Update of Pacific blue marlin (*Makaira nigricans*) catch and size statistics from the WCPFC and the IATTC

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Abstract

This study organizes the Pacific blue marlin catch and size data submitted to the WCPFC and IATTC and prepares the Stock Synthesis 3 (SS3) input data for the next stock assessment. This paper also proposes the new aggregation method and new fleet definition. In the 2016 stock assessment, the BILLWG excluded the double-counted catch of OthLL in the overlap area from 2011-2014. I suggested that the double-counted catch for all years will be excluded using WCPFC Category II data. Although the Category II data tended to be underreported, the revised OthLL catch data was more accurate than the previous one. I also propose eliminating the EPOOth and defining the WCPFCOth fleet that reflects the WCPFC Category I data update. The EPOOth included just a French Polynesia's catch. However, the WCPFC Category I data has updated other fisheries catch that include French Polynesia, Philippine and, Indonesia. The update size data showed a similar distribution to the previous data. It was considered that SS3 would estimate similar size selectivity in the next stock assessment.

Introduction

The ISC Billfish Working Group (BILLWG) is planning a stock assessment of the Pacific blue marlin using Stock Synthesis 3 (SS3). To implement SS3, catch and size statistics will need to be compiled according to the SS3 fleet definition. However, data sets of two Tunas Regional Fisheries Management Organization (RFMOs, namely WCPFC and IATTC) need to be organized to produce input data of the SS3. In particular, it is necessary to remove double-counted catches of longline fishery because multiple countries operate in the overlap area of these two RFMOs (Chang et al., 2016). This study organizes the catch statistics and size data from the WCPFC and IATTC to produce input data for SS3. This study also suggested new methods to estimate the OthLL catch and a new fleet definition called WCPFCOth that reflect the update of WCPFC statistics.

Material and methods

Data source

This study used the official statistics of WCPFC and IATTC. WCPFC statistics include three categories that are Category I, Category II, and Category III. Category I includes annual catch statistics by country and fishery type, which was downloaded from the WCPFC website (WCPFC 2020). Category II and Category III are 5° X 5° resolutions national longline catches and length-frequency data by country and fishery type. The

WCPFC provided category II and Category III to the ISC BILLWG. EPO total estimated annual catch weight and Billfish length-frequency data of purse-seine vessels in the EPO were available on the IATTC website (IATTC 2020). Table 1 summarizes all countries that reported to two RFMOs.

Fleet definition of the SS3

The catch and size data were organized according to the fleet's definitions in the 2016 stock assessment. The names of fleets were OthLL, PYFLL, EPOPS, WCPFCPS, and EPOOth. I compared WCPFC's other fishery with the IATTC other fleets (EPOOth) because the other fishery was added to the WCPFC Category I data. Following this comparison, I considered a new definition of WCPFCOth fleet. The differences between the data organization method in this study and the previous one are shown in Table 2.

Catch statistics

- **OthLL**

The OthLL fleet is the sum of catches in the longline fishery countries other than Japan, Taiwan, the United States, and French Polynesia. Data were taken from WCPFC's Category I and IATTC's EPO total estimated catch. To remove the catch in the overlap area, I estimated the catch in the overlap area as follows:

OthLL = WCPFC(Other longline) + ICCAT(Other longline)-WCPFC(Overlap area estimated by Category II).

In the 2016 stock assessment, the BILLWG used IATTC information from 2011-2014 to exclude double counting catch in the overlap area. I compared the catch used in the previous stock assessment and the new data set that excludes the double count catch of all periods.

- **PYFLL**

French Polynesian longline fishery is considered to be operating in the overlap area. Therefore, French Polynesian catches are reported to both WCPFC and IATTC. In the 2016 stock assessment, the BILLWG used WCPFC Category I. This study compared the input data from WCPFC, IATTC, and the previous stock assessment.

- **EPOPS**

I compiled the Purse seine catch data reported to the IATTC. In the previous stock assessment, the BILLWG used logbook data at 1° X 1° resolution. However, the logbook data records the catch numbers rather than the weight of the catch. This study compiled the catches from the IATTC annual statistics to provide a consistent comparison with other fleets.

- **WCPFCPS**

As with the previous stock assessment, the purse seine catch in the WCPFC was based on the WCPFC Category I aggregate by year.

- **EPOOth**

In the 2016 stock assessment, the BILLWG used the other fishery catches as reported to the IATTC only. The other fishery catches in IATTC waters reported only French Polynesia. In this study, I compared the catches of French Polynesia reported to the IATTC and the WCPFC because French Polynesia's data reported to WCPFC can also use in this study.

- **WCPFCOth**

The latest WCPFC Category I data has updated the other fishery. This paper reviews the other fishery of the WCPFC Category I data and tries to integrate it with EPOOth.

Length frequency Data

The length frequency data were available for OthLL, PYFLL, and EPOPS. OthLL and PYFLL were aggregated in 10 cm increments, and EPOPS were aggregated in 5 cm increments. Besides, these data were aggregated by year and quarter and converted to a format that can be used in SS3.

Results and Discussion

Catch data of Pacific blue marlin

- **Annual trend in Pacific blue marlin catches**

The Pacific blue marlin catch for SS3 was based on the WCPFC and IATTC annual statistics summarized by country and gear type. A total of 45 countries have reported catches to both RFMOs (Table 1). Looking at the catch by RFMO, the WCPFC longline fishery has shown an increasing trend since the 1970s, with the leading fishery country shifting from Japan to Taiwan (Figure 1). The purse seine catch increased dramatically in the 2000s in the WCPFC area (Figure 1). In the IATTC

waters, Japanese longline fishery caught the majority of the blue marlin until 2000 (Figure 2). Total longline catches increased until the mid-1990s and decreased until the mid-2000s (Figure 2). After the mid-2000s, the total catch of the longline has increased again (Figure 2). The other fishery reported to the IATTC was French Polynesia only (Figure 2). The majority of the purse seine catch in the IATTC waters is by Ecuador (Figure 2).

- **OthLL**

The total other longline catches in the WCPFC and IATTC were roughly consistent with the previous OthLL catches (Figure 3). The BILLWG excluded double-counted catches during the 2011-2014 period only (Chang et al., 2016). On the other hand, the OthLL estimated by this study excluded the double-counted catch for most of the period (Figure 3). Comparing Category I and Category II data, the Category II data tended to be less than Category I data (Figure 4). It might indicate the under the report of Category II data. However, underestimation is expected to be low because the catch in the overlap area is small (Chang et al., 2016). Considering these results, I suggest choosing the OthLL estimated by this study.

- **PYFLL**

The French Polynesian has reported the longline catch to the WCPFC and the IATTC. A comparison of these data shows that the amount of catches reported to WCPFC is larger than that reported to IATTC (Figure 5). The reason is thought that the French Polynesian longliner did not operate outside of the overlap area in IATTC waters. Thus, the catches reported to the WCPFC are better to use in the next stock assessment. The French Polynesian longline catches had shown a downward trend from the mid-1990s when the catches were around 400 tons (Figure 5).

- **EPOPS**

The purse seine catches in the IATTC area show similar trends in both the number and weight of fish (Figure 6).

- **WCPFCPS**

The updated WCPFCPS catch is similar to the input data used in the previous stock assessment (Figure 7). The catch in recent years has fluctuated sharply from 1200 tons to 500 (Figure 7).

- **EPOOth and WCPFCOth**

The EPOOth catch is reported by French Polynesia only. Comparisons of available French Polynesia catches show that the WCPFC data tends to be larger (Figure 8). It would be better to use the WCPFC data because the other fishery of French Polynesia is considered to not operate outside the overlap area in IATTC waters, as with the PYFLL. Also, WCPFC Category I has been updated to include catches from other countries (e.g., Philippines and Indonesia) (Figure 1). Thus, I propose to abolish EPOOth and establish a definition of the fleet called WCPFCOth by compiling the other fishery data from the WCPFC Category I. The WCPFCOth catch is not so huge, and that impact on the next stock assessment is a little (Figure 9).

Size data of Pacific blue marlin

The size composition remained mostly unchanged to compare the aggregated size data with the 2016 stock assessment data (Figure 10). Therefore, the size selectivity estimated by SS3 will not change significantly from the 2016 stock assessment. I confirmed the annual and seasonal variation in each fleet (Figure 11-13). The size composition of PYFLL had a large change in 2003, which is responsible for the two-mode size composition (Figure 12). In the 2016 stock assessment, this change was treated using time blocks (ISC 2016). The same treatment in the next stock assessment should not cause any problems. On the other hand, the length composition of OthLL and EPOPS did not show an annual or quarterly variation (Figure 11 and 13).

Acknowledgments

In carrying out this work, I thank Dr. Peter Williams from WCPFC and Dr. Shane Griffiths from IATTC to provide the data and explain the contents in detail. I also thank Dr. Yi-Jay Chang and Dr. Jon Brodziak for providing a detailed explanation of the previous tabulation methods. I want to take this opportunity to express our gratitude to all those who contributed to this study.

References

Chang, Y-J. Yau, A. and Brodziak, J. 2016. Summary of blue marlin (Makaira nigricans) catch and size data from the Western and Central Pacific Fisheries Commission and the Inter-American Tropical Tuna Commission. ISC/16/BILLWG-1/4

ISC 2016. Stock Assessment Update for Blue Marlin (Makaira nigricans) in the Pacific Ocean through 2014. ISC16 Plenary Report

Table 1. Country codes in this study.

AU: AUSTRALIA	NZ: NEW ZEALAND
BZ: BELIZE	OT: OTHERS
CA: CANADA	PE: PREU
CK: COOK ISLANDS	PF: FRENCH POLYNESIA
CL: COLOMBIA	PG: PAPUA NEW GUINEA
CN: CHINA	PH: PHILIPPINES
CR: COSTA RICA	PN: PANAMA
EC: ECUADOR	PT: PORTUGAL
EP: EASTERN PACIFIC US PURSE SEINE FLEET	PW: PALAU
ES: SPAIN	SB: SOLOMON ISLANDS
FJ: FIJI	SN: SENEGAL
FM: FEDERATED STATES OF MICRONESIA	SU: SOVIET UNION
HD: HONDURAS	SV: EL SALVADOR
ID: INDONESIA	TK: TOKELAU
JP: JAPAN	TO: TONGA
KI: KIRIBATI	TV: TUVALU
KR: KOREA	TW: TAIWAN
MH: MARSHALL ISLANDS	US: UNITED STATES OF AMERICA
MX: MEXICO	VE: VENEZUELA
NI: NICARAGUA	VU: VANUATU
NC: NEW CALEDONIA	VN:VIETNAM
NU: NIUE	WF: WAILLIS AND FUTUNA
	WS: SAMOA

Table 2. Difference fisheries definition between 2016 stock assessment and 2021 stock assessment.

Fishery code (2016)	Fishery code (2020)	Definition	Countries (2016)	Countries (2020)	Difference of catch
OthLL	OthLL	Various flags longline	AU, BZ ,CN, CK, CR, FJ, ID, KI, KR,MH, MX, FM, NC, NU, NZ, PG, PH, WS, SN, SB, ES, TO, TV, VU, VN	AU, BZ, CK, CN, ES, FJ, FM, ID, KI, KR, MH, MX, NC, NU, NZ, PG, PH, PT, PW, SB, SN, TO, TV, VN, VU, WS, CR, OT	- 2016 data removed catch of overlap area in 2011-2014 using IATTC information. - This study removed catch of overlap area using WCPFC Category II data.
PYFLL	PYFLL	French Polynesia longline	PF	PF	–
EPOPS	EPOPS	Various flags purse seine	EC, HD, MX, NI, PN, SV, ES, VE, VU, US	CL, EC, ES, HD, MX, NI, OT, PE, PN, SV, US, VE, VU	- Add small catch. - Change data source (Logbook (number) to Yearbook(kg))
WCPFCPS	WCPFCPS	Various flags purse seine	AU, CN, EC, FM, ID, KI, MH, MX, NZ, PG, PH, SB, SV, ES, TV, VU, KR, JP, US	AU, CN, EC, ES, FM, ID, JP, KI, KR, MH, MX, NR, NZ, PG, PH, SB, SV, TV, TW, US, VN, VU	- Add small catch but no difference
EPOOth	–	French Polynesia troll & handline, harpoon	PF	–	–
–	Other	Various flags other fishery	–	PH, US, ID, PF, VN	- New information form WCPFC - PF catch was aggregated by WCPFC Category I data.

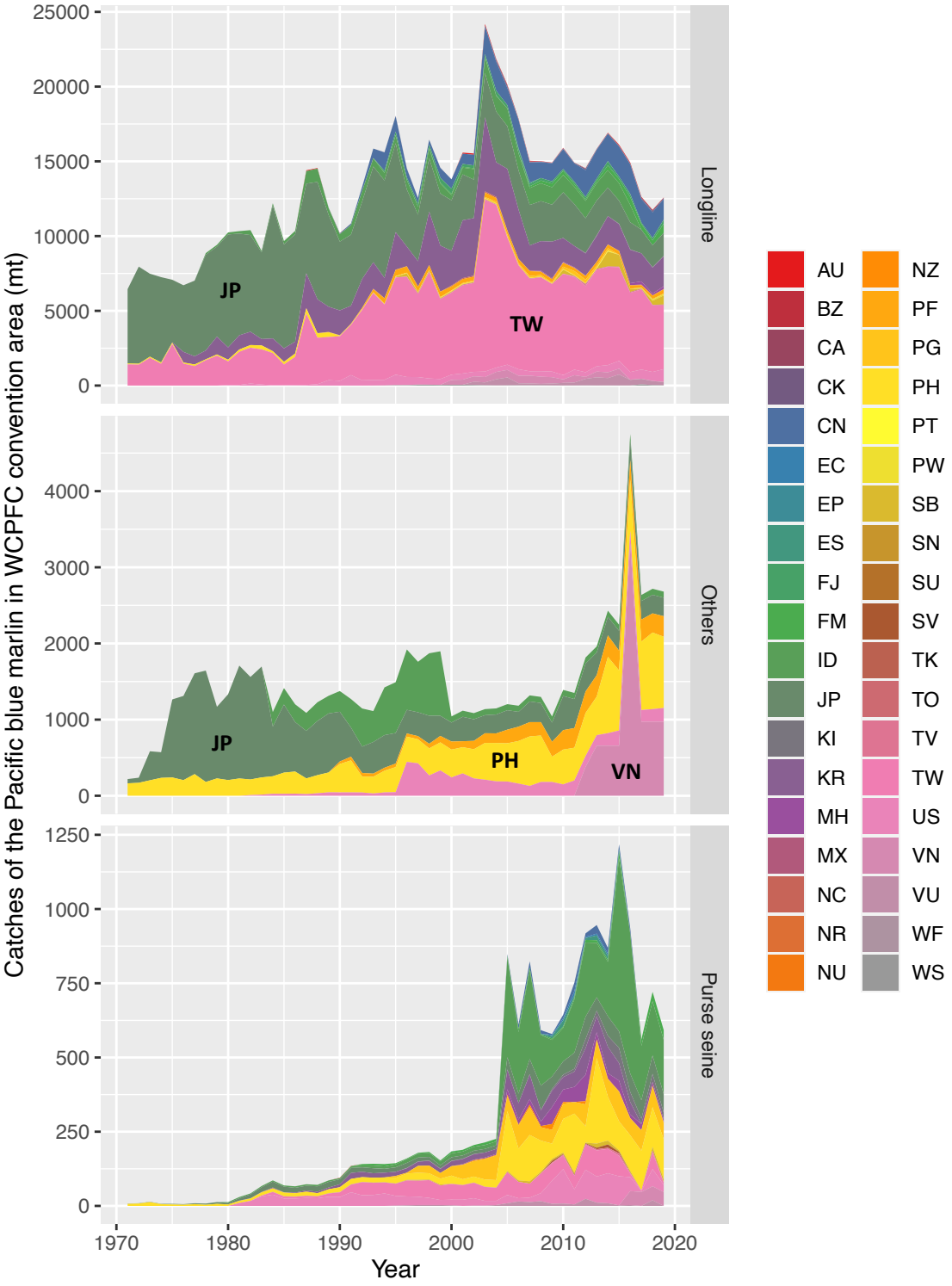

Figure 1. The Pacific blue marlin catches in the WCPFC convention area that was summarized by the Category I data (WCPFC Yearbook). The country code defines in Table 1.

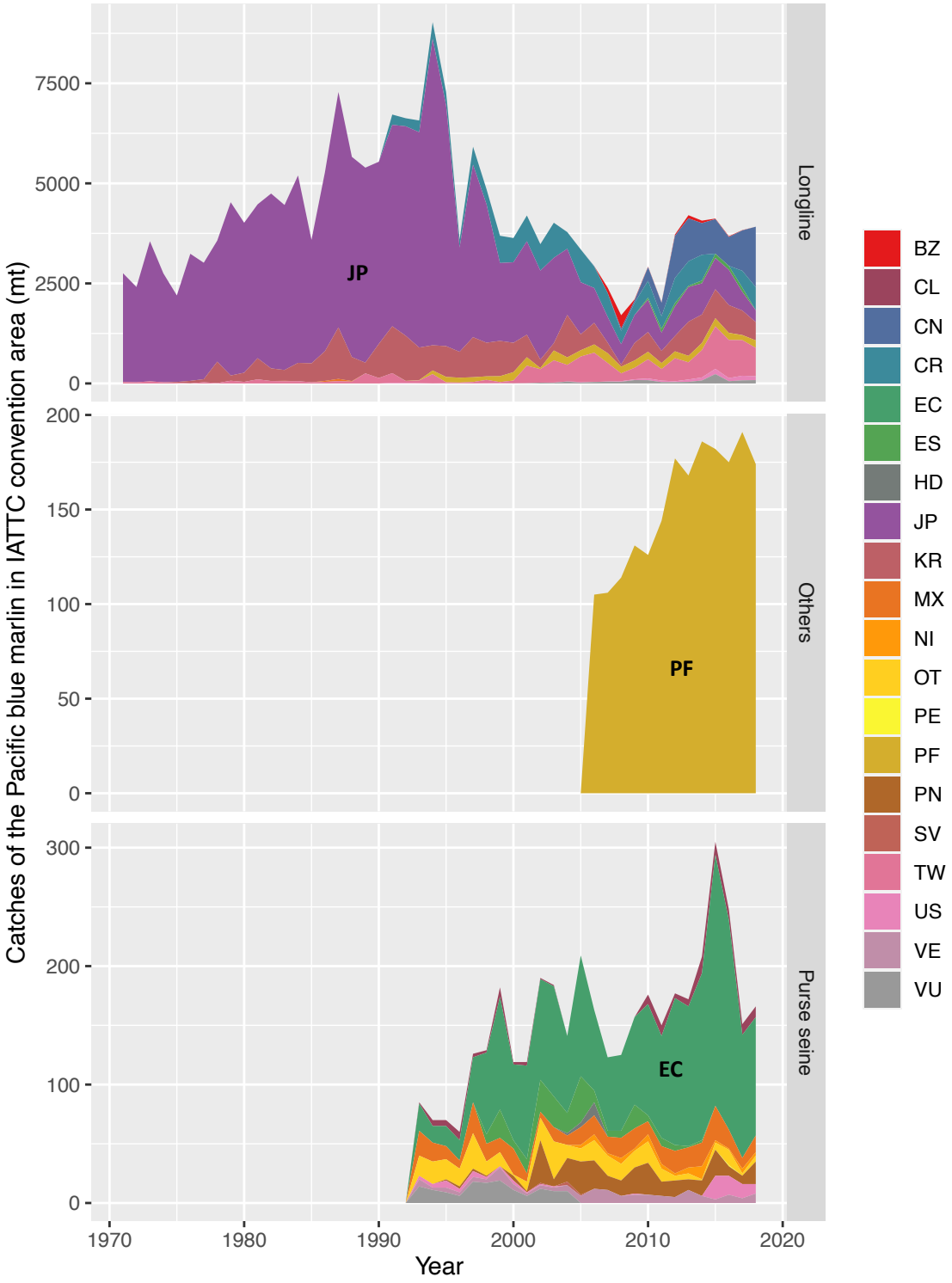

Figure 2. The Pacific blue marlin catches in the IATTC convention area that was summarized by the IATTC public domain data. The country code defines in Table 1.

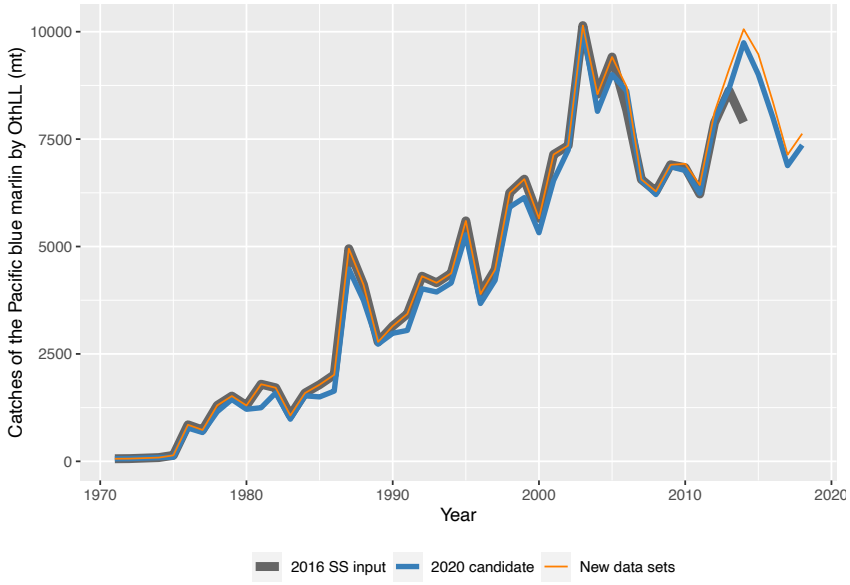

Figure 3. The Pacific blue marlin catches by the other longline fishery (**OthLL**). The New data sets summed up the WCPFC and the IATTC statistics (see Figures 1 and 2). The 2020 candidate subtracts the overlap area catch from the total WCPFC, and IATTC catches. Catch in the overlap area was calculated from WCPFC Category II data.

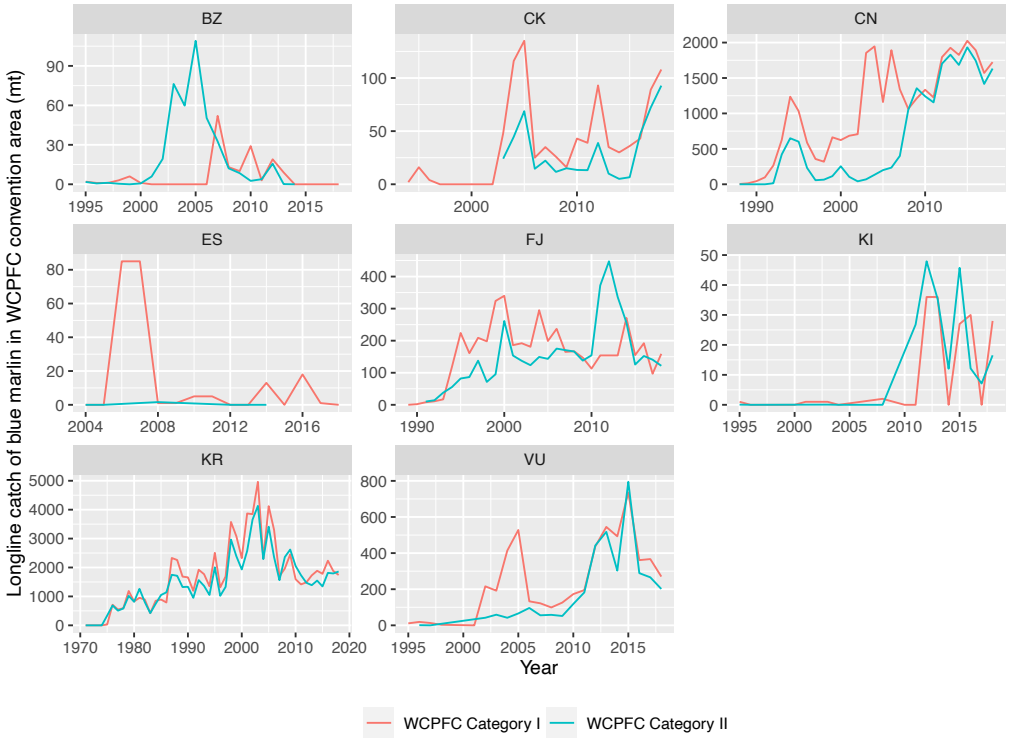

Figure 4. The comparison of the Category I and the Category II data from WCPFC. The longline catches were summarized by the other longline countries operating in the overlap area. Aggregation was done for the entire WCPFC convention area.

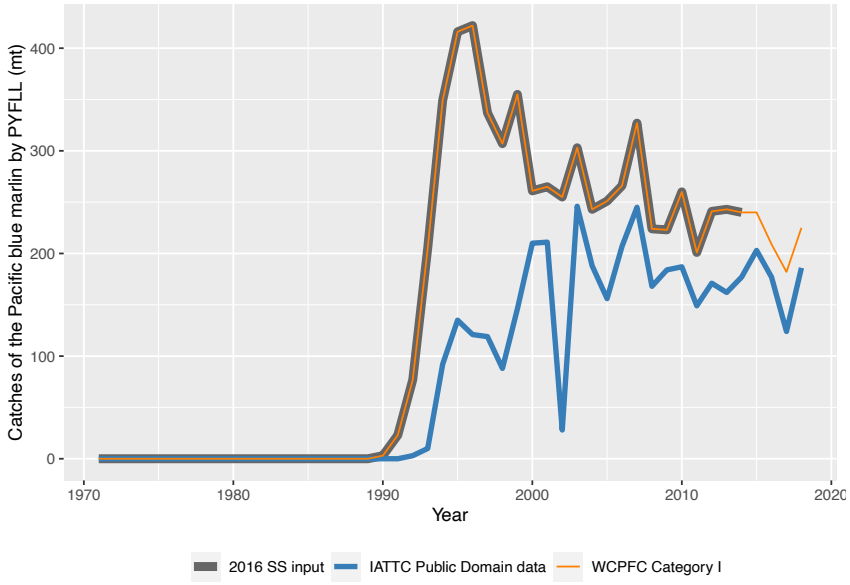

Figure 5. The catch of Pacific blue marlin by French Polynesia longline (**PYFLL**).

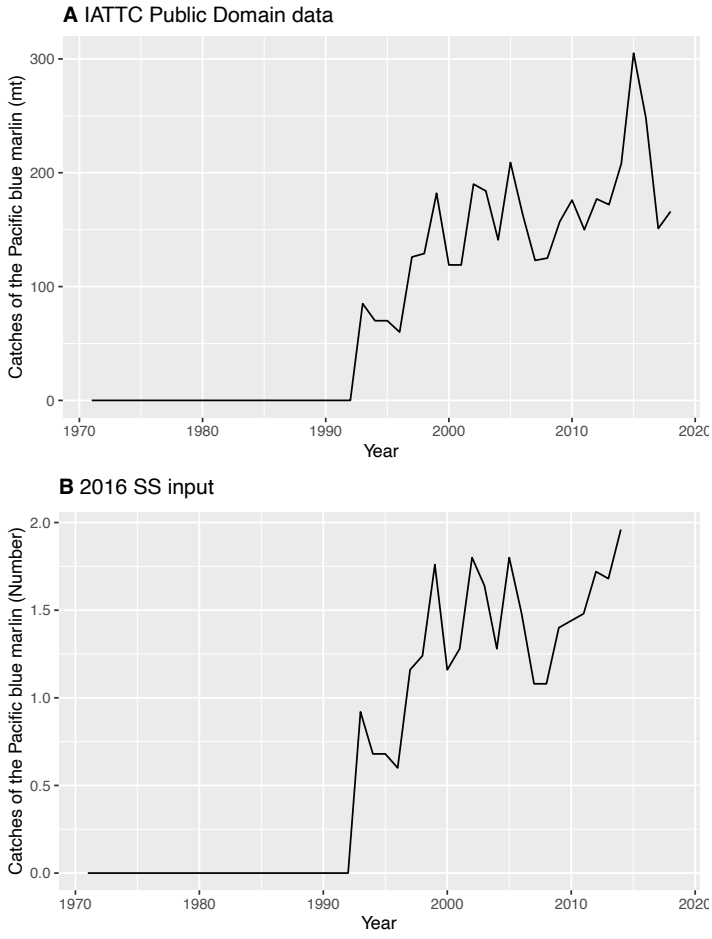

Figure 6. The catch of Pacific blue marlin caught by the Eastern Pacific ocean purse seine fishery (**EPOPS**).

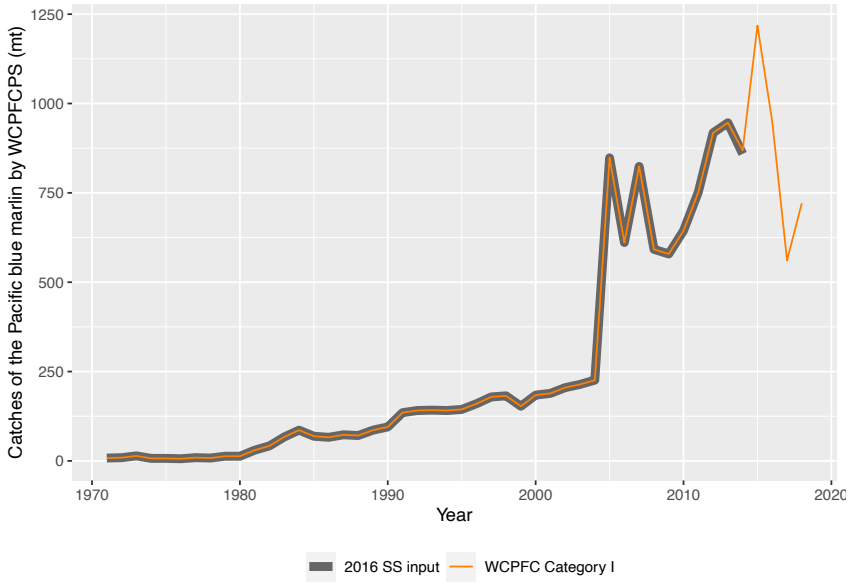

Figure 7. The catch of Pacific blue marlin by the WCPFC purse seine fishery (**WCPFCPS**).

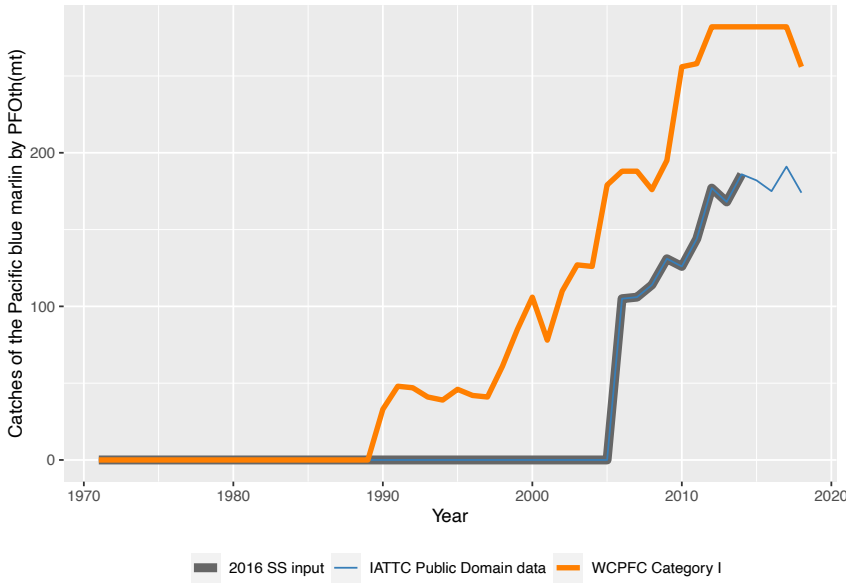

Figure 8. Pacific blue marlin catches in other fisheries of French Polynesia.

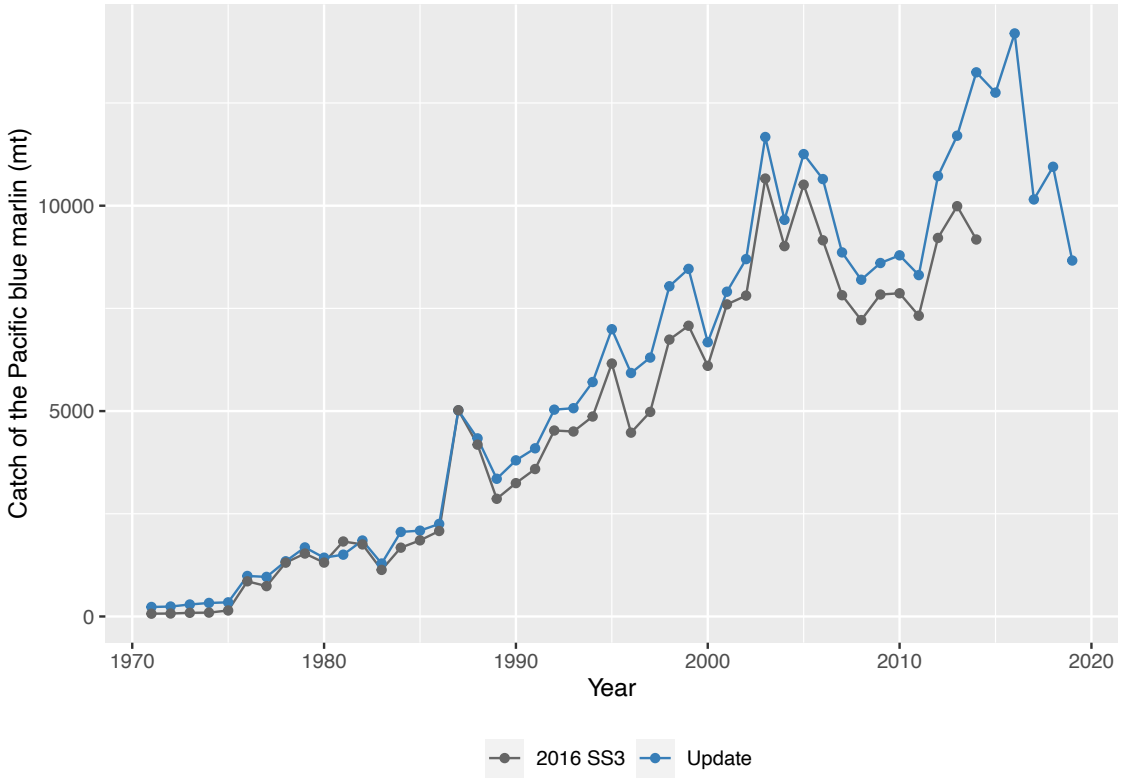

Figure 9. Comparison of catches generated from WCPFC and IATTC statistics.

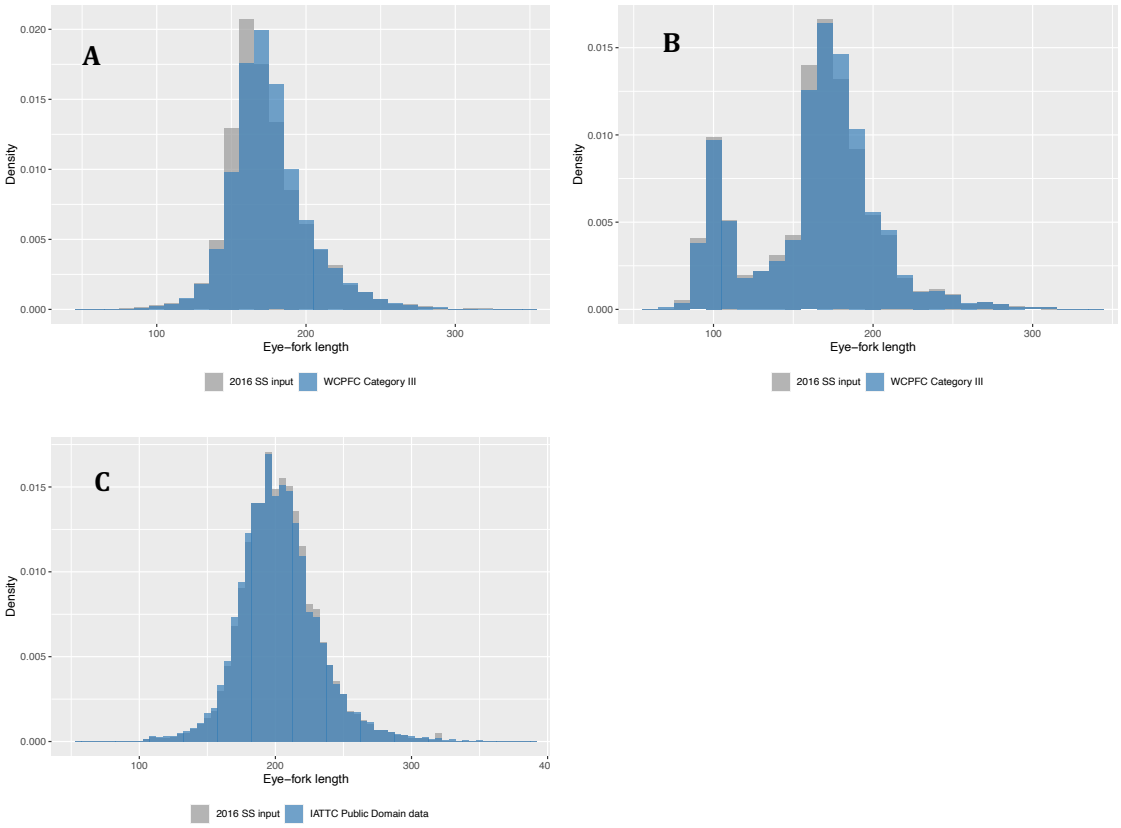

Figure 10. Size frequency of Pacific blue marlin in the WCPFC and IATTC convention area. **A**: Other longline in WCPFC convention area (**OthLL**). **B**: French Polynesia longline (**PYFLL**). **C**: Eastern Pacific ocean purse seine (**EPOPS**).

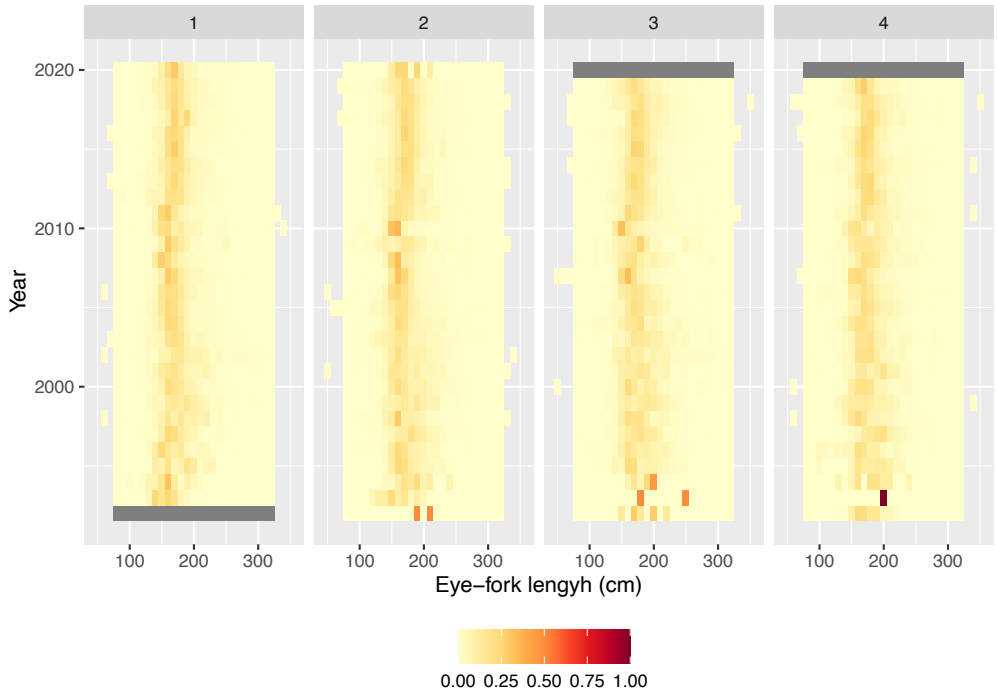

Figure 11. Annual-seasonal change of length frequency of Pacific blue marlin caught by the other longline in the WCPFC convention area (**OthLL**).

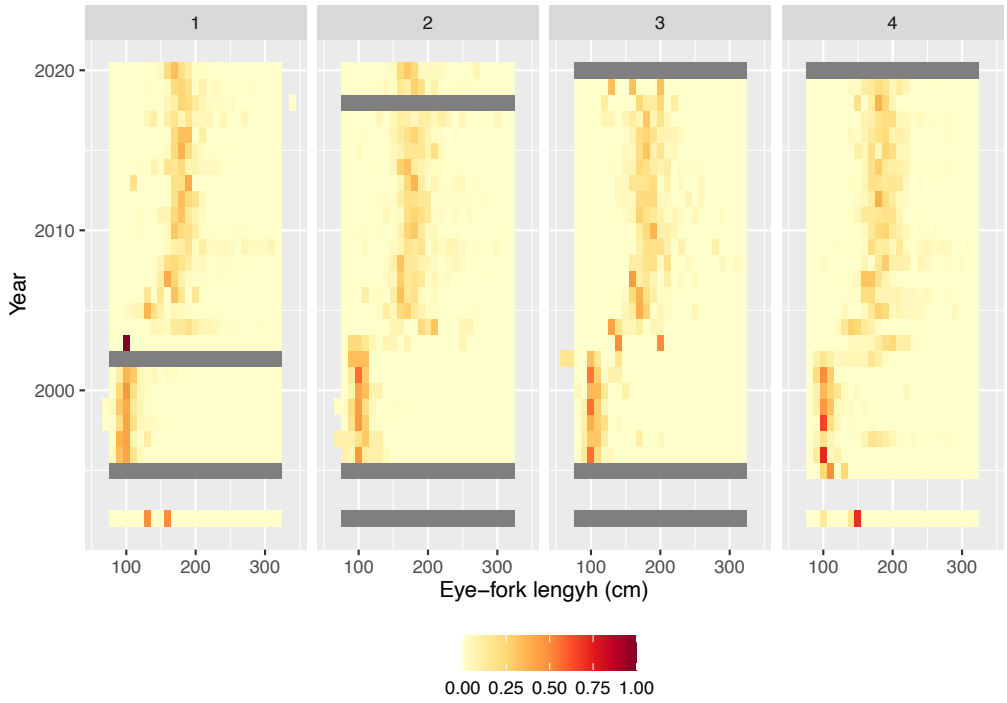

Figure 12. Annual-seasonal change of length frequency of Pacific blue marlin caught by the French Polynesia longline fishery (**PYFLL**).

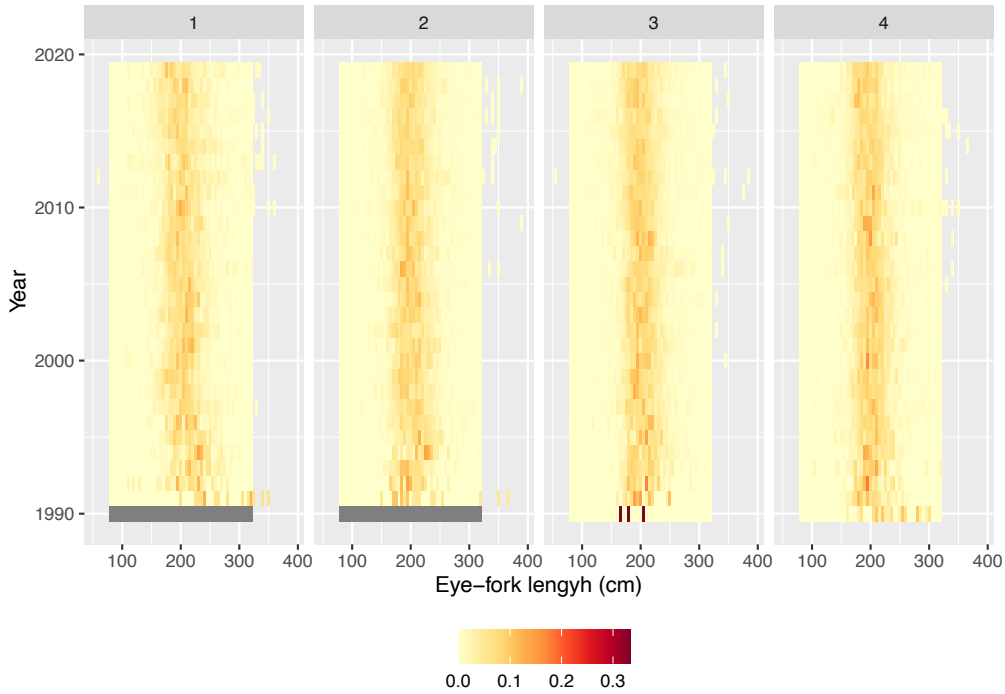

Figure 13. Annual-seasonal change of length frequency of Pacific blue marlin caught by the Eastern Pacific ocean purse seine (**EPOPS**).