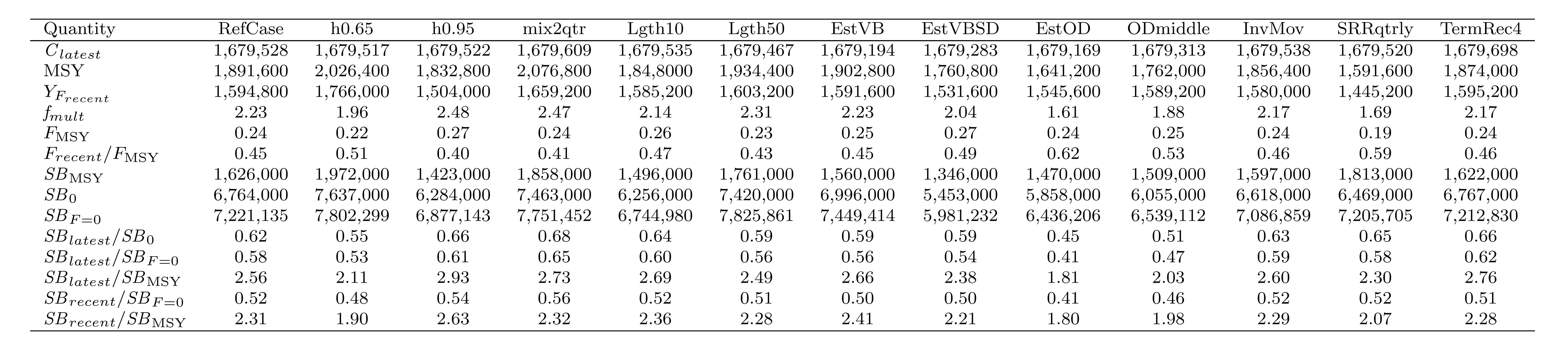
**WCPO skipjack tuna Draft Recommendation**

S. Mckechnie presented SC12-SA-WP-04 (stock assessment of skipjack tuna in the western and central Pacific Ocean) that assessed the stock of skipjack tuna in the WCPO up to the end of 2015. New developments to the assessment include addressing the recommendations of the previous assessment (2014), exploration of uncertainties in the assessment model, particularly in response to the inclusion of additional years of data, and to improve diagnostic weakness of previous assessments. Other key papers presented document: 1) methods of estimating standardised catch per unit effort indices, 2) construction of the tagging data input file, 3) revisions and summaries of fisheries definitions, and the guidance of the Pre-assessment workshop.

**Stock status and trends**

**Option 1 – stock status based on the reference case model**SC12 selected the reference case model as the base case to represent the stock status of skipjack tuna. To characterize uncertainty, SC12 chose the structural uncertainty grid. Summaries of important model quantities for these models are shown in Table SKJ1. **Table SKJ1:** Estimates of management quantities for the selected stock assessment models. For the purpose of this assessment, “recent” is the average over the period 2011–2014 and “latest” is 2015. (INSERT TABLE 6 FROM THE ASSESSMENT)



Trends in estimated recruitment, spawning biomass, fishing mortality and depletion are shown in Figures SKJ 1-4.

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| --- | --- |
| C:\skj\2016\Writeup\Figures\Stepwise\plot_recruitment_compare_2016_Sensitivities2.png | C:\skj\2016\Writeup\Figures\Stepwise\plot_biomass_compare_2016_Sensitivities2.png |
| **Figure SKJ1:** Estimated annual recruitment (millions of fish) for the WCPO obtained from the reference case model and six additional runs. | **Figure SKJ2:** Estimated annual average spawning potential for the WCPO obtained from the reference case model and six additional runs. |
| C:\skj\2016\Writeup\Figures\Reference_Case\plot_temporal_F.png | C:\skj\2016\Writeup\Figures\Reference_Case\plot_fishery_impact_SKJ-SSB.png |
| **Figure SKJ3:** Estimated annual average juvenile and adult fishing mortality for the WCPO obtained from the reference case model. | **Figure SKJ4:** Estimates of reduction in spawning potential due to fishing (fishery impact = *1-SBt/SBt,F=0*) by region and for the WCPO attributed to various fishery groups for the reference case model. |
| C:\skj\2016\Writeup\Figures\Reference_Case\plot_Majuro_Temporal.png  C:\skj\2016\Writeup\Figures\Grid\plot_Majuro_grid_compare.png | C:\skj\2016\Writeup\Figures\Reference_Case\plot_temporal_MSY.png |
| **Figure SKJ5:** Temporal trend for the reference case model (top) and the structural uncertainty grid (bottom panel) in stock status relative to *SBF=0* (x-axis) and *FMSY* (y-axis). The red zone represents spawning potential levels lower than the agreed LRP, which is marked with the solid black line (*0.2SBF=0*). The orange region is for fishing mortality greater than *FMSY* (*F=FMSY*; marked with the black dashed line). The green line indicates the interium target reference point 50%*SBF=0*. | **Figure SKJ6:** History of annual estimates of MSY compared with catches of three major fisheries for the reference case model. |

Dynamics of most model quantities are relatively consistent with the results of the 2014 stock assessment, although there has been a period of several subsequent years with high recruitments and increased spawning biomass.

Fishing mortality of all age-classes is estimated to have increased significantly since the beginning of industrial tuna fishing, but fishing mortality still remains below the level that would result in the MSY (*Frecent/FMSY* = 0.45 for the reference case), and is estimated to have decreased moderately in the last several years. Across the reference case and the structural uncertainty grid *Frecent/FMSY* varied between 0.38 (5% quantile) to 0.64 (95% quantile). This indicates that overfishing is not occurring for the WCPO skipjack tuna stock (Figure SKJ 5).

The estimated MSY of 1,891,600 mt is moderately higher than the 2014 estimate due to the adoption of an annual, rather than quarterly, stock-recruitment relationship. Recent catches are lower than, but approaching, this MSY value (Figure SKJ 6).

The latest (2015) estimate of spawning biomass is well above both the level that will support MSY (SBlatest/SBMSY = 2.56, for the reference case model) and the adopted LRP of 0.2 SBF=0 (SBlatest/SBF=0 = 0.58, for the reference case model), and SBlatest/SBF=0 was relatively close to the adopted interim target reference point (0.5 SBF=0) for all models explored in the assessment (structural uncertainty grid: median = 0.51, 95% quantiles = 0.39 and 0.67).

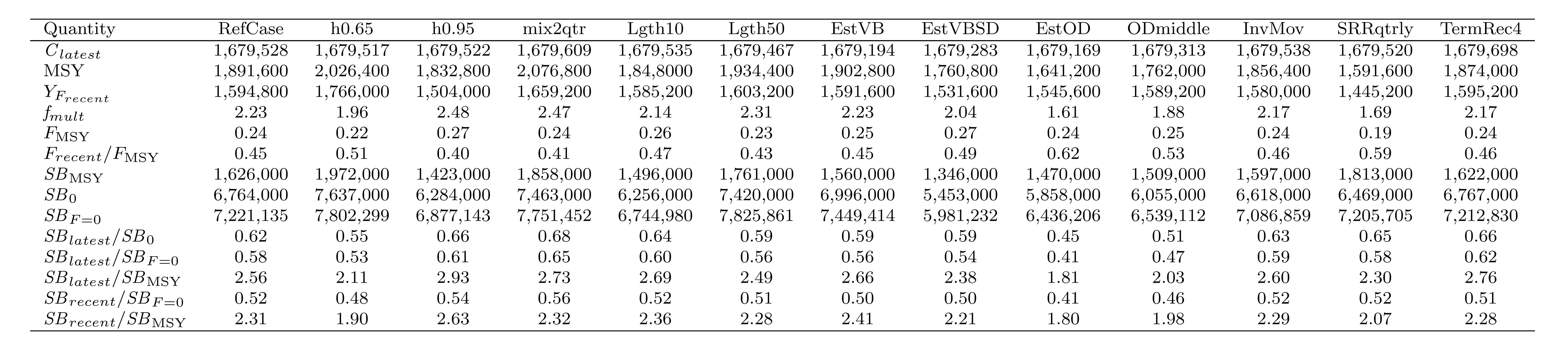
SC12 further advises the WCPFC that there is continuous concern that high catches in the equatorial region could result in range contractions of the stocks, thus reducing skipjack tuna availability to high latitude fisheries. SC12 recommends that further research on range contraction of skipjack tuna be conducted in the framework of Project 67.

**Stock status and trends**

**Option 2 – stock status based on the median of the structural uncertainty grid**

SC12 selected the median of the structural uncertainty grid to represent the stock status of skipjack tuna. To characterize uncertainty, SC12 chose all models in the structural uncertainty grid. Summaries of important model quantities for these models are shown in Table SKJ1 and 2.

**Table SKJ1:** Estimates of management quantities for the selected stock assessment models. For the purpose of this assessment, “recent” is the average over the period 2011–2014 and “latest” is 2015. (INSERT TABLE 6 FROM THE ASSESSMENT)



**Table SKJ2:** Estimates of management quantities for the median of the structural uncertainty grid.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Quantity | Reference case | Grid Median | Grid 5% | Grid 95% |
| *Clatest* | 1,679,528 | 1,679,444 | 1,678,646 | 1,679,592 |
| MSY | 1,891,600 | 1,875,600 | 1,618,060 | 2,199,880 |
| *YF,recent* | 1,594,800 | 1,607,000 | 1,486,660 | 1,808,860 |
| *fmult* | 2.23 | 2.07 | 1.57 | 2.62 |
| *FMSY* | 0.24 | 0.24 | 0.21 | 0.28 |
| *Frecent/FMSY* | 0.45 | 0.48 | 0.38 | 0.64 |
| *SBMSY* | 1,626,000 | 1,628,000 | 1,258,700 | 2,166,100 |
| *SB0* | 6,764,000 | 6,359,500 | 5,214,050 | 8,340,450 |
| *SBF=0* | 7,221,135 | 6,876,526 | 5,778,079 | 8,555,240 |
| *SBlatest/SB0* | 0.62 | 0.55 | 0.43 | 0.71 |
| *SBlatest/SBF=0* | 0.58 | 0.51 | 0.39 | 0.67 |
| *SBlatest/SBMSY* | 2.56 | 2.15 | 1.60 | 3.08 |
| *SBrecent/SB0* | 0.52 | 0.49 | 0.40 | 0.57 |
| *SBrecent/SBF=0* | 2.31 | 2.04 | 1.58 | 2.65 |

Trends in estimated recruitment, spawning biomass, fishing mortality and depletion are shown in Figures SKJ 1-4.[same Figures as option1]

Dynamics of most model quantities are relatively consistent with the results of the 2014 stock assessment, although there has been a period of several subsequent years with high recruitments and increased spawning biomass.

Fishing mortality of all age-classes is estimated to have increased significantly since the beginning of industrial tuna fishing, but fishing mortality still remains below the level that would result in the MSY (*Frecent/FMSY* = 0.48 for the median across the grid), and is estimated to have decreased moderately in the last several years. Across the structural uncertainty grid *Frecent/FMSY* varied between 0.38 (5% quantile) to 0.64 (95% quantile). This indicates that overfishing is not occurring for the WCPO skipjack tuna stock (Figure SKJ 5).

The median estimated MSY across the grid was 1,875,600 mt (95% quantiles = 1,618,060 - 2,199,880) which is moderately higher than the 2014 estimate (grid median = 1,758,600, 95% quantiles = 1,347,000 – 3,051,900) due to the adoption of an annual, rather than quarterly, stock-recruitment relationship. Recent catches are lower than, but approaching, this MSY value (Figure SKJ 6).

The latest (2015) estimate of spawning biomass is well above both the level that will support MSY (SBlatest/SBMSY = 2.15 for the median across the grid) and the adopted LRP of 0.2 SBF=0 (SBlatest/SBF=0 = 0.51 for the median across the grid), and SBlatest/SBF=0 was relatively close to the adopted interim target reference point (0.5 SBF=0) for all models explored in the assessment (structural uncertainty grid: 95% quantiles = 0.39 and 0.67).

SC12 further advises the WCPFC that there is continuous concern that high catches in the equatorial region could result in range contractions of the stocks, thus reducing skipjack tuna availability to high latitude fisheries. SC12 recommends that further research on range contraction of skipjack tuna be conducted in the framework of Project 67.

**Stock status and trends**

**Option 3– stock status based on the all of the structural uncertainty grid**

SC12 was unable to select a base case from various sensitivity models because they are all considered plausible. Therefore, SC12 decided to provide advice to WCPFC based on the all of the sensitivity models. Description of the reference case and key models chosen for the provision of management advice is shown in Table SKJ1.

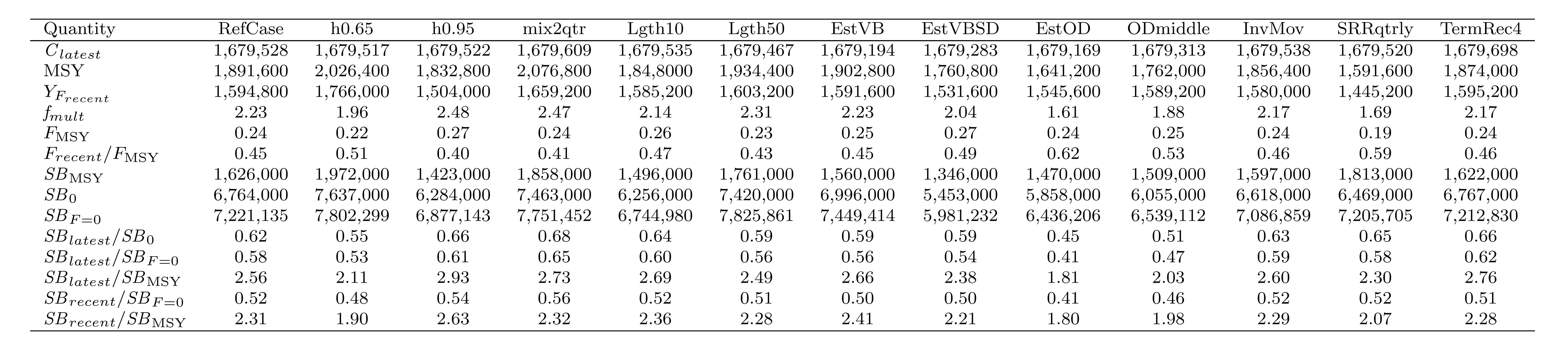
**Table SKJ1:** Description of the reference case and key models chosen for the provision of management advice. (INSERT TABLE 5 FROM ASSESSMENT REPORT) The reference case option is denoted in bold face.



Time trends in estimated recruitment, biomass, fishing mortality and depletion of various model settings are shown in Figures SKJ 1–4.

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| **Figure SKJ1:** Estimated annual recruitment (millions of fish) for the WCPO obtained from the reference case model and six additional runs. | **Figure SKJ2:** Estimated annual average spawning potential for the WCPO obtained from the reference case model and six additional runs. |
| C:\skj\2016\Writeup\Figures\Reference_Case\plot_temporal_F.png | C:\skj\2016\Writeup\Figures\Stepwise\plot_depletion_compare_2016_Sensitivities2.png |
| **Figure SKJ3:** Estimated annual average juvenile and adult fishing mortality for the WCPO obtained from the reference case model. | **Figure SKJ4:** Estimates of reduction in spawning potential due to fishing (fishery impact = *1-SBt/SBt,F=0*) for the reference case model and six additional runs. |
| **(INSERT Figure 50 and 51 FROM ASSESSMENT REPORT)** |  |
| **Figure SKJ5:** Majuro plots for each of the one off sensitivity models in stock status relative to SBF=0 (x-axis) and FMSY (y-axis). The red zone represents spawning potential levels lower than the agreed LRP, which is marked with the solid black line (0.2SBF=0). The orange region is for fishing mortality greater than FMSY (F=FMSY; marked with the black dashed line). The green line indicates the interium target reference point 50%SBF=0. | **Figure SKJ5(continue):** |

Various information on the status of skipjack such as MSY and performance against reference points are provided in Table SKJ2 (INSERT TABLE 6 FROM THE ASSESSMENT).

Table SKJ2 Estimates of management quantities for the selected stock assessment models. For the purpose of this assessment, “recent” is the average over the period 2011–2014 and “latest” is 2015.  


The estimated MSY ranged from 1,641,200 to 2,076,800 mt across the tested models.

Across the tested models *Frecent/FMSY* ranged from 0.45 to 0.62. This indicates that overfishing is not occurring for the WCPO skipjack tuna stock (Figure SKJ 5).

The latest (2015) estimates of spawning biomass are above both the level that will support MSY (SBlatest/SBMSY ranges from 1.81 to 2.93 across the various models) and the adopted LRP of 0.2SBF=0 (SBlatest/SBF=0 ranges from 0.41 to 0.65), suggesting that the stock is not overfished relative to its LRP. However, SC12 draws the attention of WCPFC that some models indicate that the latest biomass is below the newly adopted TRP of 0.5SBF=0 .

SC12 also draws the attention of WCPFC to the fact that the current method of calculating the TRP is based on the most recent 10 year recruitment information. However, the latest SSB, which is used to evaluate the current status against the TRP, for species reaching maturity relatively quick such as skipjack will increase more rapidly than the TRP, thus potentially providing more optimistic status when recruitment is in an increasing trend, as currently observed in the case of skipjack.

In order to provide more specific advice to WCPFC, SC12 requests the scientific service provider (i) to conduct assessment based on the alternative area definition suggested by Kiyofuji et al. (SA-IP09) and (ii) to prepare likelihood profile analysis for both the current and alternative assessment to SC13 so that SC13 can duly consider the selection of base case. SC12 further requests the scientific service provider for the next full stock assessment to (i) evaluate the results of multiple models such as SEAPODYM or Stock Synthesis, (ii) test different growth models such as suggested by Ochi et al. (SA-IP08), (iii) test alternative natural mortalities such as constant one or one that decreases as aging, and (iv) evaluate appropriate method to weigh tag information. In doing so, SC12 requests the scientific service provider to further promote the inclusiveness of the assessment process of member country scientists by allowing greater participation and frequent information sharing in the course of the development of assessment.

SC12 further advises the WCPFC that there is continuous concern that high catches in the equatorial region could result in range contractions of the stocks, thus reducing skipjack tuna availability to high latitude fisheries. SC12 recommends that further research on range contraction of skipjack tuna be conducted in the framework of Project 67.

**management advice and implications**

* The assessment continues to show that the stock is currently moderately exploited and fishing mortality level is sustainable. However, the recent catches are near the estimated MSY by various models or are above it in some cases and some models also indicate that the stock is currently under the TRP.
* Fishing is having a significant impact on stock size and can be expected to affect catch rates. The stock distribution is also influenced by changes in oceanographic conditions associated with El Niño and La Niña events, which impact on catch rates and stock size. Additional purse-seine effort will yield only modest gains in long-term skipjack tuna catches and may result in a corresponding increase in fishing mortality for bigeye and yellowfin tunas. The management of total effort in the WCPO should recognize this.
* The spawning biomass is now around the adopted TRP and SC12 recommends that the Commission take action to avoid further increase of fishing mortality to keep the skipjack tuna stock around TRP and advocates for the adoption of harvest control rules based on the information provided.