UPDATE OF THE PROJECTION FOR WESTERN ATLANTIC BLUEFIN TUNA

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SUMMARY

According to the workplan for 2016 adopted at 2015 SCRS, this document provides the simple update of the projection for west Atlantic bluefin tuna by incorporating the actual caches in 2014 and 2015. It is noted that the main purpose is the projection in this document, thus the VPA model used for the stock projection was not updated. Generally, the updated projection showed similar trend in the trajectories and values in the Kobe 2 Strategy Matrices compared to the 2014 projection. The probabilities showed slightly more optimistic than the 2014 projections if the future constant catch was above 2,000 mt. Though two assumptions for 2016 catch (2,000 mt or 2,1000 mt) were considered, the results were very similar.

RÉSUMÉ

Conformément au plan de travail de 2016 adopté en 2015 par le SCRS, le présent document fournit la mise à jour simple de la projection pour le thon rouge de l'Atlantique Ouest en incorporant les prises réelles de 2014 et 2015. Il est noté que le but principal est la projection dans ce document et par conséquent le modèle de VPA utilisé pour la projection des stocks n'a pas été mis à jour. D'une manière générale, la projection actualisée a montré une tendance similaire dans les trajectoires et les valeurs dans les matrices de stratégie de Kobe 2 par rapport à la projection de 2014. Les probabilités ont montré un peu plus d'optimisme que les projections de 2014 si la capture constante future était supérieure à 2.000 t. Bien que deux hypothèses pour les prises de 2016 (2.000 t ou 2.100 t) aient été prises en considération, les résultats étaient très similaires.

RESUMEN

De acuerdo con el plan de trabajo para 2016 adoptado en el SCRS de 2015, este documento proporciona la actualización simple de la proyección para el atún rojo del Atlántico occidental incorporando las capturas reales de 2014 y 2015. Se indica que el propósito principal es la proyección en este documento, por tanto, el modelo VPA usado para la proyección del stock no fue actualizado. En general, la proyección actualizada presentaba una tendencia similar en las trayectorias y los valores usados en las matrices de estrategia de Kobe 2 en comparación con la proyección de 2014. Las probabilidades se mostraron ligeramente más optimistas que las proyecciones de 2014 si la captura constante futura era superior a 2.000 t. Aunque se consideraron dos supuestos para la captura de 2016 (2.000 t o 2.100 t) los resultados eran muy similares.

KEYWORDS

Kobe II matrix, Projection, Western bluefin tuna

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Introduction

In 2015 (Anon. 2016), the SCRS proposed the workplan for 2016 to update the scientific advice at the species group meeting preceding the 2016 SCRS plenary based on (a) revised forecasts that take into account the actual catches in 2014 and 2015 and (b) updated fishery indicators (as prescribed by Rec. [12-03], paragraph 50). To meet the task (a), this document conducts the simple update of the projection for west Atlantic bluefin tuna by incorporating the actual catches in 2014 (1,626 mt) and 2015 (1,839 mt). The method of the projection used in the 2014 stock assessment was applied, and updated Kobe II matrix and trajectory of spawning stock biomass with various levels of constant catch were provided. It is noted that the main purpose is the projection in this document, thus the stock assessment in 2014 was not updated incorporating the actual catches in the recent two years.

Methods

The methods for the projection used in 2014 were continuously applied for western Atlantic bluefin tuna (Anon. 2015). The projections for the western stock were based on the 500 bootstrap replicates of the fishing mortality-at-age and numbers-at-age matrices produced by the VPA-2BOX software. As the projection started in 2014, the main change in the model setting to update the projection was the total catches between 2014 and 2015, and quota allocation in 2016, and other settings were exactly same as those used in 2014. The catches for 2014 and 2015 were the actual values which of 1,626 mt and 1,839 mt, respectively. Two scenarios were considered for the projected catch for 2016, one was equal to the TAC value (2,000 mt), the other was 2,100 mt which would assume that 10% carryover of unused U.S. quota technically can be taken in 2016 in addition to the 2016 quota.

For years beyond 2017, projections were continued using various levels of constant catch with the restriction that the fully-selected (apical) F was constrained not to exceed 2 yr_{-1}. Medium-term projections were conducted to cover the time of the rebuilding plan (2019) and extended to 2025. Projected SSB was expressed relative to the SSB associated with MSY and $F_{0.1}$ (i.e., SSB_{MSY}, $SSB_{0.1}$) for the appropriate recruitment scenario.

The two recruitment scenarios were considered: a low recruitment potential scenario (two-line model) and a high recruitment potential scenario (Beverton and Holt function). The recruitment estimates from the VPA for recent years, 2011 to 2013, were replaced with mean predicted values of stock-recruitment model (for both low and high recruitment scenarios). Numbers and fishing mortality-at-age for ages 1-3 at the start of 2011 were therefore re-calculated by projecting these generated recruitments forward under the known catches-at-age. The projected partial recruitment (which combines the effects of gear selectivity and availability of fish by age) was calculated from the geometric mean values of fishing mortality-at-age for the years 2010-2012 (rescaled to a maximum of 1.0).

Results

Updated projections of SSB were made through 2025 incorporating the actual catches in 2014 and 2015, the current TAC of 2,000 t [Rec. 14-05 for 2016, and a range of constant catches of 0 mt to 3,500 mt in 100 mt intervals for the period 2017 to 2025. The trajectories of SSB/SSB_{MSY} were shown in **Figures 1 or 2** with the assumption of catch in 2016 as 2,000 mt or 2,100 mt, respectively. The Kobe 2 Strategy Matrices are summarized in **Tables 1 to 6**. **Tables 1 and 4** summarize the probability that various constant catch policies will prevent overfishing with 2,000 mt or 2,100 mt in 2016. **Tables 2 and 5** summarize the probability that various constant catch policies will allow rebuilding under the low and high recruitment scenarios or maintain SSB above SSB_{MSY} with 2,000 mt or 2,100 mt in 2016, whereas **Table 3 and 6** summarize the joint distribution ($SSB>SSB_{MSY}$ and $F<F_{MSY}$).

Generally, the result of the projection with 2,000 mt in 2016 were very similar to those with 2,100 mt, which considered the 100mt carryover of the U.S. fishery from 2015. Also, those results were similar to the projection conducted in 2014 (ICCAT 2014). The updated projections were slightly more optimistic than the 2014 projection, when the catch was set to be more than 2,000 mt.

When we assumed the future constant catch to be equal to the current TAC of 2,000 t [Rec. 14-05], all probabilities that we showed in all tables were 100% under the low recruitment scenario. This was already found in the 2014 stock assessment. Under the high recruitment scenario with the two assumptions of the catch in 2016, the probabilities that fishing mortality was below FMSY, and SSB was above SSBMSY and fishing mortality was below FMSY became 1.0%, 1.2%, and 1.4% between 2017 and 2019, respectively. These values were exactly same results as in 2014. The probabilities that apical fishing mortality was below F_{MSY} with 2,000 mt in 2016 were 93.4%, 95.6%, and 96.4% between 2017 and 2019, respectively, while they were 93.4%, 95.4%, and 96.4% with 2,100 mt in 2016. These values were 93.2%, 94.8%, and 96.0% in the 2014 projection. Thus the updated projection showed no major difference in the Kobe 2 Strategy Matrices from the previous assessment.

References

Anon. 2015. Report of the 2014 ICCAT bluefin tuna stock assessment session (Madrid, Spain, September 22-27, 2014. 178 pp). Col. Vol. Sci. Pap. ICCAT, 71(2): 692-945.

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Table 1. Kobe II matrices giving the probability that the spawning stock biomass will exceed the level that will produce MSY ($SSB>SSB_{MSY}$, not overfished) in any given year for various constant catch levels under the low recruitment and high recruitment scenarios. The projected catch in 2016 was set to 2,000 mt. The current TAC of 2,000 t [Rec. 14-05] is indicated in bold.

Low Recruitment

TAC	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%
1500 mt	100.0%	100.0%	100.0%	100.0%
1700 mt	100.0%	100.0%	100.0%	100.0%
1750 mt	100.0%	100.0%	100.0%	100.0%
1800 mt	100.0%	100.0%	100.0%	100.0%
2000 mt	**100.0%**	**100.0%**	**100.0%**	**100.0%**
2250 mt	100.0%	100.0%	100.0%	100.0%
2500 mt	100.0%	100.0%	100.0%	100.0%
2750 mt	100.0%	100.0%	100.0%	100.0%
3000 mt	100.0%	100.0%	100.0%	100.0%
3250 mt	100.0%	100.0%	100.0%	100.0%
3500 mt	100.0%	100.0%	100.0%	100.0%

High Recruitment

TAC	2016	2017	2018	2019
0 mt	1.2%	1.2%	1.2%	2.4%
1500 mt	1.2%	1.0%	1.2%	1.6%
1700 mt	1.2%	1.0%	1.2%	1.6%
1750 mt	1.2%	1.0%	1.2%	1.6%
1800 mt	1.2%	1.0%	1.2%	1.6%
2000 mt	**1.2%**	**1.0%**	**1.2%**	**1.4%**
2250 mt	1.2%	1.0%	1.0%	1.4%
2500 mt	1.2%	1.0%	1.0%	1.2%
2750 mt	1.2%	1.0%	0.4%	1.2%
3000 mt	1.2%	1.0%	0.4%	1.2%
3250 mt	1.2%	1.0%	0.4%	1.2%
3500 mt	1.2%	0.8%	0.4%	1.2%

Table 2. Kobe II matrices giving the probability that the fishing mortality rate (F) will be less than the level that will produce MSY ($F<F_{MSY}$, no overfishing) in any given year for various constant catch levels under the low recruitment and high recruitment scenarios. The projected catch in 2016 was set to 2,000 mt. The current TAC of 2,000 t [Rec. 14-05] is indicated in bold.

Low Recruitment

TAC	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%
1500 mt	100.0%	100.0%	100.0%	100.0%
1700 mt	100.0%	100.0%	100.0%	100.0%
1750 mt	100.0%	100.0%	100.0%	100.0%
1800 mt	100.0%	100.0%	100.0%	100.0%
2000 mt	**100.0%**	**100.0%**	**100.0%**	**100.0%**
2250 mt	100.0%	100.0%	100.0%	100.0%
2500 mt	100.0%	100.0%	100.0%	100.0%
2750 mt	100.0%	100.0%	100.0%	100.0%
3000 mt	100.0%	100.0%	100.0%	100.0%
3250 mt	100.0%	100.0%	99.8%	99.6%
3500 mt	100.0%	99.8%	99.4%	98.6%

High Recruitment

TAC	2016	2017	2018	2019
0 mt	91.6%	100.0%	100.0%	100.0%
1500 mt	91.6%	99.8%	100.0%	100.0%
1700 mt	91.6%	98.2%	98.8%	99.0%
1750 mt	91.6%	98.2%	98.8%	99.0%
1800 mt	91.6%	97.8%	98.0%	98.4%
2000 mt	**91.6%**	**93.4%**	**95.6%**	**96.4%**
2250 mt	91.6%	84.8%	87.6%	89.0%
2500 mt	91.6%	71.0%	73.0%	77.0%
2750 mt	91.6%	53.0%	57.0%	58.4%
3000 mt	91.6%	37.4%	38.8%	41.4%
3250 mt	91.6%	23.4%	25.2%	26.2%
3500 mt	91.6%	14.6%	15.6%	15.6%

Table 3. Kobe II matrices giving the joint probability that the fishing mortality rate will be less than the level that will produce MSY ($F<F_{MSY}$) and the spawning stock biomass (SSB) will exceed the level that will produce MSY ($B>B_{MSY}$) in any given year for various constant catch levels under the low recruitment and high recruitment scenarios. The projected catch in 2016 was set to 2,000 mt. The current TAC of 2,000 t [Rec. 14-05] is indicated in bold.

Low Recruitment

TAC	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%
1500 mt	100.0%	100.0%	100.0%	100.0%
1700 mt	100.0%	100.0%	100.0%	100.0%
1750 mt	100.0%	100.0%	100.0%	100.0%
1800 mt	100.0%	100.0%	100.0%	100.0%
2000 mt	**100.0%**	**100.0%**	**100.0%**	**100.0%**
2250 mt	100.0%	100.0%	100.0%	100.0%
2500 mt	100.0%	100.0%	100.0%	100.0%
2750 mt	100.0%	100.0%	100.0%	100.0%
3000 mt	100.0%	100.0%	100.0%	100.0%
3250 mt	100.0%	100.0%	99.8%	99.6%
3500 mt	100.0%	99.8%	99.4%	98.6%

High Recruitment

TAC	2016	2017	2018	2019
0 mt	1.2%	1.2%	1.2%	2.4%
1500 mt	1.2%	1.0%	1.2%	1.6%
1700 mt	1.2%	1.0%	1.2%	1.6%
1750 mt	1.2%	1.0%	1.2%	1.6%
1800 mt	1.2%	1.0%	1.2%	1.6%
2000 mt	**1.2%**	**1.0%**	**1.2%**	**1.4%**
2250 mt	1.2%	1.0%	1.0%	1.4%
2500 mt	1.2%	1.0%	1.0%	1.2%
2750 mt	1.2%	1.0%	0.4%	1.2%
3000 mt	1.2%	1.0%	0.4%	1.2%
3250 mt	1.2%	1.0%	0.4%	1.2%
3500 mt	1.2%	0.8%	0.4%	1.2%

Table 4. Kobe II matrices giving the probability that the spawning stock biomass will exceed the level that will produce MSY ($SSB>SSB_{MSY}$, not overfished) in any given year for various constant catch levels under the low recruitment and high recruitment scenarios. The projected catch in 2016 was set to 2,100 mt. The current TAC of 2,000 t [Rec. 14-05] is indicated in bold.

Low Recruitment

TAC	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%
1500 mt	100.0%	100.0%	100.0%	100.0%
1700 mt	100.0%	100.0%	100.0%	100.0%
1750 mt	100.0%	100.0%	100.0%	100.0%
1800 mt	100.0%	100.0%	100.0%	100.0%
2000 mt	**100.0%**	**100.0%**	**100.0%**	**100.0%**
2250 mt	100.0%	100.0%	100.0%	100.0%
2500 mt	100.0%	100.0%	100.0%	100.0%
2750 mt	100.0%	100.0%	100.0%	100.0%
3000 mt	100.0%	100.0%	100.0%	100.0%
3250 mt	100.0%	100.0%	100.0%	100.0%
3500 mt	100.0%	100.0%	100.0%	100.0%

High Recruitment

TAC	2016	2017	2018	2019
0 mt	1.2%	1.2%	1.2%	2.4%
1500 mt	1.2%	1.0%	1.2%	1.6%
1700 mt	1.2%	1.0%	1.2%	1.6%
1750 mt	1.2%	1.0%	1.2%	1.6%
1800 mt	1.2%	1.0%	1.2%	1.4%
2000 mt	**1.2%**	**1.0%**	**1.2%**	**1.4%**
2250 mt	1.2%	1.0%	1.0%	1.4%
2500 mt	1.2%	1.0%	0.6%	1.2%
2750 mt	1.2%	1.0%	0.4%	1.2%
3000 mt	1.2%	1.0%	0.4%	1.2%
3250 mt	1.2%	0.8%	0.4%	1.2%
3500 mt	1.2%	0.8%	0.4%	1.2%

Table 5. Kobe II matrices giving the probability that the fishing mortality rate (F) will be less than the level that will produce MSY ($F<F_{MSY}$, no overfishing) in any given year for various constant catch levels under the low recruitment and high recruitment scenarios. The projected catch in 2016 was set to 2,100 mt. The current TAC of 2,000 t [Rec. 14-05] is indicated in bold.

Low Recruitment

TAC	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%
1500 mt	100.0%	100.0%	100.0%	100.0%
1700 mt	100.0%	100.0%	100.0%	100.0%
1750 mt	100.0%	100.0%	100.0%	100.0%
1800 mt	100.0%	100.0%	100.0%	100.0%
2000 mt	**100.0%**	**100.0%**	**100.0%**	**100.0%**
2250 mt	100.0%	100.0%	100.0%	100.0%
2500 mt	100.0%	100.0%	100.0%	100.0%
2750 mt	100.0%	100.0%	100.0%	100.0%
3000 mt	100.0%	100.0%	100.0%	99.8%
3250 mt	100.0%	100.0%	99.8%	99.6%
3500 mt	100.0%	99.8%	99.4%	98.6%

High Recruitment

TAC	2016	2017	2018	2019
0 mt	88.4%	100.0%	100.0%	100.0%
1500 mt	88.4%	99.8%	100.0%	100.0%
1700 mt	88.4%	98.2%	98.8%	99.0%
1750 mt	88.4%	98.2%	98.8%	99.0%
1800 mt	88.4%	97.8%	98.0%	98.4%
2000 mt	**88.4%**	**93.4%**	**95.4%**	**96.4%**
2250 mt	88.4%	84.6%	87.6%	89.0%
2500 mt	88.4%	70.6%	72.8%	76.4%
2750 mt	88.4%	52.4%	56.2%	58.2%
3000 mt	88.4%	36.6%	38.8%	41.0%
3250 mt	88.4%	23.4%	24.4%	26.0%
3500 mt	88.4%	14.6%	15.4%	15.4%

Table 6. Kobe II matrices giving the joint probability that the fishing mortality rate will be less than the level that will produce MSY ($F<F_{MSY}$) and the spawning stock biomass (SSB) will exceed the level that will produce MSY ($B>B_{MSY}$) in any given year for various constant catch levels under the low recruitment and high recruitment scenarios. The projected catch in 2016 was set to 2,100 mt. The current TAC of 2,000 t [Rec. 14-05] is indicated in bold.

Low Recruitment

TAC	2016	2017	2018	2019
0 mt	100.0%	100.0%	100.0%	100.0%
1500 mt	100.0%	100.0%	100.0%	100.0%
1700 mt	100.0%	100.0%	100.0%	100.0%
1750 mt	100.0%	100.0%	100.0%	100.0%
1800 mt	100.0%	100.0%	100.0%	100.0%
2000 mt	**100.0%**	**100.0%**	**100.0%**	**100.0%**
2250 mt	100.0%	100.0%	100.0%	100.0%
2500 mt	100.0%	100.0%	100.0%	100.0%
2750 mt	100.0%	100.0%	100.0%	100.0%
3000 mt	100.0%	100.0%	100.0%	99.8%
3250 mt	100.0%	100.0%	99.8%	99.6%
3500 mt	100.0%	99.8%	99.4%	98.6%

High Recruitment

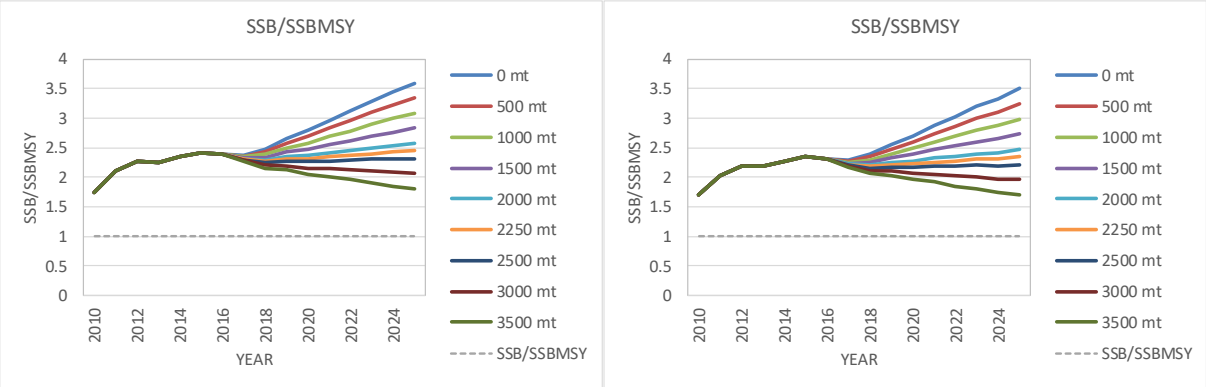
TAC	2016	2017	2018	2019
0 mt	1.2%	1.2%	1.2%	2.4%
1500 mt	1.2%	1.0%	1.2%	1.6%
1700 mt	1.2%	1.0%	1.2%	1.6%
1750 mt	1.2%	1.0%	1.2%	1.6%
1800 mt	1.2%	1.0%	1.2%	1.4%
2000 mt	**1.2%**	**1.0%**	**1.2%**	**1.4%**
2250 mt	1.2%	1.0%	1.0%	1.4%
2500 mt	1.2%	1.0%	0.6%	1.2%
2750 mt	1.2%	1.0%	0.4%	1.2%
3000 mt	1.2%	1.0%	0.4%	1.2%
3250 mt	1.2%	0.8%	0.4%	1.2%
3500 mt	1.2%	0.8%	0.4%	1.2%

a) 50% probability

Low recruitment potential

b) 60% probability

Low recruitment potential



c) 50% probability

High recruitment potential

d) 60% probability

High recruitment potential

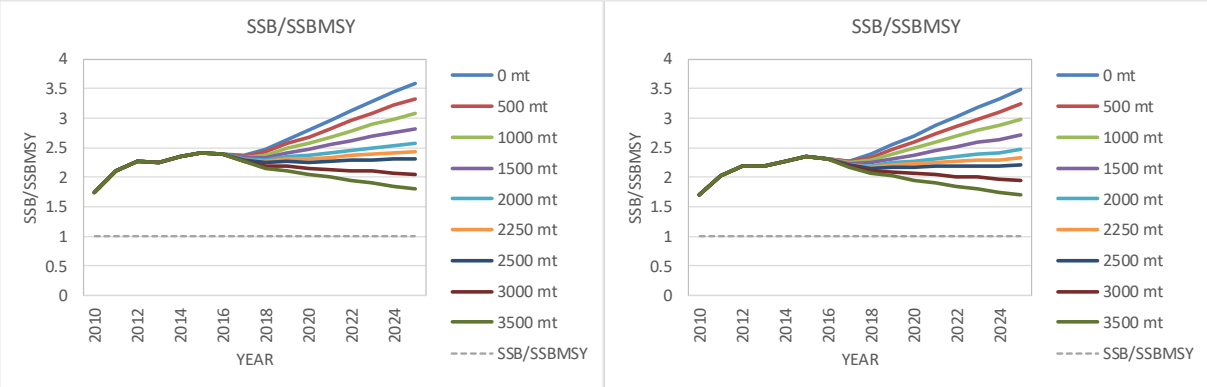
Figure 1. Updated projections of spawning stock biomass (SSB) under low recruitment potential (top panels) and high recruitment potential (bottom panels) with an assumed catch of 2,000 mt in 2016 and various levels of constant catch starting in 2017. The labels "50%" and "60%" refer to the probability that the SSB will be greater than or equal to the values indicated by each curve. The curves corresponding to each catch level are arranged sequentially in the same order as the legends. A given catch level is projected to have a 50% or 60% probability of meeting the convention objective (SSB greater than or equal to the level that will produce the MSY) in the year that the corresponding curve meets the dashed horizontal line.

a) 50% probability

Low recruitment potential

b) 60% probability

Low recruitment potential



c) 50% probability

High recruitment potential

d) 60% probability

High recruitment potential

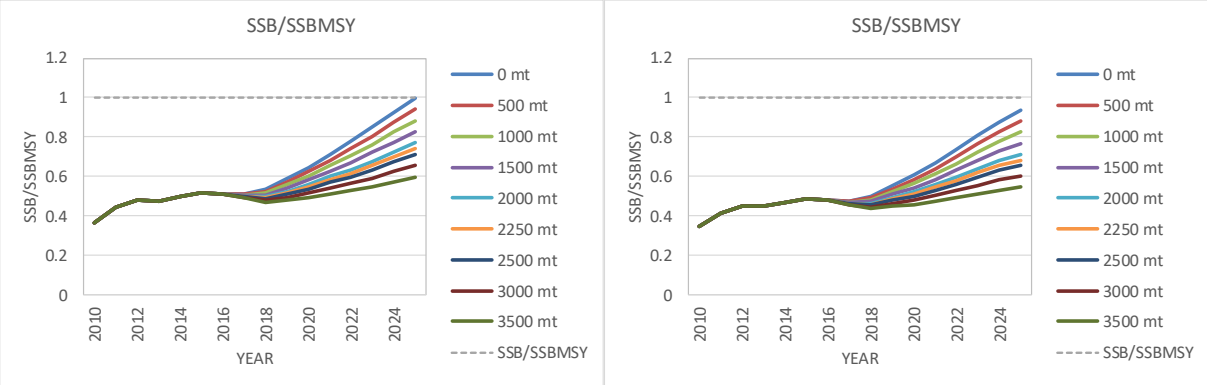


Figure 2. Updated projections of spawning stock biomass (SSB) under low recruitment potential (top panels) and high recruitment potential (bottom panels) with an assumed catch of 2,100 mt in 2016 and various levels of constant catch starting in 2017. The labels "50%" and "60%" refer to the probability that the SSB will be greater than or equal to the values indicated by each curve. The curves corresponding to each catch level are arranged sequentially in the same order as the legends. A given catch level is projected to have a 50% or 60% probability of meeting the convention objective (SSB greater than or equal to the level that will produce the MSY) in the year that the corresponding curve meets the dashed horizontal line.