Training materials (10)

Training course on stock assessments of Longtail tuna and Kawakawa in the SE Asia

SEAFDEC/MFRDMD, Kuala Terengganu, Malaysia (April 17-25, 2016)

Preliminary kawakawa (*Euthynnus affinis*) stock assessment by ASPIC using standardized CPUE of drift gillnet fisheries in Sultanate of Oman

Fatma Rashid Al-Kiyumi [1/], Badriya Al-Siyabi[1/], Lubna Al-kharusi [1/] and Tom Nishida [2/]

1/ Marine Science and Fisheries Centre, Ministry of Agriculture & Fisheries, Sultanate of Oman

2/ National Research Institute of Far Seas Fisheries, Fisheries Research Agency, Japan

June, 2013

Abstract

We preliminary attempted the stock assessment of kawakawa by ASPIC using the standardized CPUE of Omani drift gillnet fisheries (2001-2011) and the nominal catch (1950-2011). With an assumption of one stock structure in the Indian Ocean, we could not get the convergence in the first ASPIC run. With the alternate assumption of 4 stocks structure hypothesis (NW, NE, SW and SE), we re-attempted ASPIC run for the NW (Gulf and Oman Sea) hypothetical stock. Then we could get the conversion. The preliminary result suggested that the Gulf and Oman Sea hypothetical stock is at the orange zone in the Kobe plot with high Fratio (F2011/Fmsy) =1.57 and the safe level of the total biomass (TB) ratio (TB2011/TBmsy) =0.74. We also discussed about the piracy effect on the stock status and stock structure hypothesis.

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 available (best) nominal catch in IOTC secretariat and newly available standardized CPUE (STD_CPUE). Then we attempt the simple stock assessment without biological information for kawakawa (*Euthynnus affinis*) by A Stock Production Model Incorporating Covariates (ASPIC) (ver. 5) (Prager, 2004). This is a preliminary work before the IOTC/WPNT03 (July 2-5, Bali, Indonesia) using newly available STD_CPUE of Omani drift gillnet fisheries (IOTC-WPNT03-31). During the meeting, we may attempt further to explore ASPIC runs by incorporating other possibly available STD_CPUEs.

2. Stock structure

IOTC WPNT02 (2012) suggests considering the stock structure of kawakawa as one stock. We conduct the ASPIC stock assessment by following this hypothesis.

3. Input data

Global catch data

We extract the nominal kawakawa catch (1950-2011) from the IOTC nominal catch data set. Fig. 1 shows the trends of the catch by fleet.

STD_CPUE

We used estimated kawakawa STD_CPUE of gillnet fisheries by launch boat (see IOTC-2013-WPNT03-31). Fig. 2 shows the annual trend of STD_CPUE.

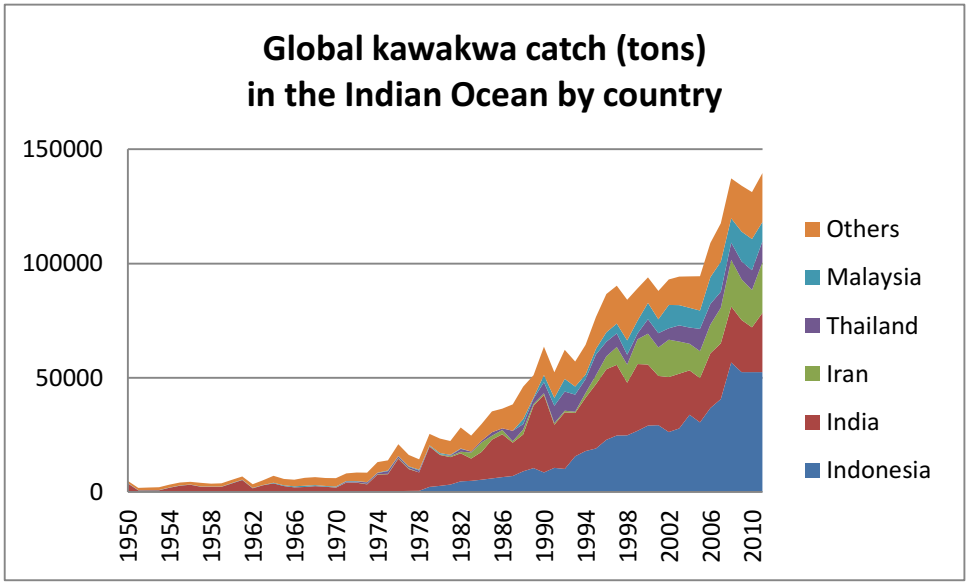


Fig. 1 Trends of global kawakawa catch (tons) by fleet in the whole Indian Ocean (1950-2011) (Source: IOTC).

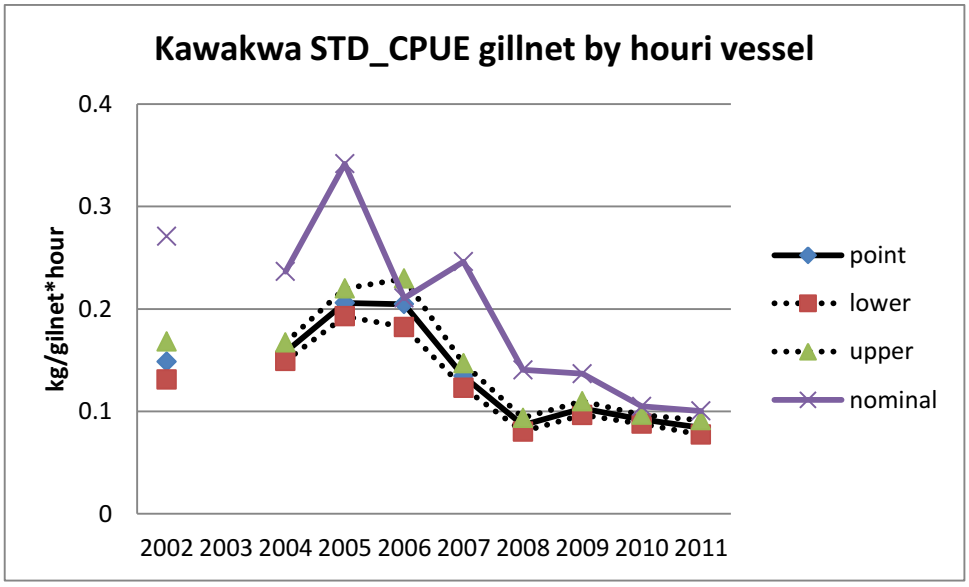


Fig. 2 STD_CPUE and its 95% confidence intervals with nominal CPUE of drift gillnet fisheries (houri type boat) in Oman (IOTC-2013-WPNT03-31)

4. ASPIC

4.1 Base (initial) run

As the base (initial) run, we attempted to run ASPIC using the global catch in the whole Indian Ocean and Omani STD_CPUE by assuming B0 (1950) =K. But ASPIC run could not get convergence.

4.2 Alternative (second) run

Alternative stock structure hypothesis

We consider that one stock structure hypothesis may not be realistic because of long geographical distances among countries, for example, between Oman and Indonesia, i.e., kawakawa probably cannot move from Oman to Indonesia as an extreme example (Box 1). However, kawakawa can migrate for shorter distances among countries, for example, between Indonesia and Australia. Thus, STD_CPUE may not able to reflect well to the global catch in the whole Indian Ocean, which might cause the convergence problem in the initial ASPIC run.

Then we set up the alternative hypothesis of the stock structure. The first IOTC-WPNT01 (2011) report considered some stock structure hypotheses for neritic tuna. For kawakawa, it indicated 4 stock structures (Box 1). Assuming the 4 stocks hypothesis, we re-attempted the ASPIC alternate run. As the STD_CPUE (Oman) belong to the NW region, we apply ASPIC for the Gulf and Oman Sea (hypothetical) stock. We again assume B0 (1950) =K.

Global catch in the Gulf and Oman Sea region

We again extracted the kawakawa nominal catch in the northwest region (1950-2012) from the IOTC catch data set, i.e., Oman, Iran, UAE, Pakistan, Somalia, Saudi Arabia and Yemen. Fig. 3 shows the trends of the nominal catch by fleet.

Results

For this time we could get the convergence and could get the reasonable results. Figs. 4-9 and Table 1 shows the results.

Box 1 Hypothesis of 4 kawakawa stocks structure in the Indian Ocean

IOTC-2011-WPN01-report (p.18)

Table 1. Neritic tunas (and tuna-like species) under the IOTC mandate with potential sub-regions/stock identified.

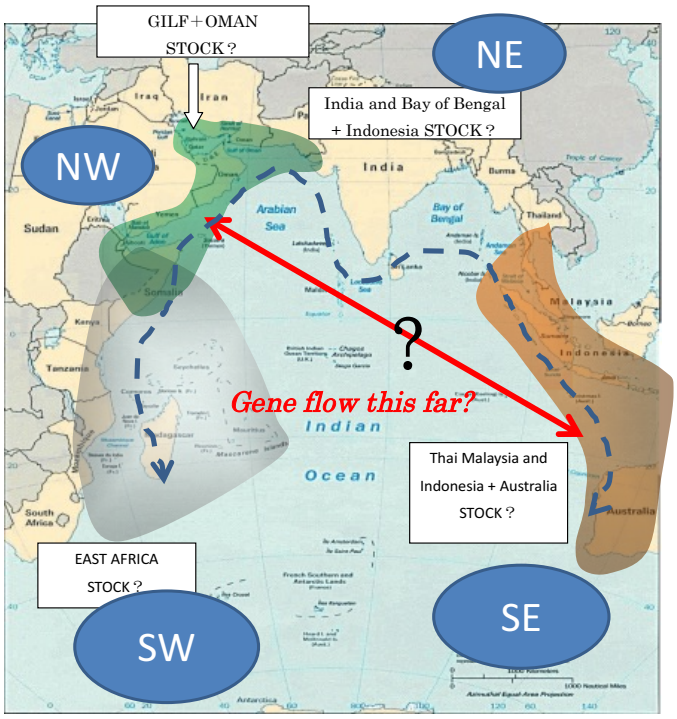
Species	Possible sub-regions and countries				
	East Africa (Kenya, Tanzania, Mozambique, Madagascar, Seychelles, Mauritius, La Réunion, Comoros, Somalia)	**Gulf, Oman Sea** (I.R. Iran, Oman, Pakistan, U.A.E., Yemen, Somalia, Qatar)	**West India** (India, Pakistan, Sri Lanka, Maldives)	**East India/Bay of Bengal** (India, Sri Lanka, Malaysia, Indonesia, Thailand, Myanmar, Bangladesh)	**Indonesia and Australia** (Australia, Indonesia, Thailand)
Longtail tuna (*Thunnus tonggol*)	▬	▬	▬	▬	▬
Narrow-barred Spanish mackerel (*Scomberomorus commerson*)	▬	▬	▬	▬	▬
Bullet tuna (*Auxis rochei*)	–	–	▬	▬	▬
Frigate tuna (*Auxis thazard*)	▬	▬	▬	▬	▬
Kawakawa (*Euthynnus affinis*)	▬	▬	▬	▬	▬
Indo-Pacific king mackerel (*Scomberomorus guttatus*)	▬	▬	▬	▬	▬

Black bars refer to potential management units for further examination/research, by species. Countries in red text are not yet Members of the IOTC, however collaborative research is encouraged.

Kawakawa

4 stocks hypothesis based on the Table 1 above.

Northwestern Stock **[Oman+Gulf]** Oman, Iran, Pakistan, UAE, Yemen, Somalia, Qatar



9

Schematic diagram of 4 stocks structure hypothesis

Red line with? Implies if kawakawa moves such a long distance to support the one stock hypothesis as the direct gene flows between these 2 regions unlikely occurs.

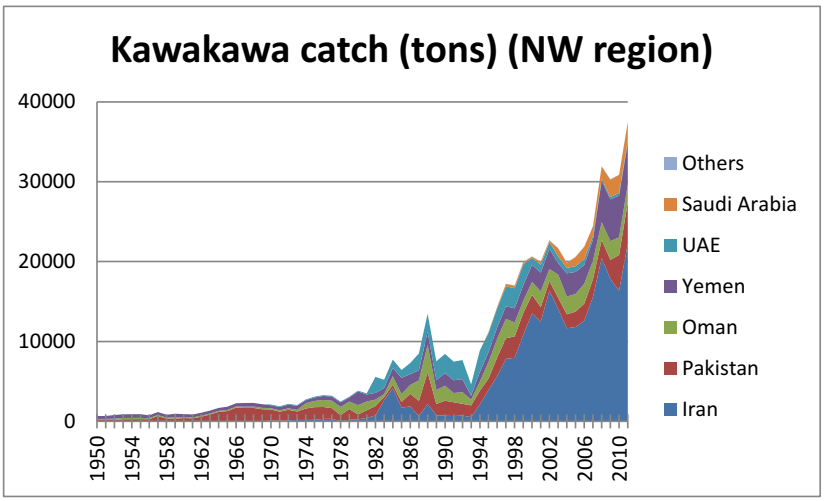


Fig. 3 Trends of kawakawa catch (tons) by fleet in the Gulf-Oman Sea (NW) region of the Indian Ocean (1950-2011) (Source: IOTC).

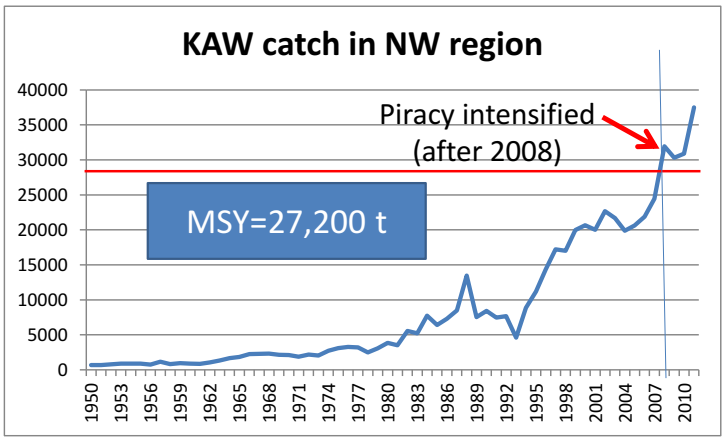


Fig. 4 Result of the alternative ASPIC run (1): Catch vs. MSY

(After the piracy intensified in 2008, catch increased. For details see the discussion)

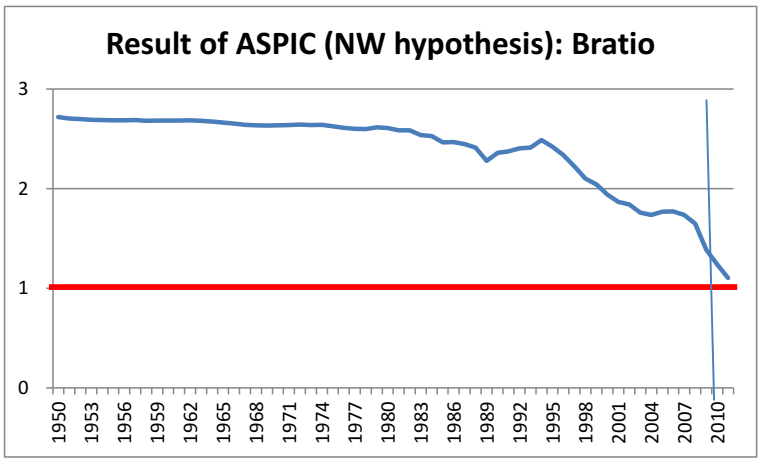


Fig. 5 Result of the alternative ASPIC run (2): TB (total biomass) ratio (TB/TBmsy)

(After the piracy intensified in 2008, TB (ratio) decreased. For details see Discussion).

Red line: MSY level (TB ratio=1)

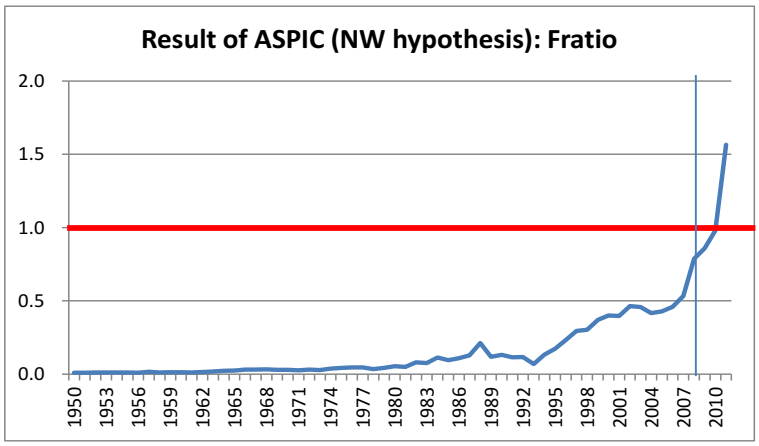


Fig. 6 Result of the alternative ASPIC run (3): Fratio (F/Fmsy)

(After the piracy intensified in 2008, F (ratio) increased sharply. For details see the discussion)

Red line: MSY level (TB ratio=1)

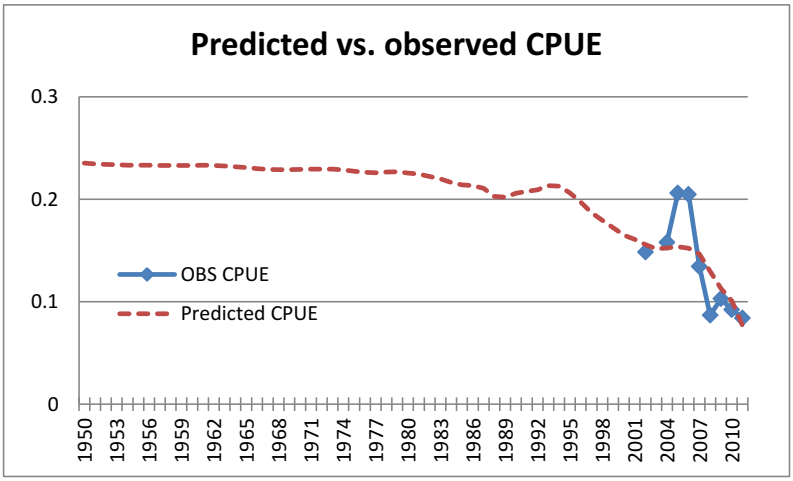


Fig. 7 Result of the alternative ASPIC run (4): Predicted vs. observed CPUE

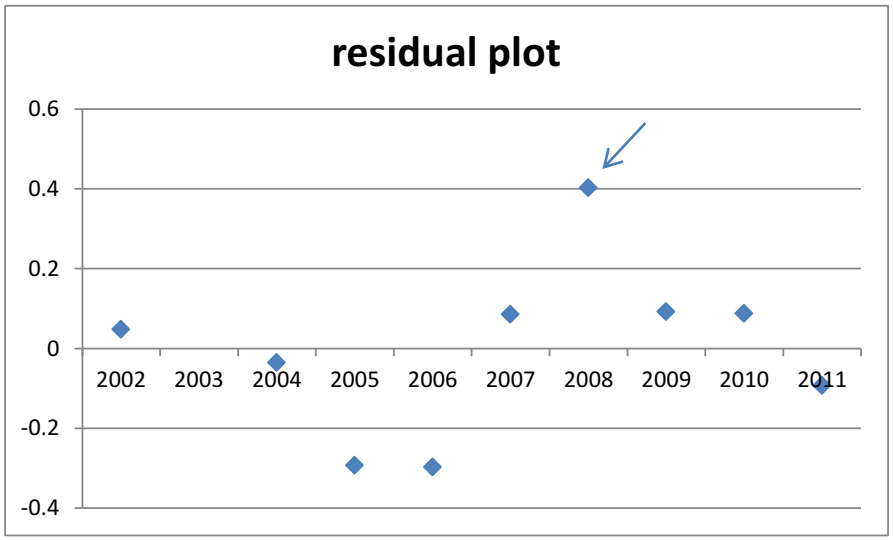


Fig. 8 Result of the alternative ASPIC run (5): Residual plot of CPUE

(Residual levels are small except the 2008 point,)

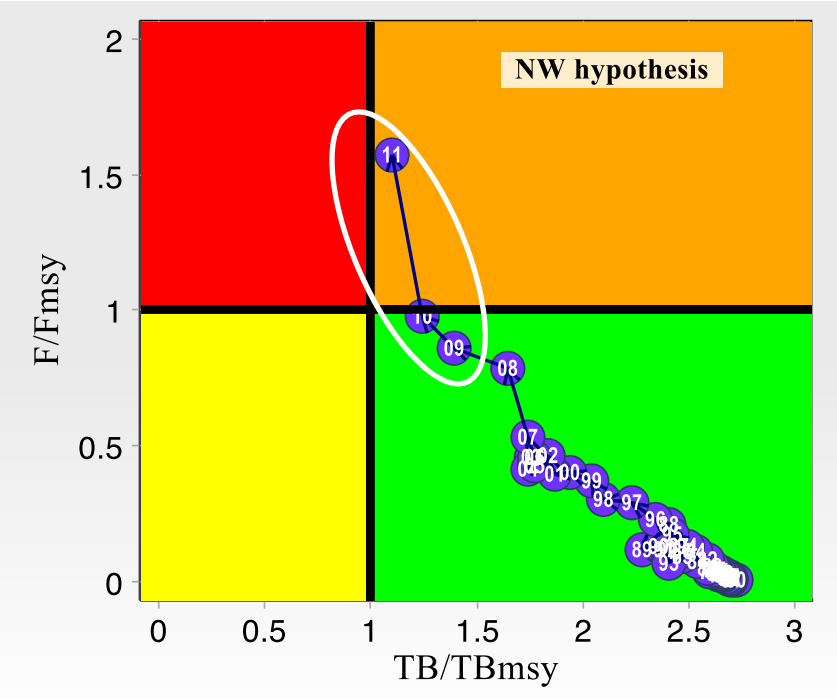


Fig. 9 Result of the alternative ASPIC run (6): Kobe plot (stock trajectory)

(After 2008, fishing pressure sharply increased due to intensified piracy activities. For details see Discussion)

Table 1 Indian Ocean kawakawa stock status preliminary summary for the NW (Gulf and Oman Sea) stock under the 4 stocks structure hypothesis.

Management Quantity	**ASPIC** **(Al-Kiyumi et al, 2013)**
Most recent catch estimate (t) (2011)	37,497
Mean catch over last 5 years (t) (2007-2011)	31,016
MSY	27,180
Current Data Period (catch)	1950-2011
CPUE	Omani drift gillnet fisheries (annual) (2001-2011)
F(2011)/F(MSY)	1.57
TB(2010)/TB(MSY)	0.74
TB(2010)/TB(1950)	0.27

5. Discussion

For this time, we did preliminary attempt of the kawakawa stock assessment by ASPIC using the Omani drift-gillnet STD_CPUE. As mentioned in Introduction, we may need to explore ASPIC runs further during the IOTC-2013-WPNT03 meeting using possibly additional available STD_CPUE.

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. 10). Numbers of active tuna longliners and purse seiners have been decreasing after 2008 (Figs. 11-12). Some vessels moved to Pacific or Atlantic Ocean.

Thus, fishing intensities for tropical tuna (yellowfin, bigeye tuna and skipjack) and also swordfish had greatly reduced after 2008. Consequently their catch sharply decreased (Fig. 13). However, a number of tuna longliners remained in the Indian Ocean moved to the southern ocean where there are albacore fishing grounds and they have been targeting albacore. Hence, only albacore catch has been increased (Fig. 13). This situation is well reflected in the Kobe plots for 5 commercially important species in IOTC, i.e., the stock status of yellowfin, bigeye, skipjack and swordfish have been recovering after 2008, while for albacore, it has been worsening after 2008 (Fig. 14).

As for the small scale fishing operating in the high seas, especially drift gillnet fisheries in the NW Indian Ocean, they 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 (for example, kawakawa in Fig 3). This situation is very similar to the one in albacore.

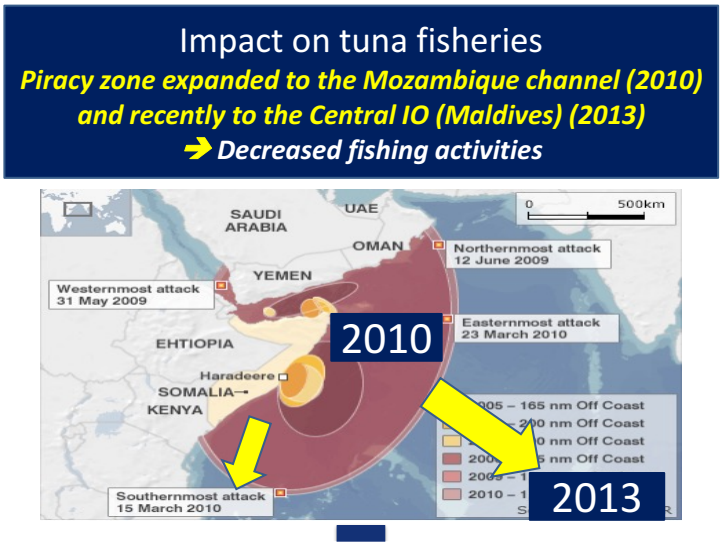


Fig. 10 Affected waters by piracy activities

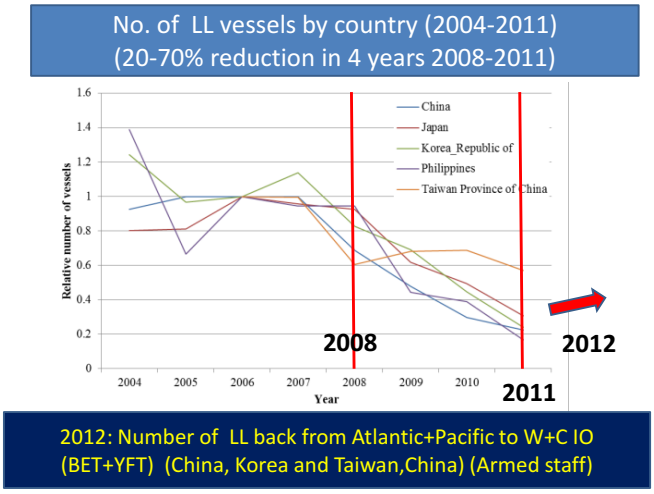


Fig. 11 Change of number of Asian industrial tuna longliners in the Indian Ocean

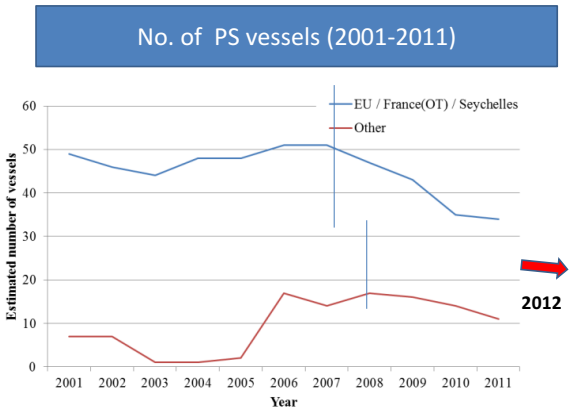


Fig. 12 Change of number of purse seiners in the Indian Ocean

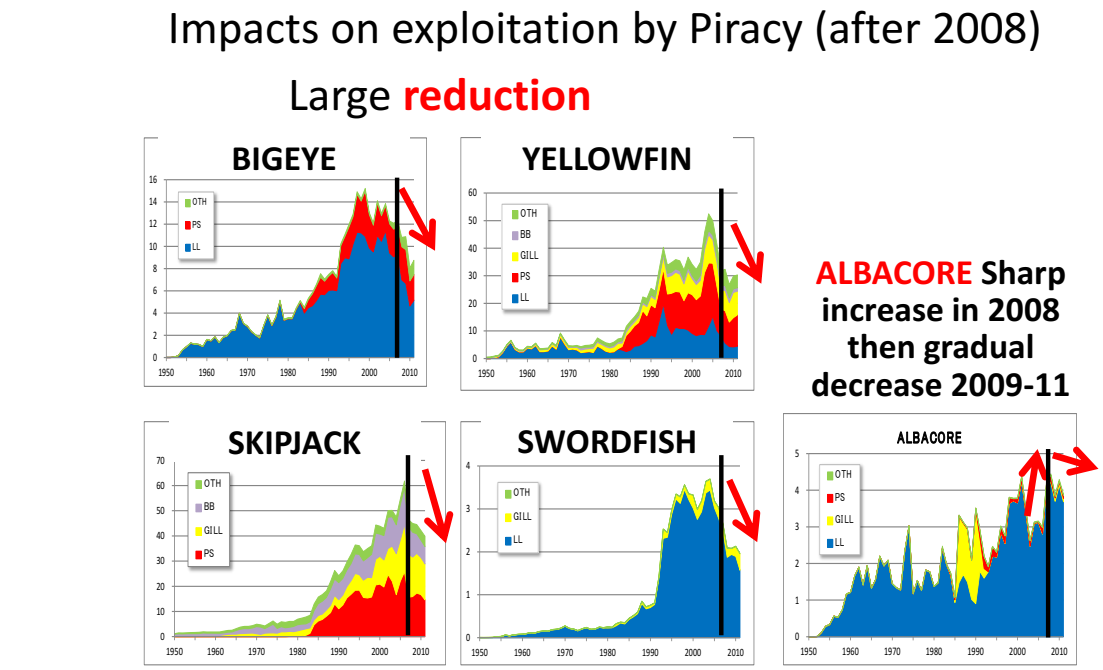


Fig. 13 Catch trends of 5 commercially important species in the IOTC. Catch[13] except albacore sharply decreased after 2008.

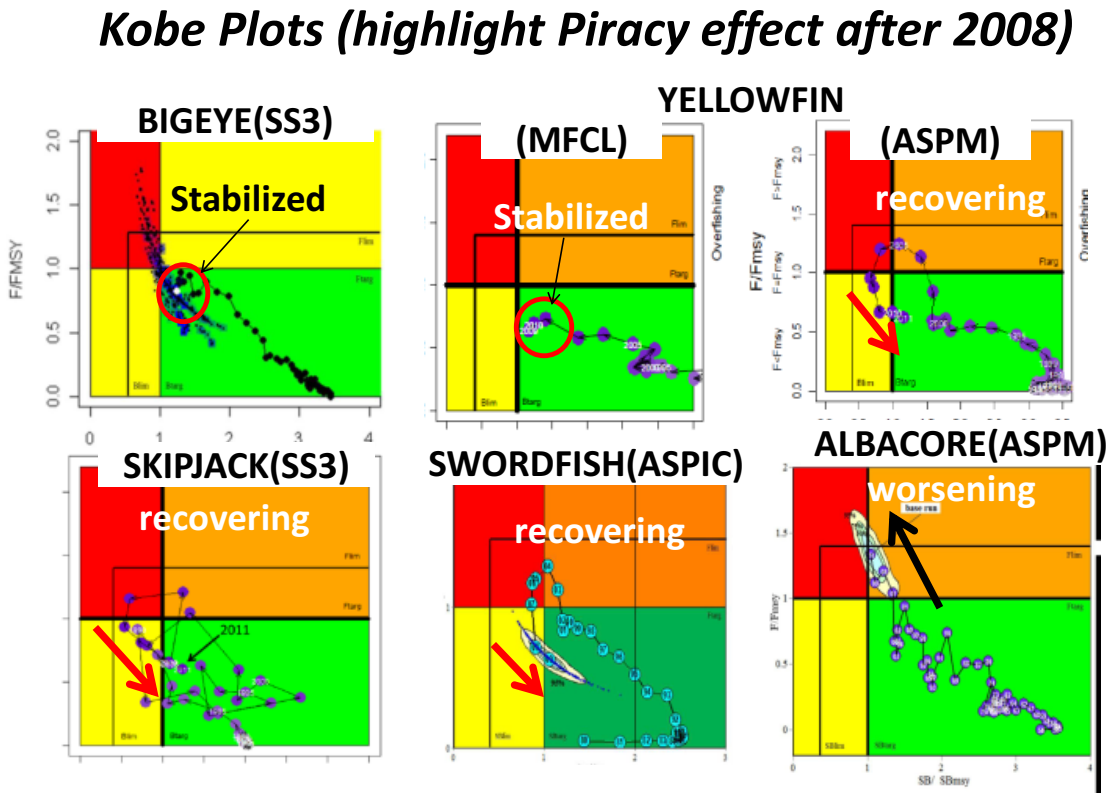


Fig. 14 Status of the stock (Kobe plots) of 5 commercially important species. All species except albacore have been recovering after 2008 when piracy activities intensified. This situation is very similar to kawakawa in the NW (Gulf-Oman Sea) region.

Stock structure

There may be some possibilities of gene flows (exchanges) in the entire Indian Ocean region and one stock hypothesis may be true (Box 1). But we could not get the convergence in the first ASPIC run when we assumed one stock, while we could get the convergence in the alternative ASPIC run using the NW (Gulf and Oman Sea) hypothetical stock structure under the 4 stocks scenario.

We wonder if gene flows are possibly occurred and genes can be mixed well in the entre Indian Ocean region as there are large geographical distances among some countries (e.g. between Kenya and Australia). Although convergence does not imply that 4 stock hypothesis is true, it might imply its possibility to some extent.

Exploring other STD CPUEs

During the WPNT03 meeting, we may need to compare available kawakawa STD_CPUE (or even with nominal CPUE: N_CPUE) from different fleet operating different waters, so that we may be able to learning geographically homogenous groups that have similar CPUE trends. Then we may be able to learn the possible stock structure, although similar CPUE trends do not necessarily imply any stock structure, but it is worth to compare and discuss.

Stock status

Assuming that there is the NW (Gulf and Oman Sea) stock in the Indian Ocean, we now discuss the kawakawa stock status. Based on the Kobe plot (Fig. 9), we understand that the kawakawa stock in the NE Indian Ocean region is now about entering to the overfished 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 when piracy activities intensified. That is the major reason why catch (F) has been sharply increased in recent years after 2008 (Figs. 4, 6 and 9). This caused the sharp decrease in its biomass (population) size and the status of the stock has been worsening (Figs. 5 and 9). 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.

Acknowledgements

We are grateful to H.E. Dr. Hamed Al-Oufi, the Undersecretary, Ministry of Agriculture and Fisheries Wealth, Dr. Saoud Al-Habsi, the Director General of Fisheries Research in in Sultanate of Oman for their encouragement. We also thank to the Agriculture & Fisheries Development, the funding agency of our on-going project, *"Management of the exploited coastal tuna fisheries resources of the Sultanate of Oman"*. Also we would like to extend our appreciation to our colleagues in the Marine Biology Section of Marine Science and Fisheries Center, for their kind supports to our work. Finally, we appreciate Mr. Miguel Herrera (IOTC data manager) to prepare kawakawa nominal catch. Without this important data, we cannot attempt the ASPIC runs.

References

IOTC (2011). Report of the Ninth Working Party on Billfish meeting (Seychelles) (IOTC-2010-WPB09-R [E]).

IOTC (2011). Report of the First Working Party on Neritic Tuna meeting (Chennai, India) (IOTC-2011-WPNT01-R[E]).

IOTC (2012). Report of the Second Working Party on Neritic Tuna meeting (Penang, Malaysia) (IOTC-2012-WPNT02-R[E]).