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Stock assessment of longtail tuna (*Thunnus tonggol*) in the NW Indian Ocean by ASPIC using standardized CPUE from drift gillnet fisheries in Sultanate of Oman

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Abstract

We attempted the stock assessment for longtail tuna by ASPIC using the standardized CPUE from Omani drift gillnet fisheries (2001-2012) and the nominal catch (1950-2012). We assumed that there is the NW (Gulf and Oman Sea) stock including waters off Pakistan, Oman, Yemen, Iran and other neighboring countries in the NW region. Results of the ASPIC analysis suggested that the NW longtail tuna stock status is now about entering to the overfishing, i.e., high F_{ratio} (F_{2012}/F_{msy}) =1.38 (F_{2012} is 38% higher than F_{msy}) and total biomass (TB) at the MSY level (TB_{2012}/TB_{msy}) =1.01. The result suggested that if the current F continued, then TB will be in the red zone of the Kobe plot (overfishing status) after 2013.

Contents

1. Introduction

Neritic tuna stock assessments in the Indian Ocean has been difficult to conduct due to data/information poor situation on (a) stock structure, (b) nominal catch, (c) CPUE and (d) biological parameters. We reduce these difficulties to some extent by setting the hypothetical stock structures, using best available nominal catch in IOTC secretariat and newly available standardized CPUE (STD_CPUE) in Oman. Then we attempt the simple stock assessment using A Stock Production Model Incorporating Covariates (ASPIC) (ver. 5) (Prager, 2004).

2. Stock structure

We assume that there is the NW Indian Ocean (Gulf and Oman Sea) longtail tuna stock considering geographical features, possible gene flow and ecological viscosity of longtail tuna (IOTC, 2013)

3. Input data

Global catch data

Fig. 1 shows longtail tuna nominal catch in the whole period (1950-2012) in the NW Indian Ocean based on the IOTC database. Catch has been increasing since 1950 and there are very sharp increases in recent years (2008-2012), which is likely caused by the intensified piracy activities since 2008. We will discuss this issue in 5. Discussion section.

Standardized CPUE (STD_CPUE)

We use estimated longtail tuna STD_CPUE (2002-2012) of drift gillnet fisheries by fiber-glass boat in Oman (IOTC-2014-WPNT04-28). Fig. 2 shows the annual trend of STD_CPUE, which is compared with the catch (2000-2012). Catch shows increasing trend, while STD_CPUE decreasing trend. This implies that catch and CPUE relation is reasonable and realistic.

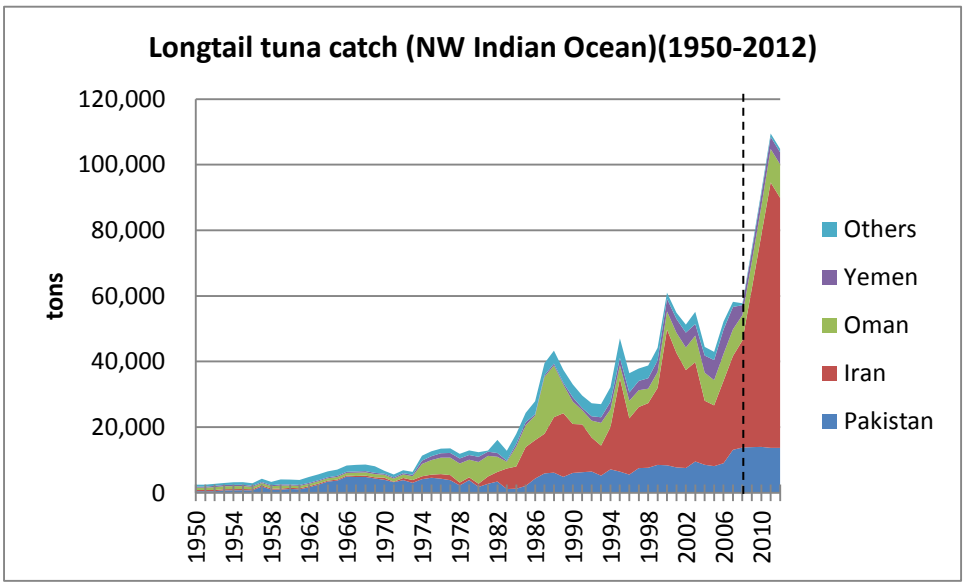
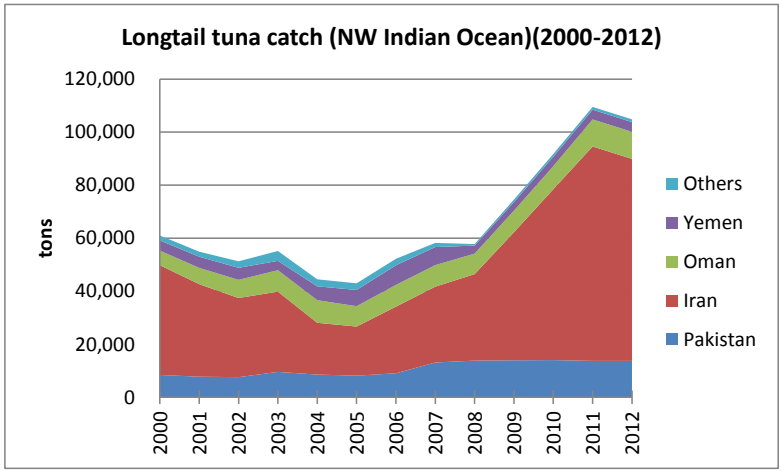


Fig. 1 Longtail catch in NW Indian Ocean (1950-2012)
(Dot line indicates year 2008 when piracy activities intensified)



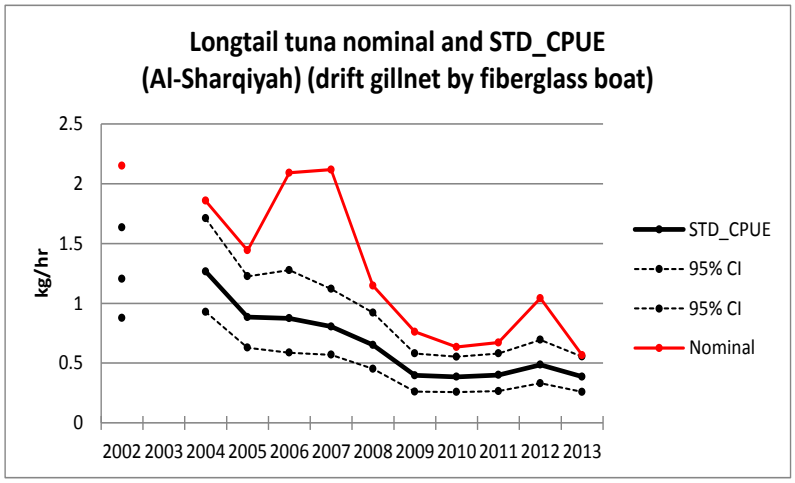


Fig. 2 *(Below)* STD_CPUE and its 95% confidence intervals with nominal longtail tuna CPUE from drift gillnet fisheries by fiberglass boat in Oman (IOTC-2014-WPNT04-28)
(Above) Recent catch trend in the NW Indian Ocean (2000-20012) to compare with STD_CPUE

4. ASPIC

Using the Omani standardized CPUE, we conducted stock assessment by ASPIC. In ASPIC we need to estimate 4 parameters (K: carrying capacity, B0/K where B0 is the total biomass in 1950, start of fisheries in our case, q: catchability and MSY). We assume that B0 =K and attempt to estimate 3 parameters (K, MSY and q). But we could not get any conversions for both Schaefer and Fox production model in the initial attempt.

Then we fixed K and attempted to explore various K values within plausible ranges, i.e., 100, 170, 180, 190 and 200 thousand tons. With the constraint (MSY < Bmsy), we found that K=180,000 tons with Schaefer model produced the best fit to the ASPIC model based on R2 and MSE (Mean Square Errors) (Table 1). Thus we selected this scenario as the representative of the ASPIC result.

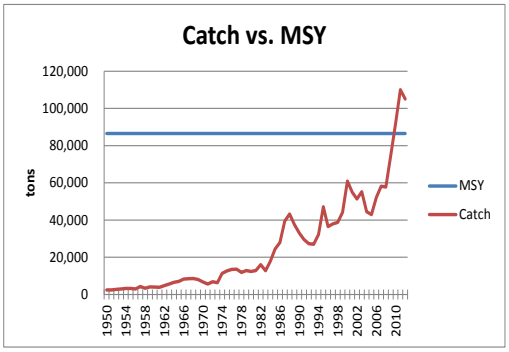
Table 1 ASPIC results based on various scenarios of K values.

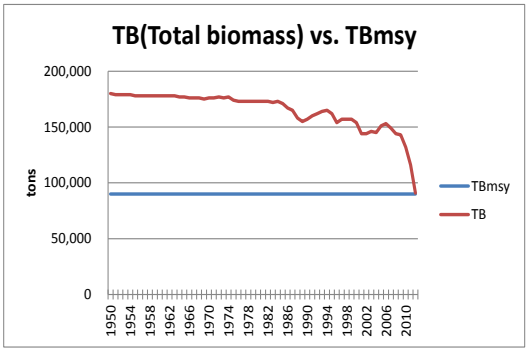
model	Schaefer					FOX
K (1000 tons)	R2	MSE	TB ratio	Fratio	MSY	NC
100	NC					NC
170	NC					NC
180 (best fit)	0.321	0.1483	0.789	1.379	86,490	NC
190	0.319	0.1488	0.780	1.409	85,160	NC
200	0.318	0.1493	0.770	1.440	83,770	NC

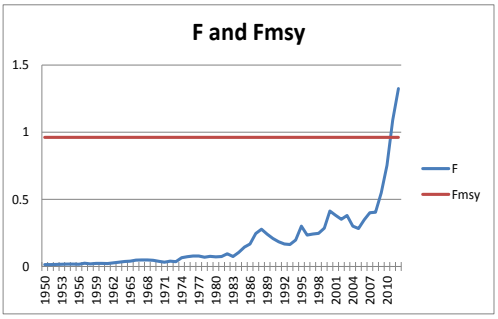
NC: Neither converged nor plausible parameters were estimated

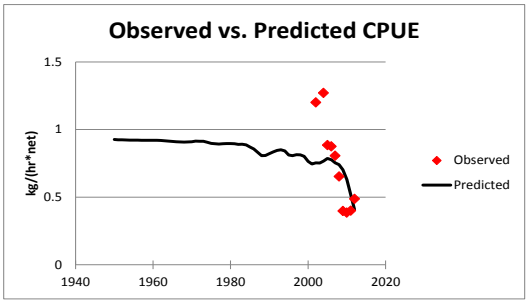
Box 1 shows results including graphs for catch vs. MSY, TB (total biomass) vs TBmsy, F vs. Fmsy, observed vs. predicted CPUE and Kobe plot.

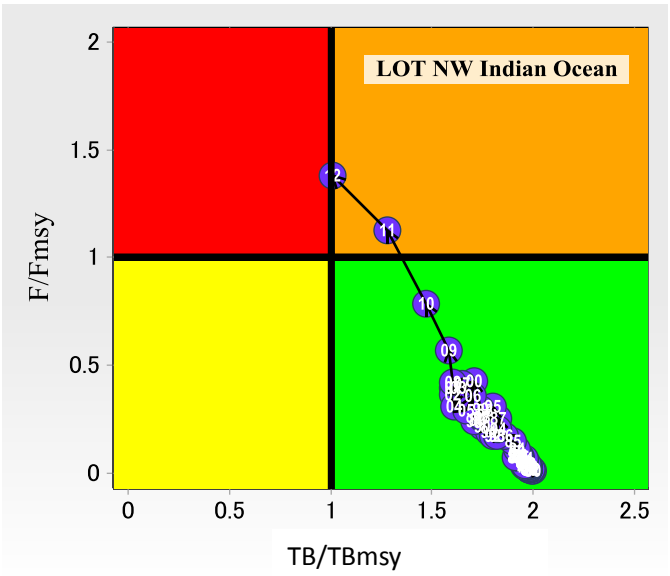
Box 1 Results of ASPIC (longtail tuna)











Based on this ASPIC results, the stock status of longtail tuna (2012) in the NW Indian Ocean is that F (fishing mortality rate) is beyond Fmsy (38% higher than the MSY level), i.e., high fishing pressure, while the total biomass is about in the MSY level. It is clear if current F level continues, longtail tuna will be entering the overfishing stage in 2013 afterwards. Table 2 is the summary of the stock assessment by ASPIC.

Table 2 Longtail tuna stock status summary in the NW Indian Ocean

Management Quantity	**ASPIC (Al-Kiyumi et al, 2014)**
Most recent catch estimate (t) (2012)	105,000
Mean catch over last 5 years (t) (2008-2012)	87,800
MSY	86,500
Current Data Period (catch)	1950-2012
CPUE	Omani drift gillnet fisheries (annual) (2001-2012)
F(2012)/F(MSY)	1.38
TB(2012)/TB(MSY)	1.01
TB(2012)/TB(1950)	0.51

5. Discussion

Piracy effects

To interpret the ASPIC results, the piracy effect is very important factor to understand the situation. Thus, firstly, we will discuss this issue then will discuss the ASPIC results incorporating the piracy effect.

The piracy activities started in the middle of 2000's off Somalia and became intensified in 2008 afterwards. Areas of their activities have been expanding to the entire north and central western Indian Ocean by 2013 (Fig. 3). Numbers of active tuna longliners and purse seiners have been decreasing after 2008. Some industrial tuna longline vessels moved to Pacific or Atlantic Ocean.

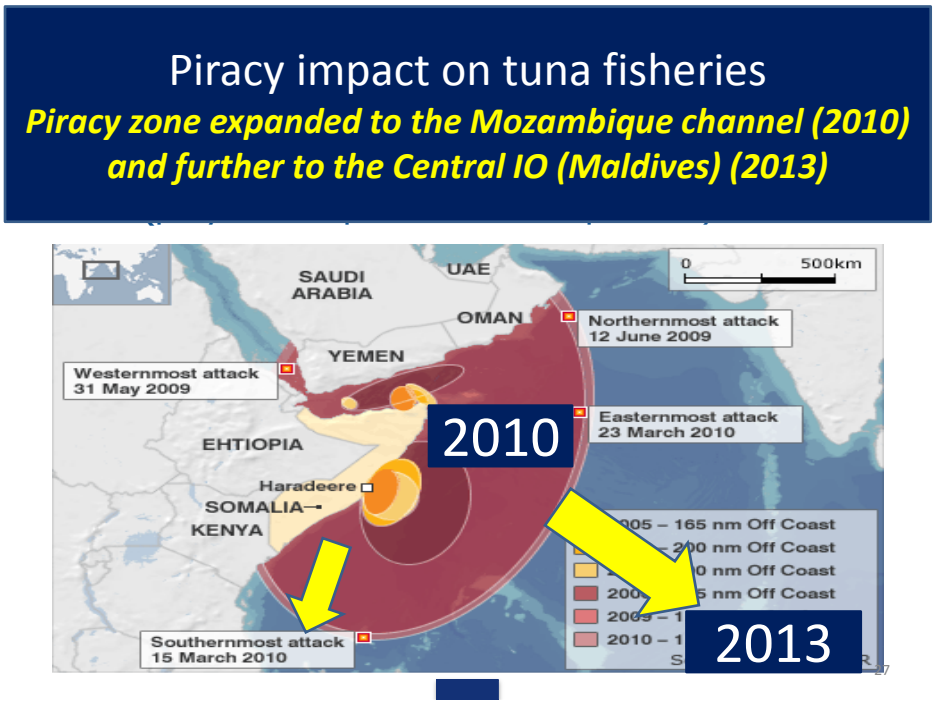


Fig. 3 Expansion of the piracy activities in the western Indian Ocean

Small scale fishing operating in the high seas, especially drift gillnet fisheries in the NW Indian Ocean, have been exploiting yellowfin tuna in the waters beyond their EEZs. But after 2008 when the piracy activities were intensified and some fishing vessels have attacked by pirates, they go back to their EEZs and they are now exploiting more neritic tuna. This situation resulted sharp increase in the neritic tuna catch (Figs. 1 and 2 above).

Stock status

Based on the Kobe plot (Box 1), we understand that the longtail tuna stock in the NW Indian Ocean region is now about entering to the overfishing status due to high fishing pressure after 2008 when piracy activities intensified.

As discussed previously, major drift gillnet fisheries in this region moved back to their EEZ waters and targeted more neritic tunas after 2008. That is the major reason why catch (F) has been sharply increased in recent years after 2008 (Box 1). This caused the sharp decrease in its biomass (population) size and the status of the stock has been worsening (Box 1). This situation is very similar to the one in albacore, i.e., more Asian industrial tuna longline fisheries started targeting albacore after 2008 in the piracy-free zone in the southern Indian Ocean, which worsen its stock status.

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