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Stock and risk assessments of albacore in the Indian Ocean based on ASPIC

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Abstract

Assessment of albacore stock in the Indian Ocean based on ASPIC was conducted using latest data. Catch (Japanese and Taiwanese longline including similar longline fisheries, and other fisheries, 1950-2010) and standardized CPUE (Japanese and Taiwanese longline) were incorporated. Catch and CPUE for Japanese and Taiwanese longline were incorporated separately or as a combined index (weighted average by catch as for CPUE). Convergence and reasonable results were obtained for the scenarios with combined longline catch and CPUE, and fixed B1/K (0.9 or 0.8). Taiwanese STD CPUE vs. catch in 1980-2010 is reasonably reflected, however, Japanese STD CPUE and catch are not well reflected, and probably that is why convergences were not obtained in the ASPIC analyses with Japanese STD CPUE except for combined index. As a result, MSY was estimated to be 35,900 tons, and TB (total biomass) ratio and F ratio (ratio of 2010 level to MSY level) was 1.16 and 1.00, respectively. The recent catch level is about 40,000 tons, which is about 4,000 tons higher than the MSY level. Hence the albacore stock is considered to be slightly overfishing. The Kobe plot 1 shows large confidential surfaces which imply that ASPIC analyses include large uncertainties. According to KOBE II (risk assessments), if current catch level will be maintained, then TB will exceed TB (MSY) in 74% of the probability and F(MSY) in 82% in 2020 (10 years later). Under such circumstances, both catch and F should be kept below current levels until the risk probability decreases. The results in the present study were a bit more optimistic than those for last assessment.

1. Introduction

Assessment of albacore stock in the Indian Ocean based on ASPIC (A Stock-Production Model Incorporating Covariates, Prager, 2004) was conducted during 2011 IOTC WPTmP meeting (IOTC, 2011; Nishida and Matsumoto, 2011). However, there are several concerns for the assessment. One is that, of several scenarios examined, only one scenario which incorporated catch and CPUE data for 1980-2010 without Japanese longline CPUE converged and got reasonable results. The results were a bit pessimistic because F-ratio ($F_{current}/F_{MSY}$) in recent years exceeded F_{MSY}. It seems that any more examinations of the model are necessary. Under these situations, we again conducted stock assessment for Indian Ocean albacore based on ASPIC.

2. Data

Two major input data to ASPIC are catch by fleet and standardized CPUE by fleet. Following is explanation of this information.

2.1 Catch

We used the nominal catch data by gear (fleet) from the IOTC database (as of July, 2012). There are 4 gear types, i.e., (a) tuna longline (LL) fisheries (Japan type including Korea and others), (b) tuna longline fisheries (Taiwan type including Indonesian and others), (c) Gillnet (GILL), (d) others including purse seine (PS) and pole and line or Bait Boat (BB). Japan and Taiwan type LL were defined by the IOTC Secretariat. Fig. 1 shows the trends of catch by fleet type.

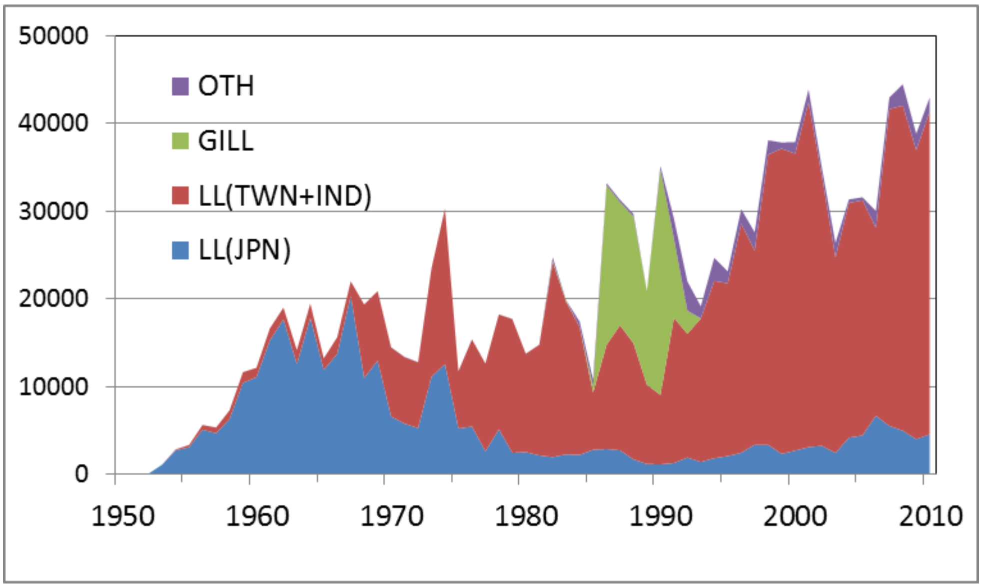


Fig. 1 Trend of albacore tuna catch in the Indian Ocean by gear (Fleet) type

(Source: IOTC database as of July, 2012)

2.2 CPUE

Standardized (STD) LL CPUE for Japanese tuna LL (1966-2011, lognormal model) (Matsumoto et al., 2012) and Taiwanese tuna LL (1980-2011) (Lee et al., 2012) are available. Fig 2 shows comparison of these indices along with average (simple average and weight average by annual catch) which have been scaled by average values as 1. Because catch by Taiwanese LL is much larger than that for Japanese LL after 1980s, weighted average CPUE is much closer to Taiwanese CPUE. It is considered to be reasonable to truncate Japanese CPUE in the early period because change in targeting occurred around 1970 (Matsumoto, 2012).

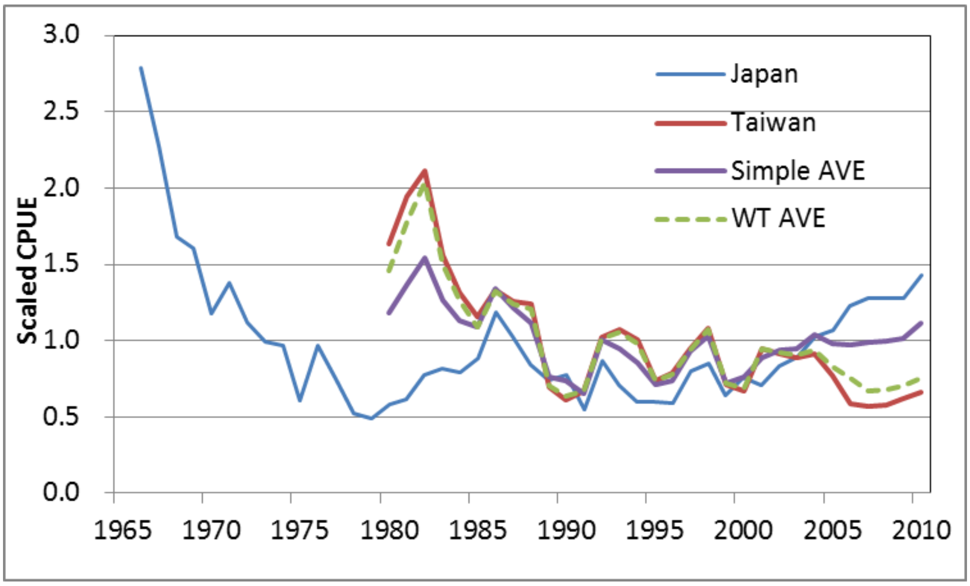


Fig. 2 Comparison among STD CPUEs and average of them

3. Evaluation on the relation between catch vs. STD CPUE

3.1 Evaluation 1 (catch vs. CPUE relations)

Before we attempted ASPIC analyses we evaluated if the relation between catch and STD CPUE for two longline fisheries are realistic. Fig 3 shows these relations by scatter plots. From Fig. 3 we understand that relation between catch vs. Japanese STD CPUE shows positive correlation. On the other hand, the relation for the Taiwan STD CPUE and catch shows negative correlation and so is reasonable and realistic.

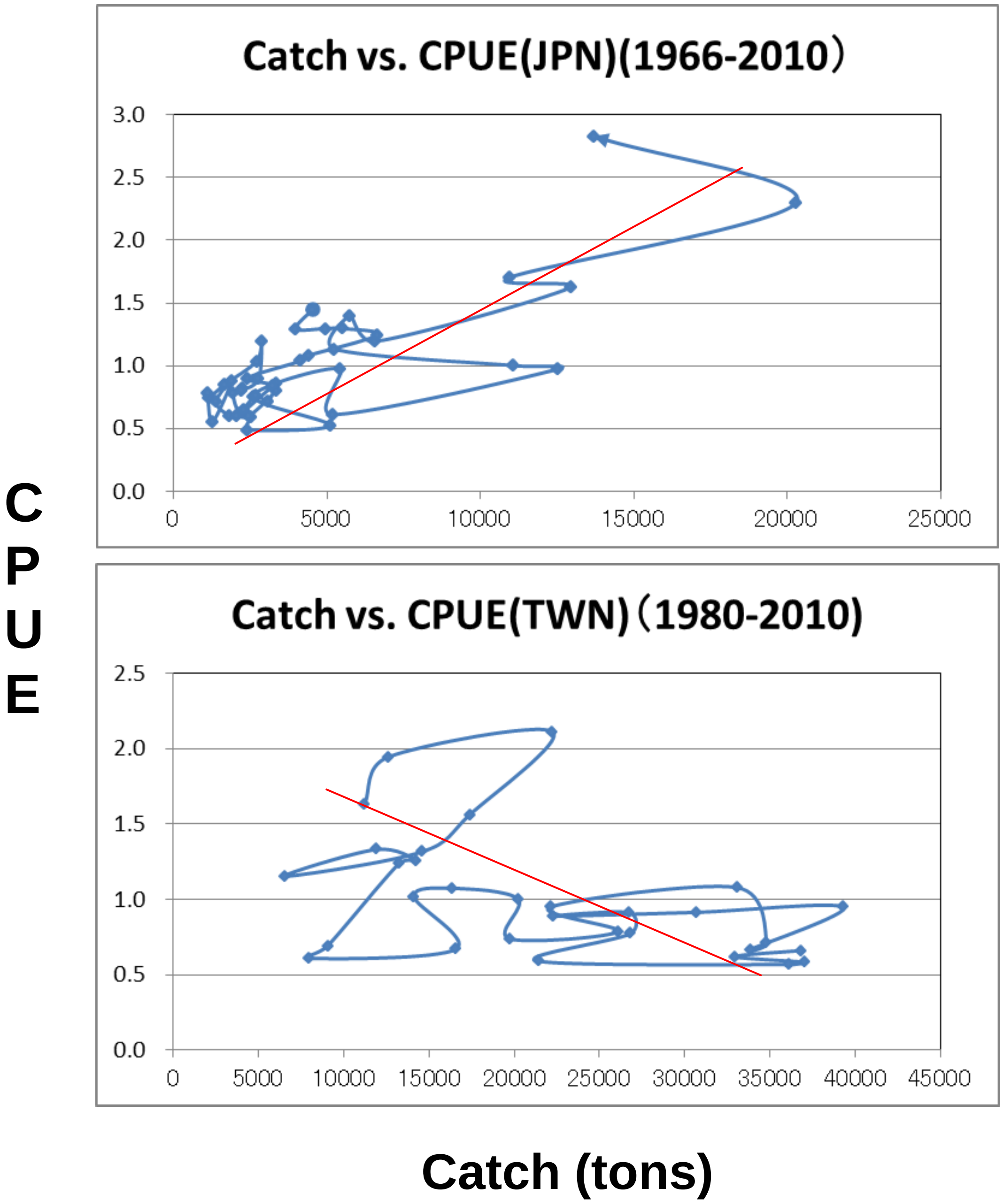


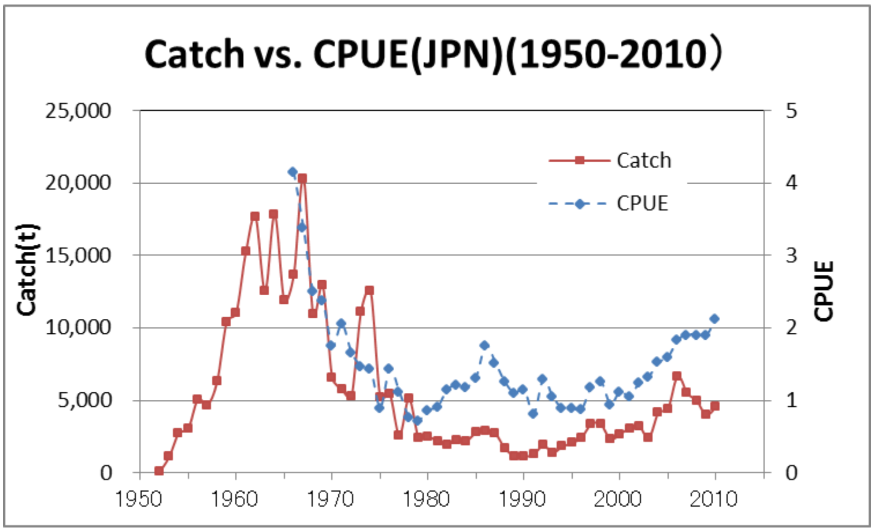
Fig. 3 Relationship among catch vs. two different types of STD CPUE (Scaled)

3.2 Evaluation 2 (catch and CPUE trends)

(1) Catch vs. STD CPUE (Japan: 1966-2011)

We further investigated the relations between catch and CPUE. Fig.4 shows trends of catch and STD CPUE (Japan 1966-2010). In the beginning (1960's), both catch and CPUE dropped sharply. From the mid 1970's to 2010, both catch and CPUE slightly increased. There trends were somewhat nonrealistic because we expect the inverse relation in the normal situation.

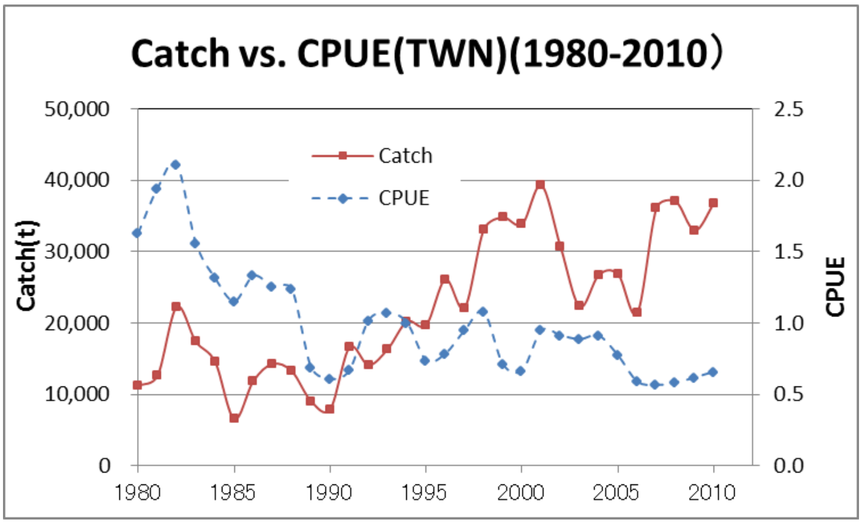
Fig. 4 Catch vs. CPUE (Japan,1966-2010)



(2) Catch vs. STD CPUE (Taiwan: 1980-2010)

We also investigated the relations between catch and STD CPUE (Taiwan: 1980-2010) (Fig. 6). In this case the general trends between catch and CPUE are inversely correlated, which implied that the relation between catch and CPUE are realistic and corresponding.

Fig. 5 Catch. and CPUE (Taiwan)



4. ASPIC analyses

4.1 Initial ASPIC runs

We used the FOX production model option available in the ASPIC software (ver. 5.05) developed by Prager (2004). For details of this software, refer to "User's Manual for ASPIC by Prager (2004).

As for catch data, we thought that it is better to use the period as long as possible. Catch data for IOTC database are available from 1950, so data for 1950-2010 were examined. Catch for fisheries other than longline was combined because CPUE for those fisheries are not available. As for

CPUE, both Japanese and Taiwanese longline indices were used separately or together (weighted average by catch). When combined CPUE was incorporated, catch for both LL was also combined. B1/K (ratio of initial biomass to carrying capacity) was either estimated or fixed (1.0, 0.9 or 0.8) considering that stock status in 1950 is close to virgin biomass.

Table 1 Summary and results of 22 scenarios of ASPIC runs

years	Fleets			CPUE		B1/K	MSE	MSY 1000 tons	TB 2010 million tons	TB msy million tons	TB ratio	F 2010	F msy	F ratio
	LL JP	LL TW	OT	JPN	TWN									
1980-2010*	on		on		1980-2010	Fix (0.9)	0.059	29.9	0.13	0.14	0.89	0.34	0.21	1.61
1950-2010	on	on	on	1980-2010	1980-2010	Estimated	NC (not converged)							
1950-2010	on	on	on	1980-2010	1980-2010	Fix (0.9)	NC (not converged)							
1950-2010	on	on	on	1980-2010	1980-2010	Fix (0.8)	NC (not converged)							
1950-2010	on		on	1980-2010, weighted AVE by catch		Estimated	NC (not converged)							
1950-2010	on		on	1980-2010, weighted AVE by catch		Fix (1.0)	NC (not converged)							
1950-2010	on		on	1980-2010, weighted AVE by catch		Fix (0.9)	0.064	35.9	0.11	0.09	1.16	0.38	0.38	1.00
1950-2010	on		on	1980-2010, weighted AVE by catch		Fix (0.8)	0.064	35.9	0.11	0.09	1.16	0.38	0.38	1.00

* Final model for 2011 assessment, TB: total biomass, TB ratio: TB_{2010}/TB_{MSY}, F ratio: F_{2010}/F_{MSY}

As a result, we could not obtain convergence from the scenarios in which Japanese and Taiwanese CPUE were incorporated separately, or from the scenario in which combined CPUE was incorporated and B1/K was estimated. The former was also observed at the 1st WPTmT in 2004. Therefore, convergence and parameters were obtained from scenarios with combined CPUE and fixed B1/K. Table 1 shows summary results of ASPIC runs. The two scenarios (B1/K=0.9 and 0.8) got almost the same results, in which all the estimated parameters are reasonable and realistic. When B1/K=0.9, MSY=35,900 tons, TB (Total biomass in 2010) =110,000 tons, TB (MSY) =90,000 tons, TB ratio (in 2010)=1.16, F (2010) =0.38, F (MSY) =0.38 and F ratio (in 2010) =1.00. These are a bit more optimistic compared with the assessment in 2011 (IOTC, 2011). Probably it is partly because recent catch for latest statistics decreased from last year' as a result of updates.

Table 3 is the summary of the ASPIC analyses requested by the IOTC Secretariat at 2011 WPTmT meeting.

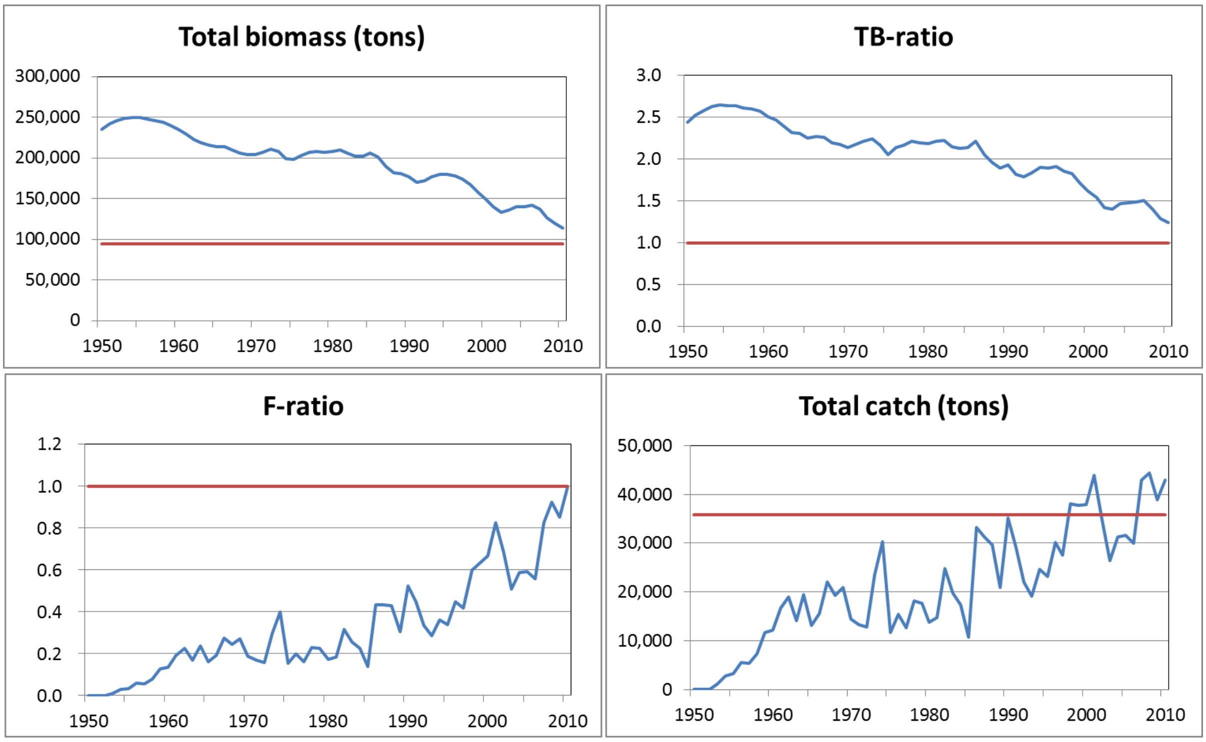


Fig. 6 Results of the scenario with fixed B/K=1.0. Horizontal lines indicate MSY level.

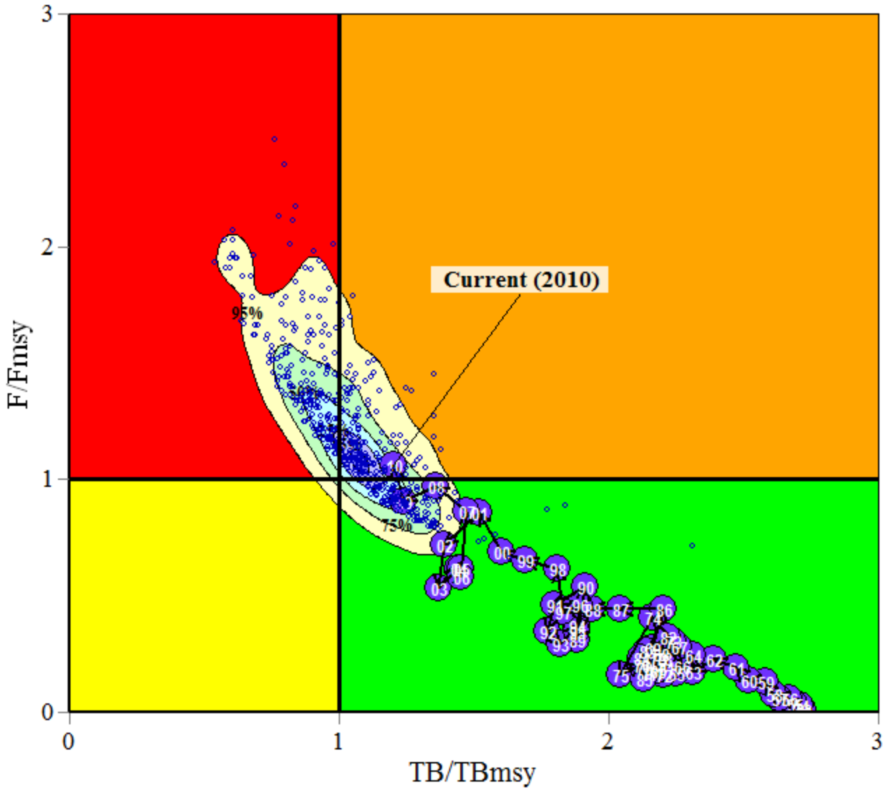


Fig. 7 Kobe plot with 95% confidence surface for the scenario with fixed B/K=1.0

Table 2 Indian Ocean albacore stock status summary based on the ASPIC analyses

Management Quantity	**Indian Ocean**
Most recent catch estimate (t) (2010)	42,968
Mean catch over last 5 years (t) (2006-2010)	39,833
MSY (1000 t) (80%CI)	35.9 (31.3-39.1)
Current data period	1950-2010
F(Current)/F(MSY) (80% CI)	1.00 (0.75-1.24)
B(Current)/B(MSY) (80% CI)	1.16 (0.96-1.49)
SB(Current)/SB(MSY)	NA
B(Current)/B(0) (80% CI)	0.44 (NA)
SB(Current)/SB(0)	NA
SB(Current)/SB(Current, F=0)	NA

5. Risk assessments

Five tuna RFMOs meetings in Kobe in 2007 recommended to produce the Kobe plot (stock trajectory) and also in Barcelona in 2010 they recommended to conduct the risk analyses for SSB (spawning stock biomass) ratio or TB (total biomass) ratio (our case). Degrees of risks are represented by probabilities to exceed TB ratio=1 (at MSY level) and F ratio =1 (at MSY level). Risks will be evaluated by 5 scenarios, i.e., in case catch level of the current year was continued and in case ±20% and ±40% of current catch were continued. Using these 5 scenarios they suggested evaluating risk probabilities within 10 years. To conduct the risk assessments, we generated 500 bootstraps to obtain possible values of TB ratios and F ratios by utilizing ASPIC-P ver. 3.16 (projection module available in ASPIC).

5.1 Risk assessments on TB ratio

Using results of the ASPIC analyses on the scenario with fixed B/K (1.0), 500 values of TB ratio and F ratio were generated by the bootstrap function available in the ASPIC-P for 2011-2020. As a first step, we made future projections of TB rations (Fig. 8). Then we made the Kobe 2 risk matrix (Table 3) and diagram (Fig. 9). These results indicated the high risk of TB ratio exceeding TB (MSY) level in the future if future catch is current level or higher (or greater than the MSY level).

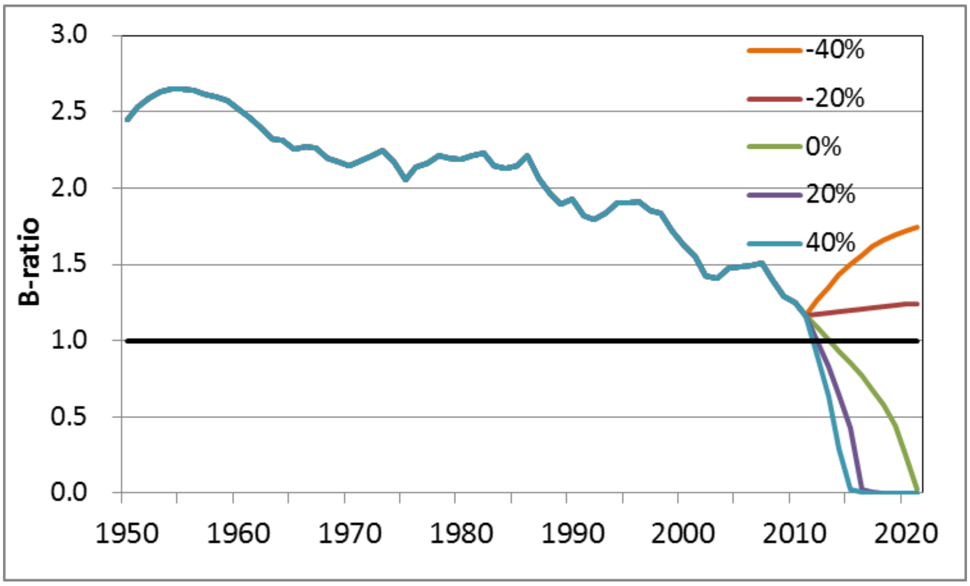


Fig. 8 Future projection of TB ratio with constant catch.

Table 3 Kobe II risk matrix for TB ratio (probability of exceeding MSY level)

Year/catch level	Catch in ton	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
-40%	25,781	0.526	0.490	0.450	0.384	0.316	0.270	0.238	0.202	0.180	0.176
-20%	34,374	0.530	0.490	0.484	0.488	0.498	0.506	0.508	0.508	0.510	0.508
0%	42,968	0.586	0.538	0.568	0.588	0.620	0.644	0.662	0.696	0.730	0.744
20%	51,562	0.684	0.632	0.674	0.700	0.722	0.752	0.772	0.804	0.848	0.872
40%	60,155	0.810	0.758	0.810	0.836	0.844	0.858	0.868	0.888	0.900	0.912

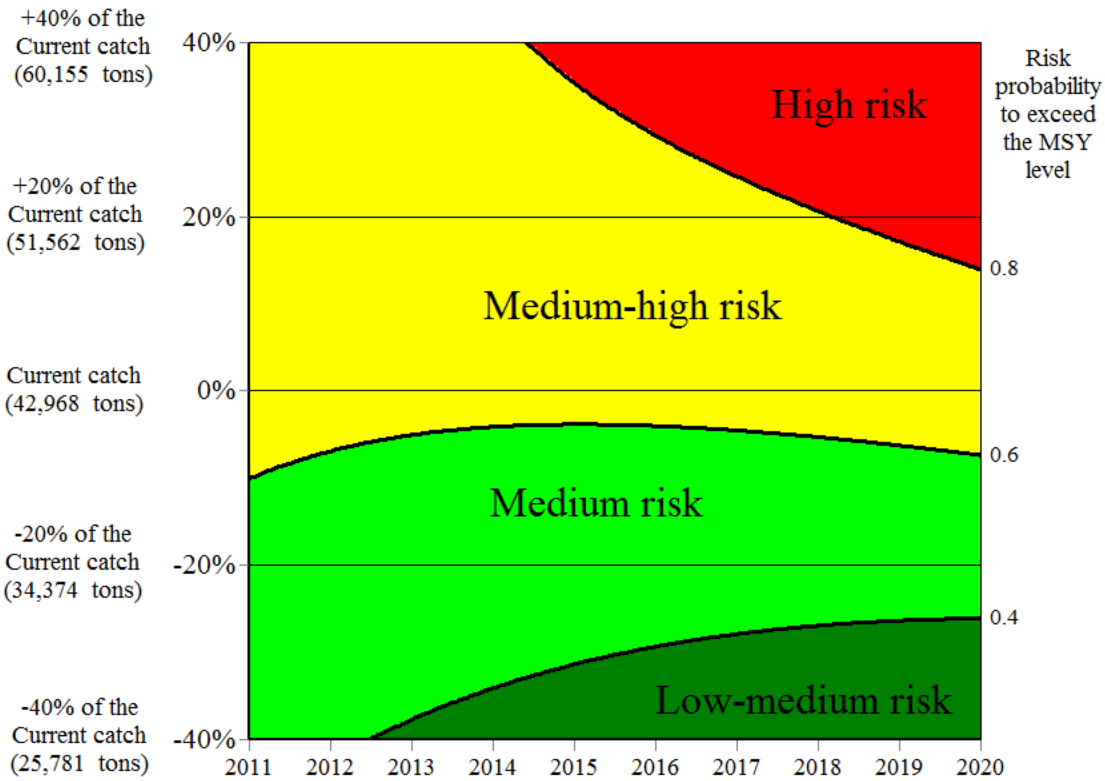


Fig. 9 Diagram of Kobe plot II (risk assessment) for TB ratio

5.2 Risk assessments on F ratio

In the same way as for TB ratio, the future projection (Fig. 10), Kobe 2 matrix (Table 4) and its diagram (Fig. 11) were made. These results also indicated the high risk of F ratio exceeding F (MSY) level in the future if future catch is current level or higher (or greater than the MSY level).

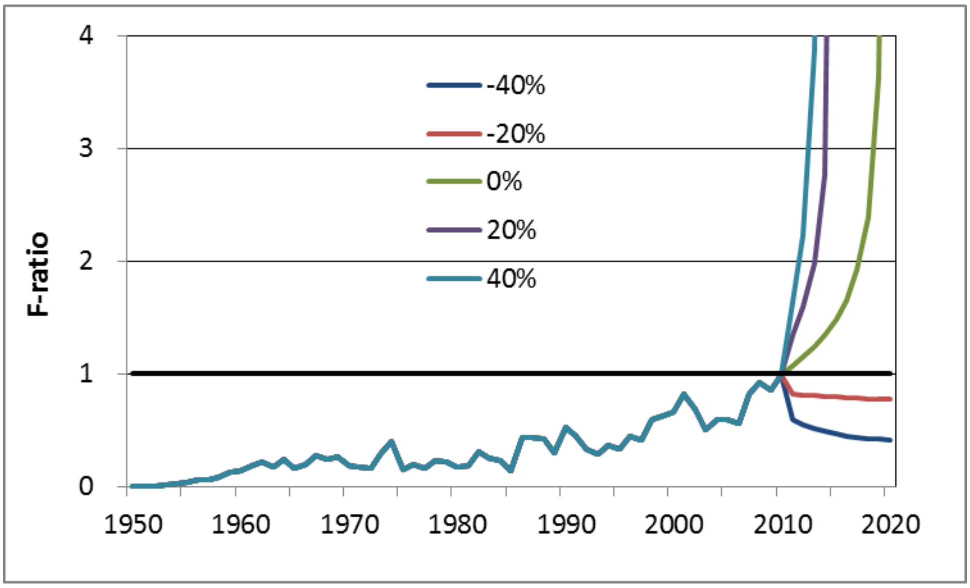


Fig. 10 Future projection of F ratio with constant catch

Table 4 Kobe2 risk matrix for F ratio (probability of exceeding MSY level)

Year/catch level	Catch in ton	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
-40%	25,781	0.258	0.178	0.110	0.058	0.030	0.022	0.006	0.002	0.002	0.002
-20%	34,374	0.470	0.474	0.470	0.476	0.474	0.478	0.482	0.488	0.490	0.488
0%	42,968	0.602	0.626	0.658	0.680	0.714	0.736	0.748	0.772	0.796	0.818
20%	51,562	0.674	0.718	0.756	0.790	0.810	0.850	0.880	0.896	0.900	0.912
40%	60,155	0.742	0.782	0.820	0.864	0.896	0.906	0.924	0.938	0.950	0.960

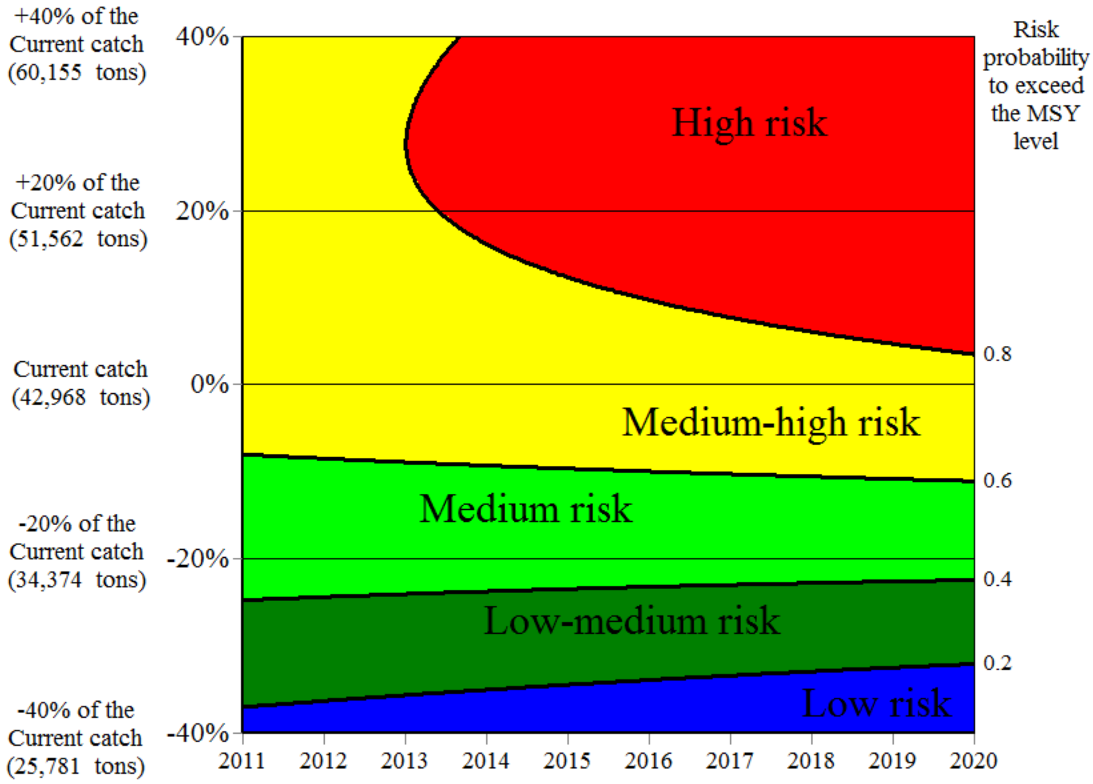


Fig. 11 Diagram of Kobe plot II (risk assessment) for F ratio

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