Further responses from Japan to the Australian responses on farming papers in Attachment 6 of ESC21 Report

ESC21 レポートの付属書 6 における畜養文書へのオーストラリアの反論に対する日本のさらなる反論

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要約

オーストラリアのミナミマグロ畜養魚における、日本による成長、年齢組成、漁獲量の推定値がオーストラリアからの報告値と大きく異なる問題について、2016 年に両者の間で質問と回答が実施された。本文書では、日本からさらに回答をし、議論を促進する。オーストラリアからは、体長成長の線形近似の問題、標識装着の成長への影響、年齢組成データの由来、太平洋クロマグロの成長との比較の解釈などについて推定方法の問題の可能性の指摘があった。しかしこれらは日本の解析では考慮されているか、指摘は不適切であった。バイアスを説明するオーストラリアからの更なる意見が必要である。さらに不確実性を減少させるには、CDS のデータを使用した詳細な解析を行うのが適切である。

Abstract

In 2016, opinions of Australian farmed SBT were exchanged between Australia and Japan in terms of growth, age composition and catch amount, which were largely different from Japanese estimation to those Australia reported. In this document, Japan further responses in order to promote the discussion. All the points explained by Australia in 2016, including linearity assumption of growth in body length, influence of tag implementation on fish growth, origin of age composition data, interpretation of growth of Pacific bluefin tuna farming, have already been taking into account in Japanese analysis or not applicable. We need further explanation from Australia for the large biases. To reduce uncertainty more, analysis of detailed size data in CDS are preferable.

Introduction

In ESC 21 held in 2016, Australia and Japan exchanged their questions relevant to growth of SBT farming. A set of responses were provided from each other. It was included in the Attachment 6 of ESC21 Report (Anon. 2016). This process seems preferable approach to reach any agreement of this issue.

We provide further responses in this document to the Australian responses for Japanese questions in order to promote this process. In addition, we also provide follow-up responses to the Japanese responses for Australian questions. In the followings, Australia[2016] in blue defines responses/questions from Australia in 2016, and Japan[2016] in red and Japan[2017] in black are responses/questions from Japan in 2016 and 2017 (this time), respectively.

First of all, we clarify some points, which might be miss understood.

1. **The growth rate derived from the SRP tagging is for growth during farming. It is not for growth in wild fish.**
2. **The growth rates were compared in 6 months after farming started (or in the period up to July 1st, 6 months later from January 1st). It is because the farming duration was mainly 6 months and expected little growth after 6 months in low water temperature in winter months.**
3. **Length-weight (or weight-length) relationships were derived from wild fish and farmed fish separately, and used separately.**

1. Concerns raised by Japan

1-1. Japan [2016]: The growth rate of farmed fish indicated by fish tagged in the SRP is much less than that implied by Australian data on farmed fish.

Australia [2016]: Your analysis of growth rates 'implied by Australian data' is based on the calculations in CCSBT-ESC/1609/24, with respect to this:

1. Australia [2016]: Bias in inferred weight-at-age (Eqn. 2). The change in weight-at-length as a fish ages from age a to a+1 will definitely not be linear (as implied in Eqn. 2) because of the effectively cubic relationship between length and weight. Using a simple linear approach like this one will always overestimate the weight-at-age at any point in the year as measured Jan 1st to Jan 1st. By over-estimating weight-at-age you will implicitly have to have a higher value for W.TIS.Catch.y to solve Eqn. 3. So, just from this issue alone, actual catch would HAVE to be higher than reported catch but driven only by a bias in the inferred weight-at-age.

Japan [2017]: Eqn.2 in CCSBT-ESC/1609/24 was the equation that estimate the date of wild capture. It is used to match the catch amount from fish with mean length-at-age on January 1st and grow in the period up to the date estimated, to the reported catch amount.

$$W.catch_{y,i} = W_{JAN,i} \times adj.mon_y \times \frac{1}{12} \times (W_{JAN,i+1} - W_{JAN,i})$$

(Eq-2) in CCSBT-ESC/1609/24

where, $W_{JAN,i}$ = average whole body weight (kg) of wild SBT at January 1st of age i;

$adj.mon_y$ = the number of months from January 1st to capture during fishing year y;

$W.catch_{y,i}$ = average whole body weight (kg) of wild SBT at wild capture by the purse seine fishery in the fishing year y.

We assumed growth in body weight from age-i to age-i+1 to be linier in this equation. It was NOT growth in length. Australian claim was not appropriate.

Furthermore, an attempt was made for non-linearity of growth in body weight. The von Bertalanffy growth curve was fitted between age-2 and age-5 of length-at-age used in CCSBT. (Although CCSBT's length-at-age was derived from more complex procedure using Richard's model and combined two stanza, any curve was enough for this examination.) Body length was converted to body weight by Robins (1963) and then compared with growth that assumed linearity (Fig. 1). As the result, the body weight increased linearly and little difference was observed between the two lines. Therefore, linear/non-linear issue on the equation cannot explain the large bias observed.

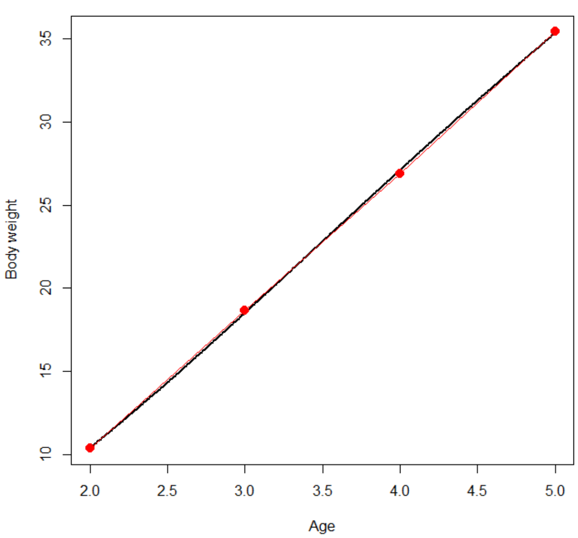

Fig. 1 Body weight at age in SBT from age-2 to 5. A non-linear curve (black line estimated from von Bertalanffy growth equation) and linear lines (red with dot) were compared.

2. Australia [2016]: The interaction of uncertainty in mean length-at-age, the nonlinear nature of in particular the length-weight relationship, and the various assumed and estimated parameters. If everything is linear, then using the

expected values of all key parameters and relationships does not produce a bias. BUT because there are a number of nonlinearities and estimated quantities it is not at all clear what role these will have in biasing the estimates. The main point of the analysis is to try and estimate the potential bias in reported catch due to sampling issues. However, the main problem is that the sequential modelling approach is likely to have a number of unknown biases in it even if the data were correct, so how do we make any conclusions based upon it if the results cannot be demonstrated to be unbiased.

Japan [2017]: As mentioned above, our analysis did not approximate body length in linear. It took account of non-linearity in length-weight relationship. While there were several assumptions, the estimated biases in growth or catch amount were quite large, which is unlikely to be explained by uncertainties relevant to those assumptions.

3. Australia [2016]: In addition, studies have demonstrated tagging impacts on growth, as discussed in paper CCSBT-ESC/1609/14.

Japan [2017]: We repeat the following response in the attachment 6 of ESC21 Report.

"From considering the literature referenced in Australian papers, including Hampton (1986), Hearn and Polacheck (2003), Itoh et al. (2003), we conclude that the influence of tag implantation on growth is not substantial. Associated details are provided in the discussion section of CCSBT-ESC/1509/32(Rev) (page 22). "

Also see the attachment 1 of this document that described it in more detail.

1-2. Japan [2016]: The age composition of farmed fish indicated by length frequency of grown out fish is biased to older fish compare to the catch at age in Australian data.

Australia [2016]: What is the source of the length frequency of the grown out fish? If this comes from the market sampling it raises the question of whether the sampling was representative and we reiterate the request to share these data to enable validation/checking.

How is the length frequency converted to age frequency? If this assumes the age/length relationship based on wild fish, this is unlikely to be representative of farmed fish.

Japan [2017]: The age composition we used came from the data submitted to CCSBT data exchange by Australia. In our analysis, the discrepancy of catch amount at wild capture was adjusted by shifting a proportion of the number of fish at age (α_y, a constant proportion among ages, but variable by year) to one higher age. Detail data of CDS which contain individual size information at harvest allows more accurate estimation.

1-3. Japan [2016]: Referring to growth rate data for other tuna, including farmed Pacific bluefin and Atlantic bluefin, the growth rate implied by Australian data on farmed fish is much higher.

Australia [2016]: As above, this is dependent on the calculations of the growth rates 'implied from the Australia data' so subject to the concerns above.

2. Concerns raised by Australia

2-1. Australia [2016]: The average weight into farms: The implications of Japan's hypothesis is that – for example – the differences between the sampled weights and actual weights are:

	Sample		*Japan hypothesis*
	Sample size	*Av. Wt (kg)*	*Av. Wt (kg)*
2010/11	*2,471*	*16.7*	*27.2*
2012/13	*2,735*	*16.2*	*26.9*

Japan's hypothesis is that the SBT going into Australian farms are, on average, 4 year old SBT. Is Japan's hypothesis that there is so many 4-5 year olds on the Australian fishing grounds, and these could be targeted so well? Looking at 2013, the hypothesis is not supported by the SAPUE or the Transect Survey raw data. It is also not supported by the realities of tuna farming – that at-sea operations are relatively immobile because of the tow net, that fish of 15-16kg grow faster than SBT of 27kg, and that all SBT ≥21kg. (gg wt) bring a largely common price.

Japan [2016]: We need to check the average weights which have been associated here with the Japanese hypothesis, because the different growth rate by age should be considered. In the GAB, it is known where age 4 fish are distributed, as well as the age 5 fish. Purse seine fishermen can therefore select SBT size (age) that they want. Hence, the age distribution of the catch can be different from the age composition of the SBT distributed in GAB.

Japan [2017]: The age composition of purse seine catch reported by Australia was 49% in age 2, 43% in age 3 and 7% in age4 in 2015. From this information we can understand some amount of SBT age 4 is distributed in GAB and actually caught.

In our analysis for the 2015 farmed fish, estimated age composition was 31% in age 2, 45% in age 3 and 21% in age4. The main composition of SBT were still age 3 and we do not need to assume plenty of age-4 SBT distributed in GAB.

2-2. Australia [2016]: Comparisons of PBT and SBT farm growth rates: Australia has provided what we understand are the latest PBT research trials (Goto 2014) of comparable size fish which enter farms in Australia. These show almost exactly the same growth as SBT in Australian farms. Does Japan have data which contradicts these trials?

Japan [2016]: The growth from PBF research trials (Goto 2014) is closer the growth rate for SBT from SRP tagging than is estimated from the 100 fish sampling; this is evident from consideration of the intrinsic growth difference of species by body length. The details of this have been reported in CCSBT-ESC/1509/32(Rev) (case 4 in page 49), and are also evident from other growth data for tunas reported in the literature.

Japan [2017]:
Followings are the description in CCSBT-ESC/1509/32(Rev).
<Case 4> From Goto (2014) for PBF.

In experiment 1, fish grew from 89 cmFL on 16 June 2013 to 113 cmFL on 16 December 2013. In experiment 2, fish grew from 77 cmFL on 7 November 2013 to 98.5 cmFL on 26 May 2014.

RFWs (Ratio of farmed fish growth over wild fish growth) are calculated as 1.80 for the experiment 1 and 1.50 for the experiment 2. It slightly exceed the RFW value (1.49) for SBT derived from the SRP tagging data, but far below the RWF corresponds to the total catch that Australia reported (RFW=2.32~4.07).

2-3. Australia [2016]: Growth rates in the wild and in farms: Japan's hypothesis is that SBT tagged in the SRP program, and then subject to large migration, periods of starvation, and other deprivation, grow in length and weight the same as SBT in farms? Is this consistent with experience in other intensive livestock production? What is Japan's assessment of the impact of tagging in the wild on feeding and growth?

Japan [2016]: From considering the literature referenced in Australian papers, including Hampton (1986), Hearn and Polacheck (2003), Itoh et al. (2003), we conclude that the influence of tag implantation on growth is not substantial. Associated details are provided in the discussion section of CCSBT-ESC/1609/BGD09 (page 22).

Japan [2017]: The growth rate from SRP tagging data was based on fish that captured by purse seine soon after tagged-and-released and farmed for several months. Then, the growth rate derived is a good approximation of growth of farmed fish.

In terms of the issue of influence of tag implementation on fish growth, we have already addressed it (see attachment 1 of this document).

2-4. Australia [2016]: Feed conversion ratio (FCR): Australia has provided the extensive literature showing that the benchmark for FCR in farming of Bluefins (including SBT) is ~10:1. Japan's hypothesis rests on Australia's FCR being up to 17:1. Does Japan have information which contradicts the literature on FCR?

Japan [2016]: We do not know what FCR value is appropriate for tuna. We welcome the information on actual observed FCR values for SBT from Australia, appreciating that this can vary with environmental conditions. The FCR values in Table 5 of CCSBT-ESC/1609/14 are based on the total amount of sardine used for food. These values may be larger than apply in reality to Bluefin alone because this food is also used to feed other species, or for other reasons.

Japan [2017]: We expect that Australia provide us the actual FRC values of SBT in this ESC.

2-5. Australia [2016]: Length/weight data used by Japan prior to 2014: The length/weight of 420,000 fish was used by Japan prior to 2014 to support the methodology used to estimate the size of SBT into farms. Australia has requested this data be supplied, with company names deleted, so we can test that methodology. Can we again request that the data be supplied for analysis?

Japan [2016]: We see two possible uses for these data. The first is to compute the weight-length (WL) relationship of grown out fish. The parameter values calculated are already provided in CCSBT/ESC/1208/30. Thus Australia can already check whether this WL relationship for farmed fish is appropriate by comparing to the WL relationship they may have. If there is large difference, it would be useful for the Australian WL relationships to be provided. The second is use for length frequency in age decomposition analysis. There is a possibility that length frequency data aggregated by month could be shared, but we would first need to check the legal aspects of this in the context of the confidentiality rule.

Japan [2017]: We expect response from Australia whether the length-weight parameters for farmed fish in our analysis shown in CCSBT/ESC/1208/30 were quite different from those calculated from data they may have. For the analysis of length frequency in age decomposition, detailed size data in CDS are better to use because it covers many years, 100% coverage of farmed fish, and may allow all scientists in CCSBT member/ external panel/ independent reviewers for analyses including evaluation of our methodology.

2-6. Australia [2016]: Japan's issues with the 100 + <10kg fish: The current Australian sampling takes the actual length/weight of ~3,000 SBT over an extended fishing season. All the available literature, including from Japan, suggests this method of sampling, by excluding fish <10 kg biases upwards the fish size sampled. Does Japan have information which contradicts this?

Japan [2016]: We accept this reasoning in regard to the exclusion of these low weight fish from the sampling. Our concern is that other sources of bias more than offset this effect.

Conclusion

Exchange of opinions like this process is constructive and welcome one. All the points explained by Australia in 2016, including linearity assumption of growth in length, influence of tag implementation on fish growth, origin of age composition data, interpretation of growth of Pacific bluefin tuna farming, have already been taking into account in Japanese analysis or not applicable. We need further explanations from Australia for the large biases of farmed SBT between reported and estimated by Japan, in growth, age composition and total catch.

In order to reduce uncertainty more, detailed size data in CDS are better to use because it covers many years, 100% coverage of farmed fish, and may allow all scientists in CCSBT member/ external panel/ independent reviewers to analyse including evaluation of our methodology.

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Attachment 1

Concern for impact of tag attachment on growth

Followings are description in CCSBT-ESC/1509/32(Rev), page 22-23.

Concern for impact of tag attachment on growth

Concern was made for conventional tags attachment on growth (Jeffriess 2014). It claimed tagging data were inappropriate for growth study because it give serious impact on SBT as shown in Hampton (1986).

Through examination in peer reviewed literatures including Hampton (1986), we conclude that tag attachment does not affect growth, especially in body length, of tunas seriously.

It is well known that conventional tagged tuna resume feeding immediately, and resulted in recaptured in pole-and-line in several times in successive days (Hallier and Fonteneau 2015). In SBT, the most frequent period in Hampton (1986) in which fish released with conventional tags recaptured, presumably by pole-and-line, was 6-10 days after release. Jeffriess (2014) referred Itoh et al. (2003) that observed less frequent feeding after release in PBF, but such a reference was inappropriate because it was "archival tagged" fish implemented in fish body cavity with surgery. The paper compared growth and fatness of recaptured fish against wild fish and did not report severe influence in short period at liberty.

Hampton (1986) compared the condition factor (W/L^3) of recaptured tagged fish to untagged fish. 94% of tagged fish were at liberty less than 20 days. He reported mean condition factor of tagged fish was 93.36% of that in wild fish. This method is indirect comparison between different individual and there is criticize. "*This method (deviations from the expected relationship) has recently been criticized as inaccurate and irrelevant to condition and likelihood of survival (Green, 2001).*" (Willis and Hobday 2015).

Hearn and Polacheck (2003) concluded, with referring Hampton (1986), that tagging had no substantial effect on the growth in body length even within the first 30 days. "*With respect to tagging effects, Hampton (1986) and Hearn (1986) have shown that there can be a significant weight loss of 7–12% for tagged fish in the first month after release. However, tagged fish recover this weight loss within a year at liberty, and there is no apparent difference between tagged and untagged fish after this time (Hearn, 1986). (There is little information available on weight loss of tagged fish at liberty between one month and one year.) In terms of length, Hearn and Hampton could not detect a reduction of growth from growth increment residuals in the tag-return data even within the first 30 days after release. Limited* *data from the effect of handling and tagging fish in commercial farm pens indicated no retardation in growth in length after 150 days. These farm fish did show a loss in weight when first caged, but the weight was regained over a period of a few months (Anonymous); therefore we do not think that tagging had any substantial effect on the growth rate of tagged fished in our study.*"

References

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