_{totDD, y} = (C_{obsDD, y} / (N_{obs, y} \times W_{obs, y})) \times C_y \quad \square \text{ 3b} \square$$

## 3. Future work

Despite some potential issues in applying ratio estimators (Stock *et al.*, 2018), however, due to limited available information, ratio estimator is used to estimate Shortfin Mako live releases and dead discards from China fisheries. We are exploring the other model-based estimators (i.e. Generalized Additive Model, Random Forest and Spatiotemporal Model) rather than the current ratio estimator which is sampling-based. Different models are being tested and compared so that reasonable estimates can be achieved by the most effective analytical method.

## References

- Stock, B. C., Ward, E. J., Thorson, J. T., *et al.* 2019. The utility of spatial model-based estimators of unobserved bycatch. *ICES J. Mar. Sci.* 76:255-267.
- Wigley, S. E., Rago, P. J., Sosebee, K., *et al.* 2007. The analytic component to the standardized bycatch reporting methodology omnibus amendment: sampling design, and estimation of precision and accuracy. NOAA, NMFS Northeast Fisheries Science Center Reference Document 07-09, 156 pp.

**Table 1.** The annual catches of Shortfin Mako from Chinese tuna fishery between 2018 and 2021.

Year	Catches (t)	Live releases (t)	Dead discards (t)
2018	/	/	/
2019	27.642	7.344	20.298
2020	6.283	3.769	2.514
2021	4.581	2.748	1.833

Note: Catches (t) = Live releases (t) + Dead discards (t)