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Revisit of data filtering for CPUE of shortfin mako, *Isurus oxyrinchus*, caught by Japanese shallow-set longliner in the North Pacific[1]

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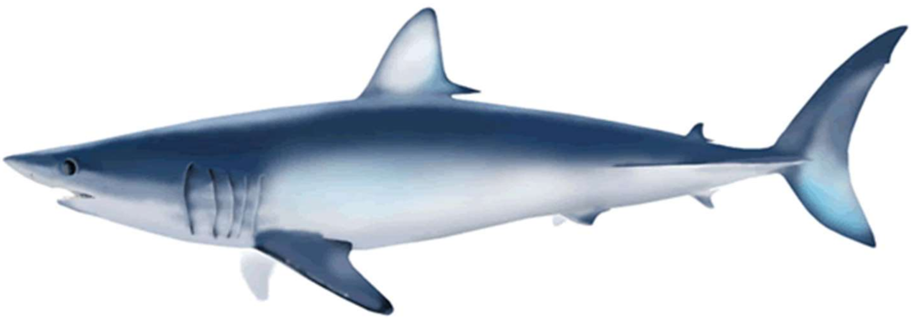

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Abstract

This working paper provides a revisit of data filtering method used in the estimation of catch per unit of effort (CPUE) of shortfin mako caught by Japanese shallow-set longliner in the western and central North Pacific. In the previous data analysis in 2017, two-step data filtering methods were applied to remove the data of mis/under reporting or discarding and to choose reliable vessels using the data in 2000s. Filtering (I) was conducted based on Akaike Information Criterion (AIC) estimated from CPUE standardization, in comparison between longline research vessel and commercial vessel. Filtering (II) was conducted based on visual observations of the positive catch of shortfin mako for each vessel. These two-step filtering methods are however complicated, doubtful verification ability and subjective. The author therefore suggests a simpler data filtering method without using the visual observations of data and the comparison of data between longline research vessel and commercial vessel for the limited area and period.

Introduction

In the CPUE standardization for shortfin mako, *Isurus oxyrinchus*, in the North Pacific Ocean in 2017 (Kai, 2017), preliminary simple data filtering was conducted to choose the vessels landing the pelagic sharks. The vessels were selected by the size (20~150 vessel tonnage) and the registered prefectures ("Tohoku, Hokkaido and Toyama") as these fisheries frequently target blue shark, *Prionace glauca*, and shortfin mako is frequently caught as bycatch. The data was also chosen by the number of hooks per baskets (HPB; 3~5) to select a shallow-set fishery. In addition, two additional follow-up filtering was conducted to remove the set-by-set logbook data of cruise which had apparently discarded the shortfin mako shark. Filtering (I): similar trends of standardized CPUEs for commercial vessels to that estimated from the longline research vessel by Ohshimo *et al*. (2014) were statistically selected using the same data regarding the periods (April to June for 2000, 2002-2013), area (25-40° N, 140-150° E), and depth (3-5 HPB). Filtering (II): The data of 19 vessels were selected from 28 vessels based on visual observation of annual trends in CPUE for shortfin mako in the past. The details are described in the previous document paper (Kai *et al*., 2015).

The two-step data filtering methods, however, have a few issues: 1) the spatial-temporal coverage of the survey data used for the validation of the CPUE trends (Ohshimo *et al*., 2014) is limited to small area (25-40 ˚N and 140-150 ˚E) and shorter periods (2000-2014) with one season (May-July), 2) the selection of the vessels based on the visual observation of CPUE pattern is subjective.

The objective of this document paper is to revisit the filtering methods used in the data analysis for the previous CPUE standardization. The author 1) examines the effect of simple data filtering such as a selection of vessel size to the annual trends in the nominal CPUE and 2) verifies effectiveness of the simple data filtering method through comparing annual trends in nominal CPUEs with those derived from data of Kesennuma fleets.

Materials and Methods

Data sources

Set-by-set logbook data from Japanese offshore and distant water longline fishery are used to examine the effect of simple data filtering to the annual trends in the nominal CPUE from 1994 to 2022. Set-by-set data used in this study included information on catch number, amount of effort (number of hooks), number of branch lines between floats (hooks per basket: HPB) as a proxy for gear configuration, location (longitude and latitude) of set by resolution of 1 × 1 degree square, vessel identity, fishery type (offshore or distant water), and the prefecture in Japan where the longline vessels were registered. The offshore-water fleet was defined by tonnage of vessels between 20 and 120 MT, while the distant-water fleet consisted of vessels larger than 120 MT.

Simple data filtering

To remove set-by-set logbook data of mis/under-reporting or discarding for pelagic sharks, simple data filtering method was employed. The data was filtered by 1) type of fishery and size of vessel (Japanese offshore and distant-water commercial longliner with more than 20 vessel tonnage: "Enyo-Kinkai" fisheries), 2) reporting ratio of pelagic sharks by cruise (more than 94.6%), 3) registered prefectures ("Tohoku, Hokkaido and Toyama" regions), and 4) depth of gear-setting (i.e., number of hooks per baskets; HPB: 3~5). The data filtered by these conditions has a characteristic that the fleets target pelagic sharks such as a blue shark, *Prionace glauca,* in the western and central North Pacific Ocean, and the fleets land shortfin mako at the Japanese fishing ports.

Effect of simple data filtering methods

To examine the effect of each simple data filtering method to annual trends in nominal CPUEs (per 1000 hooks) for shortfin mako, the nominal CPUEs were compared among five different simple data filtering methods; 1) No filtering, 2) only “Enyo-Kinkai” fisheries and removed coastal fisheries and research and training vessels, 3) “Enyo-Kinkai” fisheries with more than 94.6 % reporting ratio of sharks by cruise, 4) “Enyo-Kinkai” fisheries in the “Tohoku, Hokkaido and Toyama” regions with more than 94.6 % reporting ratio of sharks by cruise, and (5) “Enyo-Kinkai” shallow-set (HPB: 3~5) fisheries in the “Tohoku, Hokkaido and Toyama” regions with more than 94.6 % reporting ratio of sharks by cruise. In addition, the effect of the simple data filtering method was examined for the other highly migratory species such as blue shark, swordfish, *Xiphias gladius*, and striped marlin, *Kajikia audax*, as these species are frequently caught by the “Enyo-Kinkai” shallow-set fisheries targeting blue shark.

Verification of simple data filtering method

To verify effectiveness of simple data filtering method, annual trends in nominal CPUE derived from simple data filtering method for logbook data was compared with that derived from logbook data of 13 longline fleets in the “Kesennuma” city where in the north-eastern Japan (WCPFC, 2017). The “Kesennuma” longline fleets always target blue shark or swordfish using shallow-set gear and land blue shark, shortfin mako, swordfish, and striped marlin without discarding these species as these species have values in the “Kesennuma” fish market. The data of “Kesennuma” longline fleets is therefore used to verify the effectiveness of simple data filtering method. The author regards the simple data filtering method as reasonable if the annual trends in nominal CPUEs are similar between them.

Results

Effect of simple data filtering methods

Overall, the simple data filtering method had a large impact on annual CPUEs for four species (**Figure 1**). Especially, the filtering by “Enyo-Kinkai” fishery had largely changed the trends in the nominal CPUEs for four species. The filtering by 94.6 % reporting ratio by cruise had a small impact on the annual CPUEs except for the early period of nominal CPUE for striped marlin. The filtering by “Tohoku, Hokkaido and Toyama” regions also had a large impact on the annual CPUEs for all species. The filtering by shallow-set fishery had a small impact on the annal CPUEs. The main reason for the small impact is considered that the other filtering methods had already removed the data of mis/under-reporting or discarding of pelagic sharks.

Verification of simple data filtering method

Overall, the annual CPUE of simple data filtering had similar trends to that of data of Kesennuma fleets (**Figure 2**). For shortfin mako, the annual CPUE of two-step filtering had a large difference with that of simple data filtering method before 2011. These results suggested that the simple data filtering method is more reasonable than the-two step data filtering method for four pelagic species. The author recommends that the set-by-set longline data after simple data filtering should be used in the CPUE standardization for pelagic sharks including the shortfin mako to remove the data of mis/under-reporting or discarding of pelagic sharks.

Discussions

This document paper provided the effectiveness of simple data filtering method instead of the two-step data filtering method used for shortfin mako in 2017. Advantages of this simple data filtering method can choose set-by-set logbook data targeting pelagic sharks such as a blue shark without using the complicated data analysis. These fleets (i.e., offshore- and distant-water shallow-set longliner) are also known to targets swordfish using the same-gear configuration, although the main operational area and season are differed. The swordfish is commonly targeted at the lower latitude in winter and spring (Nov-Jun), while the blue shark is commonly targeted at the higher latitude in summer and autumn (Jul-Oct) (Kai *et al*., 2015). Therefore, the season and area interaction term should be considered in the CPUE standardization for blue shark and swordfish. For the CPUE standardization of blue shark caught by Japanese longline fleets in the western and central North Pacific Ocean in 2021, the spatio-temporal model (VAST; Thorson, 2019) was applied in consideration of seasonal and spatial changes of targeting (Kai, 2021). The similar approach should be used for the CPUE standardization for shortfin mako to remove the effect of the targeting for blue shark and swordfish.

The author considers that the simple data filtering method is also effective for the annual CPUEs of striped marlin and swordfish because these species are frequently caught by Japanese offshore and distant water shallow-set longline fleets. The Japanese longline fleets targeting tunas can discard the striped marlin as well as swordfish due to lower prices compared to tunas except for large-sized and weighted ones. In addition, Kesennuma fleets always land these species without discarding. The similar trends in annual CPUE of these species to that of Kesennuma fleets indicated that the simple data filtering is effective for the striped marlin and swordfish. The author therefore recommends using the simple data filtering for striped marlin and swordfish in the North Pacific Ocean when the CPUE of these species are standardized.

Two-step filtering method had a large impact on the absolute estimates of nominal CPUE, while the slight increasing trends in the nominal CPUE over the years were almost similar among different filtering methods (**Table 1** and **Figure 2**). The annual CPUE of two-step filtering seems more reasonable considering the slight increase of the annual CPUE in 1990s and 2000s for the low productivity of shortfin mako. However, the two-step filtering method can be regarded as a part of the CPUE standardization because the approach chooses the similar annual trends of CPUE to that of the standardized CPUE for research vessel (Oshimo et al., 2014). Therefore, the two annual CPUEs are simply incommensurable.

References

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Tables

Table 1. Number of efforts, number of shortfin mako shark in catch, and nominal CPUE for four data; All data without filtering, data of Kesennuma fleets, data with preliminary simple data filtering, and data with two-step data filtering in 2017.

Year	All data			Kesennuma vessels			Simple filtering method			Two-step filtering method in 2017		
	Effort (Number of hooks: mil)	Catch number	Nominal CPUE (per 1000 hooks)	Effort (Number of hooks: mil)	Catch number	Nominal CPUE (per 1000 hooks)	Effort (Number of hooks: mil)	Catch number	Nominal CPUE (per 1000 hooks)	Effort (Number of hooks: mil)	Catch number	Nominal CPUE (per 1000 hooks)
1994	213	11,705	0.05	4	195	0.06	21	2,752	0.13	4	1,512	0.34
1995	211	16,493	0.08	4	305	0.08	18	3,409	0.19	5	1,915	0.41
1996	189	13,099	0.07	4	669	0.19	19	4,982	0.26	5	2,490	0.48
1997	183	13,642	0.07	3	766	0.22	18	6,475	0.36	6	2,754	0.50
1998	183	12,185	0.07	4	1,152	0.31	18	6,821	0.38	6	3,244	0.51
1999	196	14,861	0.08	4	1,721	0.44	20	8,872	0.44	7	4,115	0.61
2000	190	15,695	0.08	5	2,208	0.44	23	12,135	0.52	8	5,806	0.76
2001	193	13,764	0.07	5	1,618	0.35	23	10,373	0.45	7	3,976	0.59
2002	180	11,459	0.06	5	1,689	0.37	20	8,888	0.44	7	3,365	0.51
2003	176	12,255	0.07	4	1,382	0.37	18	9,449	0.53	6	3,946	0.69
2004	170	12,169	0.07	4	1,038	0.27	18	10,267	0.56	6	3,791	0.68
2005	156	14,498	0.09	4	2,079	0.56	17	12,306	0.74	5	4,559	0.97
2006	155	15,644	0.10	4	2,120	0.57	16	12,221	0.76	4	4,955	1.19
2007	147	17,570	0.12	6	4,073	0.73	18	14,628	0.80	6	6,605	1.19
2008	134	15,352	0.11	5	2,943	0.64	16	11,215	0.71	5	4,968	1.08
2009	127	17,958	0.14	5	4,372	0.85	14	13,561	0.94	4	5,543	1.44
2010	132	15,375	0.12	6	3,667	0.64	14	11,910	0.86	3	3,575	1.22
2011	129	10,887	0.08	5	5,256	1.12	7	8,396	1.12	2	2,433	1.36
2012	120	11,843	0.10	6	6,104	1.04	9	10,507	1.14	2	2,643	1.43
2013	115	9,292	0.08	7	5,212	0.79	10	7,626	0.80	2	1,884	1.09
2014	113	13,381	0.12	7	7,739	1.18	10	11,459	1.17	1	1,484	1.29
2015	107	13,543	0.13	6	9,461	1.46	8	11,107	1.38	1	1,866	1.37
2016	100	18,403	0.18	8	14,282	1.84	8	14,136	1.81	1	2,080	1.90
2017	91	14,654	0.16	7	10,673	1.44	7	10,580	1.45			
2018	89	15,483	0.17	8	11,573	1.52	8	11,510	1.52			
2019	89	13,744	0.16	7	10,159	1.42	7	10,258	1.43			
2020	84	8,402	0.10	7	6,057	0.87	8	6,680	0.88			
2021	66	6,760	0.10	5	4,671	0.95	6	5,131	0.90			
2022	45	8,670	0.19	3	4,860	1.58	4	6,427	1.63			

Figures

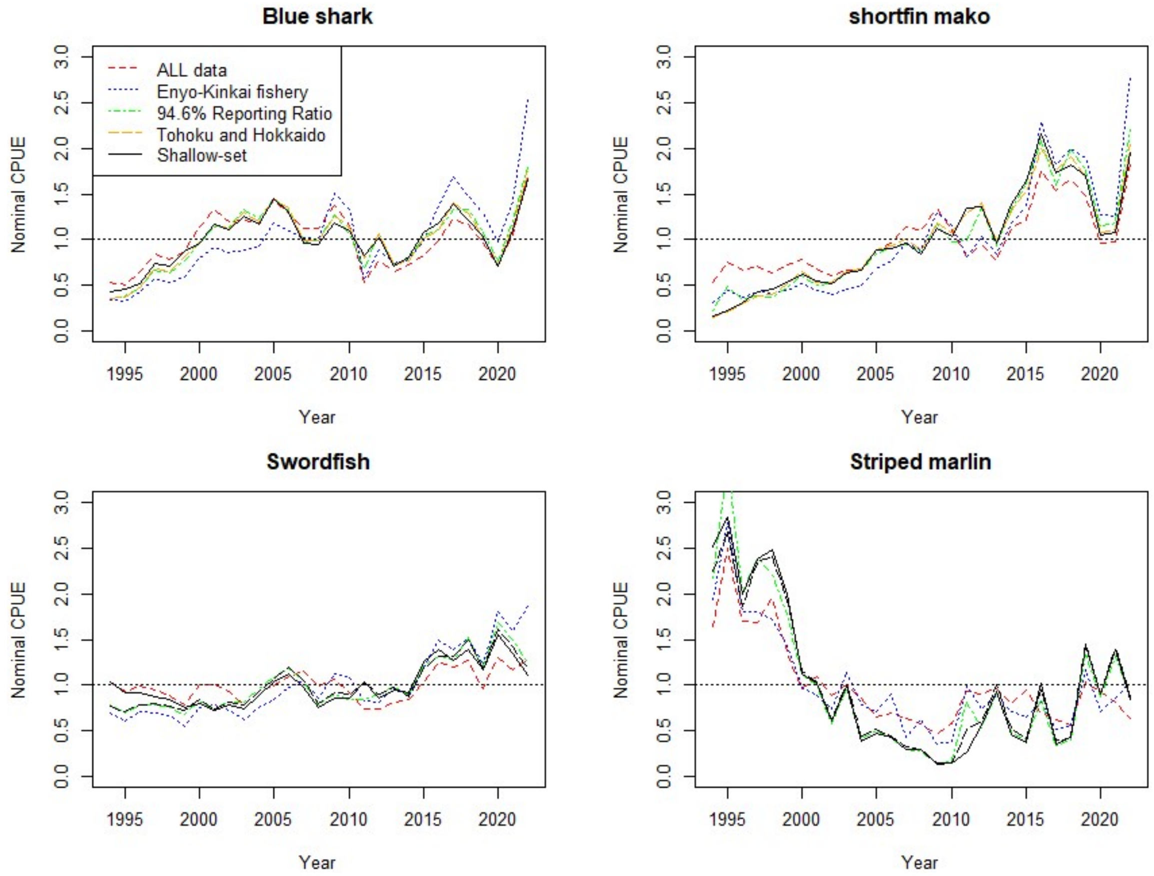

Figure 1. Comparison of annual trends in nominal CPUE (per 1000 hooks) among different preliminary filtering methods (1:No filtering, 2: Data of Enyo-Kinkai fleets, 3: Data of Enyo-Kinkai fleets with more than 94.6 % reporting ratio by cruise, 4: Data of Enyo-Kinkai fleets in Hokkaido, Tohoku and Toyama regions with more than 94.6 % reporting ratio by cruise, 5:) Data of Enyo-Kinkai shallow-set fleets in Hokkaido, Tohoku and Toyama regions with more than 94.6 % reporting ratio by cruise) for four major highly migratory species (Blue shark, shortfin mako, swordfish, and Striped marlin) caught by Japanese offshore and distant-water shallow-set longline fishery. CPUE is normalized by the mean value. The dotted horizontal line denotes mean value (1.0).

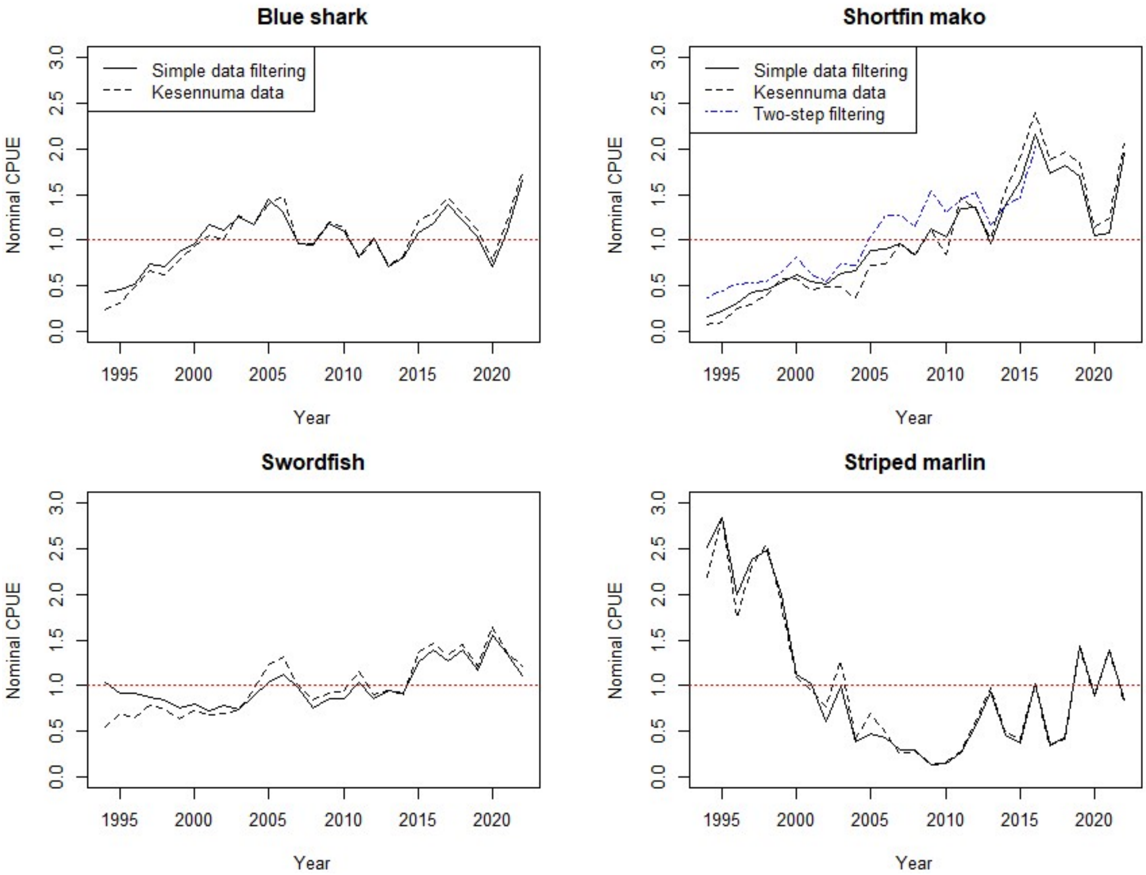

Figure 2. Comparison of annual trends in nominal CPUE (per 1000 hooks) between data filtered by simple filtering method and data of Kesennuma fleets for four major highly migratory species (Blue shark, shortfin mako, swordfish, and Striped marlin) caught by Japanese offshore and distant-water shallow-set longline fishery. CPUE is normalized by the mean value. The blue dotted line in the upper right figure denotes the CPUE derived from the two-step data filtering used in 2017. The red dotted horizontal line denotes mean value (1.0).