Preliminary estimated discarded amounts of southern bluefin tuna for Taiwanese longline fishery in 2018 and 2019

Sheng-Ping Wang[1], Ching-Ping Lu[1], Shu-Ting Chang[2], Ming-Hui Hish[3], I-Lu Lai[3]

[1] Department of Environmental Biology and Fisheries Science,
National Taiwan Ocean University, Taiwan
[2] Overseas Fisheries Development Council, Taiwan
[3] Fisheries Agency, Council of Agriculture, Executive Yuan, Taiwan

ABSTRACT

According to the discard information recoded by Taiwanese scientific observer program and fishing efforts data collected from Taiwanese large scale longline vessels in 2018-2019, we applied a procedure similar to the bootstrap approach to estimate the discarded amount of southern bluefin tuna of Taiwanese longline fishery in four areas including Atlantic, Pacific central Indian and western Indian Oceans. The results indicated that the discards of SBT mainly occurred during June to August in the central Indian Ocean. The total amount of estimated discards in three oceans were 8,605 kg in 2018 and 8,594 kg in 2019.

1. INTRODUCTION

Because the discard information of southern bluefin tuna (SBT) was not recorded regularly by fishing vessels of Taiwanese longline fishery in the early period. In order to collect scientific information from Taiwanese longline vessels, the scientific observer program had been started and the scientific observers had been deployed on board for conducting the scientific information collection of SBT since 2002. In this study, we aim to estimate the discard amounts of SBT by integrating the fishing operation data from Taiwanese commercial longline vessels with the discard information recorded by scientific observers in three basins including Atlantic, Pacific and Indian Oceans.

2. MATERIALS AND METHODS

2.1. Discard information of SBT collected by scientific observer program

The discard information of SBT included fishing date, the location information (longitude and latitude), hooks and number of discards. The data were recorded by observers dispatched to Taiwanese longline vessels operated in three oceans during 2018-2019. Because the dispatch of observers did not spread over the SBT fishing ground each year. Therefore, the data are aggregated over years. The aggregated data are used to calculate quarterly and area-specific information of SBT discard. The areas are defined as Atlantic (Atl), Pacific (Pac), western Indian (W.Ind, west of 60°E) and central Indian Oceans (C.Ind, east of 60°E).

2.2. Fishing effort of commercial longline vessels

The data of fishing effort (hooks) are based on the daily operational data (logbook data with set-by-set information) of authorized fishing SBT Taiwanese longline vessels operated in the southern waters of 25°S from 2018 to 2019. The fishing efforts of the commercial data are integrated with the discard information from observer data to estimate the amount of SBT discard of Taiwanese longline fishery.

However, there was no authorized fishing SBT Taiwanese longline vessels operated in the Pacific Ocean in 2018 and 2019. Therefore, we calculated the proportion of SBT fishing vessels in the core area with historical data. And then, applying the proportion to select the vessels, which potentially fished SBT, for conducting the estimation of SBT discards in the Pacific Ocean.

2.3. Procedure of the SBT discards estimation

We developed an approach, which is similar to bootstrap method, to conduct the estimation of SBT discard and the procedures are described as below:

(1) Randomly select the data from 50% of total fishing sets of observer data by areas (Atl, Pac, W. Ind and C. Ind) and by quarters (Jan-Mar, Apr-Jun, Jul-Sep and Aug-Dec).

(2) Calculate quarterly and area-specific proportion of fishing sets with SBT discard (i.e. fishing sets with discard/total fishing sets, abbreviated as proportion of discard sets) and SBT discard rate (number of discards/1000 hooks) when SBT discard occurred (abbreviated as discard rate) based on the data selected from step (1).

(3) Integrate the logbook data with discard information calculated from step (2) to estimate SBT discards. To estimate SBT discard, the steps of this method are described as below:

    (a) Randomly select logbook data based on a specific number of fishing sets

for each vessel.

$$\tilde{n}^{v}_{q,a} = p_{q,a} \cdot n^{v}_{q,a}$$

where,

$\tilde{n}^{v}_{q,a}$ is the number of selected fishing sets for vessel *v*, in quarter *q* and in area *a*;

$p_{q,a}$ is the proportion of discard sets in quarter *q* and in area *a* calculated from step (2);

$n^{v}_{q,a}$ is the total fishing sets for vessel *v*, in quarter *q* and in area *a*.

(b) Estimate the number of SBT discards based on the effort (hooks) obtained from step (a) and discard rate from step (2).

$$d^{v,i}_{q,a} = f^{v,i}_{q,a} \cdot \varphi_{q,a} \quad (i = 1,2,\ldots \tilde{n}^{v}_{q,a})$$

where,

$d^{v,i}_{q,a}$ is the number of SBT discards for vessel *v*, in quarter *q*, in area *a* and in fishing set *i*;

$f^{v,i}_{q,a}$ is the number of hooks for vessel *v*, in quarter *q*, in area *a* and in fishing set *i* obtained from step (a);

$\varphi_{q,a}$ is the discard rate in quarter *q* and in area *a* calculated from step (2).

(4) Repeat steps (1) to (3) for 500 times.

(5) Convert the discard amount in number into discard amount in weight based on the mean value of weight. The quarterly and area-specific mean weights are calculated based on the weight of SBT catch measured by observers (Table 1). Based on the data of observers and the information of industry, most SBT discards were small sizes when the quotas did not achieve. Before the quotas achieved, the mean weight is assumed to be 10 kg for roughly estimated according to the observer data.

(6) Estimate mean, median and confidence intervals of SBT discard by vessels, fishing sets and 5x5 longitude-latitude grids.

3. RESULTS AND DISCUSSIONS

3.1. Discard information based on observer data

The proportions of discard sets in the Indian Ocean are obviously higher than those in the Atlantic and Pacific Oceans (Table 2). The summary for the discard rate when SBT discard occurred were shown in Table 3. The highest discard rates occurred in the central Indian Ocean. However, discard rate in the Atlantic Ocean is obviously higher than those in the western Indian Ocean and Pacific Ocean. In the Pacific Oceans, the proportion of discard sets and discard rate are obviously lower than those in other areas.

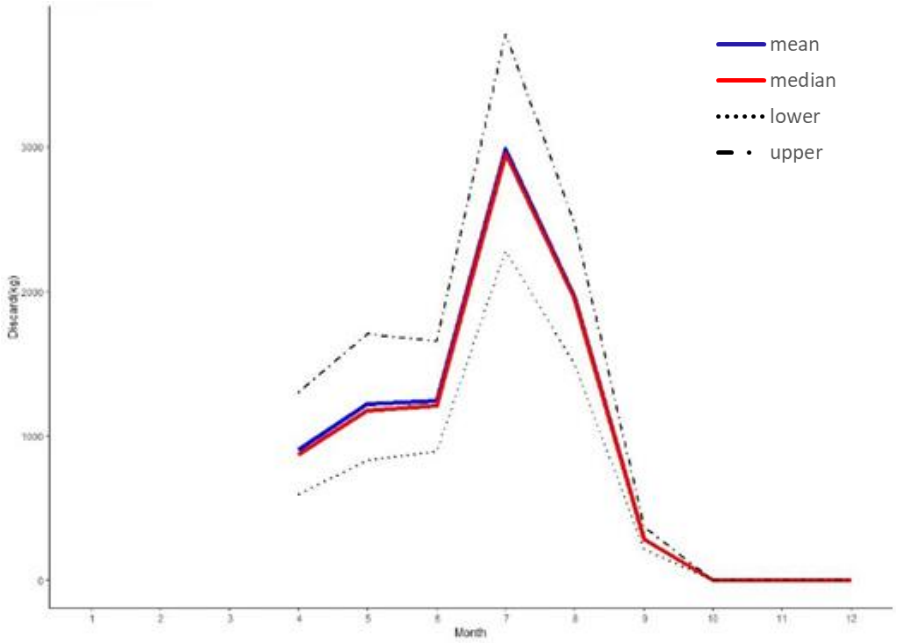
3.2. Estimate of SBT discard

The estimations of SBT in number and weight discards in four areas in 2018 and 2019 were listed in Tables 4 and 5. The highest estimations of SBT discards in number and weight were both revealed in the central Indian Ocean in both 2018 and 2019. According to the estimated discards, the average SBT discards of three areas were calculated as 8,605 kg in 2018 and 8,594 kg in 2019.

The monthly SBT discards estimated for 2018 and 2019 were shown in Fig. 1. The trends of discards were similar pattern in both 2018 and 2019. The discards mainly occurred from June to August in 2018 and 2019. And the highest values were shown in July of these two years, and there was slightly lower estimates discard in August in 2019 than in 2018.

The distributions of estimated SBT discards for 2018 and 2019 are shown in Figs. 2. In these two years, obviously higher discards of 2018 occurred in the Atlantic Ocean. The distributions of discards estimated were concentrated in the central Indian Ocean in 2018 and 2019.

2018



2019

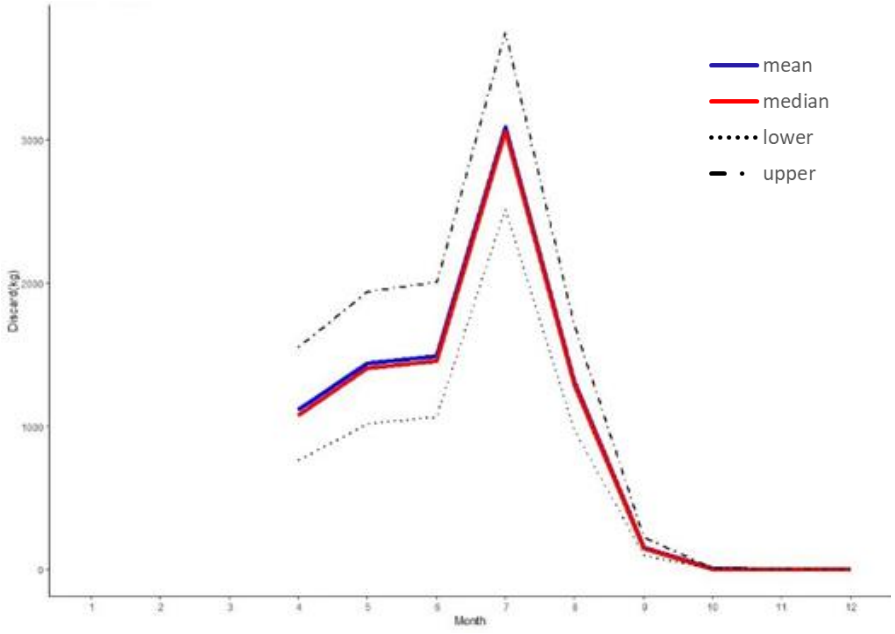
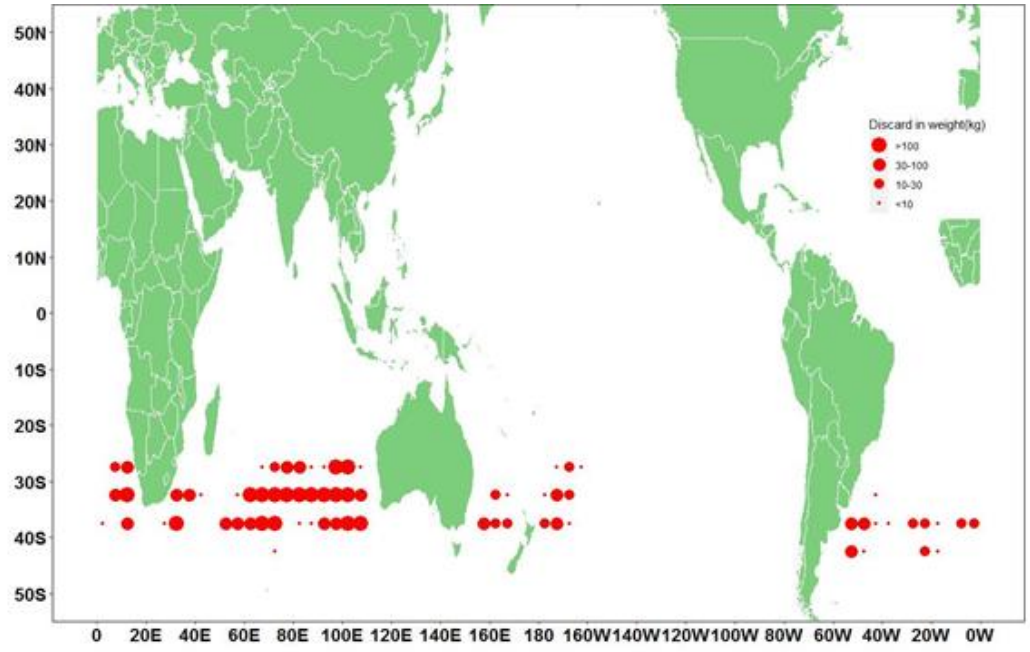


Fig. 1. The trends of monthly SBT discards estimated in 2018 and 2019.

2018



2019

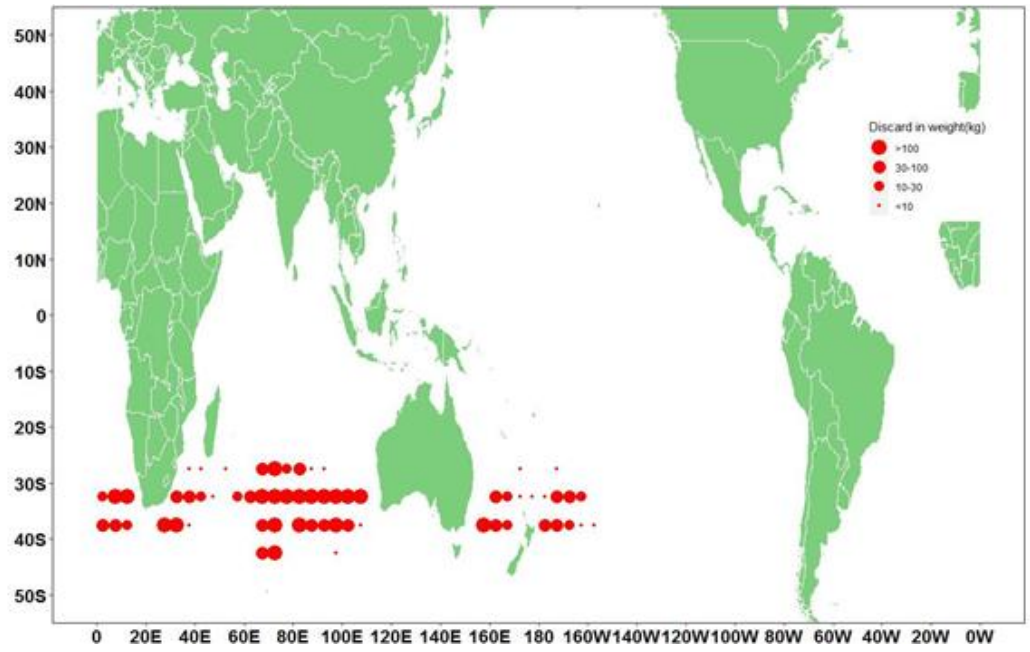


Fig. 2. The distributions of SBT discards estimated for 2018 and 2019.

Table 1. The quarterly and area-specific mean weights calculated based on the data of logbook in 2018 and 2019.

Area	Quarter	Mean weight (kg)
Atlantic	1	54.70
Atlantic	2	51.32
Atlantic	3	46.87
Pacific	1	30.17
Pacific	2	52.73
Pacific	3	53.45
W. Indian	1	29.80
W. Indian	2	53.88
W. Indian	3	37.95
W. Indian	4	47.07
C. Indian	1	38.11
C. Indian	2	36.87
C. Indian	3	30.52

Table 2. The summary for estimated proportion of fishing sets with SBT discard.

Area	Mean	Median	Lower (2.5%)	Upper (97.5%)
Atlantic	0.0055	0.0018	0.0000	0.0237
Pacific	0.0041	0.0000	0.0000	0.0246
W. Indian	0.0150	0.0100	0.0000	0.0378
C. Indian	0.0179	0.0061	0.0000	0.0496

Table 3. The summary for estimated SBT discard rate when SBT discard occurred.

Area	Mean	Median	Lower (2.5%)	Upper (97.5%)
Atlantic	0.0307	0.0000	0.0000	0.2381
Pacific	0.0027	0.0000	0.0000	0.0333
W. Indian	0.0159	0.0138	0.0000	0.0457
C. Indian	0.0307	0.0050	0.0000	0.1062

Table 4. The estimated number of SBT discards for 2018 and 2019.

Area by year	Mean	Median	Lower (2.5%)	Upper (97.5%)
2018				
Atlantic	81	73	44	135
Pacific	32	31	27	37
W. Indian	27	24	13	48
C. Indian	721	716	548	908
Total	861	844	632	1,128
2019				
Atlantic	47	42	24	78
Pacific	56	54	45	69
W. Indian	45	42	22	79
C. Indian	712	706	552	892
Total	860	844	643	1,118

Table 5. The estimated SBT discards in weight for 2018 and 2019.

Area by year	Mean	Median	Lower (2.5%)	Upper (97.5%)
2018				
Atlantic	812	731	436	1,349
Pacific	316	310	269	370
W. Indian	267	244	128	479
C. Indian	7,210	7,158	5,481	9,083
Total	8,605	8,443	6,314	11,281
2019				
Atlantic	466	423	243	784
Pacific	559	542	446	694
W. Indian	450	420	218	786
C. Indian	7,119	7,063	5,517	8.916
Total	8,594	8,448	-6,424	11,180