Preliminary development of economic capacity and reference points for Western and Central swordfish fisheries *(Xiphias gladius)* in North Pacific

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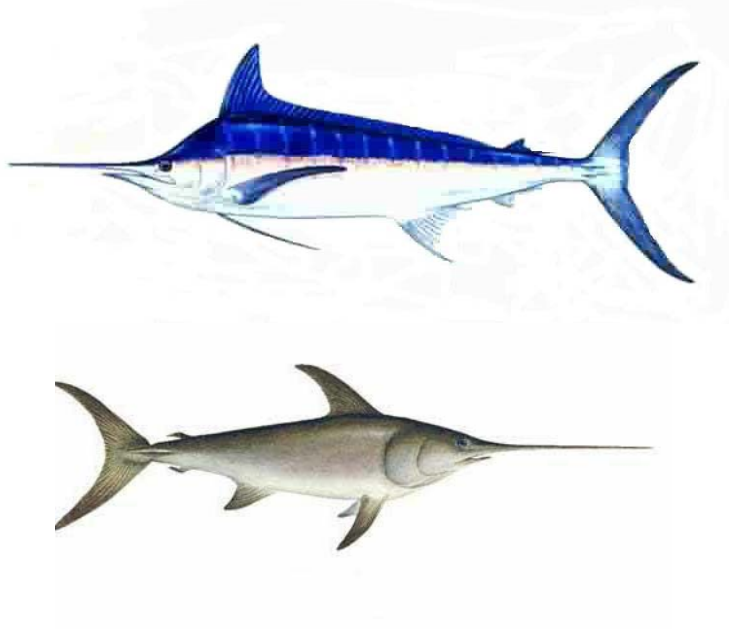

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Abstract

Economic capacity and reference points of the Western and Central swordfish stock in the North Pacific are estimated by extrapolating the optimal economic yield of a swordfish fishery by a Japanese off-shore fishing vessel which accounts for 19yes
% of landings of the North pacific. The Bayesian production model conducted in 2010, Maximum Sustainable Yield (*MSY*) and the profitability analysis on a Japanese off-shore longline fishing vessel suggest that a point estimate of the Maximum Economic Yield (*MEY*) as 3,130 *MT* per year and biomass at MEY as 31,040 *MT* and 100,640 *MT*. While the specific results from this analysis reflect the limitations of available data and characteristics of a swordfish fishery by a Japanese off-shore longline fishing vessel, additional data from other swordfish fisheries in Japan, US and Taiwan could contribute to a more complete picture of economic capacity and reference points of Western and Central swordfish fisheries in North Pacific.

Introduction

The work presented here is of the estimation of economic capacity and reference points of the Western and Central swordfish stock in the North Pacific by extrapolating the optimal economic yield of a swordfish fishery by a Japanese off-shore longline fishing vessel.

In recent years, biomass at the Maximum Economic Yield (*MEY*) has been recognized as a significant and implementable reference point in fishery management (Grafton et al., 2010). Fisheries are considered an economic activity by which fishers can catch fisheries resources (Ishimura and Bailey 2010). This fact, therefore, highlights the need for establishing reference points for the economic performance of fisheries. The majority of fisheries management, however, solely relies on monitoring catch levels and stock status (*i.e.,*conservation) based on biological reference points, such as Maximum Sustainable Yield (*MSY*), rather than economic performance indicators.

Gordon (1954) indicates that the biomass level of *MEY* is higher than the one for *MSY*. Until now, it has been well-accepted for most cases. Once rational individuals, and society, realize profit potential in fishery operations, their rational choice would be to manage the fishery to maintain the biomass level which incurs the maximum economic profits rather than one with *MSY* (Christensen 2010).

From a Bayesian production model, Brodziak and Ishimura (2010) estimate the maximum sustainable yield of the Western and Central swordfish fisheries in the North Pacific, but *MEY* has not been estimated. Ishimura et al., (2011) estimate the optimal economic efforts and economic capacity on swordfish fisheries by the Japanese off-shore longline fishing vessels, and conclude that1) optimal effort to maximize economic benefits are less than that to maximize yield, and 2) current average effort is not optimal to maximize the profit and, indeed, is close to the open access equilibrium, where profit equals zero.

The purpose of this study is to propose the approach how we are able to estimate economic capacity and reference points rather than estimate the precise *MEY* or economic reference points. Now this study estimates biomass level(s) at *MEY*(B_{MEY}) and examines the economic capacity of Western and Central swordfish in the North Pacific by elaborating from two studies; 1) Bayesian production stock assessment by

Brodziak and Ishimura (2010) and 2) optimal economic effort studies on swordfish fisheries operated by off-shore longline fishing vessels in Japan by Ishimura et al., (2011).

Method and Result

This study first adapts three biological parameters of a Bayesian production stock assessment for Western and Central swordfish fisheries estimated by Brodziak and Ishimura (2010), namely, intrinsic growth rate (*R=0.61*), carrying capacity (*K=127.6*) and production sharp parameter (*M=1.24*). A biomass at the *MSY* (B_{MSY}) is calculated as;

$$B_{MSY} = K \cdot (M+1)^{\frac{-1}{M}}$$

MSY is calculated as;

$$MSY = R\left(1-\frac{1}{M+1}\right) \cdot K(M+1)^{\frac{-1}{M}}$$

B_{MSY} and *MSY* are calculated as 66,580 *MT* and 22,490 *MT* respectively (Table 1). Note that the results here are point estimations and differ from the estimations from the posterior distribution of the Bayesian production estimation.

Ishimura at al., (2011) estimate the optimal economic efforts and economic capacity on swordfish fisheries by Japanese off-shore longline fishing vessels, and conclude that current average efforts are not optimal. They estimated a catch of 3,130 *MT* per year for off-shore longline fisheries to maximize profit, *MEY*. From the time series of landings of swordfish for entire North Pacific, we approximate the annual share of off-shore longline fisheries as 19% of the catch of Western and Central swordfish in the North Pacific. With this logic, the total *MSY* for Western and Central swordfish in the North Pacific is extrapolated as 15,560 *MT* as an economic capacity. Consequently, two biomass levels to provide the maximum sustainable economic yield, 31,040 *MT* and 100,640 *MT*, are calculated as the economic reference points for Western and Central swordfish in the North Pacific. Note that the estimated yield function by Ishimura at el., (2011) does not consider the effect of stock abundance on yield. Subsequently, two biomass levels which result in the same sustainable yield are found as B_{MEY}.

Concluding remarks

This paper highlights an approach to estimate economic capacity and reference points of Western and Central swordfish fish stock in the North Pacific. While the specific results from this analysis reflect the limited available data and characteristics of the swordfish fishery by Japanese off-shore longline fishing vessels, additional data from other swordfish fisheries in Japan, US and Taiwan would be able to contribute a complete picture of economic capacity and reference points of Western and Central swordfish fisheries in North Pacific.

Table 1. Maximum sustainable yield (MSY), biomass at MSY and MEY,

	MSY	MEY(1)	MEY(2)
Biomass (1000 MT)	66.58	31.04	100.64
Sustainable Annual Yield (Total: 1000 MT)	22.49	15.65	15.65
Sustainable Annual Yield(Per Japanese off-shore longline fishery vessel: MT)	3,949	3,130	3.130
Economicbenefits (Per trip for Japanese off-shore longline fishery vessel: 1000 USD)	24	64	64

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