The Using of Harvest Control Rule, ABC calculation Rule 2, the case study of Swordfish (*Xiphias gladius* Linnaeus, 1758) Catch Data

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Abstract

The Catch data of swordfish from Indian Ocean was provided during the scientific working group on neritic tuna stock assessment in Southeast Asian, SEAFDEC/MFRDMD, Malaysia in 2016, in order to be used as the practice for participants. The result was first analyzed by ASPIC program to calculate the MSY level of swordfish, which given the MSY level was 32,100 MT. The using of Allowable Biological Catch (ABC) Rule 2 concept was given the range of catch quota based on the recently data (3 years data). The result from rule 2 – 1 (the CPUE based analysis) was giving the catch quota range as 23,126.7 MT and 18,501.4 MT as the higher and lower range respectively and current CPUE was about 0.4773 kg/1000 hooks which ABC range of CPUE was between 0.4942 and 0.3952 MT, respectively while the result from rule 2 – 2 (the catch based analysis) was giving the catch quota range as 31,132.3 MT and 24,905.9 MT as the higher and lower range respectively.

Keywords: Swordfish, Harvest Control Rule, ABC Rule 2, Catch Data

I. Introduction

Catch data of Swordfish (*Xiphias gladius*) from longline fishing of Indian Ocean. Provided by Dr. Tsutomu Nishida, National Research Institute of Far Sea Fisheries, Japan. During the scientific working group on neritic tuna stock assessment in Southeast Asian, SEAFDEC/MFRDMD, Malaysia in 2016. This data set was analyzed by ASPIC software and summarized the result by Kobe Plot. Both two programs were using the Maximum Sustainable Yield (MSY) as a reference point which was approved that the results were reliable. However, to handle with the poor data condition of many SEAFDEC member countries. We needed to find the protocol that requiring not so many data as a not so long time series data (data less than 10 years was acceptable) to calculating the fishing quota quantity as a base data before we can be getting enough data and can be do the assessment using MSY as a reference point in many years later.

The rule 2 of Allowable Biological Catch (ABC) was about the data poor condition which can be separated into two types as

1. Rule 2-1) Only CPUE available and
2. Rule 2-2) Only catch available.

However, for both 2-1 and 2-2, their equations having the same based and character which driven by the important parameters as α, γ, δ and CPUE of Catch as these followings (using CPUE).

This study was aimed to simulate the situations that using the result from ABC rule 2 – 1 and 2 – 2 by together with the MSY based method as ASPIC and Kobe plot for a reference point. The result will be help the fishery researchers, DoF staff and other related persons to understand the concept of ABC. Including the possibility to adapt this method for Thai fishery management.

II. Methodology

The former calculation and analysis using ASPIC (Prager, 2004) and ASPIC grid software together with the summary graph from Kobe plot (Nishida *et al*., 2015).

The ABC calculation using the stock abundance index as the reference point. The concept of harvest control rule was raised in 1980 by Tanaka (Tanaka, 1980), the ABC rule 2 have been tested by Hiramatsu (2004) before modified and proposed by Oshimo and Naya (2014) and Ichinokawa *et al.* (2015), respectively, as these followings

Rule 2-1: For CPUE available data

$$ABC_{limit} = \delta \times C_t \times \gamma_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{1)}$$

When δ = The limit of ABC $\begin{cases} high = 1 \\ medium = 1 \\ low = 0.8 \end{cases}$

C_t = Catch at last year

γ_1 = The constant parameters from equation 1.1

$$\gamma_1 = 1 + \mathrm{k}\left(\frac{b_1}{I_1}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{1.1)}$$

When k = Index of sensitivity, Constant, always = 1

b_1 = Slope of CPUE data in last 3 years

I_1 = Average data of CPUE in last 3 years

Rule 2-2: For Catch available data

$$ABC_{limit} = \delta \times C_t \times \gamma_1 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{2)}$$

When δ = The limit of ABC $\begin{cases} high = 1 \\ medium = 1 \\ low = 0.8 \end{cases}$

C_t = Catch at last year

γ_2 = The constant parameters from equation 2.1

$$\gamma_2 = 1 + \mathrm{k}\left(\frac{b_2}{I_2}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{2.1)}$$

When k = Index of sensitivity, Constant, always = 1

b_2 = Slope of Catch data in last 3 years

I_2 = Average data of Catch in last 3 years

III. Results

The result from ASPIC Kobe plot

First of all, the input data were comprised with year, catch, CPUE and effort. Using the ASPIC and ASPIC grid program calculation. We can get the biological parameters of swordfish as shown including MSY, Carrying Capacity of ecosystem (K), Biomass, Fishing Mortality, Catchability Coefficient (q) and intrinsic rate of increasing (r) as shown in table 1

Parameter	Value
MSY	32,100 t
K	158,000 t
Bmsy	58,300 t
B/Bmsy	1.35
Fmsy	0.55
F/Fmsy	0.55
q	5.0E-6
r	0.55

Table 1: Biological parameters of swordfish

The result from Kobe plot have shown that the status of *X. gladius* still in the safe zone in 2008. However, the trend of catch in form of total biomass/ total biomass at MSY stage and Fishing mortality/ Fishing mortality at MSY stage showing the risky trend in 2004. Even though the catch now moving downward from the overfishing zone (orange zone) but there still close to the border zone. So, this case still needed to be observed carefully. Result shown as this following figure

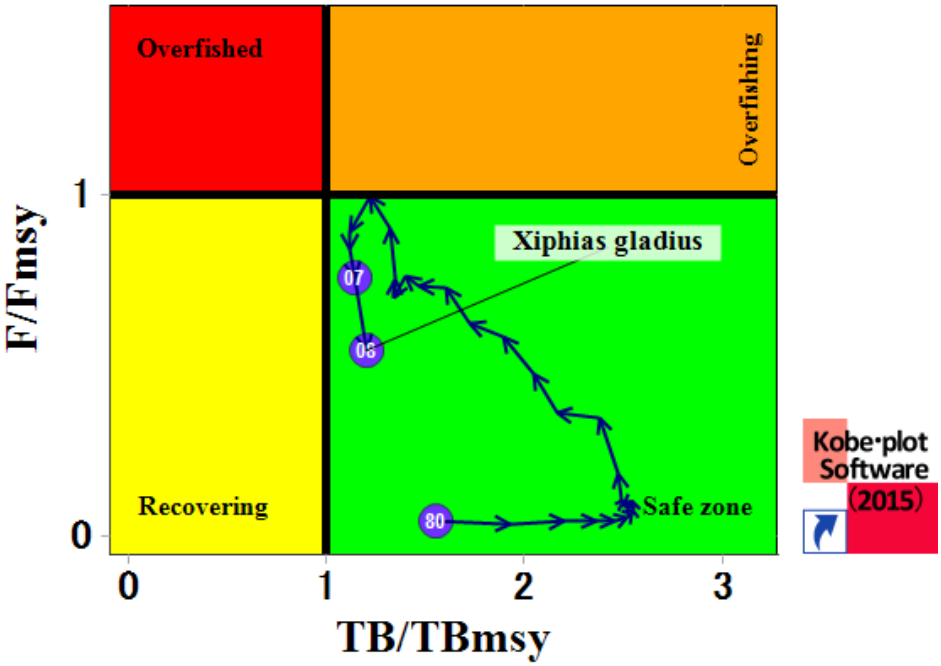

Figure 1: Kobe plot result of Swordfish (*Xiphias gladius*) assessment

For the calculation of ASPIC, the summary graph of catch and MSY level as this following when the blue line is the annual catch (MT) and the orange line is the MSY level which was about 32,100 MT. Comparing with the figure 1, in year 2004 is the peak of this following graph, the catch trends show the over MSY level (37,320 MT) and trend was declining till year 2005. Which the catch in 2005 was nearly to MSY level (32,068 MT) and getting declined. The latest catch in year 2008 was the lowest catch the decade 2010s which catch was about 22,335 MT, nearly to the catch during 1993 – 1994.

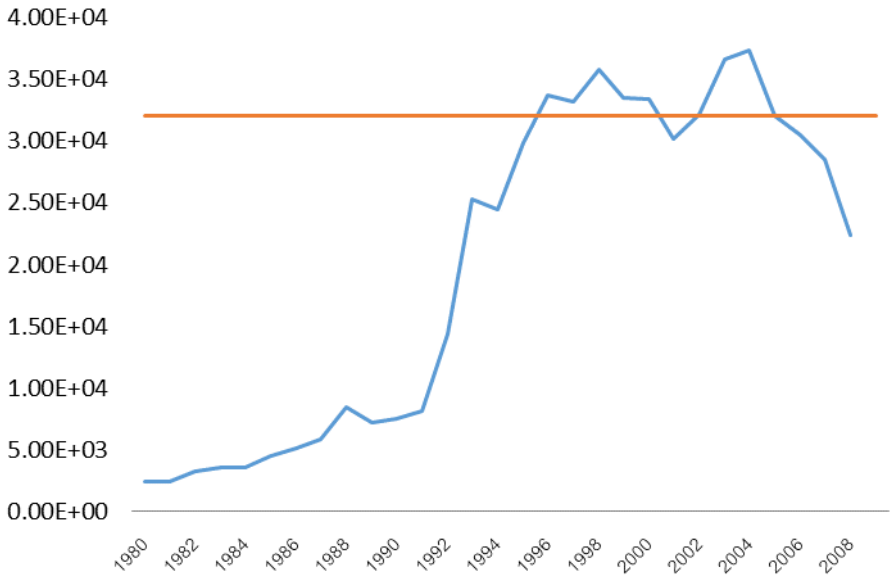

Figure 2: Graph result from ASPIC showing annual catch and MSY level

The result from ABC rule 2 calculation

Meanwhile, the result from ABC calculation, using the same data input as ASPIC and Kobe plot, also showing the interesting result from the same data set. A graph showing the blue line is the annual catch (MT), the orange line is the upper limit (MT) and the grey line is the lower limit (MT). The result was reported in range for easier to managing the catch quota, the result as these followings

- The Rule 2-1

Rule 2-1 is the calculation based on CPUE and latest year catch data which the result will be provided depends on presented fishing situation as shown in figure 3 and 4

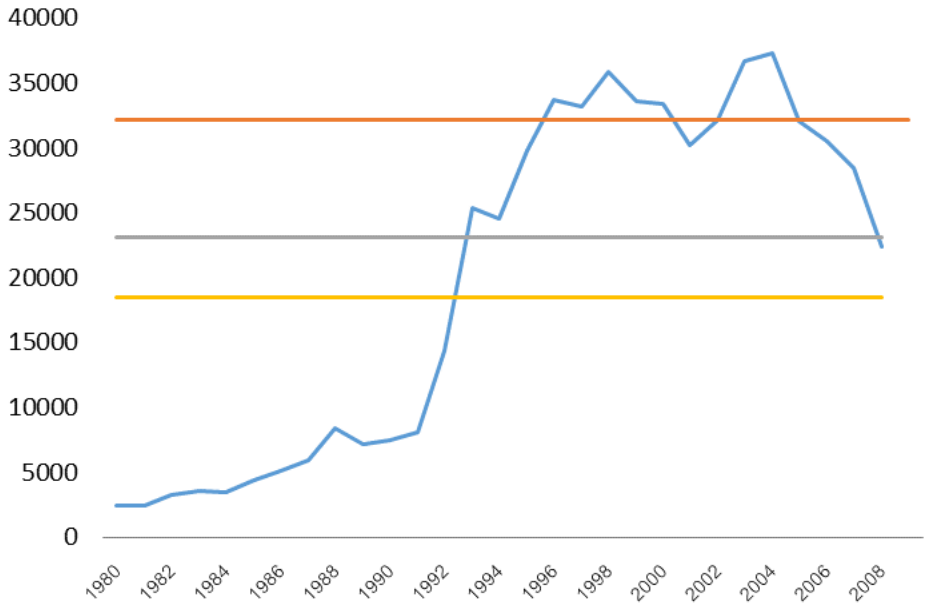

Figure 3: ABC limitation based on CPUE; catch limited, orange line is MSY level, grey line is upper limit of ABC and yellow line is lower limit, respectively.

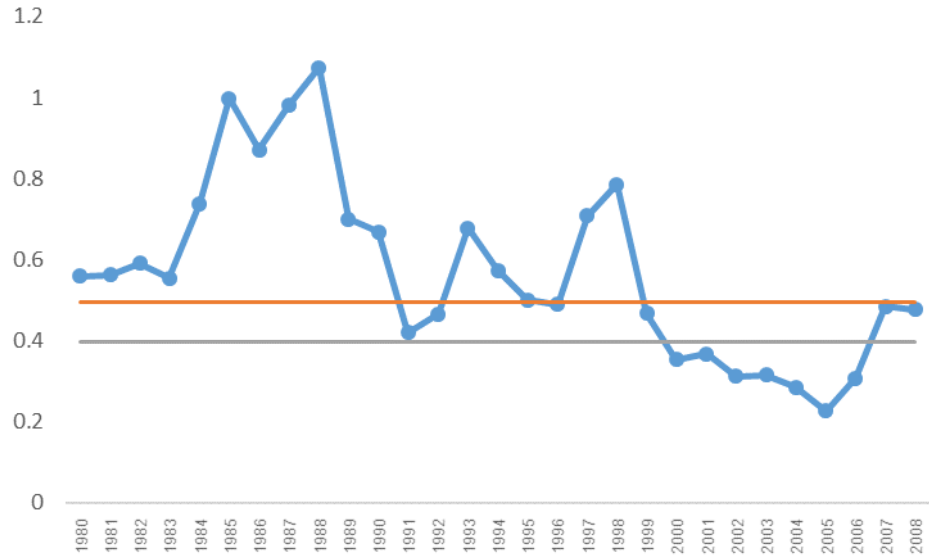

Figure 4: ABC limitation based on CPUE, CPUE limited, orange line is upper limit of and grey line is lower limit, respectively.

The result show that the upper limit of catch was about 23,126.7 MT (orange line) and lower limit (grey line) was about 18,501.4 MT. The goal of 2009 assessment is to control the catch to be not lower than 18,000 MT and not over than 23,130 MT and current CPUE was about 0.4773 kg/1000 hooks which ABC range of CPUE was between 0.4942 and 0.3952, respectively.

- <u>The Rule 2-2</u>

Rule 2-2 is the calculation based on catch in case that CPUE data not available. From the result there are some different characteristic compared with rule 2-1, the result is provided as this figure 5

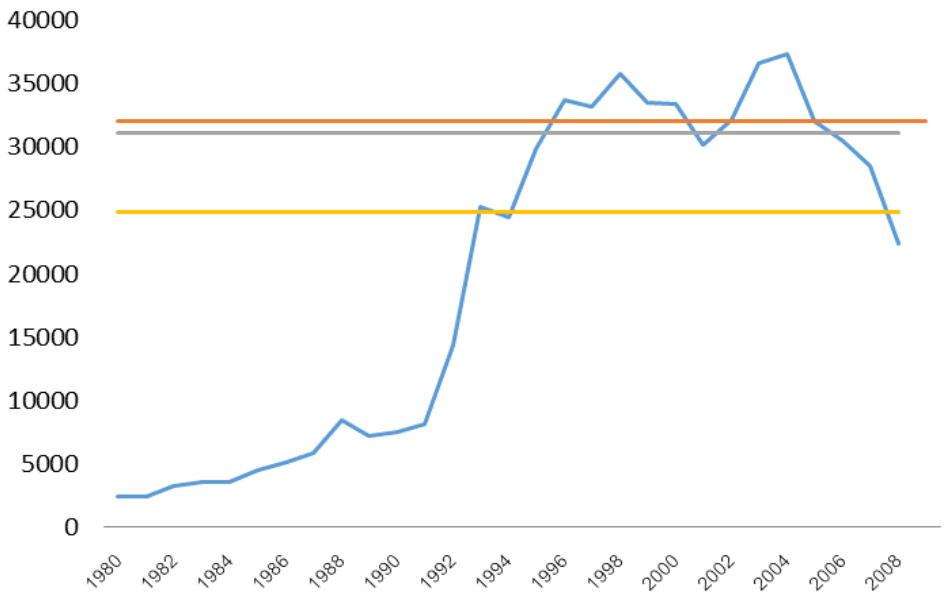

Figure 5: ABC limitation based on catch, orange line is MSY level, grey line is upper limit of ABC and yellow line is lower limit, respectively.

The upper limit of catch (orange line) was about 31,132.3 MT and the lower limit (grey line) was about 24,905.9 MT. So, the goal of year 2009 according to catch based analysis is to control the output (catch) not less than 24,910 MT and not over than 31,130 MT. The summary as shown in table 2.

Reference point	**ASPIC**	**Allowable Biological Catch**	
		Rule 2-1	**Rule 2-2**
Upper limit	32,100 MT	23,126.7 MT	31,132.3 MT
Lower limit	-	18,501.4 MT	24,905.9 MT

Table 2: Summary; the comparison of reference points between each method

ASPIC result show that the ecosystem has enough capacity for 158,000 MT of swordfish. However, the biomass of swordfish now was just about 78,705 MT, which was about 49.8% of full capacity. Considering to the report from Wang and Nishida (2014) the status of swordfish in Indian Ocean, from nine scenarios, now lower than MSY level as well as the spawning biomass also higher than MSY level. But the fishing intensity for current situations may higher than MSY level when lower productivity was assumed for swordfish. This result was in the same way as IUCN red list report (Collete *et al*., 2016) that the current status of swordfish still needed to be carefully managed, even though the status of swordfish fishery in Indian Ocean still not over MSY level yet.

IV. Discussion

From the result of all 3 methods, ASPIC which the input data set was the over 10 years catch and CPUE data. The MSY level from ASPIC having the high amount of catch. Based on the assumption, the highest peak of catch and its ±20% will be used as reference point for long term assessment. Mean while, the both result of ABC rule 2 were based on current catch and its previous 3 years data of both CPUE and Catch based analysis. Which make the result quite specific to the current timeline, means that the ABC range can be changed regarding to the current fishing situations (catch and CPUE). The important point for ABC calculation

were the weight coefficient or index of sensitivity, k. The study of Ohshimo and Naya (2014) indicated that each fish stock in each region will having their own optimum value of k, which the optimum value of k for Japanese stock was 1 and the higher number of k will be led to higher probability of management failure.

From the graphs, even though the ABC based on catch seems to be close to MSY level more than ABC based on CPUE. But, the most important characteristic of ABC is the short-term calculation. Therefore, it can be effected and corresponded to the short time data trends. For this the different trend between CPUE and catch, which those will affecting to the equation in the form of γ from equation 1.1 and 2.1. We can conclude that the limitation of rule 2-1 can be changed in year by year depending on the current 3 years data which will showing the more narrower range than rule 2 – 2. However, regarding to the study of Hiramatsu (2004) show that the rule 2 – 2 have too much uncertainties, the ABC rule 2 – 1 was the better choice.

The further work for the ABC calculation in SEA region is to analyzing and searching for the optimum k and δ value which fit to the regional fish stock, which will be led to the more efficiency TAC management in the future.

V. References

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