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Verification of All Members' Catch through Monitoring of Southern Bluefin Tuna Product Distribution

-Report-

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1 Introduction

The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) has been using data from Japan's markets for over 15 years as a means of understanding whether there may be fish entering trade that are not otherwise accounted for in official catch records. Much of the analysis presented to CCSBT by its Members over the years is based on the findings of the independent market review panel published in 2006 (Lou et al. 2006). However, recent analyses have also recognized that there have been notable changes in the fishery and markets over time such that previously specified methods and parameters may no longer apply. With this in mind CCSBT decided in 2021 to commission a new independent study with the objectives of:

A. Updating and applying methods for estimating the amount of southern bluefin tuna (SBT) product distributed in Japan's markets that is caught by Japan;
B. Developing and applying methods for estimating the amount of SBT product distributed in Japan's markets that is caught by Members other than Japan; and
C. Assessing the total amount of SBT product distributed in Japan's markets relative to the global total in order to evaluate the utility of further study of Japan's markets.

This document presents the results of additional and focused study undertaken subsequent to the agreement of the Work Plan transmitted to Members in January 2022 and accepted in March 2022. This document should be read in conjunction with the Work Plan (Annex A) which provides a detailed analysis of the market data formula as well as data sets that could be used as inputs to the formula[1]. Some of the information in this document was released in the form of a 6 June 2022 Progress Report transmitted to Members as CCSBT Circular #2022/025.

The Work Plan anticipated concentrating on updating several of the key parameters of the formula and implementing a probabilistic approach that reflects the uncertainty associated with each parameter. However, as will be explained below, further work has revealed substantial additional uncertainties and unknowns that cast doubt on the potential for meaningful application of the formula. This document therefore presents the findings from the 2022 work but does not deliver updated formulae and input parameters as envisaged by the study's terms of reference (Objective A). Since the simpler catch verification exercise for Japan-caught SBT is not considered reliable, by extension the more complex catch verification exercises for other Members is also not considered reliable (Objective B). In accordance with the approach outlined in the Work Plan to focus this study on market and trade estimations relating to Japan, and to combine Japan-based findings from this study with the Secretariat's global market estimates, the inability to produce findings for Japan prevents drawing conclusions on the relative importance at the global level (Objective C). As a result this study has been substantially curtailed and re-orientated in comparison to the effort estimated in the Work Plan.

The remainder of this report consists of a description of inputs to this study, including the findings of the Work Plan and data that have become available since the Work Plan was

[1] Issues raised in the Work Plan regarding the application of lag coefficients were resolved in the response to comments process (Annex B) with the result that the lag coefficients given in Itoh et al. (2020), Attachment 6 (as shown in Annex A of the Work Plan) were confirmed to be correct. Since the simulations presented in Section 2.2.3 of the Work Plan were based on the correct lag coefficients those results remain valid.

produced (Section 2); a succinct and updated analysis of each parameter used in the market formula and issues associated with applying the formula (Section 3); and ideas for alternative approaches (Section 4). It is noted that Section 4 is outside the original terms of reference for this study but was undertaken on the basis of CCSBT Circular #2022/034 which allows for outlining of alternatives.

2 Inputs to this Study

2.1 Simplified Overview of Work Plan Findings

The market formula proposed by the Japan Market Review Panel (JMRP) in 2006 has been analysed in the Work Plan through summarization of the inputs used over the years, a sensitivity analysis and a probabilistic simulation. Those detailed results are briefly summarized here as follows:

- Some important input parameters, namely *p*, *d* and *r* which extrapolate observed market quantities to the amount in Japan's markets as a whole, have been fixed at their current values since 2006 despite widely acknowledged changes in market channels (Work Plan Table 1); these parameters were specified largely on the basis of expert opinion because there were, and apparently still are, few statistical data available to inform them (Work Plan Section 2.3.3);

- Single factor sensitivity testing shows that two of the above extrapolation factors (*p* and *r*), along with the quantity of SBT recorded in Tokyo municipal market auctions (*To*) and product to whole weight conversion factors (*c*), are the most influential components of the formula (Work Plan Table 2);

- Using a simulation approach that allows parameters to vary around their specified median values by small ("tight" scenario) and large ("loose" scenario), but not unrealistic, amounts demonstrates that the formula results may vary by up to 2000 t ("tight") or up to 5000 t ("loose") (Work Plan Figure 2);

- As shown by these results, given the compounding of uncertainty when multiple parameters are varying simultaneously, it can reasonably be queried whether the formula can provide a sufficient basis for decision-making without significantly more accurate and precise specification of input parameters (Work Plan Section 2.2.3).

2.2 Description of Resources Consulted in the Post-Work Plan Phase

The Work Plan provides a detailed description of data used in previous market estimate work and publicly available data through December 2021. The work conducted since March 2022 has thus focused on obtaining new non-public data and interviewing those with detailed knowledge of the SBT fishery and its markets. Brief summaries of existing data, both new and previously known, are included below as background for the technical findings presented in Section 3.

2.2.1 *Japan Government*

The Japan government was consulted on numerous occasions in person and through correspondence. Representatives provided considerable new data as well as introductions to key stakeholders.

In late March, the Japan Fisheries Agency (JFA) provided a report describing a comprehensive programme of data collection which has been underway for the last 10 years to support the parameters in the market monitoring formula (Itoh & Hitomi 2022). Some of these data have been provided to CCSBT in Japan's annual market monitoring papers (and were thus accounted for in the Work Plan), but the report also contains data that have not previously been provided. The report, and some of its underlying data, were furnished as a reference for this study on the condition that it not be shared without the permission of JFA. The content of the report is discussed, in conjunction with the relevant technical issues that it informs, in Section 3.

JFA identified points of contact for five auction houses at Toyosu market, two international trading firms, one fishing and processing company in Yaizu, and Japan Tuna. Information on landings procedures and landings data were requested but not received.

2.2.2 *Tokyo Metropolitan Government*

As has been documented in previous studies, the Tokyo Metropolitan Government (TMG) collects and disseminates statistics for its central wholesale markets which, for fish, include Toyosu (formerly Tsukiji), Adachi and Ota (TMG 2022). Toyosu is the main market handling SBT, although small amounts of both fresh and frozen SBT continue to be traded through Adachi and Ota markets. These data have formed the core of the market formula, i.e. the *To* parameter (Work Plan Section 2.3.1). The following provides a summary of the types of data available:

a. **The weight, value and unit value of SBT (印度まぐろ when written in Japanese) in fresh or frozen form**[2]. Queries regarding frozen fish return the weight, value and unit value of SBT by month and by market regardless of origin, whereas queries regarding fresh fish return weight, value and unit value of SBT by month and by market partitioned into domestic production and imports. As noted in the Work Plan (and previous papers by Members) there is not likely to be any provision of fresh SBT from domestic vessels, therefore it is not known why the TMG statistics continue to record domestic fresh SBT (e.g. 5.8 t in April 2022). These data have been used to annually update the market formula in Member's papers presented to date. A useful example of these data was presented as Figure 13 in Sakai et al. (2019).
b. **The prefecture to which the SBT was dispatched in fresh and frozen form[3].** These data are available by month and by market, and tally to the totals presented under a) above (in other words, all SBT sold within Tokyo municipal markets is accounted for in the dispatch data). In recent years over half of the total SBT dispatches were to Shizuoka prefecture and another ~20% were dispatched within the Tokyo metropolitan area. It is important to note that these dispatch data cannot inform the market formula extrapolation factors relating to

[2] https://www.shijou-tokei.metro.tokyo.lg.jp/asp/smenu2.aspx?gyoshucd=2&smode=10
[3] https://www.shijou-tokei.metro.tokyo.lg.jp/asp/smenu3.aspx?gyoshucd=2&smode=20

trading within and outside other municipal markets because they only provide the prefecture of destination. These data have not been used to date.

The daily amount of SBT handled in auctions (せり (SERI-verbal bidding) or 入札 (NYUUSATSU-written bidding)) and negotiated sales (相対 (AITAI))[4]. These data are available for SBT in fresh and frozen form (いんど冷凍 (INDO REITOU) and いんど生鮮 (INDO SEISEN)) by market and show the number of kilograms traded each day. They do not indicate the sizes traded or the source (domestic or imported). Data are presented in two forms: forecast sales (卸売予定数量 (OROSHIURI YOTEI SUURYOU)) and achieved sales (販売結果 (HANBAI KEKKA)). These data have not been used to date. An example of these data was presented as Figure 12 in Sakai et al. (2019).

In order to address questions raised by Members about the nature of these data and the potential availability of other data, the TMG central wholesale market public information officer (中央卸売市場広報担当 (CHUUOU OROSHIURI SHIJOU KOUHOU TANTOU) was contacted. This officer, based in Shinjuku, was helpful but referred specific queries about SBT to his counterpart at Toyosu. The counterpart refused to accept an appointment for a meeting and insisted that all the data they hold are published. As he mentioned several times that these issues should be approached via JFA, on request JFA subsequently contacted the same individual but received the same information.

2.2.3 Commercial Data Clearinghouses

There are several companies that provide Japan market data for a fee. Foremost among these is the Jiji Press (時事通信社) OSAKANA-DX service[5]. This subscription service is designed to provide traders with up-to-the-minute auction information via smart phone. The information is restricted to use within Japan and is costly to subscribe to (33,000 yen per year)[6]. A free one-month trial subscription was used to check the contents of the service. This revealed that with two important exceptions, much of the data presented is already available from TMG and other government services (e.g. Yaizu and Osaka markets). The first exception is the listing of numbers of auctioned SBT at Toyosu by size ("small" and "large") and production area. Unfortunately, the production area information was highly aggregated (e.g. "Cape Town, Australia SW offshore" is a common entry) and in some cases suspect (e.g. "East (China) Sea"). Since the market formula uses weight, the OSAKANA-DX's data on number of fish auctioned is interesting but not particularly relevant[7]. The other exception was Jiji's monthly surveys of landings at 32 ports which record SBT as a separate category. Further investigation, however, revealed that the only port recording landings of SBT was Yaizu and that information is available online from the Yaizu Fisheries Cooperative

[4] https://www.shijou-nippo.metro.tokyo.lg.jp/SN/SN_Sui_Nengetu.html
[5] https://www.jiji.co.jp/service/osakanadx/
[6] There is also a note on the OSAKANA-DX website that states that the data cannot be used outside of Japan. This restriction could influence the use of the data for official CCSBT purposes.
[7] Australian stakeholders have requested a comparison between the Jiji Press size data from auctions and catch records showing size held by the Japan government. These catch data were requested for this study but were not provided, and so the requested comparison could not be performed under this study. Furthermore, the Jiji Press size data, even if compiled from daily auction records accessed through the subscription service, would only represent a small portion of the SBT entering the Japan market and thus the representativeness of this sample would be questionable. Therefore, it is not clear what conclusions would be able to be drawn from such a comparison.

Yearbook (YFCA 2022). In summary, there was no relevant and useful information in OSAKANA-DX that is not already available elsewhere. An example of the Jiji Press data was presented as Figure 14 in Sakai et al. (2019).

One stakeholder introduced the Fisheries Product Power Databook[8] as a primary source of intelligence for their work. Once again though, upon inspection most of the data contained in this compendium are available through government sources, and in the remaining data tuna species are aggregated making it impossible to derive statistics specific to SBT.

2.2.4 Communications with Industry Stakeholders

Japan Stakeholders

A number of industry stakeholders were interviewed with the aim of obtaining expert input on the use of market data and extrapolation factors. These stakeholders included representatives of the five auction houses operating at Toyosu, two of the largest trading companies (and their subsidiaries) handling SBT in Japan[9], and several fishing companies and/or traders operating out of Yaizu. While in Yaizu, an auction of SBT and a landing of SBT were observed.

Discussions with these stakeholders were wide-ranging and specific points of information gleaned from these discussions are presented in Section 3. However, all interviewees agreed that the market structure had shifted considerably since 2006 and that given the large number of unknowns it would be difficult to use current market data to verify catches. Despite this relatively pessimistic outlook for the study, several stakeholders welcomed the idea of revisiting the methodology particularly if it could contribute to a more positive reputation for the industry.

Australian Stakeholders

All consultation with Australian stakeholders was conducted through the Australia SBT Industry Association (ASBTIA). This mostly took the form of provision of data and posing of questions by ASBTIA.

Over 20 datasets were provided, most of which had already been identified by this study. Datasets that had already been sourced included government market (TMG and other municipalities) and customs data. Because detailed references regarding the source of these data were not provided, considerable time was required to verify that the provided data matched public domain sources and were not "new" data that had somehow been overlooked. Non-public Jiji press data were also provided which cannot be sourced independently without a subscription and are potentially subject to use limitations as described in Section 2.2.3 above. These data could not be cross-checked as the one-month Jiji trial subscription had expired. Data gathered from the websites of conveyor belt sushi chains (KAITENZUSHI) and one of the Tokyo-based auction houses were also provided. Both the Jiji (see Section 2.2.3) and KAITENZUSHI datasets were not considered relevant to the Work Plan and so were not explored further. Since the auction house data should be included in the TMG data it was also not pursued.

[8] http://www.suisantsushin.co.jp/powerdatebook.html

[9] These two traders handled nearly 50% of the SBT imported by Japan in 2021 according to CCSBT CDS data (the remaining 50% was handled by 36 other companies).

Numerous questions were posed by ASBTIA, many of which have been raised in previous submissions by Australia to CCSBT. The main line of inquiry pertained to accessing and clarifying data on the Toyosu market. Such questions included:

- Does TMG hold data on the country of origin and size of auctioned fish? (see Section 2.2.2)
- How does the quantity of SBT recorded in TMG statistics align with the quantity of SBT reported in the annual Toyosu auctioneer surveys conducted by Japan? (see Section 3.4.2)
- Can the amounts of auctioned (SERI·NYUUSATSU) and negotiated (AITAI) sales be separated in the annual Toyosu auctioneer surveys? (see Section 3.4.3)
- Can the absence of frozen farmed SBT from the auctions since 2015 be confirmed? (see Section 3.4.3)

Other questions included:

- Are SBT exports from Japan mainly body parts rather than meat? (see Section 3.9)
- Is it possible to compare catch size data with market data? (see Footnote 7)
- Can Jiji Press data be used to understand the market share of Tokyo and Yaizu markets? (see Section 2.2.3; Jiji Press data are not necessary for this—see Section 3.3)
- Are all the SBT auctioned at Yaizu caught by Japan? (see Section 3.2.2)

To the extent that these questions are relevant to the market estimation formula, they were taken into account in the work reported here. Answers can be found in the Sections marked in parentheses after each question.

3 Post-Work Plan Findings regarding the Existing Formula

The remainder of this section describes a number of findings that in aggregate cast substantial doubt on the viability of using market data in a formula designed to verify catches of SBT. Some of the issues raised may be addressed with additional data collection but for others there is no easy solution (see Section 3.13).

This discussion is organized around the parameters that appear in the formula. For each parameter, there is a description of the information available at the beginning of this study ("existing usage"), an explanation of the information provided to or gathered under this study ("new information"), and the remaining issues and outlook for resolving them ("outstanding information"). A final issue relating to uncertainty in catch data is presented in Section 3.12, followed by an overall summary in Section 3.13.

The original market formula (based on the methodology developed by Lou et al. (2006) and first written as a formula by Sakai et al. (2010)) is reproduced below as Equation 1, and in graphical form as Figure 1, for reference. Upper case letters represent quantities expressed in tonnes of SBT; lower case letters represent parameters expressed as proportions:

$$M_t = \left\{ \frac{\left(\left(\frac{To_t + Ya_t}{p} \right) - F_t - d_t - i_t + S_t \right)}{r} + E_t \right\} \times c_t$$

where

Eq. 1

M_t is the total quantity of Japan-caught SBT in Japan's markets in year t

To_t is the quantity of frozen SBT (regardless of origin) sold through Tokyo metropolitan wholesale markets in year t

Ya_t is the quantity of frozen SBT (regardless of origin) sold through the Yaizu fish market in year t

p is the proportion of frozen SBT sold in Japan's municipal wholesale markets that is sold in Tokyo and Yaizu

F_t is the quantity of frozen SBT sold in Japan's municipal wholesale markets in year t that is farmed (i.e. assumed not to be Japan-caught)

d_t is the proportion of frozen SBT sold in Japan's municipal wholesale markets in year t that is double counted

i_t is the proportion of frozen wild SBT sold in Japan's municipal wholesale markets in year t that is imported (i.e. assumed not to be Japan-caught)

S_t is the quantity of fresh, non-imported SBT in year t (i.e. assumed to be Japan-caught, if any (see Work Plan Table 1, footnote 6))

r is the proportion of Japan-caught SBT sold in Japan's municipal wholesale markets

E_t is the quantity of frozen Japan-caught SBT exported in year t [10]

and

c_t is the conversion factor to adjust market-observed quantities to their whole weight equivalents.

In order to compare the market quantity estimated in a given year to the reported catch in that same year it is necessary to account for lags (i.e. the time between catch and appearance in the market) as first investigated by Itoh et al. (2008). The existing formula for six lags can be written as:

$$c_t = \sum_{l=0}^{6} \Theta_{t,l+1} M_{t-l} \qquad \text{Eq. 2}$$

where

c_t is the estimated quantity of SBT caught by Japan in year t

l is the number of lags, in this case six (l=1 to 6), plus the current year (l=0)

$\Theta_{t,l}$ is a matrix of dimensions t (years) and l (lags) with each corresponding to the proportion of the market quantity observed in year t which derived from each lag l (or the current year, l=0)

M_t the total market observed quantity of SBT in each year t.

[10] Note that although this formula is as presented in papers submitted to CCSBT over the years, in most calculations exports have been converted to whole weight before being summed with other quantities. While this makes no difference mathematically, the term E_t should be placed outside the large bracket (i.e. to avoid converting the quantity E_t twice) in order to be consistent with historical calculation methods.

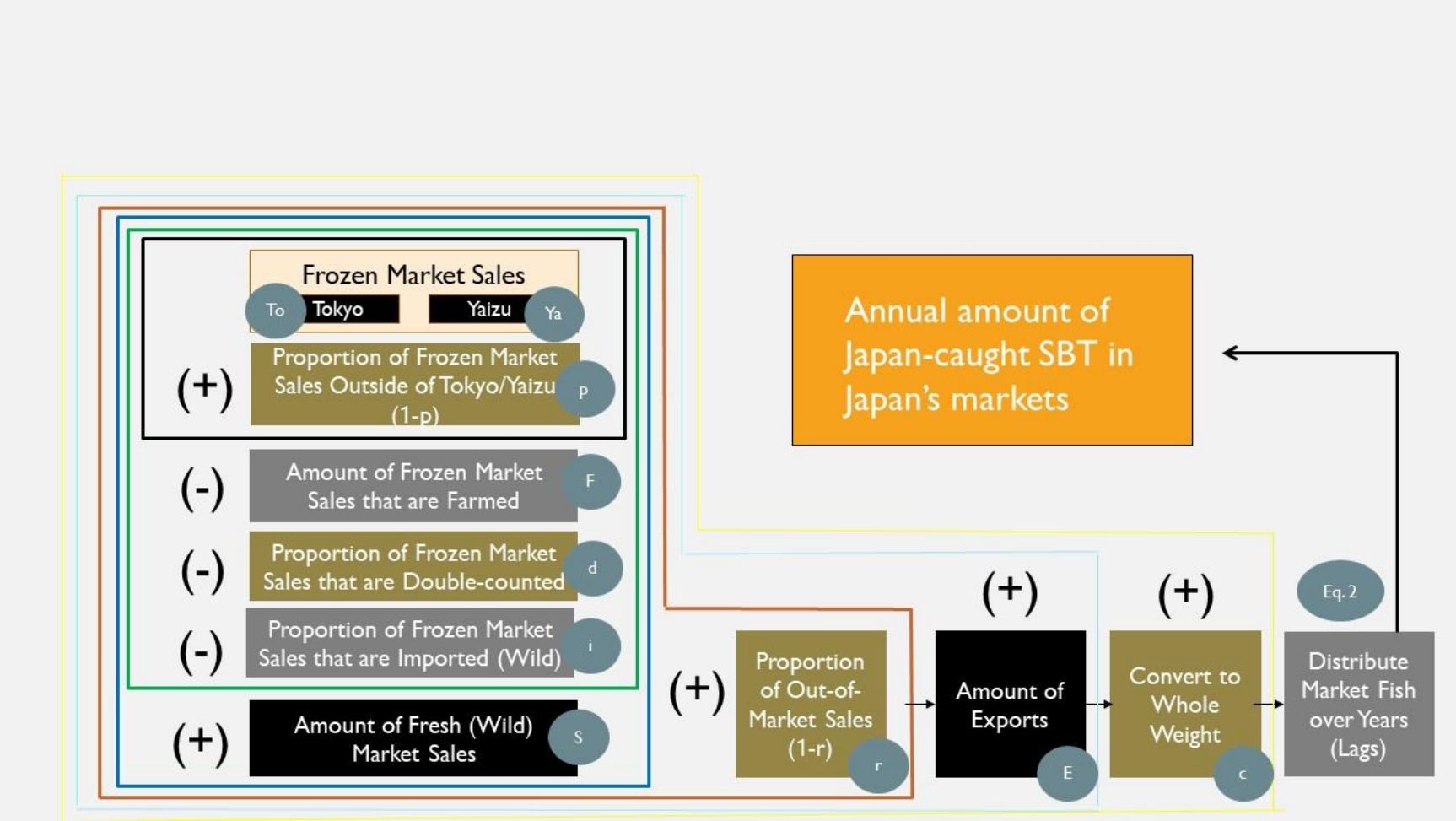

Figure 1. Graphical representation of the existing formula for estimating the total quantity of Japan-caught SBT in Japan's markets (Eq. 1). The results are then distributed over years to account for lags (Eq. 2) before being compared to reported catches by Japan. Blue circles represent the inputs to the formula. (+) or (-) indicates that quantities would rise or fall at this step. Colored outlines refer to the sequential steps taken in the calculation.

3.1 Quantities Reported in Tokyo and Yaizu Auctions (*To, Ya*)

3.1.1 Existing Usage

The core of the market formula is the number of frozen SBT recorded in auction sales records in Tokyo (*To*) and Yaizu (*Ya*). As shown in Eqs. 1 and 2, and Figure 1, these quantities are summed and then adjusted through multiple steps to produce a result that is compared to catch records. It was acknowledged in previous studies that the quantities *To* and *Ya* contain some double-counting of SBT (i.e. for the purposes of this report defined as an individual fish counted more than once) but double-counting adjustments were limited to processing within a market (i.e. the same fish counted in processed and unprocessed form) and inter-market transfers (i.e. the same fish counted in one market and then sent to another market where it is counted again for the final time)(Lou et al. 2006). This was accounted for in previous studies by the double-counting factor *d* (see Section 3.5).

3.1.2 New Information

In this study multiple interviews with Japan industry stakeholders since March 2022 revealed that it is not unusual for the same fish to be bought and sold multiple times (in fact more than two times and as many as seven times according to interviewees) sometimes in the same market and often in the main markets of Tokyo and Yaizu. According to interviews this results from a desire to maximize the value of each fish with the auction being the mechanism to do this. Specifically, if a seller is not satisfied with the auction price obtained for a certain fish, the seller will buy back the fish and auction it again, hoping to obtain a higher price than the buy-back price. This is an additional and common type of double-counting that was not envisaged in the original market formula, nor the formula proposed in the Work Plan (Section 2.4.1, Eq. 5). It has a potentially large effect on the reliability of the core *To* and *Ya* quantities which is not accounted for by the current estimate of *d* (see Section 3.5). Regardless of whether this new form of uncertainty is handled within the *To* and *Ya* parameters or incorporated into *d*, interviewees claim that it is impossible to specify what proportion of fish are handled in this way, how many times they may be bought and sold, which markets are involved, and to what extent these transactions would be recorded in market statistics.

3.1.3 Outstanding Information Needs

Values for the parameters *To* and *Ya* can be obtained annually from publicly available market statistics. However, from the above discussion it is now clear there is uncertainty in these values and this uncertainty should be captured in the market formula. One means of estimating the uncertainty was explored through an analysis Japan's tag reading auction surveys. The analysis was conducted by the CCSBT Secretariat to examine how many identical tags were read on different survey dates and thus how many individual fish might appear at auction more than once. Of over 100,000 records, full tag numbers were available for approximately two-thirds (~62,000) and ~3000 tag numbers appeared more than once in the database. However, the majority of these appeared on the same date and so were considered to represent clerical errors. Only a few tag numbers appeared more than once on different dates. Due to the high possibility of multiple appearances of tagged fish at unmonitored auctions (i.e. the tag reading only occurs twice per month (CCSBT 2021a)) it was not considered reasonable to estimate the rate of multiple auction appearances from these data. If the tag reading survey frequency was much higher, e.g. daily over several

months to a year, it might be possible to robustly estimate this new form of double-counting in the monitored auctions. It would not however inform about double-counting between markets with and without tag monitoring (this would need to be handled under *d*, see Section 3.5) or about how this double-counting might affect the proportional share of different markets (*p*, this issue is discussed in Section 3.3). Finally, the success of such tag monitoring surveys would depend on the tag remaining attached to the fish up until the point of the survey. Although many tags do remain attached beyond the first point of sale--which is the current CCSBT requirement for domestic product (CCSBT 2021b)—removal of tags could bias the estimates.

3.2 Yaizu Auction and Landings Data (*Ya*)

3.2.1 Existing Usage

The JMR Panel report (Lou et al. 2006) states on p. 74 "*The statistical documents on SBT in the Yaizu market are made up of 2 types, "water uptake" and "land transport". However, the SBT that is transacted at Yaizu market in reality was found to be comprised of "land transport".*" On this basis the JMR Panel excluded the "water uptake" figures from the formula (i.e. excluded them from *Ya*).

3.2.2 New Information

Further investigation conducted for this study has confirmed that this approach is correct. "Water uptake" (水揚げ、MIZUAGE) refers to landings which always go directly to the cold store. "Land transport" （陸送、RIKUSOU) refers to amounts brought from cold stores to the Yaizu auction. Some SBT may be enumerated in both MIZUAGE and RIKUSOU figures, whereas as other SBT may be recorded only in MIZUAGE (i.e. they are landed but not auctioned) or RIKUSOU (i.e. they are auctioned at Yaizu after being landed somewhere else).

In May 2022, an auction and a landing were observed in Yaizu. At the auction 68 SBT caught by Japanese and Korean vessels in fishing grounds off southeast Australia or Cape Town were sold[11]. Conversations with several fishing industry and trade representatives confirmed that fresh SBT are not handled in Yaizu. Several of the auctioned SBT were >40kg and this was explained to be a common occurrence due to demand for large fish in Yaizu for processing there and distribution to nearby markets.

3.2.3 Outstanding Information Needs

The MIZUAGE (landings) data published in the yearbook of the Yaizu Fisheries Cooperative Association (YFCA 2022) represents the only publicly available landings data set specific to SBT that could be identified in this study. The amount reported landed at Yaizu in 2020 was 1,831 tonnes which is approximately 31% of the total catch reported by Japan in 2020 (5,929 t)[12]. Landings reported at Yaizu in 2021 were 2,881 tonnes (YFCA (2022)) which would represent 45% of the total catch reported by Japan in 2021 (6,452 t (CCSBT Secretariat, pers. comm., July 2022)). The publicly available landings data for Yaizu provide a potentially useful, though partial, indicator of the flow of SBT into Japan, particularly if

[11] It was observed that three of these SBT did not have CCSBT tags attached.

[12] Note that SBT from non-Japanese vessels may also be landed in Japan, including Yaizu.

they could be compared to CDS data. Unfortunately, the CDS "point of export" data are not sufficiently specific to make this comparison (see Section 4.1.6). Other landings data that would allow quantification of the proportion landed in Yaizu, i.e. versus other ports, were not available to this study.

3.3 Market share of Tokyo and Yaizu as compared to other municipal markets (*p*)

3.3.1 Existing Usage

The share of frozen SBT in Japan's municipal wholesale market system that is handled by Tokyo and Yaizu (*p*) is used in the formula to extrapolate the quantities in Tokyo and Yaizu (*To* and *Ya*) to other key municipal wholesale markets before any further adjustments are made. Based on the JMR Panel's compilation of statistics from up to 16 markets[13] for frozen SBT in 2005, the proportion of the total market for frozen SBT passing through Tokyo and Yaizu has been fixed at 0.79 since 2006.

3.3.2 New Information

Recently Japan has compiled frozen SBT data from statistics published by 12 markets (Itoh & Hitomi 2022). These data show that the proportion of frozen SBT handled by Tokyo and Yaizu (i.e. versus other markets) varies between 0.84-0.87 in the last five years. Interviewees consulted for this study also remarked that the proportion should be somewhere around 0.80.

3.3.3 Outstanding Information Needs

Although there appears to be general agreement amongst sources on the most likely value of *p*, it is not clear whether there is some relationship between the market share of Tokyo and Yaizu markets and the extent to which double-counting occurs in these markets (see Sections 3.1 and 3.5). For example, if most of the double-counting occurs in Tokyo and Yaizu, the market share of these markets may be over-estimated from sales statistics. Given the difficulties with estimating this type of double-counting (see discussion of *d* in Section 3.5) it appears impossible to properly evaluate this potential bias. Furthermore, as noted in the Work Plan, according to the JMR Panel report (Lou et al. 2006) each market has its own reporting conventions (e.g. reporting auction sales only (SERI·NYUUSATSU), or reporting both auctioned and negotiated sales (SERI·NYUUSATSU+AITAI)), and this could also lead to biases. In summary, it is possible to use Japan's updated estimate of *p* (see Section 3.3.2) but the extent to which this value is made uncertain by double-counting and/or reporting biases in individual markets is unknown. It is therefore impossible at this time to objectively specify this parameter in a probabilistic manner. Tag monitoring at a greater number of municipal markets and a more thorough investigation of reporting conventions for individual markets would address this issue to some extent but might not resolve it.

[13] The exact number of markets included is given as 14 on p. 63 of Lou et al. (2006) and as 16 on p. 36. Another 15 markets were listed which might handle SBT but do not maintain statistics on it (Lou et al. (2006) p. 36-38). At present there are 41 municipal wholesale markets listed on Japan's Ministry of Agriculture, Forestry and Fisheries website (https://www.maff.go.jp/j/shokusan/sijyo/info/link.html)

3.4 Amount of frozen SBT in Japan's municipal markets that is of farmed origin (*F*)

3.4.1 Existing Usage

The parameter *F* is necessary to remove quantities of frozen farmed SBT as these would not be part of Japan's catch. In the existing market formula, *F* is derived from surveys of the five major wholesalers at Tokyo Metropolitan Government wholesale markets (predominantly Toyosu but occasionally including Adachi or Ota). This approach was adopted because the only markets that are thought to handle frozen farmed SBT are the Tokyo markets.

3.4.2 New Information

Further analysis revealed that the value of *F* is obtained by providing each of the five Tokyo wholesalers with the quantity of frozen SBT it handles based on the TMG marine products yearbook which reports quantities of frozen SBT by company (TMG 2021). The wholesalers then simply fill in the splits from the total amount provided according to how much was farmed and how much was wild.

Questions have been repeatedly raised about whether the values of *F* are based on both auction (SERI·NYUUSATSU) and negotiated sale (AITAI) quantities. Interviews with the five major wholesalers in Toyosu dealing with SBT confirmed that the quantities they report reflect both their auction and negotiated sales within the market. This can also be verified by comparing the company-specific SBT tallies in TMG (2021) to the auctioned and negotiated SBT sales tallies on the TMG website (TMG 2022), i.e. they are the same. Obviously, neither of these reported amounts reflect sales of frozen SBT (farmed or wild) outside of the market.

3.4.3 Outstanding Information

There have been suggestions that since all frozen farmed SBT are now handled as negotiated sales (this point was confirmed in the interviews), the wholesaler surveys should be modified to specifically request the amounts of frozen farmed SBT in negotiated sales (since the amount handled in auctions would be expected to be zero). Wholesalers were asked if they could report auctioned and negotiated sales quantities by wild and farmed sub-categories. Some wholesalers confirmed they could, whereas others explained that their sales systems do to not track auctioned and negotiated sales quantities separately. In any case, it is unnecessary to pay attention to the type of sale because a) *F* is a quantity, not a proportion and b) both auction and negotiated sales are included in the total provided to the wholesalers and the wholesalers account for all farmed frozen SBT they handle within the market when answering the question. In summary, the current method for deriving *F* is sound and no changes to the current methodology are recommended. It should be noted that continued use of the market formula will require specific survey effort to obtain *F* as it is not otherwise public domain information.

3.5 Proportion of frozen SBT sold in Japan's municipal markets that is double-counted (*d*)

3.5.1 Existing Usage

The double-counting parameter *d* is the only parameter in the original formula on which the JMR Panel could not agree. This has necessitated the presentation of the formula results in the form of two cases since 2006. Case 1 includes both double-counting due to processing (i.e. an individual fish counted whole and then again in processed form) and double-counting due to single transfers between markets (i.e. the same fish counted in one market and then sent to another market where it is counted again (for the last time)); Case 2 included only the double-counting due to processing. The value of *d* produced by the two cases differed but was not large (0.04 versus 0.12). The JMR Panel methods for deriving *d* varied from market to market. The Work Plan found these methods to be confusing, subjective and difficult to replicate, particularly given that this and future studies will not be able to revisit all of the markets surveyed in 2006.

3.5.2 New Information

The report produced by Japan based on data collected since 2012 (Itoh & Hitomi 2022) does not present any new data to inform *d*. Instead, it applies both the Case 1 (0.12) and Case 2 (0.04) values and two additional, arbitrarily defined cases of 0.02% and 0%. The rationale for these new values is not clear, particularly given the information presented above which would suggest that a double counting correction factor could be considerably higher, rather than lower, compared to the Case 1 value (0.12).

3.5.3 Outstanding Information

No information is available to robustly specify any of the following potential forms of double-counting as they currently occur: 1) counting of the same fish in whole and processed forms; 2) counting of the same fish in multiple markets (perhaps more than twice); 3) counting of the same fish in the same market (perhaps more than twice). In addition to potentially being out-of-date, the 2006 estimates of *d* were a) derived from a poorly documented methodology; b) not agreed upon within the JMR Panel; and c) do not account for all forms of double-counting above, therefore they should not be used as the basis for new inputs to the market formula. Aside from the difficulty of specifying the most likely value of a double-counting correction factor, it is perhaps even more difficult to specify the uncertainty around that factor. Tag monitoring at a much increased rate (to address the third type of double-counting) and over a much wider range of markets (to address the second type of double-counting) might provide a basis for better estimates but only if tags remain attached and readable (see Section 3.1.3 for a more detailed discussion). Tags are not expected to remain attached for sufficiently long enough to address the first type of double-counting, thus another approach will be necessary. Issues relating to *d* are some of the most important and yet intractable problems facing further use of the market formula.

3.6 Proportion of frozen SBT sold in Japan's municipal markets that is imported (*i*)

3.6.1 Existing Usage

In the original version of the market formula the JMR Panel subtracted a flat rate of 5% to account for frozen wild SBT that were caught by countries other than Japan and sold in Japan's municipal markets (*i*). In subsequent years, Japan has conducted twice monthly monitoring of Tsukiji/Toyosu auctions to count the number of auctioned fish of foreign origin. Part of the resulting data series (December 2007 to December 2019) was provided to CCSBT in Itoh et al. (2020; Attachment 3). These data indicate that the proportion of imported fish by weight ranged from 29-47% based on annual sums of domestic and imported fish observed[14]. Japan has used these auction data to calculate *i* as an input to the market formula for many years.

3.6.2 New Information

Japan's recent report on market monitoring results (Itoh & Hitomi 2022) provides the 2021 monthly auction monitoring data. The most recent values in the time series (2015-2021) suggest the proportion of imports is approximately one-third (33%), although the 2020 value is slightly higher (38%, unpublished data) and the 2021 value is slightly lower (29%; Itoh & Hitomi 2022).

One concern raised in the Work Plan was how the presence of farmed fish in the auctions was handled[15]. Japan has explained that all tagged fish observed at auctions are recorded in the database but farmed fish were excluded, as is proper, before calculating the proportion of frozen wild SBT that were imported. Japan also reports that the numbers of such fish have always been small, and it is noted that this issue is less important now that many sources suggest frozen farmed SBT are no longer auctioned at Toyosu.

In July 2022 Japan reported a correction to the data series for *i* (Japan Fisheries Research Agency, unpublished data). The need for this correction arises from an inadvertent inclusion of fresh SBT in the Tokyo auction sampling since 2018 which caused an over-estimation of the value of *i*. Rather than approximately one-third of the frozen wild auctioned SBT being imported, the correct value is currently on the order of one-fourth or one-fifth (18-25%). (This correction causes the market estimate to rise by approximately 500 t (Japan Fisheries Research Agency, unpublished data)).

Another question raised in the Work Plan pertained to the full list of countries that were observed to be the sources of imported SBT in Tokyo auctions. In the data presented by Japan to date, Korea and Taiwan are indicated separately with other countries grouped as "other". Japan has clarified that the "other" fish include frozen wild SBT from Australia and New Zealand as well as those of unknown origin.

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[14] The value for 2016 is missing from Attachment 3 of Itoh et al. (2020) but can be obtained from Tsuda et al. (2019a).

[15] Farmed SBT would be imported but should not be included in the imported observations here because the formula assumes that all farmed SBT have already been excluded, using *F*. Fresh SBT, which would also be imported as Japan does not produce fresh SBT (see Section 3.7), should also be excluded from the imported observations as the proportion imported (*i*) is applied to frozen fish only.

3.6.3 Outstanding Information

Although annually updated values of *i* based on sampling data are very useful, there are some limitations. Using Toyosu auction observations of imported fish as the basis for *i* assumes that the same proportions apply to all other frozen SBT in Japan's markets (i.e. to negotiated sales at Toyosu, to the auctions at Yaizu and to other municipal markets). Regarding Yaizu, Japan has collected data on the proportions of imported fish at Yaizu auctions over the same time period. These values of *i* have varied from 15-48% between 2008 and 2021 with recent values (2019-2021) averaging 13% (Itoh & Hitomi 2022 and Japan Fisheries Research Agency, unpublished data). If the formula is to be used, it is recommended that the value of *i* specific to Yaizu be applied in the formula to correct the Yaizu totals (*Ya*). This would appear to be a better approach than applying the Tokyo proportion to both Tokyo (*To*) and Yaizu (*Ya*), particularly as Yaizu's proportion of imports is consistently lower. The validity of *i* when applied to the SBT traded in Japan's other municipal markets, and to the SBT traded through negotiated sales[16], could not be verified in this study and remains a source of unquantifiable uncertainty. This information could be read from tags provided that they remain attached and readable, and assuming there is an opportunity for surveyors to access tagged fish. While it is relatively easy for surveyors to access tagged SBT at auctions, obtaining access to the number of samples required for an estimate of *i* for SBT traded through negotiated sales or through markets without auctions would be much more difficult.

3.7 Amounts of "fresh domestic" SBT in Japan's municipal market (*S*)

3.7.1 Existing Usage

The original market formula in the first few years of its application added the quantity of SBT that was recorded in Tokyo market statistics as "fresh domestic" product (*S*), assuming it was SBT caught by Japan. This amount was always very small (<30t). In the latter years of the formula's application it was considered that quantities of "fresh domestic" SBT in Japan's market must be mis-recorded as there is no production of fresh SBT by Japan's vessels. For this reason, "fresh domestic" quantities recorded at Tokyo (i.e. in the TMG statistics, ≤4t per year through 2020) were not tabulated and the need to add these quantities as *S* was eliminated (Sakai et al. 2014).

3.7.2 New Information

Interviews conducted for this study confirmed that no fresh SBT is handled at Yaizu. There are indeed fresh SBT products handled in the Tokyo markets: these would include fresh wild SBT from Australia and New Zealand as well as fresh farmed SBT from Australia. These and any other fresh SBT products observed in Tokyo markets would be imported. The outstanding question is why TMG statistics recorded 118t of "fresh domestic" SBT in 2021 (compared to 496t of "fresh imported" SBT in 2021, i.e. 24% of fresh product declared as "fresh domestic") and 30t of "fresh domestic" SBT in January-May 2022 (compared to 97t of "fresh imported" SBT over the same period, i.e. 31% of fresh product declared as "fresh domestic"). Despite examining daily TMG records it was not possible to clarify the situation,

[16] The five Toyosu wholesalers were asked whether the proportion of imported frozen SBT would be different between the auctions and negotiated sales. Three did not answer. One said that his company only trades SBT via auctions and not negotiated sales; one said he did not know.

but it is difficult to imagine that the recording of such large quantities of "fresh domestic" SBT is anything other than a clerical error or a misrepresentation.

3.7.3 Outstanding Information

Issues associated with "fresh domestic" SBT can be resolved by simply removing these quantities from the equation (either from *To* directly or via *S*) because they are not likely to be Japan-caught. However, it is not clear whose fish these really are, and this would have implications for a market formula to be used to verify all Members' catches. It also casts some doubt on the reliability of the TMG statistics as a whole.

Some of the TMG statistics that are published in yearbook form (not online) show which of the five major Toyosu wholesalers are handling the so-called "fresh domestic" SBT. The yearbook could be consulted to determine which wholesalers are reporting these SBT and this could be followed up with interviews to identify the origin. This question could not be answered by this study because the larger amounts of "fresh domestic" began appearing in 2021 and 2022 and the current version of the yearbook is for 2020 (TMG 2021). This follow-up work appears easy to do; its priority depends on the quantities being reported as "fresh domestic".

3.8 Proportion of Japan-caught frozen wild SBT sold within Japan's municipal wholesale markets (*r*)

3.8.1 Existing Usage

Under the original market formula quantities of frozen SBT in the municipal markets that are caught by Japan and not double-counted must be extrapolated to represent similar SBT traded outside the municipal markets (*r*). The JMR Panel fixed the value of *r* at 0.85 (i.e. 85% of SBT traded within municipal markets and 15% of SBT traded outside those markets), and *r* has remained at this value in papers submitted to CCSBT since 2006 (e.g. Itoh et al. 2020). While it is widely acknowledged that for SBT, as well as for other fish, the importance of the municipal markets as a trade channel has reduced over time (TMG 2021), it is not easy to quantify the reduction.

3.8.2 New Information

The Japan government has calculated the annual percentage of SBT traded within the market (*r*) since 2009 on the basis of self-reporting (sometimes referred to as KIKITORI) by supply chain stakeholders (Itoh & Hitomi 2022). These annual values of *r* have consistently been below 0.85 and varied from a high of 0.77 in 2012 to a low of 0.48 in 2018 (Itoh & Hitomi 2022). The self-reporting programme has succeeded in achieving wide coverage across different stakeholders. A comparison to a list of importers compiled from the CCSBT Catch Documentation Scheme (CDS) records (2020-2021) indicates that >94% of the weight of SBT imported by Japan in 2020-2021 was imported by companies participating in the self-reporting at some point since 2009. This percentage is likely to under-represent the true participation in the KIKITORI since companies may trade under various names (or through subsidiaries) and the analysis for this study cannot guarantee that all such names are known or matched.

3.8.3 Outstanding Information

While Japan's efforts to understand SBT market flows using the KIKITORI are commendable, the method for calculating *r* using the KIKITORI data requires further consideration. The value of *r* reported in Itoh & Hitomi (2022) is derived from self-reported data concerning the amount of frozen wild SBT that is sold to various parties (i.e. to others in the Tokyo municipal market or other municipal markets (i.e. within the market), or to processors, restaurants or other parties (i.e. outside the market)). However, given that *r* is designed to account for SBT that have never entered one of the municipal markets, and thus never been counted in municipal market statistics, calculating *r* based on to whom the SBT is sold is not entirely congruent. This is because some of the respondents recording sales of SBT to parties outside the municipal markets may be selling the SBT from within the market and thus that SBT would have been enumerated in market statistics (and so should not be included in *r*). Although the data underlying the KIKITORI self-reporting survey was provided for this study, the respondents names were anonymized[17] so it is not possible to determine which might be operating from inside the municipal market system. Even if the name of each survey respondent was revealed, it might still be difficult to determine which data should properly be included in the calculation of *r*.

It seems clear that the current value of *r* (0.61 for 2020, according to Itoh & Hitomi 2022) is lower than it was in 2006 (i.e. 0.85). Nevertheless, given the uncertainties in the methodology there appears to be no robust way of specifying the most likely value, nor the expected range of variability around that value, based on existing data. Future versions of the KIKITORI self-reporting form could specifically ask which sales consisted of SBT that were received and sold outside the market, but this would require respondents to split the quantities they handle in ways that might not align with their own recording-keeping. Furthermore, even if the trader could accurately record whether the SBT was being traded outside the market, he would not necessarily know whether the SBT had been included in market statistics before it came into his possession. There is also no known means of correcting for double-counting of SBT by multiple traders responding separately to the self-reporting survey.

3.9 Amount of frozen wild SBT exported (*E*)

3.9.1 Existing Usage

The original market formula made an allowance for SBT that were caught by Japan but are not present in Japan's markets because they have been exported (*E*). The values of *E* have usually been determined by SBT-specific export data published by the Japan Customs Authority multiplied by a conversion factor of 1.15 to obtain live weight. Until 2014 annual SBT exports were below 100t, but from 2014 to 2019 values were consistently between 100-400 t, before falling back to 9 t in 2020 and 96 t in 2021 (all weights in live weight converted from published Japan Customs Authority data (JMOF 2022))[18].

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[17] For the comparison to CDS data, a special list of KIKITORI respondents was requested. The received list showed the name of each company participating in the KIKITORI in each year but, by design, this list could not be matched to the original dataset containing the KIKITORI data provided by each company.

[18] It is important to avoid converting exported quantities to live weight twice: Itoh et al. (2020) shows *E* as being summed with other parameters before being converted to live weight in the formula, but actually

3.9.2 New Information

As for all parameters based on customs statistics there is some uncertainty regarding the true species identity. For example, there is likely to be some error arising from recording other species as SBT, or SBT as other species (or as unidentified fish). To address such questions, a point of contact for the Japan Customs Authority was requested at the beginning of this study. However, JFA considered gathering information on procedures for verifying the contents of exports to be unnecessary noting the need to for CDS documents to be attached and considering that to be sufficient verification.

Previously concerns have been raised by CCSBT Members regarding whether exports of SBT from Japan are headed and gutted frozen fish or simply offal (heads, internal organs or bones). This question was also posed to JFA and to traders but was not answered. Beyond noting that such offal might be classified under another commodity code (e.g. 0303.99-000, other frozen fish) it was not possible to further clarify this issue in this study.

Finally, as noted in the Work Plan it is theoretically possible that some SBT exports are not Japan-caught and thus do not belong in the formula (i.e. they are re-exports rather than exports). This potential uncertainty could also not be clarified.

3.9.3 Outstanding Information

There remains considerable uncertainty associated with subtracting exported SBT as reported by the Japan Customs Authority from the formula. While this uncertainly could be included in the formula through the specification of a range of values, there is currently no information available to appropriately determine that probability interval. It might be possible, with help from the Japan government, to investigate export manifests to determine which parties are exporting SBT. These parties could then be interviewed to understand the product form, gauge the likelihood of mixing or misidentification, and try to confirm whether the SBT were caught by Japan. However, the priority of such work, given the other sources of uncertainty in the formula and the relatively small amount of SBT exports in recent years, appears to be low.

3.10 Product-to-whole weight conversion factor (*c*)

3.10.1 Existing Usage

It is necessary to convert the output from the market formula from product weight to whole weight in order to compare to declared catches. A conversion factor (*c*) of 1.15 has been used to since 2006. This figure represents Japan's preferred conversion factor and is reasonable to apply in the formula since the purpose has been to verify catches by Japan. However, CCSBT Members may use other conversion factors for some products, potentially reflecting real differences in product-live weight ratios for fish caught by different fleets (CCSBT 2009).

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gives the data for *E* in live weight and sums it with other converted live weights as the final step in Table 1 (see Equation 1 and Footnote 10).

3.10.2 New Information

Some error in the market formula is likely to arise from variability in the conversion factor (*c*). A one-by-one sensitivity analysis conducted for the Work Plan (Work Plan Section 2.2.3) identified that *c* is the most influential parameter in the equation, but this is mitigated somewhat by the fact that conversion factors are likely to be well-known and more stable over time compared to other parameters.

3.10.3 Outstanding Information

Ideally, conversion factors should be specified at their most likely value (central tendency)—in this case 1.15—and a distribution around this value. The Work Plan did not propose any further investigation of the point estimate of *c* for Japan catch verification but further work would be needed to inform the specification of the distribution. There are likely to be some datasets held by fisheries researchers in Japan that could inform this distribution. More importantly, if a market formula is to be used for other Members' catch verification, given the influence of *c* on the result of the formula it would be essential to confirm which conversion factors (and distributions) are most appropriate for each observed market product by fleet origin. Individual CCSBT Members would be in the best position to advise on the most appropriate conversion factor values and distributions for their fleets. Given the importance of *c* to the market formula results further work is considered important, particularly for catch verification of Members other than Japan.

3.11 Allocating Market-observed Amounts to Catch Years based on Lag Coefficients (*l*)

3.11.1 Existing Usage

The final step in the market formula involves allocating the estimated amount of frozen SBT catch in Japan's markets to various catch years based on lag coefficients. This is necessary because some of the frozen SBT in the market in any given year was caught in previous years. As noted in the Work Plan the lag coefficients, as well as the formula itself, would need to be constructed differently if the goal is to estimate fresh and/or farmed products.

Japan has been collecting information since late 2007 on the catch year of frozen SBT appearing in auctions at Tokyo and Yaizu. This data collection has involved reading tags on individual fish at two auctions per month in Tokyo and once per month in Yaizu. Lag coefficients derived from these data have been presented in annual submissions by Japan to CCSBT (e.g. Itoh et al. 2020). The lag coefficients indicate that the majority of fish were caught in the current or immediately preceding year, with small amounts of catch from two to six years ago.

3.11.2 New Information

The most recent lag coefficients (through 2021) are presented in Itoh & Hitomi (2022). The report explores a number of different methods for calculating the lag coefficients with and without allowing for yearly and monthly variation. It also provides lag coefficients for Korea- and Taiwan-caught SBT separately, although these follow the Japan-caught SBT lags closely with almost all fish moving to market within 2 years of catch. It is interesting to note an apparent increase in stockpiling in 2020 and 2021 when slightly more SBT were recorded with a two-year lag in comparison to previous years (2007-2019).

3.11.3 Outstanding Information

As discussed above, Japan's auction sampling of tags is important for several of the parameters in the formula (*i*, and potentially *d* and *p*). It is, however, most critical for the derivation of the lag coefficients (*l*) as the date of catch (or harvest out of farms) can only be known in the market by means of reading tags. To recap, the representativeness of the lag data is determined by the representativeness of the auction tag sampling which is in turn limited by the following factors:

- Temporal Representativeness: Tag sampling is only conducted at one or two auctions per month at the major auction sites (there are ≥20 auctions per month at Tokyo);
- Spatial Representativeness: Tag sampling is only conducted at only two sites, Tokyo and Yaizu (there are at least 10 other municipal markets handling SBT (see Section 3.3))[19]; and
- Member Representativeness: A recent analysis by the Secretariat (CCSBT 2021a) shows that the ratio of tags that can be read and matched to CDS documents versus the total number of tags observed in the auctions varies considerably amongst CCSBT Members (CCSBT 2021a) (this means that the lags will be based more heavily on SBT from those Members which have more readable tags).

As a useful overview, the Secretariat's tag sampling analysis (CCSBT 2021a) concluded that overall 1.5% of tagged SBT had their tags read in auction sampling, but the percentage varied widely amongst Members and was considerably higher (~7%) for Japan-caught SBT. The Secretariat posed the question of whether the sampling is sufficiently representative of all CCSBT Members and the Commission discussed whether the sample size needed to be increased or whether another method could be found to enhance the representativeness.

Another potential problem of a different nature arises from the cyclic nature of the market (see Section 3.1). In particular, since a given tagged fish might appear at an auction multiple times (although this has not been observed, probably due to low sampling effort—see Section 3.1.3) it is possible that a more representative (i.e. larger) sample of auction tags might also need to be adjusted for double-counting.

Finally, the application of lag coefficients derived from auction sampling presumes that the flow of frozen SBT from cold stores to market occurs in a smooth and predictable manner. Shocks to the market such as the closure of, or reduced demand from, high end restaurants due to the COVID-19 pandemic could, in theory, result in an increase in frozen SBT stockpiling (see Section 3.11.2 for a hint of this in recent data). This could in turn result in a decrease of SBT observed in the market as well as longer delays in entering the market (and the expected gradual recovery from the pandemic would be expected to exert opposite influences). It is not clear how long it might take for such shocks to be transmitted through the market and thus whether contemporary tag reading surveys can properly estimate the effects (i.e. the lags can only be estimated when the fish eventually do come to market). This kind of market instability suggests a new and greater level of uncertainty in the relationship between catch and observed market quantities than has been presumed by the market formula up until this point.

[19] It appears that the lag coefficients based on Yaizu tag data have not been applied in the market formula to date.

3.12 Additional Uncertainty when Comparing to Catch Records

The market formula is designed to produce an estimate of the weight of SBT observed in Japan's market for direct comparison to reported SBT catches. While the preceding discussion has focused on uncertainties in the market formula, there are also uncertainties in the catch records themselves. In fact, an analysis conducted by the Secretariat comparing the weights of individual fish as recorded in market surveys and on CDS Catch Tagging Forms (both recording gilled and gutted product weight) found "very large discrepancies"[20]) potentially due to unstable weighing on board or other factors (CCSBT 2021a). When considering the full extent of uncertainties in the market formula it is important to bear in mind that the comparison to catch data--which is the endpoint of catch verification--will require the comparison of <u>two</u> uncertain quantities. If a formal comparison, for example for compliance purposes, is intended, further work to quantify the uncertainty in catch weights may be necessary.

3.13 Summary of Post-Work Plan Findings regarding the Market Formula

The Work Plan identified two primary tasks with regard to the market formula: update the parameters and account for uncertainty in those parameters. The preceding section has discussed both aspects of each parameter in detail. Summaries of parameter update status (Table 1) and parameter uncertainty (Table 2) are provided in Section 3.13.1. A summary of proposals to address deficiencies in the parameters is provided in Section 3.13.2.

3.13.1 Summary of Parameter Update Status and Uncertainty

Four of the parameters used in recent market formula calculations have not been updated since 2006 (Table 1, row 1), despite the fact that, by all accounts, Japan's market mechanisms have changed considerably (TMG 2021 and interviews conducted for this study). One of these parameters, *c* (product to whole weight conversion factor) is probably not necessary to update as it would not be expected to have considerably changed over time. Two of the remaining three parameters have been studied by Japan (Table 1, row 4) and new values are available but have not yet been applied in annual updates. Japan's work represents an important new contribution but unfortunately this analysis has identified problems, both old and new, with these estimates. First, in the case of *p* (proportion traded through Tokyo or Yaizu) the issues relate to the influence of double-counting on the value of *p* and differences in reporting conventions between markets (see Section 3.3.3). Second, in the case of *r* (proportion traded within the municipal market system) the estimate needs to account for only those fish which never enter the market but it currently does not do so (see Section 3.8.3). The most problematic parameter is *d* (proportion of SBT that are double-counted) as there is no information available to update it (see Section 3.5). Other parameters have been repeatedly updated annually based on published data (Table 1, row 2) or dedicated data collection by Japan (Table 1, row 3) and do not pose any substantive problems.

[20] ~18% of fish whose weights differed by ≥20% according to the two datasets; calculated from CCSBT (2021a) using ~4000+~7000 fish with differences of +/-20% from a total of 62,190 fish.

Table 1. Summary of all parameters in the market formula in terms of when and how each was last updated.

		To	*Ya*	*p*	*F*	*d*	*i*	*S*	*r*	*E*	*c*	*l*
1	Parameter remains at the 2006 value			✓		✓			✓		✓	
2	Parameter has been updated annually based on published data	✓	✓					✓		✓		
3	Parameter has been updated annually based on survey data compiled by Japan				✓		✓					✓
4	New parameter values from studies by Japan are available but have not yet been used			✓					✓			

Parameter uncertainty reflects some of the same patterns (Table 2). For *d* (double-counting) and *r* (proportion in-market) there is not even a reasonably robust, current estimate of the most likely value (central tendency) (Table 2, row 1, red). The central tendency of other parameters which are likely to be influenced by double-counting issues, i.e. *p* (Tokyo-Yaizu market share), *To* (Tokyo market amount) and *Ya* (Yaizu market amount) could be specified on the basis of existing data, but these are now known to be highly uncertain (Table 2, row 1, yellow). For the remaining parameters a reasonable estimate of the most likely value (central tendency) is available (Table 2, row 1, green).

Table 2. Summary of all parameters in the market formula in terms of availability of a data-based estimate of central tendency and probability distribution, and the presence of residual uncertainties. Green circles and tick marks indicate "yes", yellow circles indicate "maybe", and red circles indicate "no".

		To	*Ya*	*p*	*F*	*d*	*i*	*S*	*r*	*E*	*c*	*l*
1	Reasonably robust, current estimate of central tendency	🟡	🟡	🟡	🟢	🔴	🟢	na	🔴	🟢	🟢	🟢
2	Reasonably informed distribution of values around the central tendency	🔴	🔴	🔴	🔴	🔴	🟡	na	🔴	🔴	🟡	🟡
3	Prior and still unresolved uncertainties					✓			✓	✓		
4	New uncertainties identified by this study	✓	✓	✓		✓		✓	✓			✓

The previous methodology used only the central tendency values (point estimates) when implementing the market formula. As stated in the Work Plan, it is very important that the estimation methods move away from using point estimates in deterministic calculations, especially when these estimates are highly uncertain or long out-of-date. Such methods will not stand up well to scientific peer review as a credible and defensible basis for decision-making. Instead a stochastic process that allows multiple inputs to vary simultaneously within a range of likely values should be implemented in order to avoid drawing overly precise, and thus erroneous conclusions from highly variable data sources. This approach is consistent with the recommendations of CCSBT SC24 which called for the market estimation methodology to be re-designed to incorporate uncertainty. A methodology in the form of probabilistic model code is demonstrated in the Work Plan (Annex A).

Such an approach requires specification of not only the most likely value (as summarized in Table 2, row 1), but also the span and shape of the distribution of values around that value (Table 2, row 2). For some parameters which are derived from or supported by sampling

studies (*i*, *c* and *l*) it might be possible to specify a distribution (Table 2, row 2, yellow), but there would be several ways to do this, all of which would generate different results, and there is no clearly preferred method[21]. For the remaining parameters, current data does not provide an objective basis for specification of a distribution (Table 2, row 2, red). Distributions may be specified in the absence of objective data but these kinds of value judgements should be made by managers, not by scientists.

In terms of the overall level of uncertainty associated with each parameter, concerns have been expressed over the years by CCSBT Members with regard to specific parameters (*d*, *r* and *E*; Table 2, row 3). This study has not been able to resolve those concerns and has identified new concerns regarding these and other parameters (Table 2, row 4) as discussed in the preceding sections.

3.13.2 Summary of Proposals to Address Parameter Deficiencies

An additional summary is provided in this section to describe the prospects for obtaining new or better information to reduce uncertainties. Table 3 is organized to show the type of studies or data provision requirements that can be envisaged and which parameter uncertainties they might address. The elements of the table are based on conventional kinds of data gathering undertaken to date, e.g. auction sampling, self-reporting and investigation of specific topics. More ambitious and data-intensive methods, such as implementing a full chain traceability system based on mandatory reporting of tag numbers handled by each trader, are of course possible, but seem unlikely to be agreed by all CCSBT Members and so are not described here. However, other non-conventional approaches are outlined in Section 4.

Table 3. Summary of proposals for improving each parameter's estimate and/or distribution. H=high priority, M=medium priority, L=low priority as assigned based on the importance of the data to each parameter, not by feasibility or cost-effectiveness (the latter is commented upon in the text). * indicates that this type of study would only address a portion of the residual uncertainty for the parameter in question.

		To	*Ya*	*p*	*F*	*d*	*i*	*S*	*r*	*E*	*c*	*l*
1	Increase tag sampling within Tokyo and Yaizu auctions	H*	H*			H*	L					L
2	Increase tag sampling to other auctions or outside auctions			H		H*						
3	Continue current surveys of five Toyosu wholesalers				H							
4	Investigate the handling of "fresh domestic" SBT							M				
5	Re-design self-reporting forms to more specifically identify in-out market sales								L*			
6	Investigate the origin and form of SBT exports from Japan									M		
7	Assess variability in conversion factors										M	

[21] For example, it would be possible to use the most recent five-year values to define the distribution of *p* (0.84-0.87; see Section 3.3.2) but this range does not account for uncertainty potentially arising from double-counting or differences in reporting conventions between markets. Also, since the most recent values are 0.87 there would need to be a decision taken on whether to weight the higher end of the range more heavily. These types of decisions are required for many of the parameters and compound the uncertainty.

Several parameters could be better estimated if auctions at Tokyo and Yaizu were sampled more frequently to collect information from tags on which CCSBT Member caught the fish (*i*) and how long it took the fish to appear in the market (*l*) (Table 3, row 1). Since there are already reasonable estimates of *i* and *l*, increased sampling for this purpose alone is a low priority. In contrast, tag sampling is currently the only identifiable means of obtaining an objective estimate of double-counting which influences the uncertainty of parameters *To*, *Ya* and *d*[22]. Nevertheless, basing estimates on auction sampling alone, no matter how robust, assumes that the auctions are representative of other trade flows. For example, if double-counted SBT are more often traded through negotiated sales (AITAI) than through auctions (SERI・NYUSATSU) then the estimates of *To*, *Ya* and *d* may still not be accurate (see Sections 3.1 and 3.5)

There are similar concerns about representativeness associated with expanding auction sampling beyond Tokyo and Yaizu (Table 3, row 2). This could address different kinds of double-counting (e.g. the components of *d* associated with inter-market transfers beyond Tokyo and Yaizu) and its effects on the estimated proportion of SBT traded within the market system but outside of Tokyo and Yaizu (*p*). However, the number of SBT at other auctions is low and the number of potential auction sites is high, both of which lower the cost-effectiveness of this work.

The self-reporting by the five major wholesalers at Toyosu is critical to the estimation of the proportion of frozen farmed SBT in auctions (Table 3, row 3). If the market formula approach is to continue, these data are essential. No changes to the methodology are necessary (see Section 3.4).

In 2021-2022 there were small amounts of SBT in the Toyosu market reported as "fresh domestic" (*S*) even though Japan's fleet does not produce fresh SBT. Further analysis of the origin of these fish should be possible once the 2021-2022 yearbooks are published showing which wholesaler handled these fish (see Section 3.7.3). Re-assigning these fish to an appropriate category would require minimal effort and would improve the accuracy of the formula (Table 3, row 4).

Japan has diligently attempted to provide updated estimates of the proportion of SBT traded outside the municipal market system (*r*), however, the estimates produced thus far appear not to be entirely suitable for use (see Section 3.8). It might be possible to re-design the self-reporting forms given to traders to improve the estimate, but it is doubtful that the traders can report which SBT have never entered the market as they may only know in detail about the part of the supply chain that involves them). Therefore, it is unlikely that the self-reporting (KIKITORI) system could resolve the uncertainty in *r* and the priority for re-designing it is accordingly low (Table 3, row 5).

Previous comments by CCSBT Members have raised concerns regarding whether SBT exports (*E*) from Japan are whole fish or merely parts (see Section 3.9). This issue could be investigated if the Japan government can identify the exporters and ask them to clarify the product form (Table 3, row 6). However, the amount of exports is relatively low, therefore this work could be considered a medium rather than high priority.

[22] Recall that past estimates of *d* only accounted for double-counting due to processing and single inter-market transfers, therefore double-counting of unprocessed fish sold multiple times within a single market were not estimated.

The final proposal involves asking countries to verify their conversion factors (*c*; Table 3, row 7). The adjustment from product to whole weight has a large influence on the results of the market formula and is thus a medium priority, particularly if the market formula is to be applied for verification of the catch of Members other than Japan (see Section 3.10). It is likely that most CCSBT Members would already hold some data on conversion factors, therefore a straightforward compilation and summary of existing information would appear to be a cost-effective and useful exercise.

3.13.3 Overall Summary

CCSBT has been using a market formula developed in 2006 (Lou et al. 2006) as a form of catch verification for SBT caught by Japan. The formula is based on a market structure in which most frozen wild SBT flow through municipal markets where statistics are recorded and individual fish tags can be monitored. Over time conditions have changed such that progressively larger proportions of SBT do not flow through the monitored channels. As a result, several of the original parameter values in the market formula are likely long out-of-date, and available updated parameter values are based on an increasingly smaller sub-sample of the total market flow.

A report by Japan covering several market parameters was provided after the Work Plan for this study was completed. Japan's data were extremely useful for updating some parameters, but robust estimation of other parameters, e.g. the proportion double-counted and the proportion traded within municipal markets, remains simple in theory but highly elusive in practice. This analysis has revealed that there are complex relationships between parameters (e.g. those involving double-counting) that were not appreciated in past implementation. Therefore, even if previous, intensive estimation efforts for these parameters were repeated, there could still be considerable debate about the most appropriate values.

Compounding these problems, past implementation of the formula was based on point estimates which are now known to vary considerably and need to be specified as ranges (or distributions) to properly account for uncertainty. However, in some cases there is no objective basis for quantifying these distributions, and no clear pathways for resolving these data gaps. Subjective specification of both parameters and their distributions is possible, and in fact the Work Plan planned to adopt an expert elicitation methodology using trader interviews. But traders resisted this approach claiming only to understand their own operations and not the trade as a whole, thus calling into question the representativeness of the approach. Other forms of subjective specification, such as applying arbitrary ranges (e.g. +/- 10% of the current value), de-couple the formula from objective facts and undermine the scientific validity of the exercise. Under such scenarios, it would be possible to manipulate the formula to produce any number of outcomes simply by changing the input parameters.

For all of these reasons, continued use of the market formula to verify SBT catches by Japan is not recommended. By extension, use of the market formula to verify other Members catches is also not recommended. The market formula was devised at a time when there was no CCSBT catch documentation scheme (CDS) and much less developed procedures for landing catches. In comparison to the market formula, both the CDS and current landings controls provide a much more robust basis for catch verification as explained in the following section.

4 Alternatives to a Market Formula

Fisheries products flow to the consumer from their origin on fishing vessels or farms through various channels. The best point at which to monitor these flows, for example to check for the products of illegal fishing, is determined by a combination of the ease of access and the representativeness of the sample that can be obtained. This is often a trade-off: at the retail level access is easy but representativeness (especially at low sample sizes) is low, while monitoring large warehouses can be representative but is often impractical. Optimal monitoring is most often conducted as far "upstream" in the trade flow as access conditions will allow. This helps to explain why most catch certification systems operate at national boundaries (FAO 2022).

In 2006 the objective of the JMR Panel was to verify Japan's catch. The CCSBT's Trade Information System (implemented in 2000 as the precursor to the CDS) did not cover domestic landings and a landings inspection rate of 20% for SBT unloadings in Japan's ports was considered insufficient for verification purposes (Lou et al. 2006). Given this lack of ability to sample "upstream" the JMR turned to the market and adjusted available statistics to produce an estimate of the whole weight of frozen wild SBT caught by Japan.

Today, it remains true that the market for SBT is concentrated in Japan, and there may still be value in using signals from this market to cross-check other management information. But the flow of SBT through the accessible market channels has shrunk, heightening the importance of accurately estimating highly problematic extrapolation factors and cautioning against attempting to obtain a direct match between catch and market data. At the same time "upstream" monitoring data in the form of unloadings inspections and the CDS have strengthened and are likely to provide a better basis for catch verification. Two alternatives to using the market formula approach to catch verification are outlined in the following sections.

4.1 Catch and Market Data Correspondences

A correspondences approach was first proposed by Japan as a way of combining market and CDS data to improve the accuracy of the catch verification (Tsuda et al. 2019b). The CCSBT Scientific Committee subsequently considered and accepted a recommendation that the approach should be trialled (CCSBT 2019). A correspondences approach tracks the relationship between similar quantities from different datasets (not necessarily related to catch) to identify whether they change over time. The benefit, in comparison to the market formula, is that it does not expect to obtain a one-to-one match between reported catches and adjusted market statistics. Therefore, using correspondences avoids the problematic adjustment factors needed to force a match between market and catch data in the market formula approach. Instead, it relies only on readily available data sources making it easier to monitor over time with limited resources. In accordance with CCSBT Circular #2022/034 this section provides an outline of the correspondences approach using six examples. With more in-depth study, other useful correspondences are likely to appear.

4.1.1 Correspondence #1: Different measures of the proportion of imports in the Japan market

There are several sources of information on the proportion of frozen wild SBT in the Japan market that are not caught by Japan, i.e. those fish that are (or should be) imports. This information can reveal the extent of the reliance of the Japan market on non-domestic

sources, as well as suggest the extent to which Japan remains the key market for SBT overall (e.g. stable catches but falling imports could indicate product is being directed to another market). Available data are presented and interpreted in Panel 1.

4.1.2 Correspondence #2 - Different measures of the quantity of imports in the Japan market

Continuing to focus on imports, and supplementing Correspondence #1 which pertains to proportions, it is possible to examine CDS and customs statistics with regard to the quantity of imports by source country. These data focus exclusively on the quantity of foreign supply to the Japan market, and can reveal shifts in supply by flag State (other than Japan). In contrast to Correspondence #1 which makes use of auction data which focus on frozen SBT, this correspondence can examine fresh and frozen SBT separately, as well as in combination (Panels 2-4).

4.1.3 Correspondence #3 - Relationship between wild SBT in the CDS and market amounts in Tokyo and Yaizu

Not all correspondences are expected to be one-to-one matches. Correspondence #3 examines the relationship between the amount of wild SBT recorded in the CDS as entering Japan and the amount of SBT recorded in the major markets of Tokyo and Yaizu. Obviously not all wild SBT entering Japan will be traded through Tokyo or Yaizu. Similarly, not all of the SBT traded in these markets is wild, though it is likely that the amount of farmed SBT traded through these markets is small compared to the amount of wild SBT especially in recent years (see Section 3.4). As an additional caveat, this study has found that double counting is likely to inflate the market quantities in comparison to the CDS quantities. Nevertheless, if both the CDS and market recording systems are stable, the relationship between the quantities recorded in each system should also be stable (Panel 5).

4.1.4 Correspondence #4 - Different measures of the trade in farmed SBT

It is expected that there would be a one-to-one relationship between the quantity of farmed SBT exported by Australia and the quantity of farmed SBT received in Japan from Australia according to the CDS. Discrepancies could indicate differences in the reporting systems, stockpiling, or product misclassification (Panel 6).

4.1.5 Correspondence #5 - Interpretation of market time lags

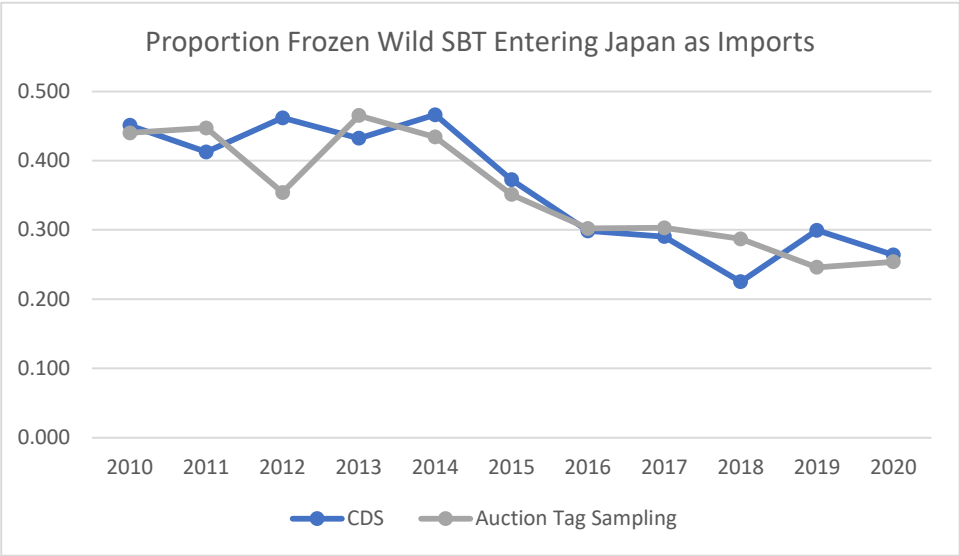
This comparison is designed to understand whether the time lags calculated from tag reading during auction surveys are representative across flag States. The ability of the CDS to inform about time lags is limited to the time difference between catch and export. In contrast, the time lag estimates from the auction surveys cover the entire period between catch and appearance at auction. As a result, the two time lags are not directly comparable. Nevertheless, if there is a difference in the time lag between fleets it would likely be due to the portions of the supply chain that differ by fleet, i.e. choice of fishing ground, method of transport and point of export to Japan. (In other words, a difference in time lag by flag State would not be expected once the SBT enter Japan). Therefore, examining time lags between catch and export from the CDS can help to identify flag State-specific differences, if any (Panel 7).

4.1.6 Correspondence #6 – Different measures of quantities of SBT entering Japan by location

The CDS collects information on the location of entry into the destination country and it should be possible to cross-check this with landings data to provide a useful complement to checks involving import data. Landings data would primarily represent domestic catch (i.e. by Japan) but would also capture some catches by Korea and Taiwan that are unloaded in designated ports. Unfortunately the only publicly available SBT-specific landings data identified in this study are those for Yaizu in Shizuoka Prefecture and Yaizu does not appear as a location receiving SBT in the CDS. However, this correspondence can explore the relationship between Yaizu landings data and data for various CDS-recorded points of entry into Japan that might include Yaizu landings at an aggregated level (Panel 8).

Panel 1. Data, graphic and interpretation for Correspondence #1 – Proportion of Imports in the Japan Market. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data represent all frozen wild SBT which are recorded as exported (or re-exported) with export destination Japan expressed as a proportion of this quantity+domestic landings by Japan. For this analysis it is assumed that all frozen re-exports with export destination Japan are wild SBT. The auction data are from a summary provided by Japan (unpublished data) based on the most recent revision (July 2022; see Section 3.6.2).

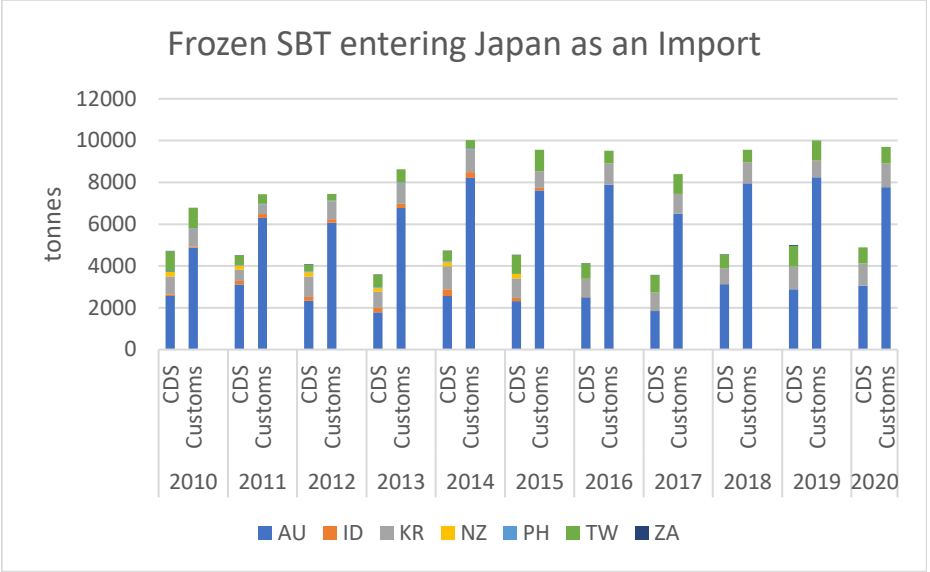
Proportion of Frozen Wild SBT entering Japan as Imports		
Year	CDS ((re)exports to JP/ ((re)exports to JP+domestic landings))	Auction Sampling (i)
2010	0.451	0.440
2011	0.413	0.447
2012	0.462	0.354
2013	0.432	0.465
2014	0.466	0.434
2015	0.372	0.351
2016	0.299	0.302
2017	0.290	0.303
2018	0.225	0.287
2019	0.300	0.246
2020	0.264	0.254



Interpretation: In the early years of the series both data sources indicate that the frozen wild SBT market in Japan was supplied fairly evenly (near 50%-50%) by domestic and foreign sources. However the foreign supply is currently only ~25%. The data from the two sources is quite consistent which suggests that if it is necessary to continue to monitor the proportion of imports, the CDS data could be used in lieu of auction sampling. The decline in the proportion of imports over time in combination with increasing quantities of SBT flowing to Japan in recent years (see Panel 5) is likely driven by an increase in the SBT catch by Japan (CCSBT 2021c). If the Japan market is inelastic (i.e. if demand does not expand as supply increases and instead Japan-caught SBT replaces imports) the declining proportion of imports may also signal growth in SBT markets outside of Japan. However, despite the declining proportion of imports, overall the quantity of imports appears relatively stable (see Panel 4).

Panel 2. Data, graphic and interpretation for Correspondence #2 – Quantity of Frozen SBT Imports. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data represent frozen SBT (both wild and farmed) recorded as an export (or re-export) with destination Japan. Customs data were downloaded from Japan Ministry of Finance website (JMOF 2022) and do not separate wild and farmed SBT (0303.46-000). Data are reported in kilograms but are shown here in tonnes.

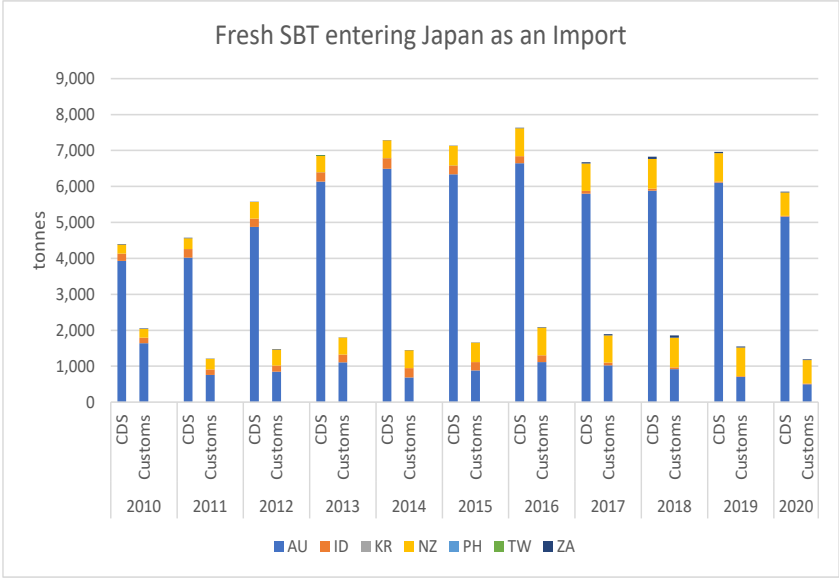
Quantity of Frozen SBT Entering Japan as an Import							
	AU	ID	KR	NZ	PH	TW	ZA
2010							
CDS	2,569	67	857	225	37	948	<1
JMOF	4,879	64	829	0	38	984	0
2011							
CDS	3,122	154	563	173	39	463	15
JMOF	6,303	175	457	0	39	459	0
2012							
CDS	2,340	184	966	208	40	316	20
JMOF	6,069	176	846	0	40	310	0
2013							
CDS	1,777	215	774	164	40	612	17
JMOF	6,769	211	1,000	0	39	612	0
2014							
CDS	2,568	316	1,098	196	39	508	3
JMOF	8,206	284	1,103	0	40	390	0
2015							
CDS	2,316	149	936	223	0	896	5
JMOF	7,621	117	800	0	0	1,022	-
2016							
CDS	2,505	4	884	<1	0	730	12
JMOF	7,885	0	1,012	0	0	622	0
2017							
CDS	1,849	<1	885	<1	0	824	18
JMOF	6,498	0	951	0	0	942	0
2018							
CDS	3,125	<1	776	0	0	650	12
JMOF	7,948	0	1,008	0	0	605	0
2019							
CDS	2,878	0	1,087	0	0	989	40
JMOF	8,249	0	788	0	0	964	0
2020							
CDS	3,047	0	1,081	0	0	768	0
JMOF	7,768	0	1,129	0	0	804	0



Interpretation: There are large discrepancies in the recorded quantities of frozen SBT (wild and farmed) entering Japan as imports according to the CDS and Japan customs statistics. These discrepancies appear to be mainly due to substantial amounts of Australian product being recorded as frozen under Japan customs statistics but not under the CDS. The Secretariat and Australia have investigated these discrepancies and it appears that substantial quantities of frozen SBT have been inadvertently reported as fresh on CDS forms. As there is no way of separating wild from farmed SBT in customs statistics, the CDS data for both wild and farmed SBT have been tallied for this comparison.

Panel 3. Data, graphic and interpretation for Correspondence #2 – Quantity of Fresh SBT Imports. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data represent fresh SBT (both wild and farmed) recorded as an export (or re-export) with destination Japan. Customs data were downloaded from Japan Ministry of Finance website (JMOF 2022) and do not separate wild and farmed SBT (0302.36-000). Data are reported in kilograms but are shown here in tonnes.

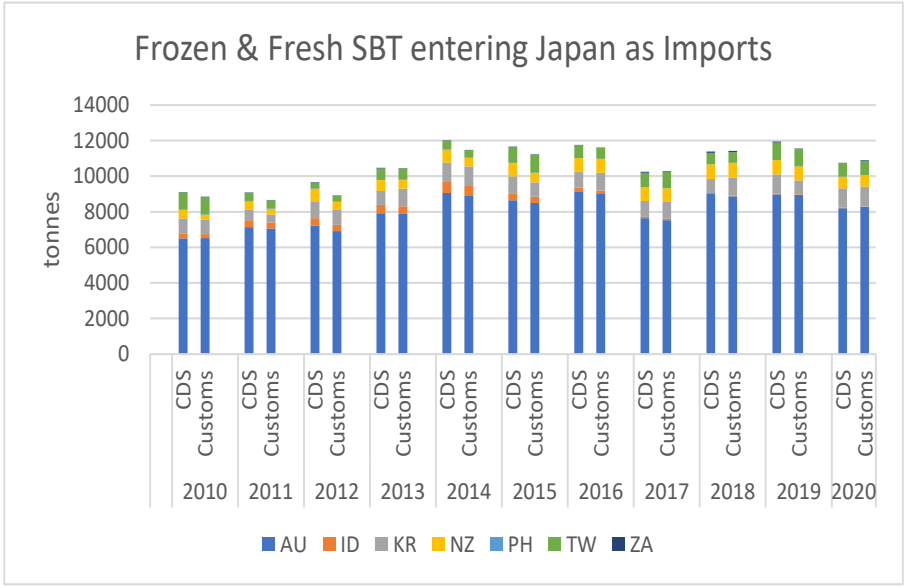
Quantity of Fresh SBT Entering Japan as an Import							
	AU	ID	KR	NZ	PH	TW	ZA
2010							
CDS	3,928	202	0	253	0	0	14
JMOF	1,638	155	0	249	0	0	11
2011							
CDS	4,018	242	0	301	0	0	11
JMOF	756	155	0	295	0	0	8
2012							
CDS	4,878	230	0	457	0	0	11
JMOF	848	170	0	449	0	0	9
2013							
CDS	6,136	256	<1	470	0	<1	5
JMOF	1,107	218	0	471	0	0	2
2014							
CDS	6,489	294	1	497	0	0	7
JMOF	685	264	0	496	0	0	1
2015							
CDS	6,336	246	3	542	0	0	10
JMOF	884	232	0	541	0	0	7
2016							
CDS	6,644	201	0	776	0	0	13
JMOF	1,113	189	0	774	0	0	12
2017							
CDS	5,798	75	0	763	0	0	36
JMOF	1,027	71	0	762	0	0	33
2018							
CDS	5,882	54	0	826	0	0	66
JMOF	917	50	0	825	0	0	62
2019							
CDS	6,108	26	<1	794	0	0	31
JMOF	703	22	0	794	0	0	32
2020							
CDS	5,159	24	0	654	0	0	20
JMOF	497	21	0	653	0	0	20



Interpretation: There are also major discrepancies in the recorded quantities of fresh SBT entering Japan as imports according to the CDS and Japan customs statistics. These discrepancies appear to be mainly due to large amounts of Australian product being recorded as fresh under the CDS but not under Japan customs statistics. The Secretariat and Australia have investigated these discrepancies and it appears that substantial quantities of frozen SBT have been inadvertently reported as fresh on CDS forms. As there is no way of separating wild from farmed SBT in customs statistics, the CDS data for both wild and farmed SBT have been tallied for this comparison.

Panel 4. Data, graphic and interpretation for Correspondence #2 – Quantity of Frozen+Fresh SBT Imports. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data represent frozen and fresh SBT (both wild and farmed) recorded as an export (or re-export) with destination Japan. Customs data were downloaded from Japan Ministry of Finance website (JMOF 2022) and do not separate wild and farmed SBT (0302.36-000 and 0303.46-000). Data are reported in kilograms but are shown here in tonnes.

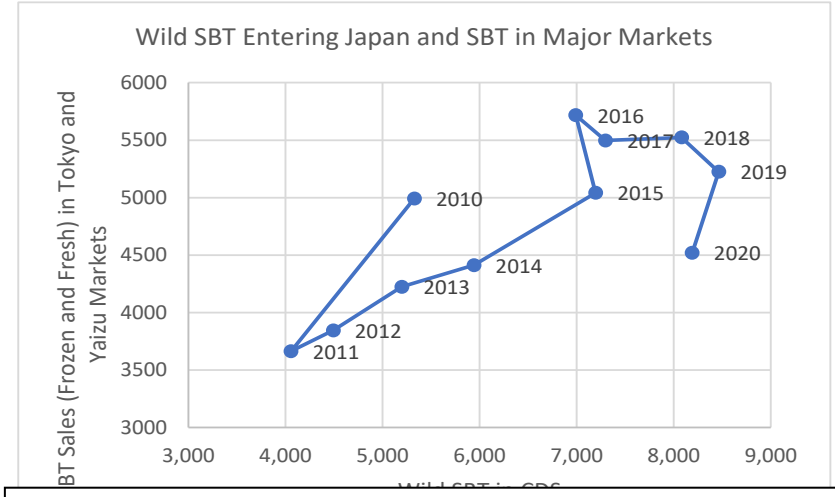
Quantity of Frozen + Fresh SBT Entering Japan as an Import							
	AU	ID	KR	NZ	PH	TW	ZA
2010							
CDS	6,496	269	857	478	37	948	14
JMOF	6,517	219	829	249	38	984	11
2011							
CDS	7,140	396	563	474	39	463	26
JMOF	7,059	330	457	295	39	459	8
2012							
CDS	7,218	414	966	665	40	316	31
JMOF	6,917	346	846	449	40	310	9
2013							
CDS	7,913	471	774	634	40	613	22
JMOF	7,876	429	1,000	471	39	612	2
2014							
CDS	9,057	610	1,099	693	39	508	10
JMOF	8,891	548	1,103	496	40	390	1
2015							
CDS	8,652	395	939	765	0	896	15
JMOF	8,505	349	800	541	0	1,022	7
2016							
CDS	9,149	205	884	776	0	730	25
JMOF	8,998	189	1,012	774	0	622	12
2017							
CDS	7,647	75	885	764	0	824	54
JMOF	7,525	71	951	762	0	942	33
2018							
CDS	9,007	54	776	826	0	650	78
JMOF	8,865	50	1,008	825	0	605	62
2019							
CDS	8,986	26	1,088	794	0	989	71
JMOF	8,952	22	788	794	0	964	32
2020							
CDS	8,206	24	1,081	654	0	768	20
JMOF	8,265	21	1,129	653	0	804	20



Interpretation: When fresh and frozen quantities are summed (without regard to whether wild or farmed) the discrepancy in quantity between CDS and customs datasets is small because the discrepancies between Australian frozen and fresh products offset each other (see Panels 2 and 3). The reduced quantities of imports from Indonesia beginning in 2015 correspond to a sharp decline in the percentage of catch reported by Indonesia to the CDS as exported (as low as 10-30% in recent years). This is one example of a potential catch verification issue that cannot be addressed using Japan market data.

Panel 5. Data, graphic and interpretation for Correspondence #3 – Wild SBT Entering Japan and SBT in Major Markets of Japan. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data represent wild SBT regardless of form (fresh or frozen), recorded as an export (or re-export) with destination Japan plus Japan's domestic landings. For this analysis it is assumed that all frozen re-exports with export destination Japan are wild SBT. Tokyo and Yaizu market data were extracted from TMG website (TMG 2022) and Yaizu Fisheries Cooperative Yearbooks (YFCA 2022), respectively, and include both frozen and fresh SBT. Data are reported in kilograms but are shown here in tonnes.

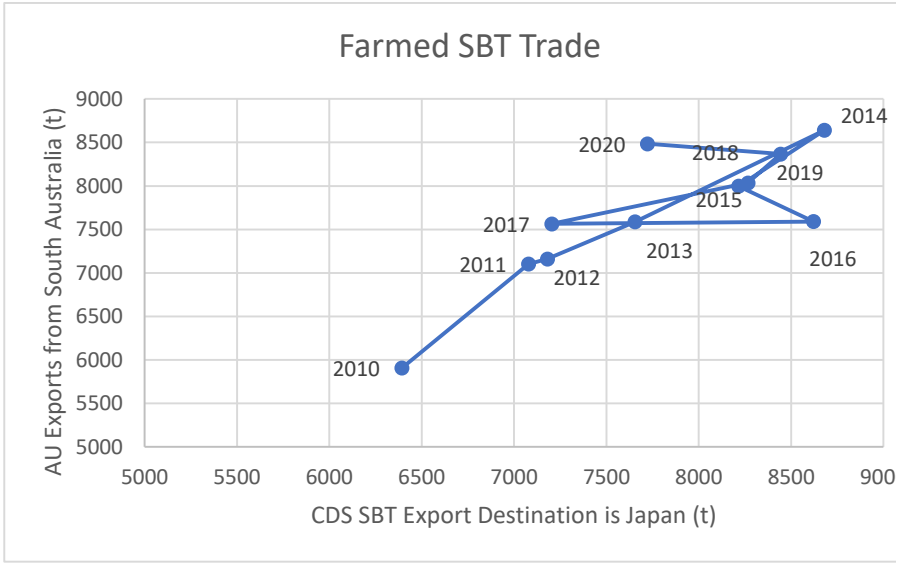
CDS Wild SBT entering Japan vs Market Sales			
Year	(A) CDS (t)	(B) Market Sales in Tokyo & Yaizu (t)	B/A (%)
2010	5,328	4,993	0.94
2011	4,057	3,664	0.90
2012	4,492	3,845	0.86
2013	5,199	4,224	0.81
2014	5,942	4,413	0.74
2015	7,196	5,041	0.70
2016	6,991	5,716	0.82
2017	7,297	5,497	0.75
2018	8,082	5,523	0.68
2019	8,464	5,225	0.62
2020	8,191	4,521	0.55



Interpretation: In 2010 the amount of fresh and frozen wild SBT received in Japan according to the CDS and the amount of fresh and frozen wild SBT recorded in Tokyo and Yaizu markets were almost the same. This is perhaps because the CDS did not immediately capture all SBT. In 2011, the amount of SBT in both the CDS and the markets reduced considerably and then grew (aside from 2016) until 2018, with the amount in the market hovering between 70-90% of the amount recorded in the CDS in each of these years. In the most recent years (2018-2020) the CDS-reported quantities were higher than in previous years, perhaps reflecting larger SBT catches overall (CCSBT 2021c), but the amounts in the Tokyo and Yaizu market did not grow at the same rate thereby altering the trend. In 2020, both datasets showed a decline, but the market decline was sharper, possibly reflecting greater stockpiling due to the pandemic's effect on demand for high grade seafood.

Panel 6. Data, graphic and interpretation for Correspondence #4 – Trade in Farmed SBT. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data represent farmed SBT (frozen or fresh) which are exported with export destination Japan. For this analysis it is assumed that all frozen re-exports with export destination Japan are wild SBT (and thus these quantities are not included). Australian SBT export data for South Australia were compiled from the FRDC Seafood Production and Trade Databases (2022). Data are reported in kilograms but are shown here in tonnes.

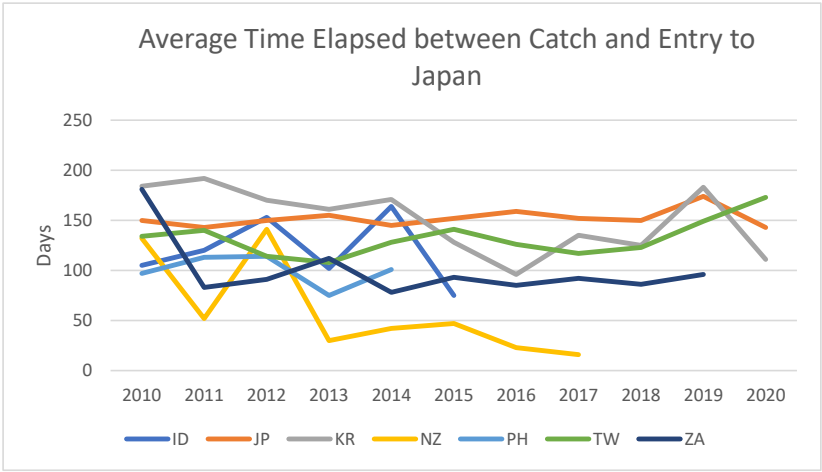
Trade in Farmed SBT		
Year	CDS (t)	AU exports from South Australia (t)
2010	6,392	5,906
2011	7,078	7,102
2012	7,181	7,160
2013	7,654	7,588
2014	8,680	8,639
2015	8,216	7,998
2016	8,622	7,591
2017	7,204	7,564
2018	8,266	8,035
2019	8,444	8,367
2020	7,723	8,484



Interpretation: The relationship is consistent, as expected, for most of the years in the series, with the Australian-reported quantities slightly lower in most years than the CDS. Deviations on the order of 500-1,000 t are observed in 2010, 2016 and 2020 which represent up to +/-14% and suggest there can be considerable error even in a straightforward comparison such as this. As for some of the other correspondences, a different relationship between the two datasets is observed in 2020 compared to other years. This could be a result of the pandemic, but in contrast to Panel 5 greater stockpiling once the farmed SBT reach Japan would not explain the observed effect.

Panel 7. Data, graphic and interpretation for Correspondence #5 – Interpretation of Market Time Lags. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data for countries other than Japan represent frozen wild SBT that are exported with export destination Japan (re-exports are excluded by design). CDS data for Japan were derived from records with flag State Japan and which are not exported (i.e. domestic landings). Average time elapsed is calculated as the number of days between harvest date and reporting date (effectively date of export), with records having elapsed times of zero or less removed.

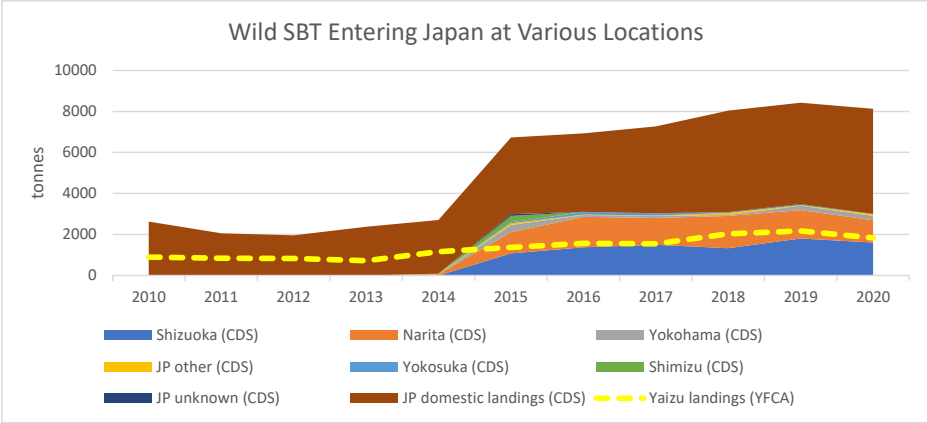
Average Time Elapsed between Catch and Entry to Japan							
	ID	JP	KR	NZ	PH	TW	ZA
2010	105	150	184	132	97	134	181
2011	120	143	192	52	113	140	83
2012	153	150	170	141	114	114	91
2013	102	155	161	30	75	108	112
2014	164	145	171	42	101	128	78
2015	75	152	128	47	-	141	93
2016	-	159	96	23	-	126	85
2017	-	152	135	16	-	117	92
2018	-	150	125	-	-	123	86
2019	-	174	183	-	-	149	96
2020	-	143	111	-	-	173	-
Average of all records	*126*	*151*	*149*	*71*	*101*	*136*	*93*



Interpretation: The CDS data for frozen wild SBT entering Japan show elapsed time in days between catch and reporting date (effectively export date) for seven flag States. The average elapsed time varies by fleet and year but without any clear time trend (with the exception of New Zealand). The overall averages for the three Members' whose catches most often appear in Japan frozen market auctions (JP, KR and TW) are remarkably similar (151, 149 and 136 days, respectively). These average lags cannot be directly compared to Japan's tag reading data because those lags represent the time between catch and market sale (i.e. they would include stockpiling time, if any) and are reported in years (0, -1, -2 etc.) rather than days. However, the assumption used thus far in the market formula that lags do not vary by fleet is not refuted by this analysis.

Panel 8. Data, graphic and interpretation for Correspondence #6 – Wild SBT entering Japan by Location. CDS data extract provided by the Secretariat and calculated for this study from 2010 (first year of implementation of the CDS) through 2020 (most recent complete year). CDS data for countries other than Japan represent wild SBT that are exported with export (or re-export) destination (i.e. import country) Japan. CDS data for Japan were derived from records with flag State Japan and which are not exported (i.e. domestic landings). Yaizu landings data extracted from Yaizu Fisheries Cooperative Yearbooks (YFCA 2022). Data are reported in kilograms but shown here in tonnes.

SBT Entering Japan by Location					
	Wild SBT entering Japan (CDS):				Landing
	Shizuoka	Narita	Other JP locations	JP domestic landings	Yaizu Landings
2010	0	3	2	2,624	892
2011	0	20	0	2,034	839
2012	0	0	0	1,962	828
2013	0	0	1	2,378	716
2014	1	62	27	2,619	1,156
2015	1077	1035	879	3,738	1,368
2016	1381	1481	246	3,823	1,563
2017	1496	1304	238	4,229	1,546
2018	1334	1570	190	4,945	2,028
2019	1803	1382	303	4,936	2,169
2020	1602	1090	305	5,126	1,831



Interpretation: More than half the wild SBT entering Japan in recent years derives from domestic landings which under the CDS are not required to record the location of landing. Considering wild exports (and re-exports) to Japan, approximately half are delivered to Shizuoka and half to Narita (less to Narita in 2019-2020), with small quantities recorded as entering at Yokohama, Yokosuka, Shimizu and other named and unnamed locations. Quantities of wild SBT recorded by the Yaizu Fisheries Cooperative Association as landed in Yaizu are similar each year to the amount of imports recorded as entering "Shizuoka", but the latter are expected to include both Yaizu and Shimizu (because quantities recorded as Shimizu have dropped to near zero in recent years) and possibly Ooigawa. For the CDS data to be useful in checking landings data several features of the datasets would need to be improved: a) SBT landings data for Japan ports other than Yaizu would need to be made available; b) the location of domestic landings should be required under the CDS; and c) recording of exports under the CDS should be specified by port or city (not merely by prefecture).

4.1.7 Summary of Correspondences Approach

This outline of a correspondences approach has illustrated that there are several different datasets that can be used as diagnostics to check the flow of SBT into the markets of Japan. There is some level of ambiguity in each correspondence, but this is a reflection of real uncertainties in catch, landings, customs, CDS, market and sampling statistics, many of which only become visible when contrasted with other data sources. For the most part these datasets are readily available to the CCSBT (unlike many of the market formula parameters). Other data that were not available to this study but could be available to the Secretariat or CCSBT members (e.g. landings data) would serve to strengthen future correspondences work.

Another advantage of the correspondences approach is that although it does not provide a direct answer to the question of whether catch limits are being exceeded, it can identify common trends as well as specific discrepancies. Relationships visible in more than one correspondence provide a strong signal and help to interpret trends in catch and trade. Discrepancies can be followed-up to improve data quality in each dataset individually as well as obtain more useful triangulations in future. For example, the following points have been raised in the analysis conducted thus far:

- There are signs that the proportion of wild frozen imported SBT is declining but this is likely to be due to expanding domestic catches by Japan rather than the diversion of previously imported SBT to other markets (Panels 1, 4 and 5).
- There are large discrepancies in quantities of Australian SBT entering Japan according to Japan customs and the CDS by product form (frozen versus fresh) (Panels 2-4). Investigation by the Secretariat and Australia suggest that the CDS data are in error, and it should be possible to rectify this discrepancy going forward.
- There are currently difficulties with merging export and re-export records within the CDS with the result that separating wild from farmed re-exports is problematic (Panels 1, 5 and 6). If the CDS is to be used for checking market or trade statistics that are specific to wild or farmed SBT, a solution to identifying the actual source of re-exports is required. This issue relates to the practice of Members within the CDS reporting more than one CMF on a REEF and a single CMF being listed as a previous document for multiple REEFs.
- Some of the correspondences reflect greater variability in recent years (Panels 1, 5 and 6) which may be due in part to ongoing shrinkage in the role of municipal markets and a greater diversification of trade. The effects of the pandemic are likely to become more apparent with new data points for 2021 and beyond.
- Theoretically straightforward comparisons between national customs statistics and CDS data indicate variability in some years on the order of several hundred tonnes (Panels 4 and 6) suggesting the potential for cross-checking between systems to improve data quality in both.
- CDS data suggest that time lags of 4-5 months are possible simply due to the logistical requirements of catch and unloading (Panel 8); depending on when in the season catch occurs (e.g. August) these lags alone could shift the allocation of market-observed SBT to an adjoining catch year and have a potentially large influence on the market formula. Stockpiling would add to this effect.

- The CDS has great potential to assist in understanding landings patterns and verifying landings data, however, this potential is currently undermined by non-specific reporting of the point of landing for exports (e.g. Shizuoka prefecture) and by the lack of a requirement to report the landing location for domestic landings (Panel 9).

A correspondences approach has a number of advantages in terms of cost-effectiveness, simplicity, and the ability to identify (and potentially remedy) data quality issues in the CDS and other datasets. A correspondences approach will not provide a solid basis for specific compliance actions, but this is also true for the market formula given the extent of uncertainties identified in this study. Even if the market formula approach is continued, ongoing monitoring of basic correspondences is advisable for data quality assurance and to provide further insights for management.

4.2 Unloadings Verification Systems

Much has improved in the monitoring, control and surveillance of fisheries since 2006. A powerful impetus for change has been the Port State Measures Agreement (PSMA) which was approved in 2009 and entered into force in 2016 (FAO 2016). While the PSMA primarily seeks to combat IUU fishing by specifying minimum standards for inspection of foreign vessels entering Parties' ports, it also calls upon Parties to apply similarly effective measures to domestic vessels (PSMA Article 20, para. 6). All CCSBT Members which are eligible to become Parties to the PSMA have done so.

The focus of the PSMA is at the point of landing. Its aim, like that of a number of CDS that have also strengthened in recent years[23], is to block the products of IUU fishing before they can reach the market. Japan, as the major market for SBT, implements the CCSBT CDS as well as a landings inspection program that covers both domestic and foreign-flagged vessels. Information from interviews and site visits conducted for this study suggest that Japan's landings inspection program exercises strict control over SBT landings. PSMA and related landings procedures, and CDS requirements, all represent new (since 2006) tools that are currently being applied to exclude any SBT from entering Japanese markets in the first place.

One potentially weak point of entry to Japan's market is imported SBT. These are covered by the CCSBT CDS but may not be subject to the landings inspection program, particularly if the fish are landed outside of Japan and containerized before arriving in Japan. However, if all landings (/containerizations) of SBT are subject to minimum inspection standards and certification regardless of where they are landed, and this process is captured by the CDS, or otherwise proved upon entry to Japan (or other cooperating market States), this would provide a strong basis for catch verification that appears to be lacking under the CDS. It would then not be necessary to conduct costly and speculative market monitoring at various points along a convoluted supply chain.

Development of a landings-based SBT catch verification program is beyond the scope of this study. However, it is noted that elements of such a program could include the following:

[23] Japan will also implement its own market-based CDS in December 2022 requiring a catch certificate from flag States when importing any one of four types of seafood (SBT is not included in the list; JFA 2022).

- Documentation of Japan's landings inspection program (and relevant import control systems in order to outline minimum standards);
- Improvement of the minimum standards to address any points of weakness and any other changes necessary to apply them widely across countries;
- Adoption of the minimum standards as applicable to all States which receive landings of SBT (or otherwise handle, e.g. containerize, SBT);
- Implementation of an audit program to measure performance against the minimum standards and identify opportunities for improvement; and
- Agreement of a mechanism for SBT landings information to be reported to the CCSBT Secretariat for catch verification purposes.

An unloadings verification approach has the advantages of i) providing directly relevant information for catch verification, ii) harnessing existing national systems and encouraging their improvement, and iii) sharing the costs of control amongst Members rather than relying primarily on Japan as the end market. Perhaps most importantly it would synergize and likely benefit from the ongoing global trend toward greater port State control.

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Annex A. Work Plan

Verification of All Members' Catch through Monitoring of Southern Bluefin Tuna Product Distribution

-Review of Existing Information and Draft Work Plan-

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1 Introduction

1.1 Background and scope

Use of market data by CCSBT

Analysis of trade and market data can provide useful insights for resource management when demand is concentrated in a few key trade hubs and the products of interest are clearly distinguished. In fisheries management such data can be used to cross-check recorded catch quantities and identify which parties are involved in sourcing and consuming fishery products. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) has been using data from Japan's markets for over 15 years as a means of understanding whether there may be fish entering trade that are not otherwise accounted for in official catch records.

Much of the analysis presented to CCSBT by its members over the years is based on the findings of the independent market review panel published in 2006 (Lou et al. 2006). However, recent analyses have also recognized that there have been notable changes in the fishery and markets over time such that previously specified methods and parameters may no longer apply. With this in mind CCSBT decided in 2021 to commission a new independent study with the objectives of:

Objectives of this study

A. Updating and applying methods for estimating the amount of southern bluefin tuna (SBT) product distributed in Japan's markets that is caught by Japan;
B. Developing and applying methods for estimating the amount of SBT product distributed in Japan's markets that is caught by members other than Japan; and
C. Assessing the total amount of SBT product distributed in Japan's markets relative to the global total in order to evaluate the utility of further study of Japan's markets.

This document based on desktop review

This document provides a summary of existing, available data reviewed in November-December 2021 which can inform the new study. A large number of CCSBT meeting documents, some of which are not in the public domain, were provided by the Secretariat and considered in this review. Otherwise, data sources were limited to those publicly available online and did not include any interviews with experts or stakeholders. Such people may be approached for interviews once the methodology proposed here is endorsed and the study begins in earnest. Once interviews commence and new information is received the methodology may need to be further adapted. The following three sections of this report address each of the study objectives in turn.

2 Objective A: Japan-Caught SBT in Japan's Markets

2.1 Task Definition

Update the formula and its inputs

The terms of reference specify both the need to update the existing formula for estimating the amount of SBT caught by Japan and distributed in Japan, as well as to update the values of the inputs the formula. The following sections review the existing formula, and its inputs to date, and propose options for modifying them to better reflect current conditions and knowledge. It is noted that if the formula needs to be changed to reflect current conditions, new inputs may need to be sourced. Proposals for

updating the implementation of the formula, in particular incorporating stochasticity, are also presented.

2.2 Summary of Previous Work

2.2.1 Existing Formula

The methodology developed by Lou et al. (2006) was first written as a formula by Sakai et al. (2010) and is consolidated here as:

$$M_t = \left\{ \frac{\left(\left(\frac{To_t + Ya_t}{p} \right) - F_t - D_t - I_t + S_t \right)}{r} + E_t \right\} \times c \qquad \text{Eq. 1}$$

where

Existing formula as currently written

M_t is the total quantity of Japan-caught SBT in Japan's markets in year t

To_t is the quantity of frozen SBT (regardless of origin) sold through Tokyo metropolitan wholesale markets in year t

Ya_t is the quantity of frozen SBT (regardless of origin) sold through the Yaizu fish market in year t

p is the proportion of frozen SBT sold in Japan's municipal wholesale markets that is sold in Tokyo and Yaizu

F_t is the quantity of frozen SBT sold in Japan's municipal wholesale markets in year t that is farmed (i.e. assumed not to be Japan-caught)

D_t is the quantity of frozen SBT sold in Japan's municipal wholesale markets in year t that is double counted

I_t is the quantity of frozen wild SBT sold in Japan's municipal wholesale markets in year t that is imported (i.e. assumed not to be Japan-caught)

S_t is the quantity of fresh, non-imported SBT in year t (i.e. assumed to be Japan-caught, if any (see Table 1, footnote 6))

r is the proportion of Japan-caught SBT sold in Japan's municipal wholesale markets

E_t is the quantity of frozen Japan-caught SBT exported in year t [1]

and

c is the conversion factor to adjust market-observed quantities to their whole weight equivalents.

In graphical form (Figure 1), the existing formula produces the total quantity of Japan-caught SBT in Japan's markets each year by:

[1] Note that although this formula is as presented in papers submitted to CCSBT over the years, in most calculations exports are converted to whole weight before being summed with other quantities. While this makes no difference mathematically, the term E_t should be removed from the large bracket in order to be consistent with historical calculation methods.

How the existing formula operates in words

- Estimating the total frozen SBT in Japan's municipal wholesale markets from a subset of those markets and extrapolating to the total (black outline);
- Subtracting frozen farmed, double-counted and frozen wild imported quantities (green outline);
- Adding any fresh, domestic SBT (blue outline);
- Inflating that quantity to account for SBT handled outside of Japan's municipal wholesale markets (red outline);
- Adding any SBT exports from Japan (turquoise outline); and
- Converting the market-observed quantities to whole weight equivalents (gold outline).

Since three of the quantities in Eq. 1, i.e. F_t, D_t and I_t, are factors of other quantities, the formula can be re-written as (Eq. 2):

$$M_t = \left\{ \frac{\left(\left(\frac{To_t + Ya_t}{p}\right) - \left(\left(\frac{To_t + Ya_t}{p}\right) \times f_t\right) - \left(\left(\frac{To_t + Ya_t}{p}\right) \times d\right) - \left(\left(\frac{To_t + Ya_t}{p} - \left(\frac{To_t + Ya_t}{p} \times f_t\right) - \left(\frac{To_t + Ya_t}{p} \times d\right)\right) \times i_t\right) + S_t \right)}{r} + E_t \right\} \times c \qquad \text{Eq. 2}$$

Existing formula re-written

where f_t is the proportion of frozen SBT that originates from farming in year t, d is the proportion of frozen SBT in the major municipal wholesale markets that is double-counted, and i_t is the proportion of frozen wild SBT that is imported in year t. Although this notation is cumbersome it highlights the dependency of the formula on the quantities observed in Tokyo and Yaizu markets.

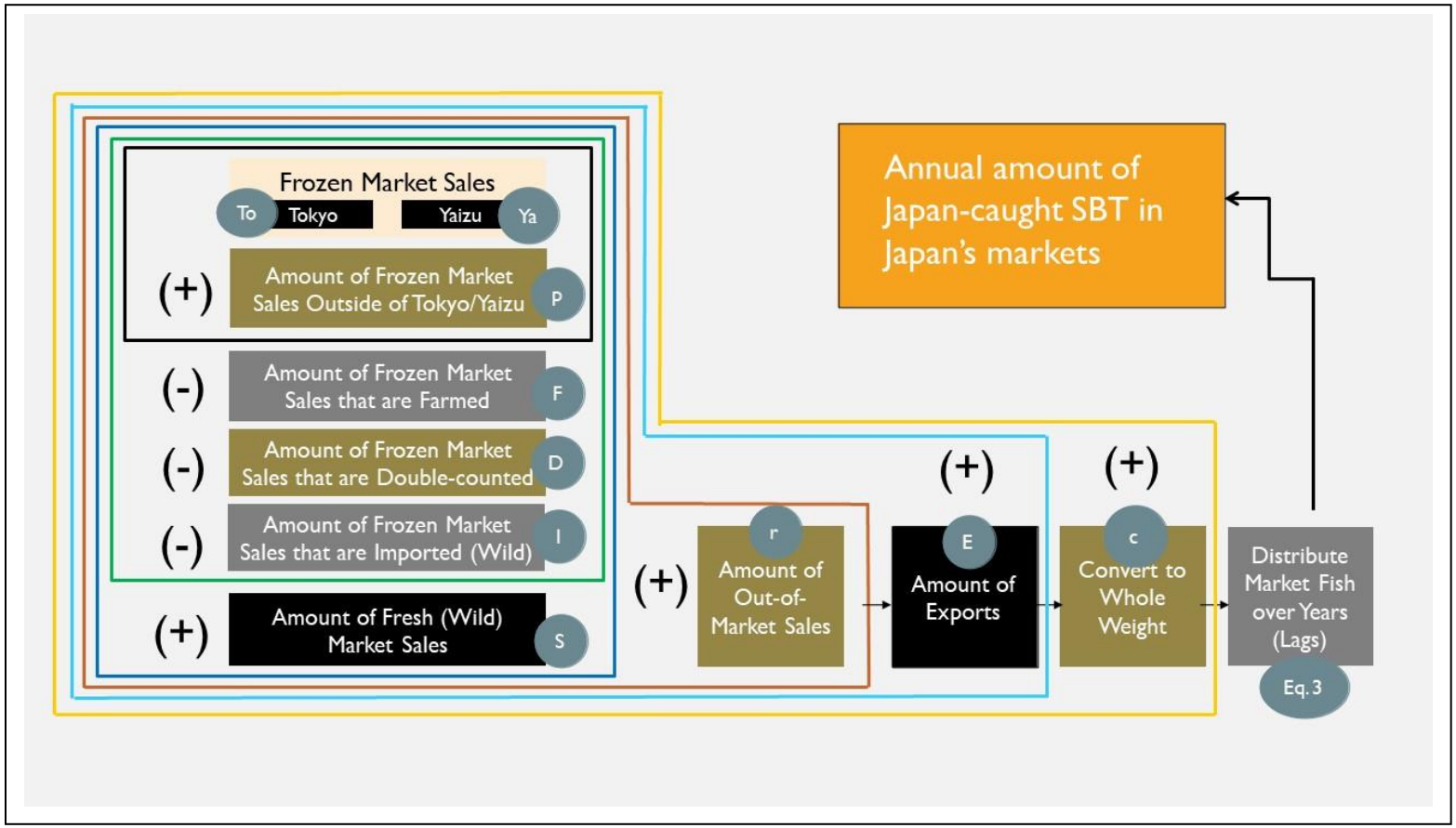

Figure 1. Graphical representation of the existing formula for estimating the total quantity of Japan-caught SBT in Japan's markets (Eq. 1). The results are then distributed over years to account for lags (Eq. 3) before being compared to reported catches by Japan. Blue circles represent the inputs to the formula. (+) or (-) indicates that quantities would rise or fall at this step.

In order to compare the market quantity estimated in a given year to the reported catch in that same year it is necessary to account for lags (i.e. the time between catch and appearance in the market) as first investigated by Itoh et al. (2008). The existing formula for six lags can be written as (based on Itoh et al. 2020; Eq. 3):

$$C_t = \alpha \times M_{t-6} + \beta \times M_{t-5} + \gamma \times M_{t-4} + \delta \times M_{t-3} + \varepsilon \times M_{t-2} + \zeta \times M_{t-1} + \eta \times M_t \quad \text{Eq. 3}$$

where

Existing formula for lags

- C_t is the estimated Japan-caught SBT during year t
- α is the proportion of the market in year t which is comprised of SBT caught in year *t-6*
- β is the proportion of the market in year t which is comprised of SBT caught in year *t-5*
- γ is the proportion of the market in year t which is comprised of SBT caught in year *t-4*
- δ is the proportion of the market in year t which is comprised of SBT caught in year *t-3*
- ε is the proportion of the market in year t which is comprised of SBT caught in year *t-2*
- ζ is the proportion of the market in year t which is comprised of SBT caught in year *t-1*
- η is the proportion of the market in year t which is comprised of SBT caught in year t
- M_t is the total market-observed Japan-caught SBT in year t

This formula can be written more generally (i.e. to account for a variable number of lags) and compactly as (Eq. 4):

$$C_t = \sum_{l=0}^{6} \Theta_{t,l+1} M_{t-l} \quad \text{Eq. 4}$$

where

Generalized lag formula

- C_t is the estimated Japan-caught SBT during year t
- l is the number of lags, in this case six (l=1 to 6), plus the current year (l=0)
- $\Theta_{t,l}$ is a matrix with dimensions t (years) and l (lags) with each corresponding to the proportion of the market quantity observed in year t which derived from each lag l (or the current year, l=0)
- M_t the total market observed Japan-caught SBT in year t.

Applying the lag formula

The formula serves to redistribute the majority of the market quantity observed each year to previous years in accordance with tag data (which can be used to ascertain the catch date of each fish). Once the necessary redistribution is accomplished, the quantities for each year can be tallied to compare to Japan's catch records.

2.2.2 Historical Formula Inputs

History Market Estimation Inputs

Some inputs have been maintained at the same fixed values since 2006

A summary of the history of the inputs to the existing formula is presented in Table 1. The summary highlights that relatively few of the inputs are based on data from published sources (e.g. market and customs statistics). Rather, the majority of inputs have been determined by sampling, interviews or assumptions. Some inputs, such as the proportion of frozen in-market SBT which is farmed (f_t) and the proportion of frozen in-market SBT which is imported (i_t), have been updated annually through sampling or surveys of key traders operating at the major market in Tokyo. Several other inputs including the proportion of frozen SBT sold in Japan's municipal wholesale markets that is sold in Tokyo and Yaizu (p), the proportion of frozen SBT sold in Japan's municipal wholesale markets that is double-counted (d), and the proportion of frozen SBT that is sold in Japan within the municipal wholesale market system (r), have been maintained at the same fixed values since the original market study in 2006 (Lou et al. 2006).

Table 1. Summary of inputs used to estimate market quantities since 2006. "Reference", "Member" and "Year Submitted" refer to the paper, the CCSBT member submitting the paper, and year the paper was submitted to CCSBT, respectively, and are keyed in the box below. Yellow cells (*To*, *Ya*, *S*, and *E* in most years) represent data from published sources. Other inputs (*p*, *f*, *d*, *i*, *r* and *c*) are inputs that have been fixed on the basis of sampling, interviews or assumptions. Blue cells represent inputs that derive from the original independent market review panel's report (Lou et al. 2006). All inputs are as provided in the referenced paper, i.e. subsequent updates to historically provided values are not shown.

	Reference	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	**K**	**L**	**M**	**N**	**O**
	Member	AU	JP	AU	JP	JP	JP	JP	JP	JP	AU	JP	JP	JP	JP	JP
	Date Submitted	*2007*	*2007*	*2008*	*2008*	*2009*	*2010*	*2011*	*2014*	*2015*	*2013*	*2015*	*2017*	*2018*	*2019*	*2020*
To	Tokyo market frozen (t)	4,542	4,542	3,974	3,974	4,134	3,798	2,915	3,093	3,887	3,179	3,883	5,009	3,811	4,082	3,882
Ya	Yaizu market frozen (t)	575	575	613	613	633	560	418	693	612	519	627	626	872	797	713
p	Tokyo-Yaizu:all proportion	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79
f	Frozen farmed proportion[2]	0.10	0.3237	0.0648 (To) 0 (Ya)	0.3564	0.3418	0.3227	0.3473	0.293	0.278	0.0648 (To) 0 (Ya)	0.276	0.319	0.203	0.208	0.208
d	Frozen double-counted proportion	0.04	0.1182	0.018 (To) 0.17 (Ya)	0.1182	0.1182	0.1182	0.1182	0.1182	0.1182	0.1182	0.1182	0.1182	0.1182	0.1182	0.1182
i	Frozen imported proportion[3]	0.05	0.1685	0.05	0.3048	0.4133	0.4537	0.4549	0.388	0.329	0.05 (Ya); 0.13 (To)[4]	0.319	0.304	0.306	0.288	0.336
S	Domestic fresh	1[5]	1	0.127	1	26.6	0.8	4.5	omitted [6]	omitted	0	omitted	omitted	omitted	omitted	omitted
r	Proportion in-market	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
E	Exports	30	30	0.2	0	0.5	33	1.3	60	323	omitted	363	108	198	198	181
c	GG:WW conversion	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15	1:1.15

[2] Values which do not derive from Lou et al. (2006) are based on surveys of five major Tsukiji/Toyosu market sources
[3] Values which do not derive from Lou et al. (2006) are based on monthly monitoring of Tsukiji/Toyosu markets
[4] Values for Yaizu are based on Lou et al. (2006); values for Tokyo are based on a visit to Tsukiji market on 4 July 2014
[5] Notional fixed amount
[6] This parameter was removed from the formula by Japan starting in 2014 on the basis that all of Japan's SBT vessels produce only frozen, not fresh, product (Sakai et al. 2015b).

Reference Key for Table 1

A. Anon (Australia). 2008. Japanese Market Update 2008. CCSBT-CC/0810/12 (CCSBT-EC/0801/BGD14 (Australia)). 14pp. (data from Case 2)

B. Anon (Japan). 2008. Japan's preliminary analysis on CCSBT-CC/0810/12. CCSBT-ESC/1909/BGD 23 (Previously CCSBT-ESC/0810/21). 11pp. (data from Case 1)

C. Phillips, K. and G. Begg. 2009. Japanese Market Update 2009. CCSBT-ESC/0909/09. 17pp. (data from Case 2)

D. Sakamoto, T., O. Sakai and T. Itoh. 2009. Monitoring on Japanese markets. CCSBT-ESC/0909/41. 7pp. (data from Case 1)

E. Sakai, O., T. Itoh, T. Yamamoto and T. Kawashima. 2010. Monitoring on Japanese domestic markets: 2010 update. CCSBT-ESC/1009/32(Rev) (CCSBT-ESC/1909/BGD 26). 17pp. (data from Case 1)

F. Sakai, O. T. Itoh, M. Mishima and T. Kawashima. 2011. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2011 update. CCSBT-ESC/1107/27 (CCSBT-ESC/1909/BGD 27). 17pp. (data from Case 1)

G. Sakai, O., T. Itoh, M. Mishima and Y. Akatsuka. 2012. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2012 update. CCSBT-ESC/1208/31(rev. 1) (CCSBT-ESC/1909/BGD 28). 17pp. (data from Case 1)

H. Sakai, O., C. Fukugama and S. Takeda. 2014. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2014 update. CCSBT-CC/1410/19 (CCSBT-ESC/1909/BGD 29). 19pp. (data from Case 1)

I. Sakai, O., T. Itoh and Ryo Omori. 2015a. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2015 update. CCSBT-CC/1510/Info 04 (CCSBT-ESC/1909/BDG 31). 24pp. (data from Case 1)

J. Jeffries, B. 2015. A review of SBT supplies in Japan's Domestic Market. CCSBT-CC/1510/Info3. 11pp. (data from Case 2)

K. Sakai, O., T. Itoh and R. Omori. 2016. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2016 update. CCSBT-CC/1610/22 (CCSBT-ESC/1909/BGD 32). 26pp. (data from Case1)

L. Sakai, O., Y. Tsuda, T. Itoh and R. Omori. 2017. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2017 update. CCSBT-ESC/1708/25 (CCSBT-ESC/1909/BGD 33). 27pp. (data from Case 1)

M. Tsuda, Y., O. Sakai, T. Itoh and T. Ara. 2018a. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2018 update. CCSBT-ESC/1809/30 (CCSBT-ESC/1909/BGD 34). 28pp. (data from Case 1)

N. Tsuda, Y., O. Sakai, T. Itoh and Y. Morita. 2019a. Monitoring Southern Bluefin Tuna trading in the Japanese domestic markets: 2019 update. CCSBT-ESC/1909/21. 28pp. (data from Case 1)

O. Itoh, T., Y. Tsuda and Y. Morita. 2020. Monitoring of Southern Bluefin Tuna trading in the Japanese domestic markets: 2020 update. CCSBT-ESC/2008/22. 30pp. (data from Case 1)

History of Lag Calculations

Lag calculations have been used by both Australia (Phillips & Begg 2009) and Japan (mostly recently Itoh et al. (2020)) to redistribute market-observed quantities to prior years to account for delays between catch and entry to the market. Japan has collected information since 2007 from tags observed on fish in Tokyo markets to determine for each year of sampling the proportion of fish deriving from each of six previous catch years and the current year. These proportions (lag coefficients) represent nearly 30,000 tags observed (Itoh et al. 2020), of which over 80% of the readable tags were attached by Japan (CCSBT 2021a).

Recent application of the lag coefficients should be clarified

It has not been possible to replicate the lag calculations in Itoh et al. (2020) either due to an error in the data provided or a misunderstanding regarding the application of the formula. Specifically, the annual coefficients given in Attachment 6 of Itoh et al. (2020) do not produce the figures shown in Attachment 7 of Itoh et al. (2020). There are numerous such discrepancies between Attachments 6 and 7 (see Annex A of this document), and these may affect the accuracy of the reported anomalies between market quantities and Japan's declared catch (e.g. Table 2 in Itoh et al. (2020). It is not clear which lag coefficients are correct, but noting that the coefficients in Attachment 6 tally to 1 and those in Attachment 7 do not, for this document the coefficients in Attachment 6 are assumed to be correct.

2.2.3 Formula Performance

Itoh et al. (2020) presents market quantity estimates (*M* from Eq. 1) alongside Japan's domestic unloadings figures for 2004-2019 finding anomalies from +3761 t (market quantity > unloadings) in 2004 to -2300 t (unloadings > market quantities) in 2019 (Case 1 data). Japan interprets these results as providing no evidence for under-reporting of its catch, and attributes the anomalies to the lack of updating of some of the market estimation formula's inputs (Itoh et al. 2020).

A simple sensitivity analysis was conducted to explore the influence of various inputs on the results of the existing formula (Table 2). Equation 1 was implemented in Excel and each input was, in turn, reduced to 0.8 of its 2019 value as given in Itoh et al. (2020) with all other inputs staying the same. This analysis indicates that the inputs *To*, *c*, *p*, and *r* have the largest influence on the result. The amount of frozen SBT handled by Tokyo markets (*To*) is obviously influential in the calculation as it is the largest component of the "core" quantity from which several other quantities are calculated (see Eq. 2). The influence of the inputs *c*, *p*, and *r* is because they are used to factor a large number of terms in the equation. Although it is influential, the gilled and gutted to wet weight conversion factor (*c*), is likely to be well-known and is thus not expected to be a major source of uncertainty. In contrast, *p* and *r*, which relate to the proportion of the main municipal wholesale market tuna handled by Tokyo and Yaizu, and the proportion handled outside of the municipal wholesale market system, respectively, are poorly known. These two inputs were specified in the original study (Lou et al. 2016) based on expert opinion and have not been updated, presumably due to the difficulty of obtaining current information.

Simple sensitivity testing reveals that To, c, p *and* r *are the most influential inputs*

These four inputs (*To, c, p, and r*) remained the most influential inputs when the sensitivity test reduced each quantity to -50% and +120% of its 2019 value (not shown). When each quantity is increased by 150% (noting that this is mathematically

but not theoretically possible in all cases, i.e. those inputs expressed as proportions need to be less than 1), the import parameter (*i*) is similar in influence to *To* and *c*, but still considerably less influential than *p* and *r* (not shown).

Table 2. Sensitivity analysis of the formula for calculating Japan-caught SBT in Japan's markets (*M*) to reducing each input, in turn, to 80% of its 2019 value (first column). Yellow highlights indicate the input quantity being tested and the amount of the reduction. The final row shows the percent change in *M* from its 2019 value (i.e. 3701 t). Pink highlights indicate the most influential inputs.

	2019 value	To	Ya	p	f	d	i	r	E	c
To	3882	3105.6	3882	3882	3882	3882	3882	3882	3882	3882
Ya	713	713	570.4	713	713	713	713	713	713	713
p	0.7896	0.7896	0.7896	0.6317	0.7896	0.7896	0.7896	0.7896	0.7896	0.7896
f	0.208	0.208	0.208	0.208	0.1664	0.208	0.208	0.208	0.208	0.208
d	0.1182	0.1182	0.1182	0.1182	0.1182	0.0946	0.1182	0.1182	0.1182	0.1182
i	0.336	0.336	0.336	0.336	0.336	0.336	0.2688	0.336	0.336	0.336
r	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.68	0.85	0.85
E	181	181	181	181	181	181	181	181	144.8	181
c	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	0.92
M	3701	3108	3594	4584	3921	3827	4060	4584	3667	2999
Δ		-0.19	-0.03	0.19	0.06	0.03	0.09	0.19	-0.01	-0.23

A Monte Carlo simulation tested the effect of multiple inputs varying simultaneously

Another analysis was conducted to determine the effect on the calculated market quantity (*M*) of variability in multiple inputs simultaneously (see Annex B for details). This analysis employed a Monte Carlo simulation focusing on those inputs which *a priori* appear to have high uncertainty because they are not based on publicly available data and/or have not been updated since the original study (Lou et al. 2006). These inputs include *p* (proportion Tokyo+Yaizu), *r* (proportion in-market), *d* (proportion double counted), *f* (proportion farmed) and *i* (proportion wild imported). The first two inputs were identified in the preceding analysis as being highly influential on the result.

As there is little information available to judge the true variability of these inputs, two scenarios corresponding to "tight" and "loose" variability were notionally defined for the sake of illustration (Table 3). In both scenarios, for the inputs that are currently fixed, i.e. for *p*, *r* and *d*, binomial distributions were defined with the median approximately equal to the current values (see Table 1). For the "tight" scenario, the variance was set so that the value was allowed to vary by ±10% around its median. For the "loose" scenario, the variance was arbitrarily doubled to produce a wider range of values around the same medians (Table 3). The inputs *f* and *i* are informed by annual survey data provided by Japan, but there is also ongoing debate about their proper specification (Table 1). In the "tight" scenario, *f* and *i* were estimated within the model using an uninformative binomial distribution and the existing data provided by Japan for 2010-2019. In contrast, for the "loose" scenario *f* and *i* were allowed to vary between the lowest and highest values in Table 1.

Table 3. Inputs values used in the Monte Carlo simulation for *p*, *r, d, f* and *i* . Note that the probability intervals are not necessarily symmetric around the median when the proportions approach 1 (as 1 is the highest possible value).

	p	*r*	*d*	*f*	*i*
Current value	0.7896 (point estimate) from Lou et al. (2006)	0.85 (point estimate) from Lou et al. (2006)	0.1182 (point estimate) from Lou et al. (2006) Case 1[7]	Annual values from 0.21 to 0.37 from Itoh et al. (2020)	Annual values from 0.29 to 0.46 from Itoh et al. (2020)
Scenario 1 ("Tight") Median (95% probability interval)	0.79 (0.73 to 0.84)	0.85 (0.70 to 0.93)[8]	0.12 (0.04 to 0.30)	0.28 (0.24 to 0.33)	0.36 (0.32 to 0.42)
Scenario 2 ("Loose") Median (95% probability interval)	0.79 (0.67 to 0.88)	0.85 (0.48 to 0.97)	0.12 (0.01 to 0.57)	0.20 (0.06 to 0.35	0.25 (0.06 to 0.44)

Simulation model results were compared to deterministic point estimates to assess the effect of input variability

Results for the market quantity (*M*) were produced for 2010-2019 and compared to the estimates in Table 1 of Itoh et al. (2020) which are based on deterministic point estimates. For both scenarios in all years the maximum difference between the median *M* from the model and Itoh et al. (2020) was 24 t (<1%), indicating that the model's median can closely reproduce the market estimates. However, when the model results were lagged according to the coefficients in Attachment 6 of Itoh et al. (2020) the model output did not correlate well with the lagged values reported by Itoh et al. (2020) in Table 2. This was traced to discrepancies which are internal to Itoh et al. (2020; see Annex A). Although they may be incorrect, for the sake of consistency the lag coefficients used by Itoh et al. (2020) to produce Table 2 (i.e. the coefficients from Attachment 7) were used in the model. This allows an assessment of whether the 95% probability interval for the model's (lagged) market estimate exceeds Japan's unloadings figure for each year (i.e. the implied threshold for the presence of overcatch).

Given the uncertainty can the formula provide a sufficient basis for decision-making?

For the "tight" scenario the 95% probability interval only exceeds this threshold in 2014 (95th percentile = 3,679 t and unloadings = 3,595 t). In contrast, for the "loose" scenario the 95% probability interval extends past the unloadings threshold—often by thousands of tonnes—in each year modelled. Although the "loose" scenario was designed to represent a worst case, its parameters are not unrealistic. In reality the true values of some parameters may lie outside the ranges specified here. Given that to date, the use of point estimates has masked the uncertainty, and given that even under the "tight" scenario the range of annual estimates is broad, it is important to consider whether use of the formula provides a sufficient basis for decision-making. This clearly depends on the accuracy and precision of the inputs, some of which are likely to be dynamic and/or difficult to specify even with intensive effort. Ideas for improving the specification of the inputs are presented in the following section.

[7] The Case 1 value for *d* was selected as the median for this simulation because it is larger and thus allows a wider range of variance within the boundary conditions (i.e. between 0 and 1). Note that the "tight" scenario allows *d* to vary between Case 1 and Case 2 values.

[8] Tsuda et al. (2019b) states that the current amount of SBT distributed outside of municipal wholesale markets may be 20-30% (i.e. *r*=0.7 to 0.8).

Figure 2. Results from the Monte Carlo simulation of formula inputs *p*, *r*, *d*, *f* and *i* for "tight" and "loose" variability scenarios (see Table 3 for specification). "Japan market estimates (Case 1)" (blue circles) and "Japan unloadings" (red circles) are taken from Table 2 in Itoh et al. (2020). Black circles and lines show the median from the simulation model and the width of the 95% probability interval, respectively.

2.3 Updating the Inputs in the Existing Formula

The terms of reference specifically call for updating the inputs to the existing formula. In this respect, the inputs specified in Eq. 2 can be classified into three categories: inputs based on published data, inputs which were initially specified based on expert judgement but are now supported by data collection, and inputs which are primarily based on expert judgement. These three categories are discussed below. Each input is evaluated based on the degree to which it is supported by data (and the quality of that data), how appropriately it represents the quantity of interest, and its consistency with other statistics and knowledge.

2.3.1 Inputs based on Published Data (To, Ya, S and E)

Inputs based on published data, include *To*, *Ya*, *S* and *E* and have been updated each year in CCSBT members' papers on the basis of market and customs statistics. As updated values are readily available, further work on these inputs should focus on determining whether they should continue to be used in the current manner.

S, the quantity of Japan-caught fresh SBT, may be excluded

In recent years Japan has omitted fresh domestic SBT (*S*) from the formula on the basis that no such product is produced by Japan's fisheries (Sakai et al. 2015b). If this situation is confirmed, *S* will be excluded from any formulas designed to estimate Japan's contribution to SBT markets. (It may, however, be important for other formulae (see Section 3)).

E, exports, are generally few and considered a low priority

Exports (*E*) have been assumed to be reported accurately in customs statistics (JMOF) as gilled and gutted products and so converted to wet whole weight in the formula. The major uncertainty for *E* is mixing of SBT with other species, i.e. either failing to declare SBT exports as SBT or declaring non-SBT exports as SBT. It is also theoretically possible that some SBT exports are not Japan-caught and thus do not belong in the formula (i.e. they are re-exports rather than exports). Through interviews with traders and government officials (customs and/or fisheries), and reference to results from genetic testing programmes (e.g. Tsuda et al. 2018b), it may be possible to determine how much uncertainty should be associated with *E*. However, since the volume of *E* is generally low (~200 t per year)[9] it does not have a large influence on the formula (see Section 2.2.3) and further investigation is considered a low priority.

To *and* Ya, *frozen SBT in Tokyo and Yaizu are important inputs*

In contrast, the quantities of SBT handled by Tokyo (*To*) and Yaizu (*Ya*), particularly the former, should be investigated due to their influence on the formula. The Tokyo metropolitan government's (TMG) central wholesale market website reports quantities of SBT (印度マグロ) handled in three categories: total frozen 冷凍総合, fresh imports 鮮魚輸入 and fresh domestic 鮮魚国内 (Figure 3; TMG 2021a). The first category (total frozen) has been used in the formula from the beginning (Lou et al. 2006); fresh domestic has been considered *S* in the past (see above (this section)).

[9] Exports through 2019 are reported in Itoh et al. (2020). Exports since 2019 have been considerably lower (9 t of frozen SBT to Korea and a very small amount to Bahrain in 2020, and 41 t of frozen SBT to Korea in 2021 (JMOF (2021) data through October 2021).

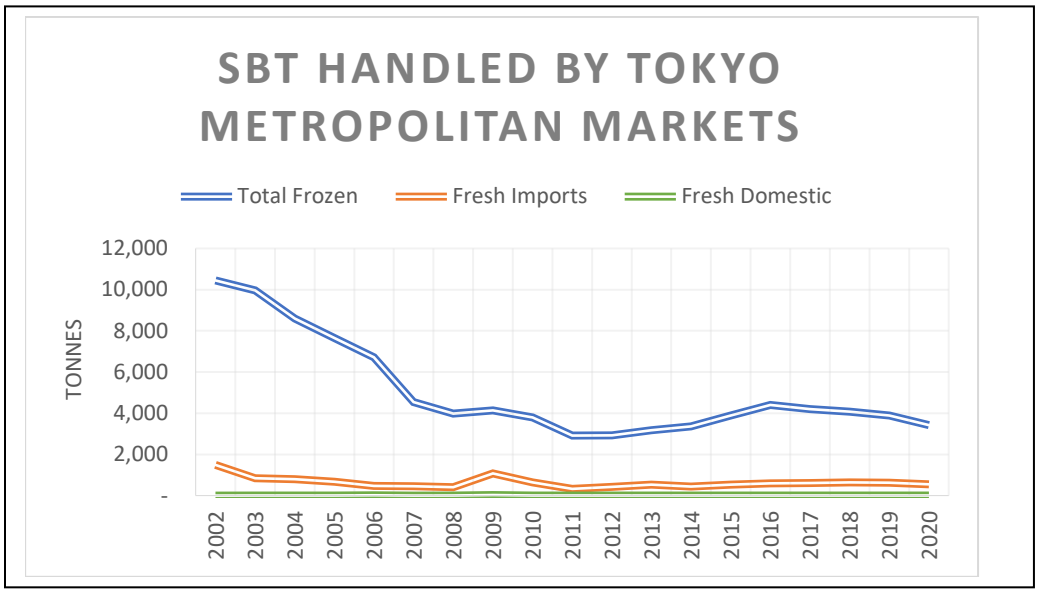

Figure 3. Frozen and two types of fresh SBT handled by Tokyo metropolitan government wholesale markets, 2002-2020 (Source: TMG 2021a).

Tokyo SBT market statistics show the prefecture of origin and might help explain market flows

All three amounts are reported by 出荷地 which translates as "shipping place" and in this case means the prefecture from which the SBT was provided to Tokyo (i.e. not the prefecture to which it was shipped). For frozen SBT the most common prefecture of origin is given in these statistics as Shizuoka, although the proportion has declined from 67% in 2002-2006 to 53% in 2016-2020, with proportions from Tokyo, Kanagawa and Chiba increasing and proportions from Kagoshima remaining stable (Figure 4). The location of nine of Japan's ten designated ports for unloading SBT in Shizuoka (Shimizu, Yaizu and Oigawa), Kanagawa (Kawasaki, Misaki, Yokohama and Yokosuka), Tokyo (Tokyo) and Kagoshima (Kushikino), along with the presence of Narita Airport in Chiba, help to explain the importance of these five districts. However, the indication of Gunma, Saitama and coastal prefectures without designated ports as sources of SBT is more difficult to interpret. A similarly wide range of prefectures is also listed as the source for fresh domestic and fresh imported SBT handled in Tokyo municipal wholesale markets. Gaining a better understanding of how these data are compiled (e.g. based on the headquarters of the company introducing the SBT to the market?) might help map product flows and thus separate domestic from imported SBT[10].

[10] For example, based on information given in Sakai et al. (2015b) it might be appropriate to assume that all fresh and frozen SBT recorded as originating from Chiba prefecture are imports via Narita Airport.

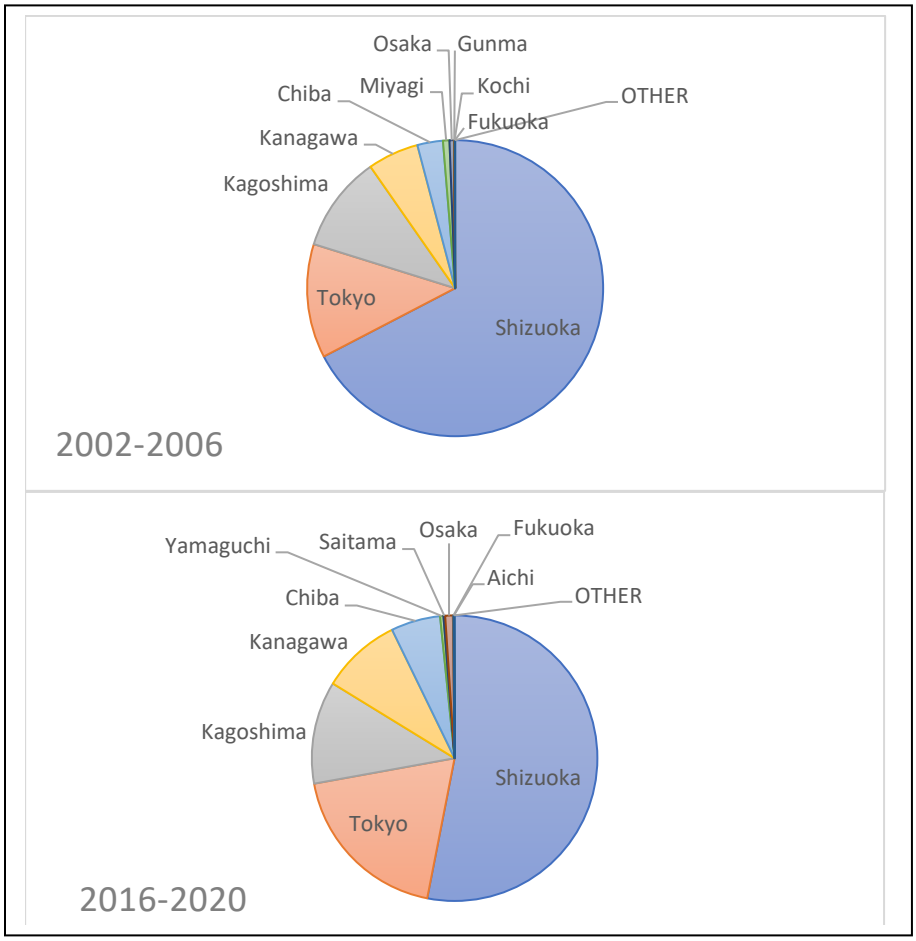

Figure 4. Sources, by prefecture/city, of frozen SBT handled in Tokyo central wholesale markets in 2002-2006 and 2016-2020. (Source: TMG 2021a)

Other sources of Tokyo market data may be available

One additional data source for the Tokyo markets was identified in the form of daily records of the amount of fresh and frozen SBT auctioned (せり・入札, SERI) and handled in negotiated sales (相対, AITAI) in each of the three markets (i.e. up to 12 data points per day). There is notation regarding the origin of the fish but this usually refers only to "various overseas areas". These records are available from January 2004 to the present (TMG 2021b)[11].

Data on quantities of SBT handled in Yaizu are limited to monthly landings (水揚品, i.e. brought by vessels) and monthly amounts brought by land (陸送品).[12] Product form is not specified therefore it is assumed that all product handled in Yaizu is frozen. Since

[11] The existence of other data held by TMG, in particular data that could help separate SBT by origin, has been debated by Members over the years. For example, Jeffries (2015) argues that data on the source country for each frozen tuna handled by TMG are available. Tsuda et al. (2019b) states that handwritten forms contain the information but are not compiled and electronic forms do not contain the information. These issues will be investigated and independently confirmed if possible.

[12] Lou et al. (2006) found that SBT landings and amounts brought by land are not reported separately prior to 1994 and as a result applied ratios to calculate the missing amounts (see Footnote 8 on p. 63). In fact, these data can be found for 1985-1992 on the Yaizu Fishery Cooperative website https://www.yaizu-gyokyo.or.jp/catch-year/ (data for 1993 are indeed not available).

the beginning of the market estimation exercises only the amounts brought by land have been included in the calculation. This appears to be based on the statement in Lou et al. (2016) that "*SBT transacted at Yaizu market in reality was found to be comprised of "land transport"*" (i.e. brought by land). SBT landings in Yaizu were similar in quantity to the amount brought by land in the mid 2000s but are now more than double (~2,000 t per year, Figure 5). Given this large amount of landings and the lack of information about its disposition (i.e. since it is not included in *Ya* under the current formula, does it all enter the Tokyo market?), the current flows of both SBT landed and brought by land to Yaizu should be re-confirmed through interviews with Yaizu Fishery Cooperative statisticians. In addition, it will be important to understand whether the amounts brought by land refer only to transfers from local ports (e.g. Shimizu, Oigawa) to Yaizu or potentially to transfers from other markets (e.g. Tokyo) thereby contributing to double-counted quantities.

The rationale for excluding landed quantities from Ya *should be investigated*

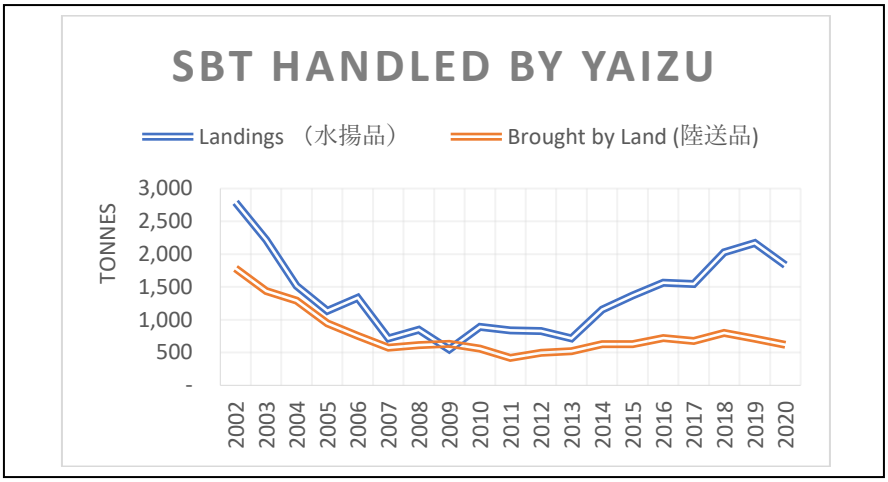

Figure 5. SBT landed (水揚品, from vessels) and brought by land (陸送品) in Yaizu, 2002-2020 (Source: YFCA 2021).

Another source of market data for Tokyo is the subscription-based Jiji Press data service[13]. A free trial subscription was obtained to understand in detail what data are available, though it should be noted that an annual subscription fee would be required to access the data after the trial period, and the terms of use do not allow the data to be used outside of Japan. The information provided is orientated toward traders and thus focused on the current number of fish (rather than weight) passing through the market and their price (i.e. in general the online portal does not provide access to data more than one year old). For SBT there is information provided on the size (large or small) and fishing ground which, in theory, could help to separate domestic from imported SBT, as well as farmed SBT from wild. However, for 2021 all SBT were listed as originating in "Cape Town, SW Australian waters" which suggests a lack of discrimination in the data. Further inquiries could be made but the likelihood of discovering further useful information appears to be low.

Jiji Press data does not appear to be useful for the purposes of this study

Need to confirm the usual data sources are accurately indicating flows through To *and* Ya

In summary, the formula inputs that have been based on published data are easily updated by accessing the usual sources. Nevertheless, given the influence of the market quantities (*To* and *Ya*) on the formula results it will be important to confirm that the

[13] The Jiji Press fish information service is located at https://www.jiji.co.jp/service/osakanadx/

usual data sources are providing an accurate indication of the flows through the Tokyo and Yaizu markets. This will require understanding both how SBT flows into and through these markets, as well as how existing statistical systems capture those flows. In particular, the inclusion in *To* and *Ya* of the relatively large landings of frozen SBT at Yaizu should be carefully considered.

2.3.2 Inputs based on Expert Judgement supported by Data Collection (f, i and lags)

There are several inputs to the existing formula, including *f, i*, and the lags, which were initially specified by the independent market review panel based on expert judgement. Although there are now data available to update these inputs, there still may not be consensus on their appropriate values.

Market and customs statistics do not separate farmed and wild SBT

The proportion of in-market frozen tuna that is derived from farming (*f*) was assumed by Lou et al. (2006) to be 10% or below, but found to be between 21-36% based on Japan's surveys of Tokyo wholesalers in 2007-2020 (Table 1). Verification of these figures is complicated by the fact that customs statistics record imports but cannot separate farmed from wild SBT; published market statistics likewise do not separate farmed from wild fish. The amount of fresh and frozen SBT imported from Australia (the only country that farms SBT) has varied from 6,500 to 9,000 t per year between 2007-2019 (JMOF 2021), but amounts of farmed SBT estimated by applying Japan's market surveys results (*f*) to the estimate of total in-market quantities (*F* as given by Itoh et al. 2020), and then extrapolating to the entire Japan market (i.e. dividing by 0.85) are considerably lower at 1,350 to 2,700 t per year. If the market-based estimates of *f* are correct, even if not all Australian SBT is farmed, this comparison suggests that large quantities of farmed SBT are bypassing the municipal wholesale markets (Figure 6).

Estimates based on survey data suggest large quantities of farmed SBT bypass the market

One reason for this could be that according to some sources farmed SBT is of standard quality and does not need to be individually appraised at auction to determine its value. Therefore farmed SBT tends to be handled in negotiated sales (AITAI, 相対) or traded outside of the market altogether (Sakai et al. 2015b). However fresh farmed SBT may be more likely to be handled in Japan's municipal wholesale markets due to the need to find buyers quickly, and if so these fresh products are required by law to be auctioned (Sakai et al. 2015b). It is interesting to note that Japan's market survey-based quantities are similar to the amounts of fresh SBT imported from Australia (Figure 6) despite the fact that *f* is designed to factor the quantity of frozen in-market SBT only (i.e. *To* and *Ya* consist of frozen SBT only).

Current estimates of f *(farmed proportion in market) appear sound*

Japan's estimate of *f* is formulated from a tally of the farmed and wild frozen SBT quantities reported as handled by five major Tokyo-based wholesalers (Itoh et al. 2020). Inaccuracies could arise if these five wholesalers' SBT is not representative of the SBT handled by Tokyo markets as a whole[14], however according to Itoh et al. (2020) the amounts of SBT reported by the wholesalers total 95 to 98% of the total amount of SBT reported as handled by Tokyo municipal wholesale markets (and the TMG total includes both SERI and AITAI quantities (Lou et al. 2006, Itoh et al. 2020, TMG 2021b)). Japan's estimate of *f* therefore seems sound in that it is based on repeatedly collected (survey) data, appears to be representative of the Tokyo wholesale market as a whole, and is consistent with customs statistics and what is known about how farmed SBT flows through the market. Pending independent confirmation of these points, and unless there are existing sources of information which have not yet been identified that can separate farmed and wild SBT in municipal wholesale markets, prospects for further clarifying *f* appear limited. This situation in combination with the fact that the existing formula is not particularly sensitive to *f* (see Section 2.2.3) suggests that additional work on this input is not a high priority.

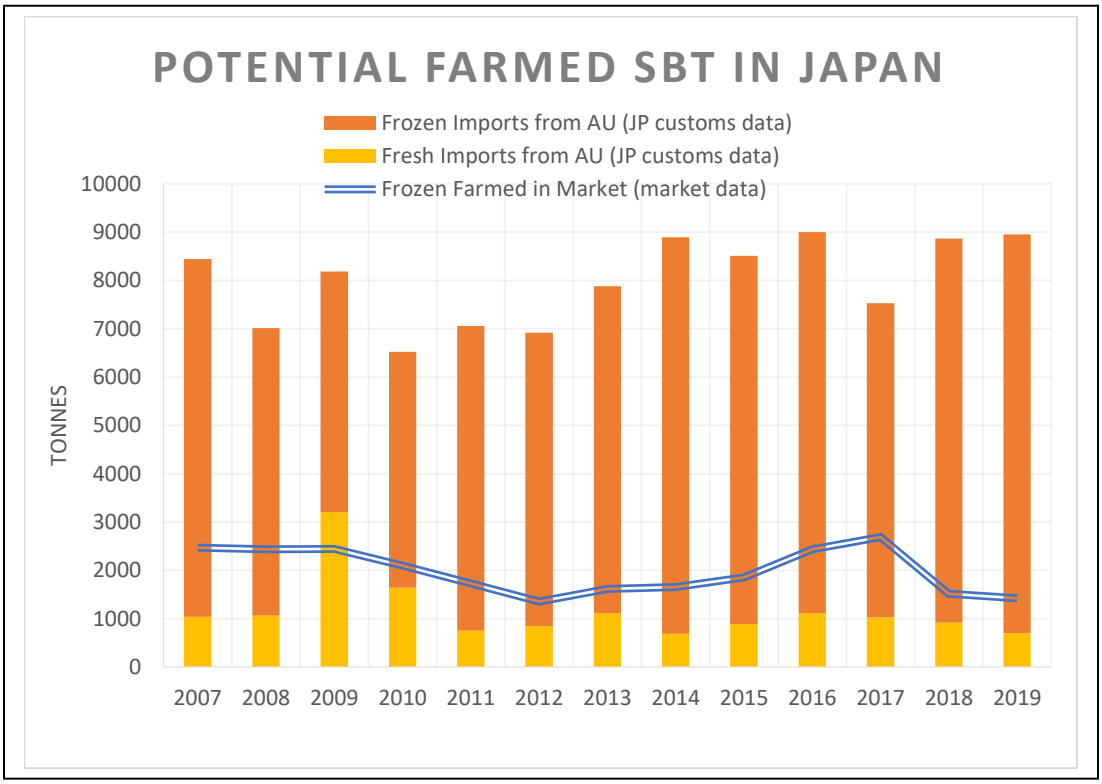

Figure 6. Potential amounts of farmed SBT in Japan based on Japan customs statistics (fresh and frozen imports from Australia; JMOF 2021) and market surveys of the top five wholesalers conducted by Japan (Itoh et al. 2020) extrapolated to Japan's markets as a whole. Note that not all Australian fresh and frozen imports are necessarily of farmed origin, e.g. Australia reported 850 t of SBT catch by gear other than purse seine indicating that up to this amount could be supplied to the Japan market as fresh or frozen non-farmed SBT (CCSBT 2021b).

[14] The possibility that the quantities reported by the five wholesalers represent only auctioned (SERI せり・入札) sales and not negotiated (AITAI 相対) sales of SBT—or are otherwise not representative of the Tokyo municipal wholesale market as a whole—has been raised in Jeffries (2014, 2015, 2016, 2017, 2018)).

Estimates of i *(imported wild proportion in market) are based on market surveys*

The existing formula also requires *i*, the proportion of frozen in-market wild SBT that are imported, i.e. not caught by Japan. Like *f*, this input was originally fixed by the independent market review panel (at 5%, apparently based on interviews with Tokyo market officials) and has been estimated by surveys conducted by Japan since 2007 as ranging between 17-45% (Table 1). These surveys are conducted once per month on a Friday which is considered by Japan to be a representative day of the week. The weight and origin of auctioned fish are recorded and an average annual ratio of imported (from Korea, Taiwan and "other") versus domestic origin is derived (Itoh et al. 2020).

Need to confirm that i *is representative of the market as a whole*

There are however important differences between the specification and usage *f* and *i*. As described above *f* appears to be representative of the market as a whole, whereas *i* is derived from a sample of auctioned (SERI,せり・入札) fish only. In other words, *i* does not necessarily correspond to the proportion of imported frozen wild SBT in the market as whole if such fish are differentially represented in SERI (せり・入札) and AITAI (相対) sales. Also, according to Eq. 2, the factor *i* is applied to a quantity intended to represent only wild fish (i.e. farmed SBT have already been subtracted) but since it is known that some farmed SBT are auctioned (see above) it is not clear how or whether farmed fish have been excluded from the dataset used to specify *i*.

Correspondence between market-based wild imports and customs statistics is quite close

It has been suggested that if the proportion of wild SBT imports in Japan's market is as high as suggested by Japan's auction monitoring that the total estimated amount of SBT imports could exceed the quantity of SBT imports reported in customs statistics (CCSBT 2009a). To examine this possibility, Japan's estimates of in-market frozen wild imports based on *i* (*I* in Itoh et al. 2020) were extrapolated to the entire Japan market and compared to customs statistics (JMOF 2021) for fresh and frozen SBT from all countries excluding Australia, assuming that most Australian SBT is farmed (Figure 7). While the market-based estimates were similar to the customs statistics in the early part of the series, they are approximately two-thirds the customs-recorded imports, and less than half the reported catches, in 2013-2019. Part of the discrepancy between the market-based estimates and the customs statistics is due to the increase in fresh SBT imports which are not accounted for in the market-based estimate. The correspondence between the market-based estimate and the frozen customs statistics is quite close.

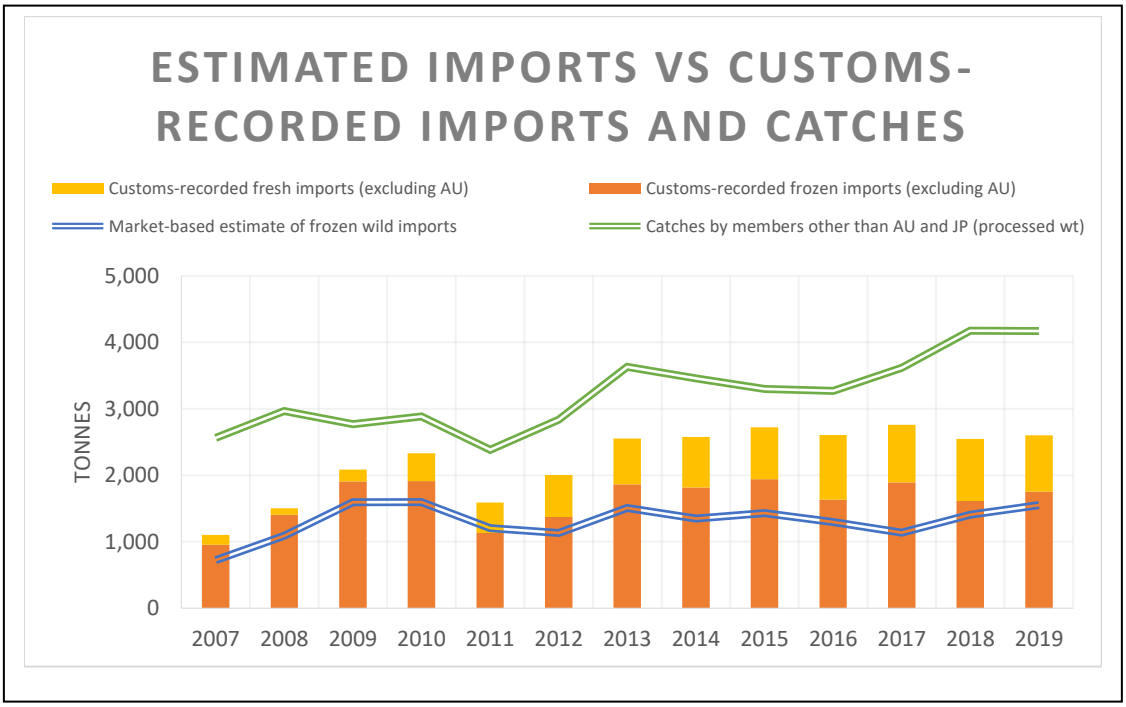

Figure 7. Catches and imports of frozen and fresh SBT to Japan from countries other than Australia compared to estimated quantities of in-market frozen wild imported SBT derived using monthly auction surveys in Tokyo. Imports from Australia are excluded on the basis that they are predominantly farmed products. Australian catch data are excluded for the same reason; catches by Japan would not be imported and are also excluded. (Sources: CCSBT 2021b, JMOF 2021 and Itoh et al. 2020).

The current specification of i *appears reasonable if it can be confirmed to be representative*

This analysis of *i* suggests that the current specification based in Japan's market surveys is reasonable as it is based on repeatedly collected (survey) data and is consistent with customs statistics. However, sampling auctioned SBT is not necessarily representative of all wild SBT passing through the market. If available, data on the origin of a broader sample of in-market SBT (unpublished TMG or other data) should be used to confirm this. It would also be useful to document how farmed fish are excluded from the auction sample and to detail which origins appear in the "other" category (up to 10% of the total in Itoh et al. 2020) to assist in national attribution of imported wild SBT in Japan's market (see Section 3).

The third and final input in this partially data-based category is the lags used to distribute observed market quantities to catches in current and prior years. No lags are specified in the independent market review although shortly thereafter an assumption was made of 70% for *t-1* (previous year) and 30% for *t* (current year; Itoh et al. 2008). Monthly sampling by Japan of tags at auctions since 2007 has resulted in a large (n=29,987) database, despite problems with the readability of tags such that overall only 66% could be read (CCSBT 2021a). The tag data are consistent from year to year showing that most observed fish are caught in the previous year (57%) or the current year (36%; Figure 8)[15].

[15] For an alternative data visualization see Figure 1 in Tsuda et al. (2019b)

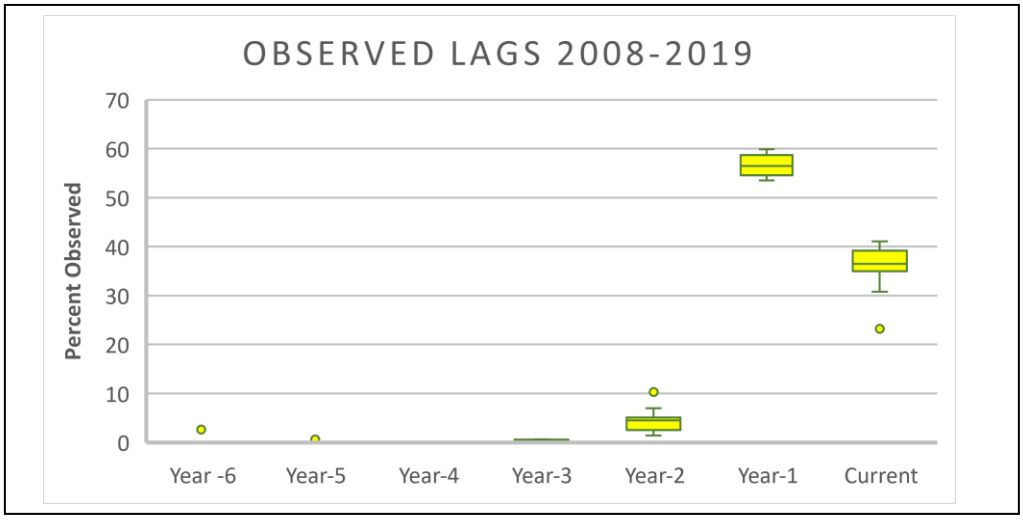

Figure 8. Compilation of annual average lag coefficients for current year and six previous years based on data collected from December 2007-December 2019 (Itoh et al. 2020).

The lag coefficients are well-specified for frozen auctioned SBT

Despite the large sample size and consistent results, the specified lags used in the existing formula suffer from the same issue as *i*: it is assumed that the observed lags for auctioned fish apply to the market as a whole. Therefore, in addition to investigating the potential mis-application of the lag coefficients in Itoh et al. (2020) Attachment 7 (see Section 2.2.2 and Annex A) and better defining how the lag coefficients should be applied, the applicability of the auction tag data to the entire market should be confirmed, if possible. This could involve investigating whether there are any other ways of estimating stockpiling and/or allowing for alternative lag coefficient specifications for SBT which are not auctioned. Aside from these issues, the lag inputs are well-informed by data and have not been challenged, therefore further investigation of lag coefficients is not considered a high priority.

2.3.3 *Inputs primarily based on Expert Judgement (p, d, r and c)*

*The inputs relating to extrapolation to other markets (*p, d *and* r*) are challenging to specify*

This final category contains three inputs relating to the structure of Japan's market: *p* (the share of frozen SBT in Japan's key municipal wholesale market system that is handled by Tokyo and Yaizu), *d* (the proportion of frozen SBT sold in Japan's municipal wholesale markets that is double counted) and *r* (the proportion of frozen wild SBT that is handled within Japan's markets as a whole). Due to the complexity and dynamic nature of Japan's market systems, these three inputs are challenging to specify. They were not particularly robust when they were first fixed by the independent market review panel in 2005 (i.e. they were based on limited expert judgement) and they have not been updated since that time. The potential variability associated with these inputs is high and they are some of the most influential in the formula (see Section 2.2.3).

The share of SBT in Japan's municipal wholesale market system that is handled by Tokyo and Yaizu (*p*) is used in the formula to extrapolate the quantities in Tokyo and Yaizu (*To* and *Ya*) to other key municipal wholesale markets. The independent market review panel obtained an estimate of *p* by compiling data for Tokyo, Yaizu and 12 other

p *(extrapolation to other key municipal markets) was not particularly robust*

markets for 1985-2005[16]. The share of Tokyo and Yaizu over these years was 0.72-0.79, but *p* was specified as 0.7896 on the basis of 2005 alone (Lou et al. 2006). The independent market review panel was not able to obtain all of these data from published sources and so filled in missing data using interviews and assumptions. This initial uncertainty in *p*, in conjunction with the fact that conditions have undoubtedly changed, argues strongly against continuing to use a sixteen-year-old point estimate.

It is difficult to know which markets handle SBT and whether their statistical systems are comparable

To explore how feasible it would be to update the estimate of *p*, an online search for recent market statistics for the 12 markets used in the original estimate of *p* was conducted (Table 4). With the exception of Misaki, up-to-date statistics were located, although SBT was not always listed perhaps because it was not handled. As explained in Lou et al. (2006) each market has its own conventions for enumerating what quantities it reports (e.g. auctioned (SERI (せり・入札)) only, or auctioned and negotiated sales (AITAI (相対))), and this may blur the line between what is considered inside and outside the market *(*i.e. between *p* and *r*, see below)). An additional uncertainty arises from the decision regarding which markets to include in *p*. For example, Lou et al. (2006) used 12 markets besides Tokyo and Yaizu (Osaka city, Nagoya, Kawasaki, Yokohama, Osaka prefecture, Misaki, Sapporo, Kobe, Hiroshima, Funabashi, Saitama and Nara) but there may be others that sometimes handle SBT (e.g. Kagoshima[17])[18].

*The proportion double-counted in key markets (*d*) is based on a complicated & controversial method which is difficult to update*

Another input necessary to factor the amounts handled by Tokyo and Yaizu (*To* and *Ya*) is *d*, the proportion of SBT within the key municipal wholesale markets that is double-counted. The independent market review panel considered that double-counting could occur both within and between markets and devised a complicated method for estimating *d* which applied different considerations for each market. The panel could not agree on the methodology and eventually specified two cases: *d*=0.1182 and *d*=0.044. As both values are small relative to the quantities being factored, *d* does not have a large influence on the market estimate (see Section 2.2.3). The previous methods used to estimate *d* seem confusing, subjective and difficult to replicate without a full-scale revisiting of each key market. Furthermore, the processes contributing to double-counting are likely to continue changing over time suggesting that *d* should be allowed to vary and/or be frequently re-specified.

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[16] Lou et al. 2006, p. 63. Note that overall the report states that data from 16 markets was compiled (p. 36)

[17] Kagoshima was selected at random as an example of a municipal wholesale market that was omitted from the original list but which might handle SBT, especially given that it is one of the designated ports for landing SBT. A search for market statistics identified that frozen tuna trade is reported by the Kagoshima central wholesale market only as "マグロ maguro" (https://bit.ly/3JaA3sb).

[18] In addition to the 12 (or 16) markets from which data were compiled by Lou et al. (2006) another 15 markets are listed which might handle SBT but do not maintain statistics on it (Lou et al. (2006), p. 36). At present there are 41 municipal wholesale markets listed on Japan's Ministry of Agriculture, Forestry and Fisheries website (https://www.maff.go.jp/j/shokusan/sijyo/info/link.html)

Table 4. Online availability of market statistics on SBT for the seven key markets tabulated separately in the original estimate of *p* (Lou et al. 2016). Market data for Tokyo and Yaizu are discussed in Section 2.3.1 and thus not shown here.

Market	Frequency	SBT specific?	Notes	Weblink
Osaka city	monthly	Yes (main market) No (east market)	Shows total quantity and origins (but not quantity by origin)	https://bit.ly/3ms83Xk
Nagoya	monthly	yes	Main market and north market reported separately	https://bit.ly/33JgaIx
Kawasaki	monthly	no	Possible that it would show SBT specific data if any	https://bit.ly/3srWXWo
Yokohama	monthly	yes	Reports by product type and origin prefecture(usually Chiba, Tokyo, Kanagawa and Shizuoka)	https://bit.ly/3Fo3pkS
Osaka prefecture	monthly	yes	Reports by product type and origin prefecture/country (e.g. Shizuoka, Taiwan, Australia, Korea)	https://bit.ly/3FrqlQg
Misaki	annual	no	Possible that it would show SBT specific data if any	https://bit.ly/3qgA1GT
Sapporo	monthly	yes	Reports by origin prefecture (e.g. Miyagi, Chiba, Mie)	https://bit.ly/3Fk3oOB

If d *is considered necessary the way it is used in the formula should be reviewed*

Finally, the position of *d* in the existing formula may be an artifact from the original study that no longer makes sense. In particular, it might be more logical to factor the quantities in Japan's municipal wholesale markets to account for double-counting within and between markets, and then subtract farmed SBT (using *f*) and imported wild SBT (using *i*). The existing formula as applied in Itoh et al. (2020)--and previously--first subtracts farmed SBT (using *f* without accounting for double-counting), then subtracts an allowance for double counting (using *d*), and then subtracts wild imports (using *i* after accounting for double counting). Although not clear, this could be because the original formulation of *d* was intended to apply only to wild fish. However, given the difficulties in distinguishing between farmed and wild fish in existing market statistics, the way in which *d* is used in the formula adds uncertainty to what is already an opaque adjustment.

*The amount of SBT traded within Japan's markets as a whole (*r*) is perhaps the most uncertain yet influential input*

The final market structure input *r* (the amount of SBT traded within Japan's markets as a whole) adds further uncertainty to the calculation. The independent market review panel was unable to identify any statistics or data to inform this input so it used expert judgement to fix it at 0.85. Not only is *r* one of the most influential inputs to the equation (see Section 2.2.3), it is also perhaps the most uncertain with no obvious means of accurately determining its current value.

It is difficult to know how the specification of *p*, *d* and *r* can be improved to the extent necessary to produce credible, current market estimates on an ongoing basis. One approach could be to redefine these inputs as a single extrapolation factor (*w*) which is specified by a more rigorous expert elicitation process and assigned a range of possible values. For example, the "core" quantity which is currently defined as $To+Ya/p$ could be defined instead as the quantity of SBT traded through Tokyo and Yaizu excluding double-counted amounts (thereby accounting for *d*). This is recommended because it is likely that the mechanisms contributing to double-counting would be more accurately defined in the context of these two major markets than for 14 markets across the country. This "core" quantity could be factored by *f* and *i* to remove farmed and wild imported SBT, then extrapolated (using the new single extrapolation factor *w*) to the amount of wild domestic SBT in Japan as a whole. The residual uncertainty associated with how much wild domestic SBT appears in other key municipal wholesale markets and has not been double-counted (*p*), as well as how much wild domestic SBT is traded outside of Japan's markets (*r*)would be combined into *w*. Similar to the approach used by the independent market review panel, *w* could be specified using expert judgement from traders and market officials who would be asked to estimate what proportion of the wild domestic SBT in Japan flows through Tokyo and Yaizu markets. Available data from other markets (Table 4), which are, as explained above, inherently more uncertain, would not be explicitly incorporated into the formula but would be accounted for in *w* and could be used to groundtruth it. This approach would downgrade the influence of the data from other markets, but this appears warranted given how little is known about the extent of double-counting within and among these markets, and between these markets and quantities traded outside of the market system altogether. (There are also substantial uncertainties associated with the application of *f*, *i* and the lag coefficients, all of which are based on Tokyo markets, to these other municipal markets).

An alternative proposal involves keeping To *and* Ya *as the "core" quantities and extrapolating to other markets using a single factor (*w*)*

Aside from the three inter-related market structure inputs *p*, *d* and *r* discussed above, there is one further input that appears largely based on expert judgement. This is the conversion factor for processed weight to wet weight (*c*). The value of 1.15 is the default conversion factor within CCSBT, although some members use other conversion factors for some products (CCSBT 2009b). The sensitivity analysis presented in Section 2.2.3 demonstrated the existing formula is quite sensitive to the specification of *c* because it is used to factor the entire quantity estimated by the remainder of the equation. Nevertheless, as 1.15 is Japan's preferred conversion factor and the formula is designed to estimate the amount of SBT caught by Japan it would appear to be a reasonable choice. Further investigation of *c* is therefore not proposed.

*Further investigation of the conversion factor (*c*) is not proposed*

2.4 Summary and Work Plan for Estimating Product Amounts of Japan-caught SBT in Japan's Markets

Market studies are usually opportunistic and iterative, so methods may evolve

The terms of reference call for the specification of detailed methodologies in the draft work plan. However, market quantification studies are usually opportunistic in devising methodologies based on the data that are available. This is necessarily an iterative process. As a case in point, it is unlikely that the independent market review panel would have been able to specify the methods for formulating their 2006 market estimate in advance. Following on from that study, this study could attempt to adhere to the former methods (noting that they are not always well-documented), but much is likely to have changed over the past 15 years and new methods may need to be developed to reflect those changes.

After an initial effort to update the estimation approach results should be evaluated to judge the effects of uncertainty

The following work plan is based on updating the both the existing formula and its inputs using data that will be gathered from interviews and on-site research. Ideally, these would be conducted in-person assuming pandemic regulations allow for travel and meetings within Japan as is currently the case. It is difficult to propose in advance the entire set of data sources that will be consulted and how much time might be required, however, indicative time allocations are provided as ceilings for planning purposes[19]. Once the agreed time allocations have been expended, it is proposed to revisit the formula with the best available data at that time to assess the level of uncertainty in the output. Members can then evaluate whether the expected uncertainty is low enough to provide a reliable basis for decision-making. If not, members may call for further research into the formula and its inputs, or decide to pursue other methods of cross-checking SBT catches and market conditions (e.g. greater use of the CDS data similar to proposals in Section 3 for non-Japan catch).

2.4.1 Updating the Existing Formula

The preceding analysis has highlighted several ideas for updating and improving the existing formula. These can be summarized as follows:

Five ideas for updating the existing formula

- Pending independent confirmation that there is no domestic fresh SBT eliminate *S* from the formula (as has already been done by Japan).
- Change the formula so that *f* and *i* are used to factor the same quantity, i.e. at present *i* takes double-counting into account but *f* does not;
- Eliminate explicit specification of the complex and highly uncertain *d* (any double counting between Tokyo and Yaizu should be considered when specifying *To* and *Ya*);
- Eliminate explicit specification of the difficult-to-update and uncertain *p* by focusing the "core" calculation on the largest and best understood Tokyo and Yaizu markets and considering the other markets (used by Lou et al. (2006) to calculate *p*) under *w*;
- Re-formulate *r* (previously relating to the proportion of trade that is within Japan's markets as a whole) to combine it with *p* (see preceding bullet), as a new extrapolation factor *w* specifying the proportion of frozen SBT that flows

[19] Since the assignment is contracted on a time and expenses basis it is understood that only time spent will be compensated.

through Tokyo and/or Yaizu (which is likely to be more easily understood and thus better quantified).

The proposed approach reduces the number of inputs, allowing for easier updating and more focused expert specification

These revisions to the formula would allow the new formula to produce results which are compatible with the existing formula while concentrating much of the uncertainty associated with expert judgement in a single variable (w). This will not only allow available resources to be focused on better specifying/updating that one input, it will simplify sensitivity testing and the quantification of uncertainty in the final estimate. Some might argue that eliminating d and p would result in discarding useful information, but in reality d and p are very poorly known and very difficult to estimate well and as a result they contribute little more than additional uncertainty. Based on previous studies, this is true for p because the actual number of markets handling SBT is unknown, and some of the markets that do handle it have missing data that need to be filled using assumptions. Based on previous studies, this is true for d because every market has unique trading patterns and statistical systems and it seems impossible to know for sure how much double counting is occurring across a wide variety of them. Even if this study were to re-estimate d and p, these inputss would need to be frequently updated as trading patterns change and this would be a time-intensive task.

The proposed simplified formula is as follows (Eq. 5):

"Core" *Farmed* *Imported*

$$M_t = \left\{ \frac{\left((To_t + Ya_t) - \left(f_t \times (To_t + Ya_t)\right) - \left(i_t \times \left((To_t + Ya_t) - \left(f_t \times (To_t + Ya_t)\right)\right)\right)\right)}{w} \times E_t \right\} \times c \qquad \text{Eq. 5}$$

$\rightarrow lags$

where

The proposed new and simplified formula for Japan-caught SBT in Japan's markets

- M_t is the total quantity of Japan-caught SBT in Japan's markets in year t
- To_t is the quantity of frozen SBT (regardless of origin) sold through Tokyo metropolitan wholesale markets in year t
- Ya_t is the quantity of frozen SBT (regardless of origin) sold through the Yaizu fish market in year t
- f_t is the proportion of frozen SBT sold in Japan's municipal wholesale markets (based on the entire Tokyo market) in year t that is farmed (from ongoing market surveys)
- i_t is the proportion of frozen wild SBT sold in Japan's municipal wholesale markets in year t that is imported (from ongoing market sampling)
- w is the proportion of domestic wild SBT in Japan as a whole that is sold through Tokyo and Yaizu municipal wholesale markets

E_t is the quantity of frozen Japan-caught SBT exported in year t

c is the conversion factor to adjust market-observed quantities to their whole weight equivalents

and

lags are lag coefficients estimated from Japan's auction sampling.

The lag formula for Japan-caught SBT is not proposed to be updated

This simplified formula allows a clearer focus on the priorities for updating the most important inputs (Table 5). Obviously, if new information is discovered during the update process the formula may need to be modified further.

It is not proposed to modify the lag formula, however, as described in Section 2.2.2 and Annex A it is necessary to better document how the lag coefficients are applied.

2.4.2 Updating the Inputs to the Formula

35.5 days' allocation is proposed to update inputs for Japan-caught SBT estimations

The following list of inputs, and associated priorities and time allocations (Table 5), are linked to the proposal for the new formula above. In particular p and d are proposed to be eliminated and thus would not be updated. (If these inputs need to be updated each of the 12 key municipal markets (other than Tokyo and Yaizu) would need to be investigated, ideally through on-site interviews, with an allocation of several days per market (not shown)). Further investigation of inputs for c is not proposed (see Section 2.3.3) and thus not shown in Table 5.

Table 5. Work plan for updating inputs for the proposed new formula (Eq. 5) to estimate Japan-caught SBT in Japan's markets using market data.

Section	Input	Issues and Approach	Priority	Time allocation (days)
2.3.1	S	Confirm the appropriateness of omitting this from the formula through consulting government officials and traders regarding the presence/absence of Japan-caught fresh product	Low (because there is little doubt that fresh domestic SBT exists)	0.5
2.3.1	E_t	Investigate the degree to which quantities declared as SBT exports are actually SBT by reviewing genetic testing program results and interviewing relevant personnel. Access and compile data. Specify E as a range, if necessary.	Medium (because exports are low)	2
2.3.1	To_t	Map SBT flows into and through Tokyo markets using interviews and exploration of potential new data sources. Account for double-counting with Yaizu. Access and compile data.	High (because this is the top market)	5
2.3.1	Ya_t	Understand why the existing formula excludes SBT landed in Yaizu and map SBT flows into and through the Yaizu market using interviews and exploration of potential new data sources. Account for double-counting with Tokyo markets. Access and compile data.	High (because this is the second most important market)	4
2.3.2	f_t	Confirm that Japan's methods for estimating the proportion of farmed SBT are representative through interviews and exploration of potential new data sources.	Medium (because the current data seem robust)	3

Section	Input	Issues and Approach	Priority	Time allocation (days)
2.3.2	i_t	Verify whether current estimates of *i* are representative of both auctioned and unauctioned SBT through interviews and exploration of potential new data sources. Understand how farmed fish are excluded from i_t. Identify which countries' imports are included under "other".	High (because there is a need to confirm whether current data are representative)	3
2.3.3	*w*	Devise and carry out an expert elicitation approach (involving at least 10 experts including stakeholders from municipal wholesale markets other than Tokyo and Yaizu) to estimate *w* – now defined as the proportion of domestic wild SBT sold through Tokyo and Yaizu. Ensure, through use of a standardized methodology, that *w* can be easily updated in future. Specify *w* as a range.	High (because this is the most uncertain input and will be highly influential on the result)	15
2.3.2	lags	Determine whether lags in auctioned fish are representative for Japan as a whole through interviews. Explore whether there may be other data on stockpiling times that could be used to better inform lag coefficients.	Low (because the existing data are consistent, and might be difficult to improve)	3
	TOTAL			35.5

The expert elicitation for w *will be the largest task*

Data will be updated mainly through interviews and online sources. Members will be contacted to suggest initial interview targets; these will be supplemented by opportunistic approaches by the consultant. As is typical in market studies interviewees will be asked to suggest other interview targets (i.e. "snowball" approach). The expert elicitation for *w* will be designed with reference to best practice techniques (e.g. Morgan 2014) and to facilitate future updates (e.g. by using standardized questions and/or materials). A minimum of 10 experts should be included in the exercise including both those from the major markets of Tokyo and Yaizu and other smaller municipal wholesale markets, as well as traders working outside the municipal wholesale market system.

It is assumed that the other inputs will continue to be provided from ongoing data collection

It is important to note the reliance of this proposed methodology on continuing the Tokyo survey of traders (to update the estimate of f_t) and the Tokyo sampling of tagged fish at auctions (to update the estimates of i_t and the lag coefficients). Although the estimates of these inputs seem reasonably stable in recent years, periodic updating at the same, or perhaps slightly lower, frequency will be necessary. It is assumed that the publication (or availability, if new sources are discovered) of data supporting To_t, Ya_t and E_t will continue; if not, the methodology and time allocations will need to be revised. Aside from investigating/confirming existing inputs, the only new input is *w* and the sourcing of data to support it is accounted for in the Table 5 time allocations.

2.4.3 Updating the estimate of the amount of SBT caught by Japan and distributed in Japan

It is very important that the estimation methods move away from using point estimates in deterministic calculations, especially when these point estimates are highly uncertain and long out-of-date. Such methods will not stand up well to scientific review as a credible and defensible basis for decision-making. Instead, a stochastic process that allows multiple inputs to vary simultaneously within a range of likely values

should be implemented in order to avoid drawing overly precise, and thus erroneous, conclusions from highly variable data sources. This approach would be consistent with the recommendations of CCSBT SC24 which called for the market estimation methodology be re-designed to incorporate uncertainty.

The estimation should be implemented stochastically

A starting point for the new implementation is provided in the form of a Monte Carlo simulation in Section 2.2.3. The model can be re-designed around the new formula with an improved specification of parameter distributions (e.g. based on new expert judgement) and better use of datasets (rather than just prior distributions) to inform parameter values. If uncertainty is high the probability interval could be wide and the interpretation of whether overcatch has occurred may not be straightforward. While this might be considered troublesome by those expecting a yes or no answer, if the model is specifying and propagating the true uncertainty in the parameters, it is actually providing more and better information for decision-makers.

CDS data should be used to cross-check and improve market estimates

Another important update to the implementation of the market formula is to check the results against data available from the Catch Documentation Scheme (CDS). At the time the original market formula was developed CCSBT used a Trade Information System (TIS) which did not account for domestic landings and so was not useful in understanding the amount of Japan's catch flowing into Japan's markets. However, since 2010 CCSBT has implemented a CDS which encompasses both internationally traded quantities and domestic landings. CDS documents validated by Japan, particularly the Catch Monitoring Form, can provide a largely[20] independent check on the quantities of *M* (i.e. Japan-caught SBT in Japan's markets) estimated using either the existing or updated formula. CDS data can also be used to check the consistency of *I* (i.e. imported in-market wild SBT) estimated using the market-based methods described in this section, and extrapolated to Japan's market as a whole, against the quantities of frozen wild SBT exported to Japan by other CCSBT members reporting to the CDS. It might also be possible to calibrate the extrapolation factor (*w*) by using the CDS to estimate the size of the Japan's entire market size and determine the proportion of that amount that is comprised by Tokyo and Yaizu markets.

10 additional days are allocated for stochastic implementation and cross-checking

It is estimated that 10 additional days (beyond the allocation proposed in Table 5) should be sufficient to perform these calculations and cross-checks and document the results. The overall allocation for the estimation of SBT product amounts caught by Japan and distributed in Japan's markets is thus 45.5 days.

[20] The quantity *E* in the existing and updated formulae might not be considered independent of data reported under the CDS depending on how closely the customs statistical system and the CDS reporting system for exports are related.

3 Objective B: SBT Product Amounts derived from Other Members' Catches in Japan's Markets

3.1 Task Definition

Market estimates can be applied to non-Japan catches/harvests

Japan has long been the prime consumer of SBT products so it is logical that quantities flowing through its markets can provide useful signals regarding the amount of catch not only by Japan but by other CCSBT Members. The terms of reference reflect an interest in applying new Japan market-based estimation methods to assess the amount of SBT in Japan's markets contributed by other Members. In the case of imported wild SBT, relating these product amounts to whole weights (i.e. catches) can be achieved using a processed weight:whole weight conversion factor such as 1:1.15 (see Section 2.3.3). For imported farmed SBT, relating product amounts to catches will require information on farm production rates which is beyond the scope of the current study.

Customs and CDS data provide bilateral data sources for estimating other Members' SBT entering Japan

SBT catch by other Members is assumed to enter Japan as imports (i.e. not smuggled). Therefore in addition to estimating the amounts of imported farmed and wild SBT from market data, these quantities can be informed by customs data (both from the exporter and Japan as the importer). Also unlike Japan's domestic catch which was not originally subject to the CCSBT TIS, catch by other Members entering Japan's markets have always been subject to TIS and now CDS reporting. Under the CDS both parties to the trade (i.e. importer and exporter) must provide documents to the Secretariat on a quarterly basis for reconciliation. These CDS data represent a critical resource for estimating product amounts contributed by other Members other than Japan.

The following two sections provide brief summaries of the customs and CDS datasets to supplement the summary of market data provided above in Section 2. The next section then outlines how these three data sources (market, customs and CDS) can be used to quantify other Members' wild and farmed SBT in Japan's markets. The final section provides a summary and work plan specific to quantifying other Members' contributions to Japan's markets.

3.2 Background on Customs and CDS Datasets

3.2.1 Customs Data

Customs data may suffer from species mis-identification (market data too)

Customs data tabulate the amounts of SBT imported and exported in fresh and frozen form by country. The most serious shortcoming of customs data is that there may be some degree of uncertainty regarding whether other species are recorded as SBT or vice versa[21,22]. Nevertheless, customs data can be extremely useful for understanding what proportion of SBT derives from non-Japan catches. Since each trade transaction should be independently recorded twice—once by the exporter and once by Japan—there is an in-built cross-check.

[21] Some potential examples of this are shown in Annex C, i.e. Brazil and Tunisia reporting exports of SBT to Japan.

[22] Note that this uncertainty also exists for market data though perhaps to a lesser degree.

Two sources of compiled customs statistics are COMTRADE and FISHSTATJ

CCSBT Members' imports and exports of SBT can be accessed via COMTRADE (2021)[23]. Trade statistics are also available from FAO's FISHSTATJ system which matches COMTRADE's ability to identify the trading partner as of its 2021 release (FAO 2021). Chord diagrams are a useful way of visualizing the data holdings of the two systems with regard to fresh and frozen SBT into the Japan (Figure 9). In 2019 most of the trade was between Australia and Japan, although 700-1,000 t each originates from Korea, New Zealand and Taiwan (identified in COMTRADE as "Other Asia, nes" (not elsewhere specified)). In 2019 within both the COMTRADE and FISHSTATJ databases there are small discrepancies of 8-12 t between Japan and some its trading partners but a >300 t discrepancy with Korea (Annex C)[24]. There are also discrepancies between the two databases, namely ~60 t less frozen SBT reported by Australia in FISHSTATJ than in COMTRADE, and 69 t of frozen SBT from Mozambique in FISHSTATJ that does not appear in COMTRADE (Annex C).

Some examples of cross-checking market and customs data

Customs data can be used to cross-check quantities estimated from market data. For example, if--for the sake of simplification in this example to ensure removal of farmed quantities--all imports from Australia are excluded, COMTRADE and FISHSTATJ record frozen (wild) imports to Japan at 1,753 to 2,110 t in 2019[25]. Factoring the amount of frozen wild imports estimated in 2019 by Itoh et al. (2020), i.e. 1,319 t or 1,465 t in Cases 1 and 2, by the historical value of r to expand the amount to the entire Japan market results in 1,552-1,724 t (~80-90% of the customs-based estimate). Entry into Japan's markets of any wild SBT from Australia would further expand this discrepancy. This might suggest that either the amount of imported frozen wild SBT (I) estimated from market sampling (i) is too low, or that a larger quantity of these fish are being traded outside of the markets (i.e. r is too low). A similar cross-check was presented in Section 2.3.2 for farmed SBT and suggested that, as expected, large quantities of farmed SBT are bypassing the municipal wholesale markets (see Figure 6).

[23] Some Members have found discrepancies between their own national databases and those available through COMTRADE (CCSBT 2021c).

[24] Korea reports exporting 1,096 to SBT to Japan but Japan reports importing only 788 t from Korea.

[25] Range based on excluding Australian quantities from COMTRADE recorded imports and exports and FISHSTATJ recorded imports and exports (i.e. four data points).

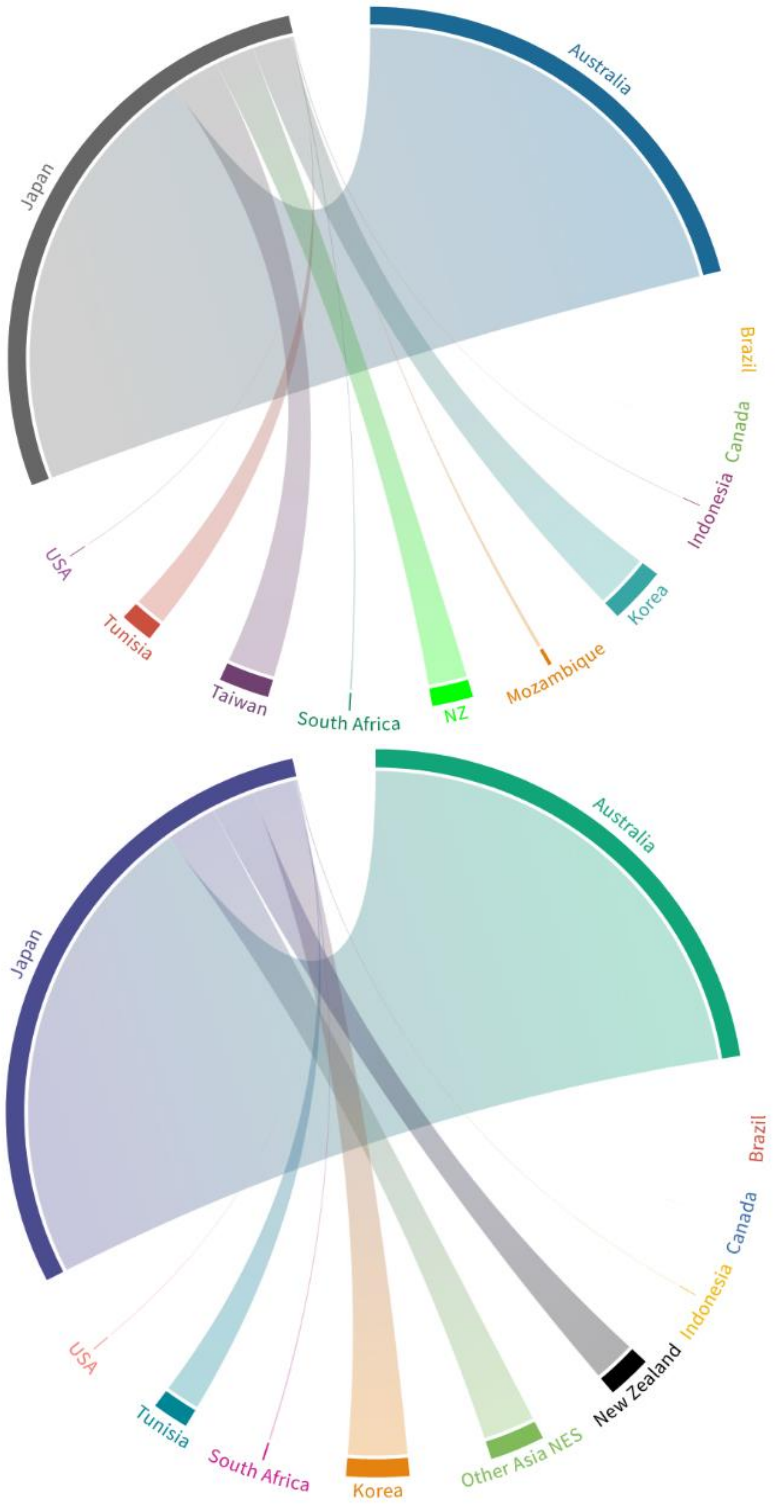

Figure 9. Chord diagrams based on FISHSTATJ (2021, upper) and COMTRADE (2021, lower) illustrating the flow of fresh and frozen SBT entering Japan in 2019 as reported by Japan as imports (upper end of each chord) and reported by trading partners as exports (lower end of each chord). In the case of Brazil, Canada, Mozambique (FISHSTATJ only), Tunisia and the USA the chord disappears at the upper end because Japan does not record any imports from these countries (see Annex C for data).

3.2.2 CDS data

CDS data were unavailable for this work plan

It was not possible to analyze the CDS dataset because it is not in the public domain and has not been provided for the purposes of developing this work plan. Therefore, this section is based on a review of summarized CDS data in CCSBT (2021c), a review of the CDS forms (CCSBT 2021d), and a layman's understanding of how the CDS operates.

CDS data is likely to be the best way to verify catch amounts

The CCSBT CDS was developed over a decade ago in order to provide "tracking and validation of legitimate product flow from catch to the point of first sale on domestic or export markets" (CCSBT 2021d). It is therefore an important, if not the most important, resource available to the Commission to verify all Members' catch of SBT. CDS data has already been compared to customs statistics (COMTRADE) as part of the compliance monitoring work of the Secretariat (CCSBT 2021c). This comparison highlighted some discrepancies which could be due to lag issues, i.e. CDS data and customs data for the same fish being recorded in different years.

CDS data compilations prepared by the Secretariat have thus far not accounted for lags

The Secretariat has also prepared a CDS-based estimate of each Member's market size based on a formula suggested by Japan (i.e. domestic catch – exports + imports; CCSBT 2021c). This calculation indicates that in 2020 Japan had by far the largest national market at ~15,700 t (product weight), followed by Indonesia at ~750 t (product weight). The paper suggests that these market size estimates may be higher or lower than the true value due to lags which are not taken into account (CCSBT 2021c). Both Japan's and Indonesia's domestic markets, as calculated here, appear to be larger than markets in non-cooperating non-Member (NCNM) countries which have been estimated based on COMTRADE[26]. Of these NCNM countries which reported more than 2 t of SBT imports in 2020 (Malaysia (556 t), USA (160 t), Canada (71 t), China (46 t) and Singapore (28 t)), only the USA is cooperating with the CCSBT CDS (CCSBT 2021e).

Japan has suggested several ways that CDS data could be used to cross-check market estimates (Tsuda et al. 2019b):

Some examples of cross-checking market and CDS data

- First, the paper suggested that the market-based estimate of *i*, the proportion of imported wild frozen SBT (see Eqs. 1, 2 and 5 and Section 2.3.2) could be checked using CDS data. This would be possible both in aggregate (i.e. proportion of total imports) and by individual country, but this would assume that the sample of CDS data, which would represent all of Japan, is comparable to the data supporting *i*, which are derived from auctioned fish only. (Also, there may be differences between *i* and the CDS data if there are significant lags between when SBT are recorded entering Japan by the CDS and when they arrive in the market—see the following point and Figure 10 (red arrow)).
- Second, the paper suggests that the CDS data could be used to validate the lag coefficients applied to the annual estimates of *M*, the total market quantity (Eqs. 1, 2, and 5). The CDS can indeed be used to derive lag coefficients but they would represent the time between catch (or harvest out of a farm) and the first point of sale/final point of import, not necessarily when the fish reaches market (auction) which is where the lag data have been collected thus far (Figure 10, brown versus blue arrow). Although the market-based and CDS-based lag coefficients might not be comparable, compiling lag coefficients from the CDS would be useful for lagging customs statistics (e.g. COMTRADE) for countries

[26] Note that there may also be lag issues associated with these customs-based data.

not participating in the CDS (i.e. Figure 10 brown arrow = lags for both CDS and customs data). It might also be possible to establish a relationship between these two sets of lag coefficients to estimate the time between first point of sale/final point of import and appearance in the market—a third type of lag (e.g. representing stockpiling in Japan) which is currently unknown (Figure 10, red arrow). It is not known whether there are currently any public domain data on lags representing the time between harvest out of farms and appearance in the market (Figure 10, larger gray arrow).

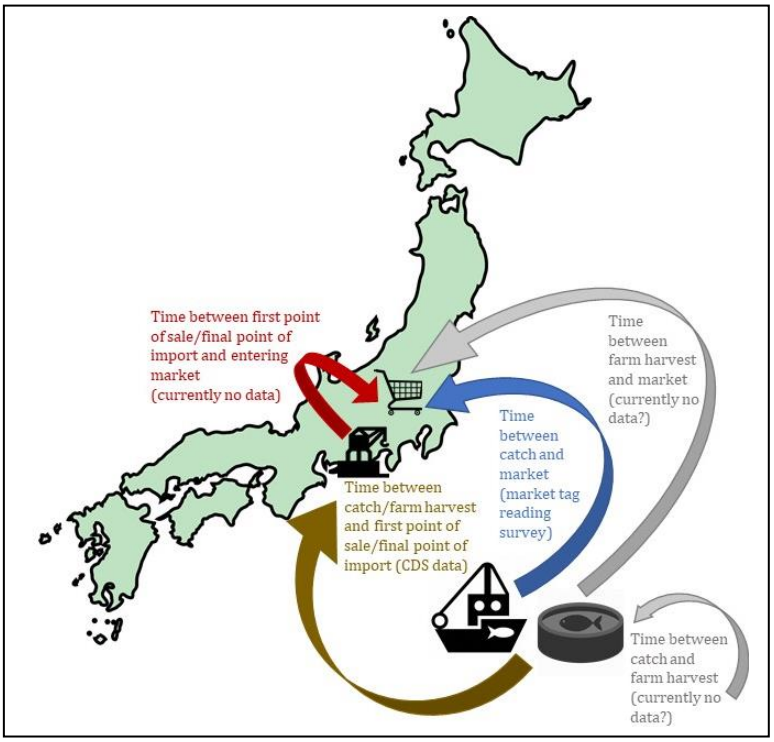

Figure 10. Illustration of the different lags that can estimated by market tag reading surveys (blue arrow) and CDS data (brown arrow). Three other lags (1. between first point of sale/final point of import and market entry (red arrow); 2. between harvest out of farms and market entry (larger gray arrow); and 3. between catch and farm harvest (smaller gray arrow)) are shown but have not yet been estimated.

The different kinds of lags in various datasets complicate comparisons

- Third, the paper notes that an estimate of the total size of the Japan market in a given year based on CDS data (e.g. like that produced in CCSBT 2021c) could be compared to the annual estimates of *M*, the total market quantity, and used to adjust the extrapolation factor relating SBT within municipal wholesale markets to the quantity in Japan as a whole[27]. This would be a very useful calibration of the market data, however, since *M* is adjusted with lag coefficients for the purposes of comparing to catches, the issue of lags in the CDS data, acknowledged in CCSBT (2021c), would need to be addressed (again, the difference between Figure 10 blue and brown arrows).

[27] This extrapolation is *r* in the original formula (Eqs. 1 and 2) and *w* in the proposed revised formula (Eq. 5).

3.3 Proposals for Estimating Products derived from Other Members' Catches of SBT in Japan's Markets

Market-based estimates for other Members' SBT may be even more uncertain

Considerable effort has been expended in recent years to understand how to reliably partition quantities of Japan-caught frozen wild SBT in Japan's municipal wholesale markets from the quantities observed in Japan's markets as a whole. Applying the inverse of this same process to estimate other Members' catches from market data will only be appropriate if those catches also flow through the major and better understood Japan municipal wholesale markets. If not, for example if they are mainly traded outside these markets, a market-based estimate will be even more uncertain for other Members' catches. Fortunately, as all other Members' catches are imported and subject to the CDS these additional resources can help make the estimation more robust.

3.3.1 Imported Wild SBT

Other Members' frozen SBT is available from the Japan-caught estimation formula

The first step in constructing a market-based estimation of other Members' catch of imported wild SBT in Japan's markets involves the calculating the "core" quantity of frozen and fresh SBT in major municipal wholesale markets. The quantity of imported frozen wild SBT in the principal municipal wholesale markets of Tokyo and Yaizu is given by the import portion of the market formula in Eq. 5: $i_t \times ((To_t+Ya_t)-(f_t \times (To_t+Ya_t)))$. Using this term as part of the "core" quantity for the other Members' estimate ensures some degree of consistency with the Japan catch estimation formula.

Other Members' fresh SBT must also be estimated using both market data and CDS or customs statistics

The quantity of imported frozen wild SBT in Tokyo and Yaizu must be summed with fresh SBT imports handled in these markets because other CCSBT Members export fresh wild SBT to Japan. It appears that Yaizu does not handle fresh products. Fresh SBT in the Tokyo market should probably be considered the sum of fresh imported and fresh domestic (if any) since the latter is thought to be a misrepresentation of fresh imported SBT (Sakai et al. 2015b). It is necessary to partition the Tokyo market's fresh SBT quantities into imported wild and farmed quantities, however, this appears impossible to do on the basis of existing market statistics. Therefore, it is proposed to partition on the basis of CDS data (preferred option) or customs data (fallback option). Although neither dataset will indicate whether the fresh SBT has entered the municipal wholesale markets, based on existing information (Sakai et al. 2015b) it is reasonable to assume that both fresh wild and fresh farmed SBT have an equal propensity to be traded through municipal wholesale markets therefore, the proportion of each in the Tokyo fresh SBT data can be assumed to be equal to the proportion of each in the CDS or customs data. For this partitioning the CDS data are preferred as they contain information specifically confirming whether the SBT were farmed. In contrast, customs data do not distinguish between farmed and wild fish, but since Australia is the only country producing farmed SBT it may be possible, in the absence of CDS data, to derive an approximation of the ratio of fresh wild and fresh farmed imports entering Japan using the national origin from customs statistics and some knowledge regarding the amount of Australian wild product that is shipped to Japan in fresh form (if any).

Once this "core" quantity of imported wild SBT is estimated it will need to be extrapolated to Japan as a whole. It is proposed above (see Section 2.4.1) to simplify this extrapolation by eliminating the separate specification of p (other key municipal wholesale markets), d (double-counting by other key municipal wholesale markets) and r (proportion traded within Japan's markets as a whole) because they are poorly known, very difficult to estimate separately and may exaggerate the uncertainty in the

A different value of w *may need to be specified to account for fresh wild imported SBT*

result. Rather, it is proposed that the extrapolation from Tokyo and Yaizu to Japan as a whole is specified as a single input *w* (see Sections 2.3.3 and 2.4.2). Imported frozen wild SBT is similar to domestic frozen SBT in its propensity to enter the market through auctions in order for its quality to be assessed and its price determined (Sakai et al. 2015b). Smaller quantities of imported fresh wild SBT are present in, but potentially less likely to enter, municipal wholesale markets (Sakai et al. 2015b). Therefore, while a similar extrapolation approach (i.e. *w*) is recommended for imported wild SBT as for domestic SBT it may be necessary to specify a different value of *w* to account for fresh product. Exploring a different value of *w* for imported wild SBT (if necessary) can be incorporated into the expert elicitation proposed for *w* in Section 2.4.2 without substantial additional effort.

The estimate of wild imported SBT in Japan's markets can be partitioning by Member using i*, CDS data or customs data*

Once the extrapolated quantity is available it could be allocated amongst Members using proportions established by the auction data collected by Japan to inform *i* (see Section 2.3.2). This approach is based on two assumptions. First, proportions obtained from sampling Tokyo auctions of frozen SBT are representative of the entire population of wild imported SBT (fresh and frozen) entering Japan as a whole. Second, auction sampling to record the origin of frozen SBT will continue. The latter is necessary because the proportional contribution of each Member to the Japan market might easily vary from year to year. For the sake of an additional cross-check, and especially if either of these assumptions is not met, it is recommended to allocate quantities to individual members on the basis of customs statistics and/or CDS data (but see Section 3.2 regarding the need to resolve lag issues in customs and CDS data, e.g. Figure 10).

Member-specific results would need to be lagged and converted to whole weight

The final step would involve applying a processed weight:whole weight conversion factor (*c*) and lag coefficients to each Member's share of the imported wild SBT. Although Japan's tag reading sampling is not limited to Japan's catch, it should be confirmed that the lag coefficients produced by that sampling (e.g. as presented in Itoh et al. 2020) are based on all tags read and not only those attached by Japan. If so, the same lag coefficients should be applicable to imported wild SBT. If not, it might be possible to construct a separate set of lag coefficients from past auction data collected from imported SBT only.

Using CDS or customs data instead of market data might be a simpler and equally effective approach

Although the algorithm outlined above is not any more complicated than the algorithm for estimating Japan's SBT catches from market data, it nevertheless involves multiple assumptions and uncertainties. In the case of imported wild SBT it seems that a simpler and more straightforward approach might be equally effective: using customs and/or CDS data to compile the quantity of imported fresh and frozen SBT for all countries other than Australia; working out how to partition the Australian imports into farmed and wild fish; and applying lags and conversion factors to facilitate comparison to catches[28]. If the market-based estimate is considered worth pursuing, it is recommended that the customs and CDS-based approaches be used for comparison in an initial trial.

3.3.2 Imported Farmed SBT

For consistency, it is proposed to use both market-based methods as well as customs/CDS data-based methods to estimate the amount of imported farmed SBT in

[28] Two of these three steps are similar to what Japan has already prepared as an example in Attachment 2 of CCSBT-EC/2010/19.

Market-based estimates can also be constructed for imported farmed SBT

Japan's markets. Once again the market-based approach begins with establishing the amount in the two primary municipal wholesale markets (i.e. Tokyo and Yaizu) as the "core" quantity. For frozen farmed SBT this is given in Eq. 5 as $f_t \times (To_t + Ya_t)$ and will be produced by the Japan catch estimation formula. Then from the method outlined above for imported wild SBT we can assume that the amount of fresh farmed SBT in these markets will be approximated by summing fresh imported and fresh domestic quantities reported by the Tokyo markets and factoring this quantity using CDS or customs statistics to remove amounts originating in countries which do not farm SBT (i.e. all countries except Australia; see Section 3.3.1 for rationale). As above, an additional adjustment will be required to remove quantities of fresh wild SBT from Australian market contributions (if any).

The extrapolation factor w_{farm} *will need to reflect the different market structure for farmed SBT*

It is thought that large amounts of frozen farmed SBT are sold outside of the major municipal wholesale markets (Sakai et al. 2015b), therefore the extrapolation to the market in Japan as a whole will necessarily require a different specification of w. This farmed extrapolation factor (w_{farm}) is likely to require a specification process that is more orientated toward traders who handle large quantities of farmed SBT products.

Appropriate lags and conversion factors for farmed SBT may need to be handled outside of this study

As there is only one Member producing farmed SBT the allocation of the total estimated amount of farmed SBT to individual Members can be omitted. However, the application of lag coefficients may require further work specific to farming activities (Figure 10, gray arrows). At a minimum it would be necessary to confirm that the lags between harvest out of the farms and entry into the market are the same for wild and farmed fish before applying the existing market-observed lags (Figure 10, blue arrow). If not, farm-specific lags will need to be developed (e.g. from the CDS). Finally, a conversion factor can be applied to adjust farmed product weights to whole weight, but this will not produce correct catch figures without further adjustment for farm growth rates. As this is a sensitive topic which appears to be outside the scope of this study, this final step in the algorithm may need to be handled separately.

Using CDS data instead of market data appears to be a more straightforward and reliable approach for farmed SBT

Similar to the situation for imported wild SBT, the market-based estimation approach for farmed SBT is subject to multiple assumptions and their associated uncertainties. It is therefore recommended that a simpler approach involving customs statistics and/or CDS data be used as part of an initial trial to provide an alternative estimate. The preferred approach for the cross-check would be to use the CDS data to directly compile the quantity of fresh and frozen SBT delivered by Australia to Japan in each year and to apply appropriate lags and conversion factors to adjust those product quantities to harvests in specific years[29]. If the CDS data are not available for this purpose, customs data can also be used as an approximation (see Footnote 28) though it will be more difficult to separate farmed from Australian wild SBT (if any) and appropriate lags will be difficult to specify. The use of customs data is more likely to produce results that are incompatible with the market-based estimates and thus reduce the utility of the cross-check exercise.

[29] As mentioned immediately above the specification and application of appropriate lags and conversion factors for time spent and weight gained while in farms may be outside the scope of this study.

3.4 Summary and Work Plan for Estimating SBT Product Amounts derived from Other Members' Catches in Japan's Markets

Iterative approach, evaluation of uncertainty and stochastic implementation are recommended

In summarizing the existing information and proposing a work plan for estimating SBT product amounts from Japan's catches, Section 2.4 explains the importance of an iterative approach to market studies, specifically the need to revise the approach as necessary as new information emerges. It also suggests the need for feedback from Members after some trial results are produced to determine whether the expected degree of uncertainty will provide a reliable basis for decision-making. Most importantly it recommends estimation using a stochastic approach based on ranges of input values rather than deterministic point estimates. All three considerations are equally relevant to this discussion of estimating product amounts of SBT caught by Members other than Japan.

3.4.1 Imported Wild SBT

The proposed formula for estimating the quantity of imported wild SBT in Japan's markets from market data is (Eq. 6):

$$Y_{t,k} = \left(\frac{i_t \times \left((To_t + Ya_t) - \left(f_t \times (To_t + Ya_t) \right) \right) + (S_t \times h_t)}{w} \right) \times c \rightarrow partition\ by\ k$$

(i_t: *Frozen*; S_t: *Fresh*; $\rightarrow lags$)

Eq. 6

where

Proposed formula for imported wild SBT in Japan's markets

- $Y_{t,k}$ is the quantity of imported wild SBT in Japan's markets in year t caught by country k
- i_t is the proportion of frozen wild SBT sold in Tokyo municipal wholesale markets in year t that is imported (from ongoing market sampling)
- To_t is the quantity of frozen SBT sold through Tokyo metropolitan wholesale markets in year t
- Ya_t is the quantity of frozen SBT sold through the Yaizu fish market in year t
- f_t is the proportion of frozen SBT sold in Japan's municipal wholesale markets in year t that is farmed (from ongoing market surveys)
- S_t is the quantity of fresh imported and "fresh domestic" SBT in Tokyo municipal wholesale markets year t
- h_t is the proportion of imported fresh SBT that is of wild origin (determined from CDS or customs data) in year t
- w is the proportion of imported wild SBT sold through Tokyo and Yaizu municipal wholesale markets
- c is the conversion factor to adjust market-observed quantities to their whole weight equivalents

partition by k is proportioning the total quantity estimated in year t by the contribution of each Member to the market in year t based on ongoing market sampling, customs statistics or CDS data for year t

and

lags are lag coefficients estimated from Japan's auction sampling (either those in Itoh et al. (2020) or a subset of that sampling for imported SBT only).

Many of the inputs are the same as for Japan-caught SBT estimates

Many of the inputs above are necessary for estimating product amounts derived from Japan-caught SBT in Japan's markets; they are therefore already accounted for in Table 5 (i.e. i_t, To_t, Ya_t and f_t). In particular, much of the necessary stakeholder consultation time (i.e. "snowball" interview effort) to understand the current flows of SBT into and through Japan's markets will be conducted for the work shown in Table 5. The methodology for imported wild SBT similarly relies on the continual updating of i_t, To_t, Ya_t, f_t and S_t from ongoing surveys, sampling and market statistical systems. If these data are not available, the methodology will need to be revised.

New inputs are mainly associated with the addition of fresh SBT to the algorithm

New or potentially adjusted inputs required for the estimation of imported wild SBT products are: S_t (to incorporate quantities of fresh products), h_t (to partition fresh wild from fresh farmed products), w (the extrapolation factor for imported wild SBT), c (to account for national differences in conversion factors), the partitioning coefficients (based on i, customs statistics or CDS data for each year) and the lag coefficients (for imported wild SBT if different from wild SBT as a whole). Proposals for obtaining, updating and/or adjusting these inputs are summarized in Table 6 (see Section 3.3.1 for background).

Table 6. Work plan for updating inputs for the proposed formula (Eq. 6) for estimating products derived from imported wild SBT in Japan's markets using market data.

Input	Issues and Approach	Priority	Time allocation (days)
S_t	Confirm fresh products are not handled in Yaizu. Confirm the appropriateness of combining Tokyo's reported fresh imported SBT and fresh domestic SBT into a single figure for fresh imported SBT. Access and compile data.	Medium (because this is a theoretically important input but quantities are expected to be small)	1
h_t	Compute the proportions of farmed fresh SBT and wild fresh SBT in Japan using CDS data (preferred option) or customs statistics (fallback option)	High (because this is essential to the inclusion of fresh products in the formula)	3*
w	Include exploration of the need for a separate specification for imported fish (both fresh and frozen) into the expert elicitation exercise proposed for w in Table 5. Ensure, through use of a standardized methodology, that w can be easily updated in future. Specify w as a range.	High (because this is the most uncertain input and will be highly influential on the result)	1
c	Consult Members who export wild SBT to Japan on whether the processed weight:whole weight conversion factor used in in past market estimates (1:1.15) is appropriate for their products.	Medium (because c is influential on the formula's result)	0.5

Input	Issues and Approach	Priority	Time allocation (days)
partition by k	Compile and cross-check partitioning coefficients from *i*, customs statistics or CDS data for each year. Consider whether the partitioning should be deterministic or stochastic.	High (because this is necessary to achieve Member-specific estimates)	1
lags	Determine whether lags in auctioned fish are representative for imported SBT through interviews, and potentially through re-analysis of Japan's tag data. If not, explore compiling an alternative set of lag coefficients for imported fish only using the auction tag reading survey data or other sources.	Medium-Low (because the existing lag coefficients are likely to be representative)	2
TOTAL			8.5

* It is difficult to estimate the time required to obtain access to and become familiar with CDS data. If access is not granted and customs data are used, compiling these data will be straightforward, however, understanding how to partition Australian imports between farmed and wild products will require further investigation. In either case, this estimate represents a minimum.

8.5 days' allocation is proposed to obtain inputs for wild imported SBT estimations

As explained in Section 3.3.1 it is proposed to estimate quantities of imported wild SBT in Japan's markets from the above described market-based approach as well as using a simple CDS and/or customs data-based approach. The only non-trivial component of the simplified approach is the specification of appropriate lag coefficients to relate products amounts to catches in a given year. One option is to assume that the appropriate lags for the customs and CDS data lags are the same as the auction tag reading survey lags (i.e. in Figure 10 assume blue arrow=brown arrow + red arrow). Otherwise access to CDS data will be necessary to estimate the lag between catch and final point of import (Figure 10, brown arrow)[30], and the lag between final point of import and market entry (Figure 10, red arrow) will need to be estimated or approximated. Without any knowledge of the CDS data it is difficult to estimate the time required for such work.

An additional 8 days is proposed to implement the calculations and perform cross-checks for imported wild SBT

Three additional days (beyond those shown in Table 6) are proposed to implement the market-based calculations in a stochastic manner and document the results. The cross-check work, including lag estimation using CDS data will add another 5 days. Therefore, the overall allocation for estimating imported wild SBT is 16.5 days.

3.4.2 Imported Farmed SBT

The proposed formula for estimating the quantity of imported farmed SBT in Japan's markets from market data is (Eq. 7):

[30] This is because customs data do not contain any information on when catches occurred so lags cannot be estimated.

Frozen *Fresh*

Eq. 7

$$Z_t = \left(\frac{\left(f_t \times (To_t + Ya_t)\right) + (S_t \times j_t)}{w_{farm}} \right) \times c \rightarrow lags$$

Proposed formula for farmed SBT in Japan's markets

where

Z_t is the quantity of farmed SBT in Japan's markets in year t

To_t is the quantity of frozen SBT sold through Tokyo metropolitan wholesale markets in year t

Ya_t is the quantity of frozen SBT sold through the Yaizu fish market in year t

f_t is the proportion of frozen SBT sold in Japan's municipal wholesale markets in year t that is farmed (from ongoing market surveys)

S_t is the quantity of fresh imported and "fresh domestic" SBT in Tokyo municipal wholesale markets year t

j_t is the proportion of imported fresh SBT that is of farmed origin (determined from CDS or customs data) in year t

wf_{arm} is the proportion of farmed SBT sold through Tokyo and Yaizu municipal wholesale markets

c is the conversion factor to adjust market-observed quantities of farmed SBT to their harvested whole weight equivalents (or catch weight equivalents, if that is desirable and appropriate data can be made available)

and

lags are lag coefficients representing the annual adjustment necessary to relate the quantities of farmed products in the market to their harvest year (or catch year, if that is desirable and appropriate data can be made available).

Many of these inputs are already accounted for in Tables 5 and 6 (i.e. f_t, To_t, Ya_t ,S_t and j_t $(1\text{-}h_t)$). The assumptions and caveats for these inputs have been explained above.

New inputs relate to special extrapolation and conversion factors and lags for farmed SBT

New or potentially adjusted inputs required for the estimation of farmed SBT products are: w_{farm} (the extrapolation factor for farmed SBT), c (conversion factors from product weight to whole weight at harvest out of farms or catch), and the lag coefficients (accounting for time elapsed between appearance in the market and harvest out of farms or catch). The work plan for these three inputs is summarized in Table 7 (see Section 3.3.2 for further explanation).

Table 7. Work plan for updating inputs for the proposed formula (Eq. 7) for estimating products derived from farmed SBT in Japan's markets using market data.

Input	Issues and Approach	Priority	Time allocation (days)
w_{farm}	Specification of w_{farm} through an additional expert elicitation focused on farmed SBT trade flows which are expected to be mostly outside of municipal wholesale markets. Although the methods will be similar, a different population of stakeholders will need to be identified and engaged. Ensure, through use of a standardized methodology, that w_{farm} can be easily updated in future. Specify w_{farm} as a range.	High (because this is the most uncertain input and will be highly influential on the result)	10
c	Consult stakeholders who export farmed SBT to Japan regarding processed weight:whole weight conversion factors. It is assumed here that whole weight will be the weight at harvest out of farms.	Medium (because *c* is influential on the formula's result)	0.5
lags	It is assumed here that the desired lag is between harvest out of farms and appearance in the market. The lag between harvest out of farms and final point of import can be estimated using CDS data (Figure 10, brown arrow) but the additional lag between final point of import and entering the market (Figure 10, red arrow) will need to be estimated using stockpiling data and/or interviews.	Medium (because Members may wish to make a separate decision about which lags to apply)	5*
TOTAL			15.5

* It is difficult to estimate the time required to obtain access to and become familiar with CDS data. It is also not clear what data might be available to estimate the lag between the final point of import and entering the market (Figure 10, red arrow). Therefore, this estimate represents a minimum for estimating appropriate lags. If CCSBT wishes to handle the lags separately this allocation would drop to zero.

15.5 days' allocation is proposed to obtain inputs for farmed SBT estimations

In parallel with the approach for imported wild SBT it is proposed to estimate quantities of farmed SBT in Japan's markets from the above described market approach as well as from a simple CDS and/or customs data-based approach (see Section 3.2.2). In the case of farmed SBT, the market-based approach already requires that lags be estimated from CDS data (see Table 7, lags) therefore there is only minimal additional effort required for the farmed SBT estimation cross-check[31].

An additional 4 days is proposed to implement the calculations and perform cross-checks for farmed SBT

Three additional days (beyond those shown in Table 6) is proposed to implement the market-based calculations for farmed SBT in a stochastic manner and document the results. The cross-check work would require one additional day. Therefore, the overall allocation for estimating farmed SBT is 19.5 days.

[31] This assumes that the desired estimated quantity is the whole weight at harvest out of farms. If the goal is to estimate the original catch weight (i.e. before being placed in a farm) additional data (conversion factors and lags) will need to be provided and more time will need to be allocated.

4 Objective C: Relative Importance of Japan's Markets in the Global Market for SBT

4.1 Task Definition

Japan product amounts will be discussed in a global context

The final task outlined in the terms of reference requires contrasting estimates of SBT in Japan's markets (caught by Japan and caught by other Members) with the global market amount. In accordance with the footnote in the terms of reference and its associated paper, it is understood that this global market amount is being estimated by the Secretariat using CDS data, and initial results are provided in CCSBT (2021c).

4.2 Proposed Approach

It is likely that there will be further work by the Secretariat to quantify the global market before the conclusion of this Japan market study. Therefore it seems premature to describe in detail how the results of one might be combined with the other. In general, the proposed approach will be to place the Japan market estimates in a global context, and make recommendations for future Japan market monitoring based on new insights gained from the combination of this study and the work by the Secretariat.

It is understood that the scope of this study is limited to Japan

In this context, given the potential for ambiguity in the title of this study and in clause (2.1) d) of the terms of reference it would be useful to clarify (and agree) that the scope of this study is limited to market and trade estimations relating to Japan. Studies of other potential markets such as the United States, Malaysia, Canada or China (all of which are identified in CCSBT (2021c)) would appear to be of a completely different nature and are not anticipated under this study.

Estimating the global market for SBT is not envisaged under this study

Furthermore, it is noted that estimating the global market based on CDS data might not be realistic if there is substantial trade by countries not cooperating with the CDS (i.e. three of the four countries listed above). Similarly, relying on global customs statistics might misrepresent the extent of trade due to mis-declaration of SBT (or smuggling). For these reasons, constructing an estimate of the global SBT product distribution amount is not a trivial undertaking and is not envisaged under this study.

5 Conclusion

In conclusion, a few key points for CCBST Members' consideration are highlighted:

- **Iterative approach**. This document was developed on the basis of a desktop review of available information. The ideas presented here will undoubtedly be informed and improved by consultation with Members who have engaged on these issues for many years. Once the study approach has been agreed, interviews and other data gathering with stakeholders will bring more information to light and may open new lines of inquiry and analysis.
- **Uncertainties.** Market estimation is not an exact science. There are uncertainties associated with most inputs, whether they are acknowledged or not, and this will lead to uncertainties in the estimation results. Market estimates are therefore best used to flag anomalously high or low values, or to

highlight discrepancies between data sources, to identify the need for further investigation. As with limit reference points in harvest control rules, it will be important for decision-makers to define tolerances beyond which specific actions are triggered.

- **Market evolution**. Market quantification studies work best when a large proportion of the trade is channeled through a few major nodes. This was historically the case for Japan's SBT markets but the situation may be changing or have changed. As markets will continually evolve it is important to define methods that are flexible and easily repeatable at low cost to provide updated values. However, as markets diversify uncertainties may increase.

- **The power of cross-checks**. When estimates are uncertain it is essential to triangulate using different data sources and methods. For SBT market estimates the most powerful dataset is the CDS and it should be used as much as possible to cross-check market and customs data. Direct access to CDS data is request since allowing only indirect access, for example via the Secretariat, will handcuff this study's ability to explore correspondences with market data. Specific examples of how the CDS data can be used to strengthen the market estimates are given in Sections 2.4.3, 3.3 and 3.4.

Members are invited to provide comments and corrections to this document to improve and refine it. Clarification, further elaboration and/or a presentation will be provided on request. Members' efforts to absorb the detail necessary to understand this complex subject are greatly appreciated.

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Annex A. Discrepancies in lag coefficients

Table A1. A summary of average annual lag coefficients for 2013-2019 given in Itoh et al. (2020), Attachment 6.

Year	t-6	t-5	t-4	t-3	t-2	t-1	t	sum
2013	0	0	0	0.001	0.103	0.535	0.361	1
2014	0	0	0	0.004	0.052	0.564	0.369	0.99
2015	0	0	0	0.001	0.046	0.542	0.411	1
2016	0	0	0	0.004	0.018	0.599	0.375	1
2017	0.026	0.006	0	0.004	0.014	0.588	0.357	1
2018	0	0	0	0.001	0.039	0.552	0.401	0.99
2019	0	0	0	0.006	0.022	0.565	0.394	0.99

Table A2. A summary of average annual lag coefficients for 2013-2019 calculated from Attachment 7 of Itoh et al. (2020).

Year	t-6	t-5	t-4	t-3	t-2	t-1	t	sum
2013	0	0	0	0.001	0.127	0.466	0.360	0.95
2014	0	0	0	0.006	0.059	0.732	0.369	1.17
2015	0	0	0	0.002	0.076	0.688	0.411	1.18
2016	0	0	0.001	0.006	0.025	0.640	0.374	1.05
2017	0.049	0.009	0	0.005	0.013	0.514	0.357	0.95
2018	0	0	0	0.001	0.046	0.746	0.401	1.19
2019	0	0	0	0.006	0.025	0.487	0.394	0.91

Example 1: Attachment 6 gives the proportion of SBT marketed in 2018 which were caught in the previous year (i.e. 2017 or t-1) as 55.2%, but Attachment 7 gives the weight of fish from 2017 observed in 2018 as 2371 t which is 74.6% of the 2017 market estimate of 3177 t.

Example 2: Attachment 6 gives the proportion of SBT marketed in 2015 which were caught in the 2013 (t-2) as 4.6%, but Attachment 7 gives the weight of fish from 2013 observed in 2015 as 173 t which is 7.5% of the 2013 market estimate of 2318 t.

Note that some of the discrepancies, especially for t-1 coefficients, are too large to be due to rounding error alone.

If the Attachment 7 calculations are incorrect the anomalies reported in Table 2 of Itoh et al. (2020) will change.

Annex B. Code for Monte Carlo simulation

```
model

{
#the proportion of frozen SBT that is farmed (tight)
        for (i in 1:10) {
        bfarm[i] ~ dnorm(mufarm,taufarm)
        rfarm[i] ~dbin(pfarm[i],1000)
        logit(pfarm[i]) <- bfarm[i]
        }
                                        #
        pop.mean.farm <- exp(mufarm) / (1 + exp(mufarm))
        mufarm ~dnorm(0.0, 1.0E-6)
        sigmafarm ~dunif(0,1000)
        taufarm<-1/(sigmafarm*sigmafarm)

#the proportion of frozen SBT that is farmed (loose)
        f ~dunif(0.05,0.36)

#the proportion of frozen SBT that is wild imports (tight)
        for (i in 1:10) {
        bwild[i] ~ dnorm(muwild,tauwild)
        rwild[i] ~dbin(pwild[i],1000)
        logit(pwild[i]) <- bwild[i]
        }
        pop.mean.wild <- exp(muwild) / (1 + exp(muwild))
        muwild ~dnorm(0.0, 1.0E-6)
        sigmawild ~dunif(0,1000)
        tauwild<-1/(sigmawild*sigmawild)

#the proportion of frozen SBT that is wild imports (loose)
        i ~ dunif(0.05,0.45)

#the proportion of market total passing through Tokyo or Yaizu (p)
        bToYa ~ dnorm(1.33,tauToYa)
        logit(pToYa) <- bToYa
        sigmaToYa ~dunif(0,0.5)                 #0.25 for tight, 0.5 for loose
        tauToYa<-1/(sigmaToYa*sigmaToYa)

#proportion outside the municipal wholesale market system
        bInOut ~ dnorm(1.75,tauInOut)
        logit(pInOut) <- bInOut
        sigmaInOut~ dunif(0,1.4)        #0.7 for tight, 1.4 for loose
        tauInOut<-1/(sigmaInOut*sigmaInOut)

#proportion within the market that is double-counted
        bDouble ~ dnorm(-2,tauDouble)
        logit(pDouble) <- bDouble
        sigmaDouble ~dunif(0,1.8)       #0.9 for tight, 1.8 for loose
        tauDouble<-1/(sigmaDouble*sigmaDouble)

for (x in 1:10) {                                                       #2010-2019
        TotFroz[x] <- (To[x]+Ya[x]) / pToYa
        ImpAdj[x] <- (TotFroz[x]-(TotFroz[x]*f) - (TotFroz[x]*pDouble)) * I     #substitute pop.mean.farm for f
when tight
        M[x] <- (((TotFroz[x] - (TotFroz[x]*f) - (TotFroz[x]*pDouble) - ImpAdj[x] + S[x] ) / pInOut) *GGWW ) + E[x]
                                        }                               #substitute pop.mean.wild for i when tight

#LAGS
Y2013 <- (0.360*M[4]) + (0.466*M[3]) + (0.127*M[2]) + (0.001*M[1])
```

```
Y2014 <- (0.369*M[5]) + (0.732*M[4]) + (0.059*M[3]) + (0.006*M[2])
Y2015 <- (0.411*M[6]) + (0.688*M[5]) + (0.076*M[4]) + (0.002*M[3])
Y2016 <- (0.374*M[7]) + (0.640*M[6]) + (0.025*M[5]) + (0.006*M[4]) + (0.001*M[3])
Y2017 <- (0.357*M[8]) + (0.514*M[7]) + (0.013*M[6]) + (0.005*M[5]) + (0.009*M[3]) + (0.049*M[2])
Y2018 <- (0.401*M[9]) + (0.746*M[8]) + (0.046*M[7]) + (0.001*M[6])
Y2019 <-  (0.394*M[10]) + (0.487*M[9]) + (0.025*M[8]) + (0.006*M[7])
}


#DATA
        list(GGWW=1.15,
        To=c(3800,2919,2950,3179,3355,3883,4402,4205,4082,3882),                    #2010-2019
        Ya=c(560,418,495,519,627,627,718,677,797,713),                              #2010-2019

                #rfarm=c(323,347,263,293,278,276,319,369,208,208),          #feed in these data for “tight”
                #rwild=c(440,453,356,465,377,351,302,305,288,336), #ditto
                S=c(0,0,0,0,0,0,0,0,0,0),
                E=c(33,1.3,16,67,118,363,194,198,285,181))

#INITS
                list(bToYa = 1.1,
                bInOut =1.5,
                bDouble=0.3,
                sigmaInOut = 0.5,
                sigmaToYa = 0.25,
                sigmaDouble=0.30,
                #bfarm=c(0.3,0.2,0.3,0.2,0.3,0.2,0.2,0.2,0.3,0.3), sigmafarm=1, mufarm=0, #needed to tight
                #bwild=c(0.4,0.3,0.2,0.4,0.3,0.2,0.4,0.3,0.2,0.5),sigmawild=1,muwild=1)          #needed for tight
```

Annex C. Trade data for fresh and frozen SBT entering Japan in 2019 from COMTRADE (2021) and FISHSTATJ (2021) as illustrated in Figure 9

COMTRADE 2019, FRESH + FROZEN SBT

Reporter	Partner	kg
Japan	Australia	8951567
Japan	Indonesia	22325
Japan	New Zealand	793712
Japan	Other Asia, nes	964515
Japan	Rep. of Korea	788361
Japan	South Africa	32272
	SUBTOTAL	11552752
Australia	Japan	8962413
Brazil	Japan	133
Canada	Japan	67
Indonesia	Japan	11754
New Zealand	Japan	780751
Other Asia, nes	Japan	956795
Rep. of Korea	Japan	1095970
South Africa	Japan	32542
Tunisia	Japan	633150
USA	Japan	15750
	SUBTOTAL	12489325

FISHSTATJ 2019, FRESH + FROZEN SBT

Reporter	Partner	tonnes
Japan	Australia	8951.57
Japan	Indonesia	22.28
Japan	Korea	788.36
Japan	New Zealand	793.71
Japan	South Africa	32.34
Japan	Taiwan	964.51
	SUBTOTAL	11552.77
Australia	Japan	8902.64
Brazil	Japan	0.13
Canada	Japan	0.07
Indonesia	Japan	11.75
Korea	Japan	1095.97
Mozambique	Japan	69.23
New Zealand	Japan	780.75
South Africa	Japan	32.71
Taiwan	Japan	956.79
Tunisia	Japan	633.15
USA	Japan	15.75
	SUBTOTAL	12498.94

Annex B. Response to Comments on Work Plan

Response to Comments on "Verification of All Member's Catch through Monitoring of Southern Bluefin Tuna Distribution, Review of Existing Information and Draft Work Plan"

Index	Comment from Member	Response from Market Expert Consultant
JP-1	Through long-time market survey, Japan has collected potentially useful information which the expert might have not had but may contribute to the estimation works. We welcome requests and communication.	Thank you very much for this offer.
JP-2	It would be appreciated to describe the time frame which may include some opportunities for members to look into trial results from the estimation work before formal submission to CCSBT.	In consultation with the Secretariat, the following schedule is proposed: • Provision of a draft report of progress and outcomes by 26 July 2022 • Comments from members on the draft report received by 16 August 2022 • Submission of report of progress and outcomes for the 17th Meeting of the Compliance Committee by 6 September 2022 • Presentation of the report at the 17th Meeting of the Compliance Committee (4-7 October 2022).
JP-3	As ToR 2. d) asks for in, it would be expected to develop a proposal for the mechanism to check SBTs caught by each member utilizing the developed/updated estimation methodology and the estimated distribution volumes, taking it into account that they cover the catch and distribution from all the members and the core actors in the mechanism would be possibly the secretariat/ committee.	As explained in Section 4 of the Work Plan, to address TOR 2.1d it is planned to contrast estimates of SBT in Japan's markets (caught both by Japan (Objective A) and by other Members (Objective B)) with global market amounts estimated by the Secretariat (Objective C). Checking all Member's catch using a market methodology applicable to all markets worldwide is not considered to be within the scope of the

		assignment as defined by the TOR. It is anticipated that methodology would be designed so that the Secretariat would be able to perform the market checks themselves in future.
JP-4	As Attachment C of CCSBT-CC/2110/04(Rev1)(especially, the table of iii)) demonstrates that small portion of SBTs was exported to Japan in 2020 and the most of the exported SBTs from Indonesia went to the US, it enlightens about the necessity to investigate the global distribution of SBTs with special attention to other countries than Japanese market. Therefore, although the secretariat produced the above document and continues such a work, it would be appreciated to estimate the global distribution of SBTs based on available information such as the above document, CDS data and customs statistics of the importing/exporting countries, especially other countries than Japan to the extent possible. Even if it would be difficult, it would be expected to analyze the recent global movement/trend of SBTs and assess the Japanese market placed in the global market in terms of SBTs distribution.	As stated above, the quantities of SBT in Japan's markets will be contrasted with the quantities of SBT in the global market as a whole as estimated by the Secretariat. The referenced paper has already presented available information from customs statistics and the CDS, and it is not likely that any other desktop information exists. Undertaking field studies in other markets such as the United States, Malaysia, Canada and China (identified in the cited paper as destinations for small amounts of SBT, i.e. Japan in 2020 still comprised ~92% of the total market), is an entirely different line of work to that described in the TOR, therefore it is not anticipated under this study.
JP-5	It is necessary to revise the descriptions in Example 1 and 2 of Annex A "Discrepancies in lag coefficients" in Page 47 as follows. In our calculation, the time lag is the proportion of fish caught in the past among fish placed at market now. The expert may think it is the proportion of fish placed at market in future years among fish caught this year. Example 1: Attachment 6 gives the proportion of SBT marketed in 2018 which were caught in the previous year (i.e. 2017 or t-1) as 55.2%, but Attachment 7 gives the weight of fish from 2017 observed in 2018	Thank you for the explanation. I can now understand how the lag calculations were made.

	as 2371 t which is 55.16~~74.6~~% of the 2018~~2017~~ market estimate of 4298~~3177~~ t. Example 2: Attachment 6 gives the proportion of SBT marketed in 2015 which were caught in the 2013 (t-2) as 4.6%, but Attachment 7 gives the weight of fish from 2013 observed in 2015 as 173 t which is 4.58~~7.5~~% of the 2015~~2013~~ market estimate of 3779~~2318~~ t.	
JP-6	Regarding the question about the lag coefficients in 3rd paragraph of Page 36, the management tag survey covers not only tags attached by Japan but also those by other members.	Thank you for the clarification. It thus appears that it would be appropriate to apply the same lag coefficients to Japan-caught and imported wild SBT.
JP-7	The following minor revision may be considered. • The 5th line in 1st paragraph of Page 19 needs to be revised as follows.These surveys are conducted twice~~once~~ per month on a Friday which・・・. • The proposed formula(Eq.5) in Page 26 has " x(multiply) Et" but the x may be +(plus).	Thank you for these corrections.
JP-8	We recognize the importance of the direct access to CDS which will be utilized to strengthen the market estimates.	Noted.