

PROPOSALS OF DISCUSSIONS AND FUTURE WORKS FOR THE RE-EVALUATION OF STOCK STATUS FOR THE ATLANTIC SHORTFIN MAKO

Y. Semba¹, M. Kai¹, D. Ochi¹, H. Honda¹

SUMMARY

Several issues to be solved in the next stock assessment of Atlantic shortfin mako were raised, especially for the northern stock. It is important to review the past assessment and clarify the problems in advance of the assessment meeting to progress the request by the Commission (re-evaluation of the stock status of Atlantic shortfin mako), on time. Thorough exploration of the stock assessment models, the verification of the output of models, and review of abundance index and major biological parameters to be used for the assessment, are required to improve the assessment. Regarding the stock assessment models, especially for the stock synthesis (SS3), model diagnostics, sensitivity analysis, and future projection are high priorities to complete. Regarding the biological parameter, developments of in-depth explanations to change the productivity (r) and natural mortality (M) are high priorities because the estimate of r in the northern stock in the 2017 assessment was changed to one-half of the amount of the 2012 assessment and M is one of the most influential biological parameters in stock assessment models. Furthermore, we propose a tentative inventory and timeline of these works for the next stock assessment.

RÉSUMÉ

Nous soulevons plusieurs problèmes à résoudre lors de la prochaine évaluation du stock de requin-taube bleu de l'Atlantique, en particulier pour le stock du nord. Il est important d'examiner l'évaluation passée et de clarifier les problèmes avant la réunion d'évaluation pour faire progresser, dans les délais prévus, la demande de la Commission (réévaluation de l'état du stock de requin-taube bleu de l'Atlantique). Une exploration approfondie des modèles d'évaluation des stocks, la vérification des résultats des modèles et l'examen de l'indice d'abondance et des principaux paramètres biologiques à utiliser pour l'évaluation sont nécessaires pour améliorer l'évaluation. En ce qui concerne les modèles d'évaluation des stocks, en particulier Stock synthèse (SS3), les diagnostics du modèle, les analyses de sensibilité et les futures projections figurent au premier rang des priorités. En termes de paramètres biologiques, des explications approfondies des changements de la productivité (r) et de la mortalité naturelle (M) sont hautement prioritaires, car l'estimation de r pour le stock nord dans l'évaluation de 2017 se situait à la moitié de celle de l'évaluation de 2012 et M , qui est l'un des paramètres biologiques les plus influents des modèles d'évaluation des stocks, a également varié. Nous proposons également un inventaire provisoire et un calendrier de leurs travaux pour la prochaine évaluation des stocks.

RESUMEN

Se plantean diversas cuestiones que tienen que resolverse en la próxima reunión de evaluación de stock de marrajo dientuso del Atlántico, especialmente para el stock del norte. Es importante revisar la evaluación anterior y aclarar los problemas antes de la reunión de evaluación para progresar a tiempo en la solicitud realizada por la Comisión (re-evaluación del estado del stock de marrajo dientuso del Atlántico). Para mejorar la evaluación se requiere una exploración minuciosa de los modelos de evaluación, la verificación de los resultados de los modelos y la revisión de los índices de abundancia y de los principales parámetros biológicos que se van a usar en la evaluación. En lo que concierne a los modelos de evaluación de stock utilizados, especialmente para stock synthesis (SS3) reviste gran prioridad que se completen los diagnósticos del modelo, los análisis de sensibilidad y las proyecciones del stock futuras. En lo que concierne a los parámetros biológicos, las explicaciones detalladas de los cambios en la productividad (r) y mortalidad natural (M) revisten una elevada prioridad porque la estimación de r para el stock del norte en la evaluación de 2017 fue la mitad de la de la evaluación de 2012 y M , que es uno de los parámetros biológicos más influyentes en los modelos de evaluación de stock, también variaba. También proponemos un inventario y calendario provisional para estos trabajos con miras a la próxima evaluación de stock.

KEYWORDS

Atlantic shortfin mako, Stock assessment, Longline Fishery, Population dynamics

¹ National Research Institute of Far Seas Fisheries, Japan Fisheries Research and Education Agency, 5-7-1, Orido, Shimizu-Ward, Shizuoka-City, Shizuoka-Prefecture, 424863, Japan. E-mail: senbamak@affrc.go.jp

Introduction

In 2017, stock assessment of Atlantic shortfin mako was conducted for the first time in 5 years. For the northern stock, BSP2-JAGS and stock synthesis (SS3) were mainly used to assess the stock status (ICCAT 2017). Although improvement was made in various aspects including fishery statistics (i.e., catch, effort and size data), assessment model, and biological parameters compared to last assessment, it was recognized that there are remaining lots of works such as model diagnostics, sensitivity analysis, and future projections in SS3 and the verification of the output of each model, parameters and setting of the models have not been entirely discussed. For re-evaluation of the stock status of Atlantic shortfin mako, the request by Commission, it is necessary to clarify the problems and propose the timeline for a series of tasks to be completed before the stock assessment meeting. In this document paper, we make proposals to be discussed for further improvement of the assessment.

Proposal

In general point of view, it is suggested that high priority be given to filling the gap of the output of stock status between two stock assessment models used in the last assessment. For this purpose, full consideration of parameter setting is necessary step as described below.

1. Stock assessment model

1.1 BSP

Discussion of model performance of selected model (BSP2-JAGS) would be necessary. For example, the large difference of prior and posterior distribution of the productivity parameter: r (Figure 3(b) in Babcock and Cortés 2017) may indicate the mismatch between initial setting for this parameter and productivity estimated based on fishery data. This may indicate the possibility that the prior initially set for this parameter is lower than the real productivity parameter. In addition, a shape parameter, the value of biomass at MSY (B_{MSY}) relative to carrying capacity (K), is a key parameter to have a large impact on the stock status, however, the results of current stock status on biomass have a large difference between BSP2-JAGS and SS3, so that it is also necessary to discuss again and describe the process in the document explicitly.

1.2 SS3

Full assessments of SS3 including the verification of model diagnostics, reconsideration of sensitivity analysis and future projection are necessary to be conducted. For the model diagnostics, general approach such as residual plots, likelihood profile, retrospective analysis and age-structured production model (ASPM) are minimum requirement. For the sensitivity analysis, re-consideration of combination of biological parameters (especially in case of change of biological parameter etc.) and fishery data including data weighting, would be worth to be done. For future projection, some kinds of scenario should be decided and agreed at the data preparatory meeting. In the discussion of the model performance, description on the effective sample size for size data and data weighting is useful.

2. Biological parameter

Thorough evaluation including the derivation of each parameter needs to be shared among participants as listed below for example;

2.1 Intrinsic rate of natural increase (r)

Compared to the setting of r in BSP between 2012 and 2017 stock assessment based, that for the northern stock changed from 0.058 (in 2012) to 0.0254 (in 2017), while that for the southern stock changed little from 0.058 (in 2012) to 0.052 (in 2017). It is necessary to discuss whether this large difference for the northern stock is reasonable or not, taking into consideration of mis-fitting between prior and posterior distribution of this parameter in BSP2-JAGS (Babcock and Cortés 2017) described above and a recent work in which uncertainty of biological parameter was considered in the estimation of r (Yokoi *et al.* 2017). At least, more detailed information on the derivation, such as the input parameter or estimator, and following discussion including the setting of sensitivity for this parameter would be appropriate at the data preparatory meeting or intersessional e-mail discussion. In relation to this logical sequence, other parameters related to the calculation of this parameter (e.g. longevity, maturity size, fecundity, reproductive cycle) is also necessary.

2.2 Natural mortality (M)

As described above, more detailed information on the derivation, input parameter or estimator, and following discussion for M would be appropriate at the data preparatory meeting or intersessional e-mail discussion. The discussion of the selection of estimator would be beneficial. M used for the calculation of r is necessary to be consistent with that used for SS analysis.

2.3 Growth parameter

Especially for the southern stock in which periodicity of band pair deposition has not been settled (Doño *et al.* 2015, Barreto *et al.* 2016), application of meta-analysis including each work as random effect would provide insight into the setting for SS as adopted in North Pacific (Takahashi *et al.* 2017). In this meta-analysis, length-at-age data from analysis based on vertebrae, tagging and size frequency analysis can be treated within one framework and uncertainty in each study can be incorporated. Although it depends on the time of work schedule, this approach can work as one candidate.

3. Treatment of several stock assessment model

In consideration of the biological (i.e. age- and sex-specific growth, sex-specific mature size, fecundity proportional to maternal body length, low-fecundity stock recruitment relationship, lower natural mortality through all the age classes) and fisheries characteristics (i.e. selectivity for immature sharks in all fleets and sex- and age-specific availability and vulnerability) of shortfin mako shark, the results of the sex- and age-specific structured model (SS3) which take into complex biological characteristics and unique selectivity described above, is suggested to be more suitable to provide management advice than production type models, once the model has been fully explored (ICCAT 2017). However, given the philosophy of ICCAT of equal weighting of each model, results of BSP and SS3 needs to be discussed equally at least.

4. Review of abundance index and catch

For the stock assessment process, it is important to review abundance index submitted for the use in the assessment. Information on the spatiotemporal coverage, statistical soundness, and evaluation from various viewpoints enables to discuss the representativeness or weighting of each index can be discussed and thus improve the uncertainty of the assessment. We propose to apply the evaluation method adopted in 2012 shortfin mako stock assessment as the starting point which is indicated in Table 14 in the assessment report (ICCAT 2012). If the revised method is available, the new evaluation approach may be replaced.

In the next stock assessment, it is desirable for all fleets to develop historical catches, taking into consideration of the history of each fishery. These information for each fleet is necessary to be available at the data preparatory meeting, regardless of the participation of the meeting.

Conclusion

Given the discussion above, we made a temporal (tentative) inventory with corresponding timeline (Table1). Regarding SS analysis, trials based on the data which were used in the last 2017 assessment and review of the results or performance of the model (i.e., diagnostics) at the data preparatory meeting or within small working group of assessment scientists, would work to find underlying problems such as settings in the model (e.g., data weighting for abundance index and size data). Discussing and clarifying the points to solve these problems prior to the stock assessment meeting is necessary to get a consensus about the data and model settings and efficiently develop any types of stock assessment models, because, otherwise, much time is consumed to obtain the base-case and little time is left to explore the appropriateness of the results, projections and reasonable recommendations.

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Table1. Tentative inventory of work for the re-evaluation of stock status of Atlantic shortfin mako in 2019 with corresponding timeline.

<i>Topic</i>	<i>Contents of discussion</i>	<i>Timeline</i>	<i>Relation to model</i>
Biological parameter	Derivation of productivity (r) and its estimates (including sensitivities)*	data Prep. meeting	BSP
	Derivation of natural mortality (M) and its estimates	data Prep. meeting	BSP, SS
	Update of growth parameters	data Prep. meeting	BSP, SS
	Update of steepness*	data Prep. meeting	SS
	Discussion of other parameters (e.g. longevity, maturity size, fecundity, reproductive cycle)	data Prep. meeting	BSP, SS
Fishery data	Review of abundance index of each fleet to be used for the assessment**	data Prep. meeting	BSP, SS
	Review of catch to be used for the assessment	data Prep. meeting	BSP, SS
	Review of size data	data Prep. meeting	SS
Model setting	Assessment period	data Prep. meeting	BSP, SS
	Derivation of shape parameter (approach/setting)	data Prep. meeting	BSP
	Sensitivity (combination of parameter)	data Prep. meeting	BSP, SS
	Data weighting (Methods)	data Prep. meeting	SS
	Future projection (Scenarios)	data Prep. meeting	BSP, SS
Model diagnostics	Residual plots, Likelihood profile, Retrospective analysis and Age-structured production model and Bayesian diagnostics	intersessional meeting	SS
Discussion of the results	Sensitivity run, stock status, Future projections, Future work and recommendation etc.	stock assessment meeting	BSP, SS
	Discussions on conclusions, stock status, recommendations, and future work	stock assessment meeting	BSP, SS
Current proposal	Test-run of SS with data in 2017	data Prep. meeting	SS

*Productivity (r) and steepness are computed based on the other basic parameters, so the other basic parameters should be provided to the analyst before the Data Preparatory meeting.

** Scoring methodology developed during the Assessment and Methods Working Group is candidate approach to be used.