Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

SUMMARY REPORT

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The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
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EXECUTIVE SUMMARY

OPENING OF THE MEETING

1. The Chair, D.Y. Moon (Korea) opened the Fourth Regular Session of the Scientific Committee, which took place in Port Moresby, Papua New Guinea (PNG) from 11–22 August 2008.

2. The matters considered by the Scientific Committee (SC) and its six Specialist Working Groups — Biology (BI), Ecosystem and Bycatch (EB), Fishing Technology (FT), Methods (ME), Statistics (ST), and Stock Assessment (SA) — included:

- a review of the fisheries in the western and central Pacific Ocean (WCPO) and the eastern Pacific Ocean (EPO);
- a review of the status of stocks of bigeye, skipjack and southern albacore tunas in the Convention Area, swordfish stocks in the southwest and south-central Pacific, with a focus on requests for advice and recommendations arising from the Fourth Regular Session of the Commission in Guam, USA in December 2007;
- a summary of the most recent information and assessments for tuna and billfish stocks in the North Pacific;
- bycatch mitigation issues associated with seabirds, sea turtles, sharks, juvenile bigeye and yellowfin tunas, and ecological risk assessment;
- issues associated with the data available to the Commission and initiatives to address data gaps, the status of the Indonesia and Philippines Data Collection Project, and the Pacific Tuna Tagging Programme;
- cooperation with other organizations;
- the special requirements of small island developing states and territories;
- a review of interim arrangements for science structure and function;
- the process for developing the programme of work for the SC and the 2009-2011 work programme for the SC; and
- administrative matters associated with the functioning of the SC.

OVERVIEW OF THE WESTERN AND CENTRAL PACIFIC OCEAN FISHERIES

3. The provisional total Convention Area tuna catch for 2007 was estimated at 2,396,815 mt, clearly the highest annual catch recorded, and more than 120,000 mt higher than the previous record in 2006 (2,273,322 mt; Fig. 1). During 2007, the purse-seine fishery accounted for an estimated 1,739,859 mt (73% of the total catch, and a record for this fishery), with the pole-and-line fishery taking an estimated 214,935 mt (9%), the longline fishery an estimated 232,388 mt (10%), and the remainder (8%) taken by troll gear and a variety of artisanal gear, mostly in eastern Indonesia and the Philippines. The Convention Area tuna catch (2,396,815 mt) for 2007 represented 84% of the total Pacific Ocean catch of 2,800,740 mt, and 55% of the global tuna catch (the provisional estimate for 2007 is just under 4.4 million mt).

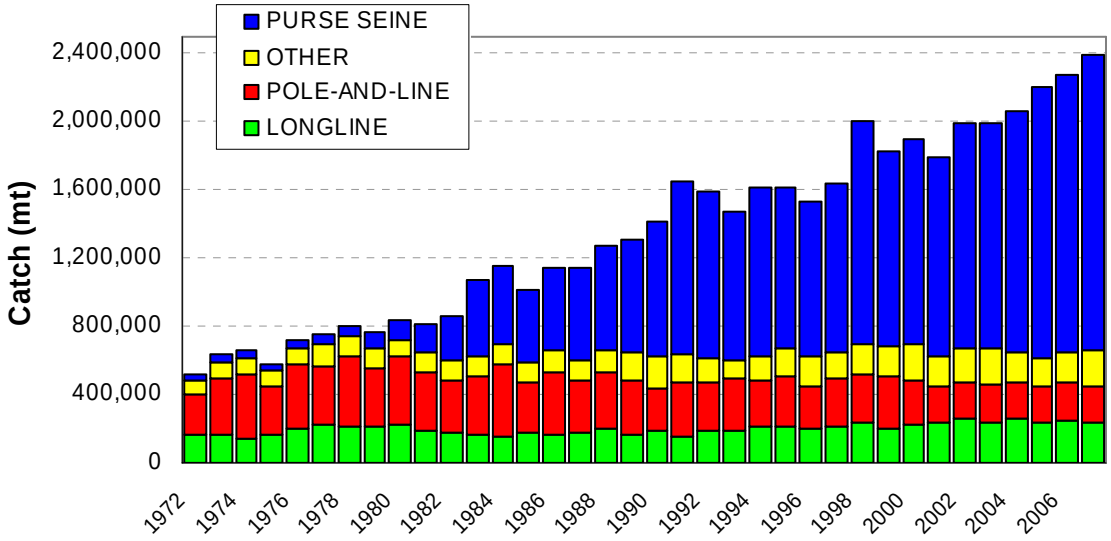

Figure 1. Catch (mt) of albacore, bigeye, skipjack and yellowfin tunas in the Convention Area, by longline, pole-and-line, purse seine and other gear types.

4. The 2007 Convention Area catch of skipjack (1,726,702 mt – 72% of the total catch) was the highest ever, continuing the trend of consecutive record catches since 2002 (Fig. 2). The Convention Area yellowfin tuna catch for 2007 (431,814 mt – 18%) was lower than in 2006 (442,288 mt), but higher than the average catch level for the period since 2000 (~424,000 mt). The Convention Area bigeye tuna catch for 2007 (143,059 mt – 6%) was the second highest on record (after the catch in 2004, which was 156,768 mt). This was mainly due to a relatively high estimated bigeye tuna catch from the purse-seine fishery, although observer data for 2007, used to estimate the purse-seine bigeye tuna catch, are very preliminary. The 2007 Convention Area albacore catch (95,240 mt, or 4%) was the lowest for over 10 years, primarily due to the continuing trend of low catches in the North Pacific in recent years.

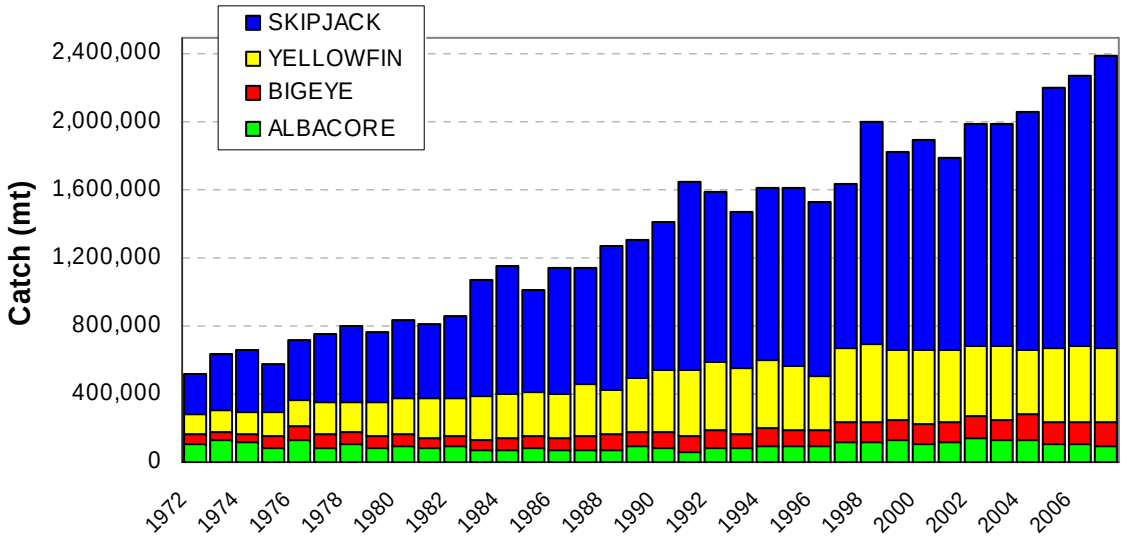

Figure 2. Catch (mt) of albacore, bigeye, skipjack and yellowfin tunas in the Convention Area by species for all gear types combined.

STATUS OF THE STOCKS AND MANAGEMENT ADVICE AND IMPLICATIONS

WCPO bigeye tuna

Status and trends

5. The assessment results from the base-case model closely approximate the results from the 2006 assessment (Table 1), with inclusion of additional fisheries and changes in fishery configurations. These changes represent refinements to the model rather than substantive changes to model structure, and result in only minor changes to biomass trajectories. The key conclusions of the models presented are similar to the comparative model runs from the 2006 base-case assessment: depletion levels estimated in the base-case (0.26) were slightly lower than the 2006 (LOWSAMP) assessment (0.29), $F_{current}/\widetilde{F}_{MSY}$ was more pessimistic (1.44 (Figs. 3 and 4) compared with 1.32 for 2006) and $B_{current}/\widetilde{B}_{MSY}$ was higher (1.37 (Figs. 3 and 5) compared with 1.27) while $SB_{current}/\widetilde{SB}_{MSY}$ was comparable (1.19 compared with 1.20). These metrics indicate that recent fishing mortality has continued to increase unless fishing patterns and the maximum sustainable yield (MSY) have changed, although biomass levels have continued to be sustained by higher recruitment. However, the MSY-based reference points are not directly comparable as there has been a shift in the age-specific fishing mortality in recent years due to the recent decline in the longline catch.

6. The estimate of $F_{current}/\widetilde{F}_{MSY}$ indicates that overfishing of bigeye tuna is occurring in the WCPO with a very high probability (100% for the scenario shown in Fig. 4). While the stock is not yet in an overfished state with respect to total biomass ($B_{current}/\widetilde{B}_{MSY} > 1$), the situation is less optimistic with respect to adult biomass. A number of plausible model options indicate that adult biomass has been below the $\widetilde{SB}_{MSY}$ level for a considerable period ($SB_{current}/\widetilde{SB}_{MSY} < 1$).

For the base-case model, there is also a 42.8% probability that $SB_{2006} / \widetilde{SB}_{MSY}$ is less than 1.0. Further, both the adult and total biomass are predicted to become overfished at 2003-2006 average fishing mortality levels and long-term average recruitment levels. This is consistent with a recent decline in biomass under increasing fishing mortality levels, resulting in an increase in the probability of the stock becoming overfished over time.

7. Recent catches are high relative to the estimated MSY, both because of high recent fishing mortality and because the stock has benefited from above-average recruitment over the past 15 years.

Table 1. Estimates of reference points from the 2008 and 2006 bigeye tuna stock assessments. Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, the ranges shown for each reference point should not be compared across years nor be considered as confidence intervals.

Management Quantity	**2008 Assessment**	**2006 Assessment**
Most recent catch	143,059 mt (2007)	156,768 mt (2004)
MSY	Base case: 64,600 mt Range: 56,800 ~ 65,520 mt	Base case: 72,880 mt Range: 64,600 ~ 91,400 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Base case: 0.94 Range: 0.50 ~ 0.97	Base case: 0.96 Range: 0.94 ~ 0.99
$\mathbf{B_{current}/B_{current,\ F=0}}$	Base case: 0.26 Range: 0.20 ~ 0.28	Base case: 0.29 Range: 0.28 ~ 0.44
$\mathbf{F_{current}/F_{MSY}}$	Base case: 1.44 Range: 1.33 ~ 2.09	Base case: 1.32 Range: 0.87 ~ 1.48
$\mathbf{B_{current}/B_{MSY}}$	Base case: 1.37 Range: 1.02 ~ 1.37	Base case: 1.27 Range: 1.27 ~ 1.59
$\mathbf{SB_{current}/SB_{MSY}}$	Base case: 1.19 Range: 0.76 ~ 1.20	Base case: 1.20 Range: 1.10 ~ 1.74

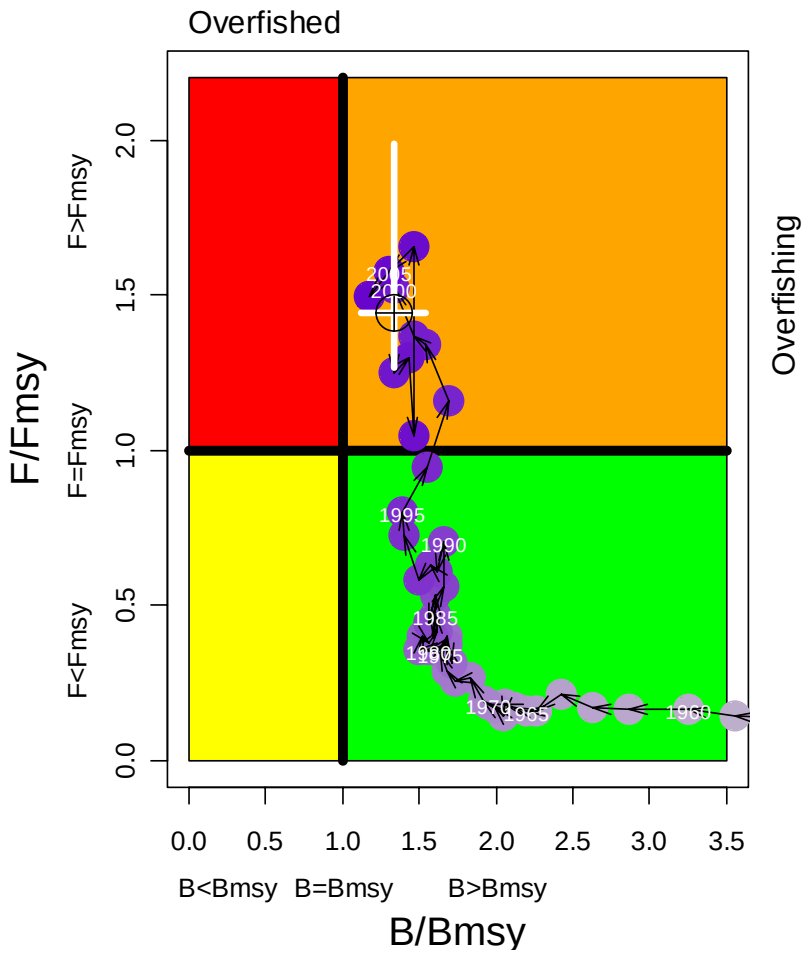

Figure 3. Temporal trend in annual stock status for bigeye tuna, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1952–2006) from the base-case model (run 4). The colour of the points is graduated from mauve (1952) to dark purple (2006), and the points are labelled at five-year intervals. White lines represent the confidence interval associated with F/F_{MSY} and B/B_{MSY}. The last year of the model (2007) is excluded because it is highly uncertain.

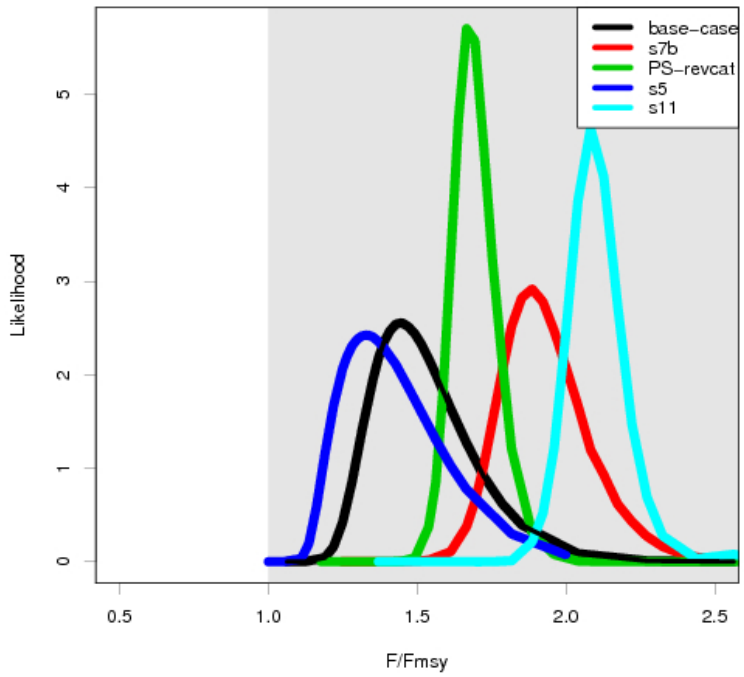

Figure 4. Probability distributions of $F_{current}/\widetilde{F}_{MSY}$ for bigeye tuna based on the likelihood profile method for the base-case model and main sensitivity analyses.

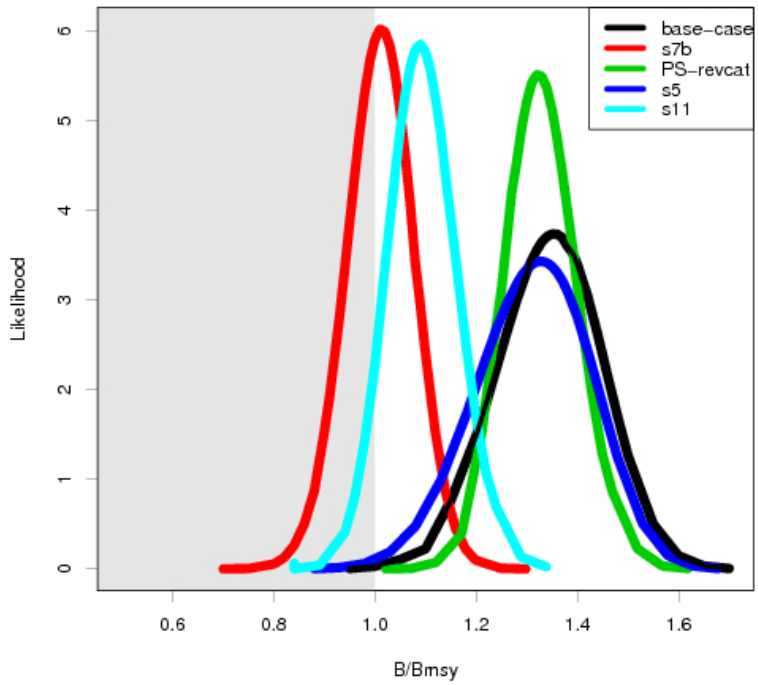

Figure 5. Probability distributions of $B_{current}/\widetilde{B}_{MSY}$ for bigeye tuna based on the likelihood profile method for the base-case model and main sensitivity analyses.

8. Three projection runs were considered to illustrate stock status in relation to biomass quantities: i) status quo of continuing the $F_{current\ (2003–2006)}$; ii) reducing $F_{current}$ from the status quo by 30% at start of projection (2008); and iii) reducing $F_{current}$ from the status quo by 10% per year over three years. Fig. 6 illustrates three projections of $F_{current} / \widetilde{F}_{MSY}$.

9. All projection runs from 2008 to 2018 indicate that the stock will be overfished after 2013 with regards to both total biomass ($B_{current} / \widetilde{B}_{MSY}$ <1.0, Fig. 7) and spawning biomass ($SB_{current} / \widetilde{SB}_{MSY}$ <1.0, Fig. 8), although there is increasing uncertainty in projections through time. As expected, the stock is projected to be overfished sooner if $F_{current\ (2003–2006)}$ is maintained. Estimates of $F_{current} / \widetilde{F}_{MSY}$ (Attachment L, Table BET2), $B_{current} / \widetilde{B}_{MSY}$ (Attachment L, Table BET3) and $SB_{current} / \widetilde{SB}_{MSY}$ (Attachment L, Table BET4) were computed for three fishery groupings (longline, purse-seine associated, and Indonesian/Philippines) with decreases or increases in fishing effort (60%, 70%, 80%, 90%, 100%, 110% and 120%). Most multiples of reductions in fishing effort still result in overfishing (Attachment L, Table BET2) and a bigeye tuna stock that is overfished with regards to both biomass and spawning biomass (Attachment L, Tables BET3 and BET4).

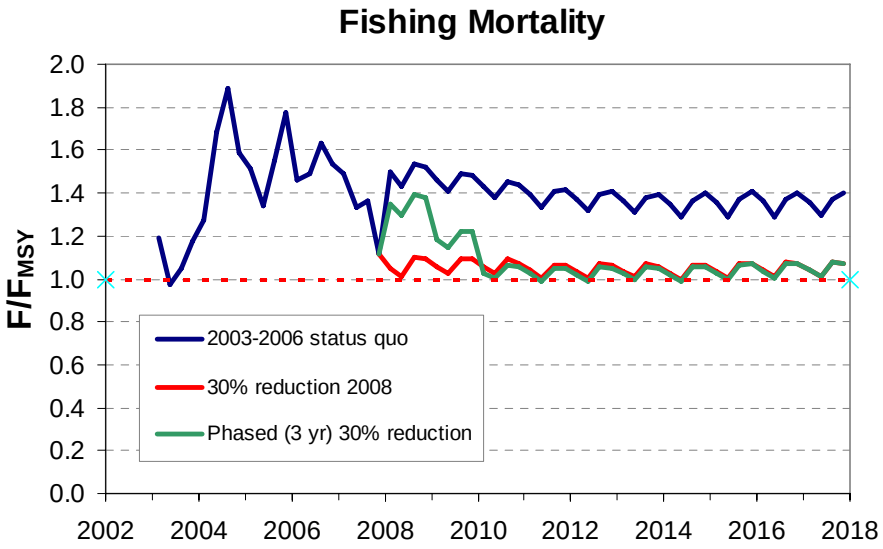

Figure 6. Estimated (2003–2006) and projected $F_{current} / \widetilde{F}_{MSY}$ for bigeye tuna based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at the start of projection (2008), and reducing $F_{current}$ from the status quo by 10% per year over three years.

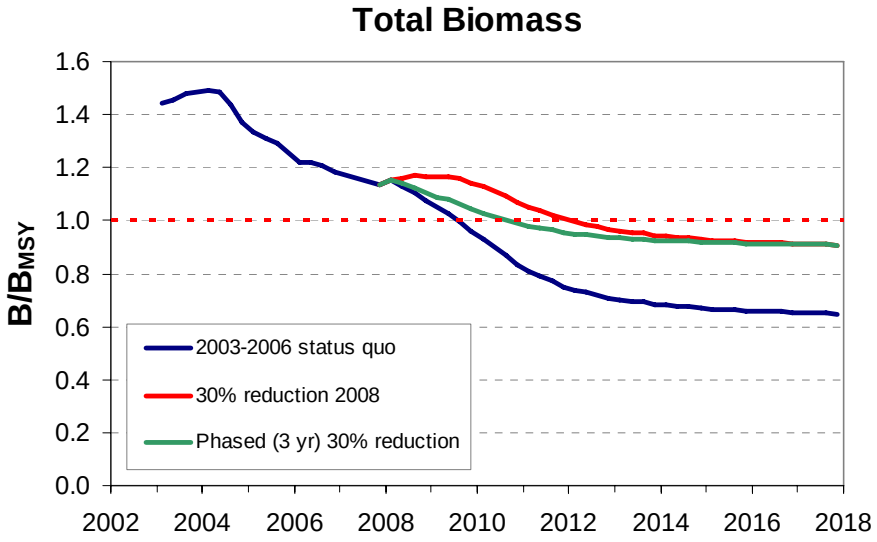

Figure 7. Estimated (2003–2006) and projected $B_{current}/\widetilde{B}_{MSY}$ for bigeye tuna based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at start of projection (2008) and reducing $F_{current}$ from the status quo by 10% per year over three years.

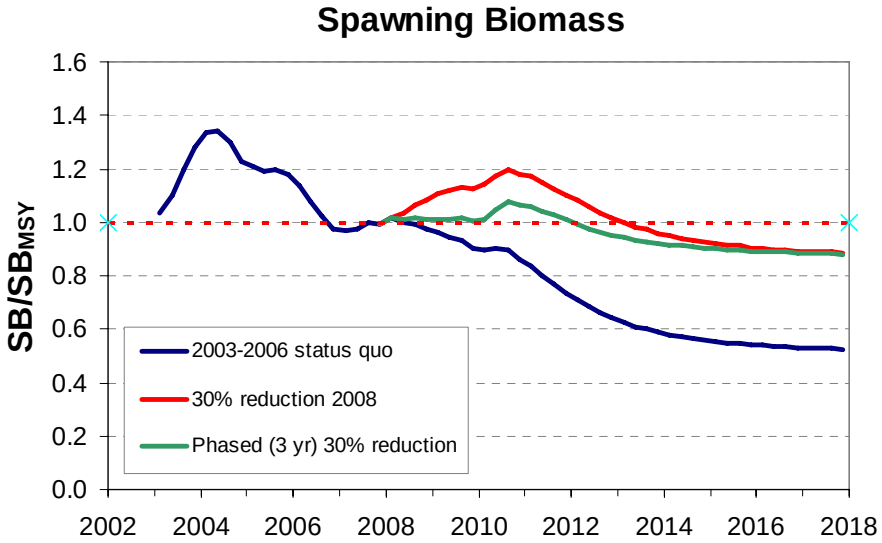

Figure 8. Estimated (2003–2006) and projected $SB_{current}/\widetilde{SB}_{MSY}$ for bigeye tuna based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at start of projection (2008) and reducing $F_{current}$ from the status quo by 10% per year over three years.

Management advice and implications

10. The SC recommended a minimum 30% reduction in fishing mortality from the average levels for 2003–2006, with the goal of returning the fishing mortality rate to F_{MSY}. The point estimate of the $F_{current\ (2003–2006)}/F_{MSY}$ ratio (1.44) in the 2008 assessment was higher than the point

estimate (1.32) in the 2006 assessment. A recommendation of a 30% reduction in fishing mortality is consistent with the SC recommendation issued in 2006 of a 25% reduction. The SC acknowledged that projections indicate that the bigeye tuna stock may become overfished (biomass<B_{MSY}, spawning biomass<SB_{MSY}) in the future with regards to both total biomass and spawning biomass, even with a 30% reduction in fishing mortality. Therefore, it may be necessary to recommend additional reductions in fishing mortality in the future if assessments indicate that fishing mortality is greater than F_{MSY}.

11. The SC also provided alternative schemes (as shown in Attachment L, Figs. BET8–10 and Tables BET2–4) to achieve this reduction in fishing mortality, and suggested that these results be seriously considered when management measures are discussed.

12. The SC reiterated SC2's advice that exploitation rates differ between regions and that exploitation rates are highest in the western equatorial region; therefore, the SC recommended a reduction in fishing mortality throughout the WCPO from all major fishing types with priority in the western equatorial region.

13. Regarding the Commission's request for advice on the potential for technological solutions to minimize the impact of fishing gear for small tuna on floating objects (or juvenile yellowfin and bigeye tunas), while minimizing the impact on the skipjack fishery (WCPFC4 Summary Report, paras 286–287), the SC noted that research was reviewed by the SC and is still ongoing in this area, but it had no further recommendations for the Commission beyond those provided by SC2.

14. In relation to the Commission's request that the SC will also provide information, analysis and evaluation of relevant management options (WCPFC4 Summary Report, paras 279–280), the SC noted that Tables BET2 and BET3 in Attachment L contain information on the impact of fishing effort reductions by the main categories of fishing fleets on F/F_{MSY} and B/B_{MSY}.

WCPO yellowfin tuna

15. No stock assessment was undertaken for WCPO yellowfin tuna in 2008. Therefore, the stock status description and management recommendations from SC3 are still current.

WCPO skipjack tuna

Status and trends

16. The major conclusions of the skipjack assessment are essentially unchanged from the last three assessments (2002, 2003 and 2005) and Table 2 compares reference points between the 2008 and 2005 assessments. According to the key conclusions of the models presented, overfishing is not occurring and the stock is not in an overfished state. These conclusions are similar to the model runs from the 2005 base-case assessment. Depletion levels estimated in the 2005 WCPO assessment (0.86) were similar to the current equatorial model (0.66), $F_{current}/\widetilde{F}_{MSY}$ was more optimistic (0.17 for 2005 compared with 0.26) and $B_{current}/\widetilde{B}_{MSY}$ was essentially the same (3.01 for 2005 compared with 2.99, Table 2, Fig. 9). There is a zero probability that $B_{current}/\widetilde{B}_{MSY}$ is below to 1.0 (Fig. 10).

Table 2. Estimates of reference points from the 2008 and 2005 skipjack tuna stock assessments. The spatial domain of the 2008 assessment is limited to the equatorial region of the WCPO. Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, the ranges shown for each reference point should not be compared across years. They should not be considered as confidence intervals.

Management Quantity	2008 Assessment	2005 Assessment
Most recent catch	1,546,436 mt (2007[1]) 1,726,702 mt (2007[2])	1,403,085 mt (2004[2])
MSY	Equatorial: 1,280,000 mt	Base case: 1,996,000 mt Range: 1,304,000 ~ 2,656,000 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Equatorial: 0.70	Base case: 0.46 Range: 0.45 ~ 0.63
$\mathbf{B_{current}/B_{current,\ F=0}}$	Equatorial: 0.66	Base case: 0.86 Range: 0.82 ~ 0.86
$\mathbf{F_{current}/F_{MSY}}$	Equatorial: 0.26	Base case: 0.17 Range: 0.08 ~ 0.34
$\mathbf{B_{current}/B_{MSY}}$	Equatorial: 2.99	Base case: 3.01 Range: 2.91 ~ 3.38
$\mathbf{SB_{current}/SB_{MSY}}$	Equatorial: 3.82	Base case: 3.72 Range: 3.21 ~ 5.00

[1] Equatorial region; [2] WCPFC Convention Area

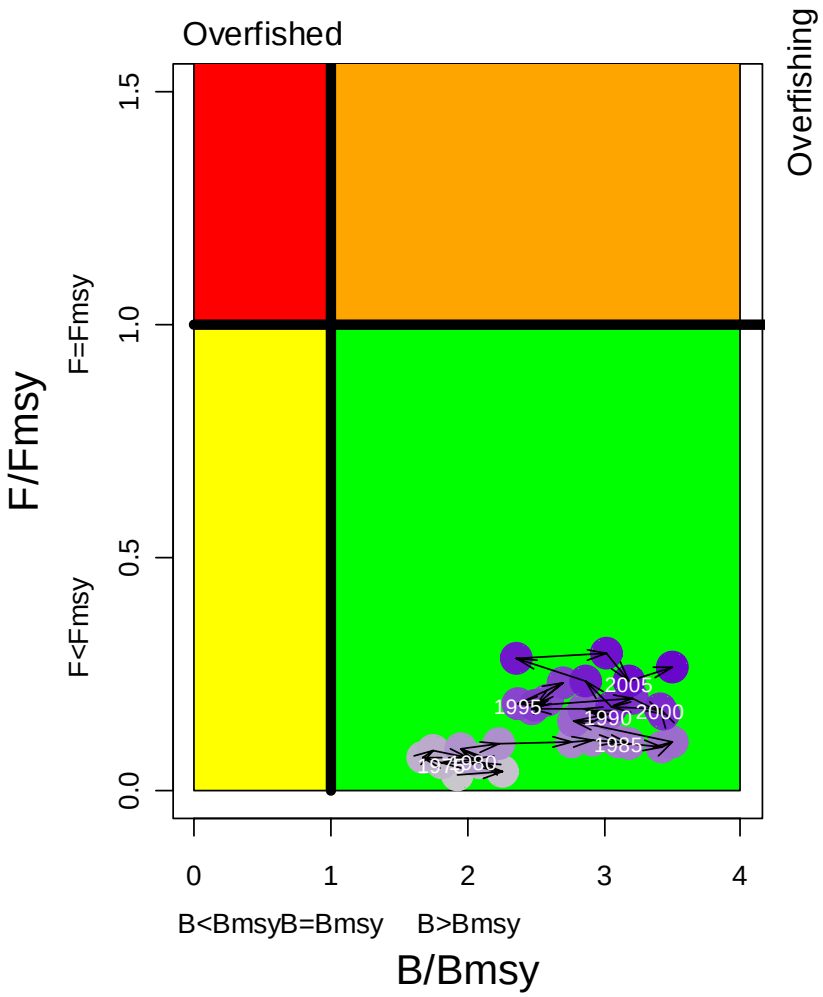

Figure 9. Temporal trend in annual stock status for skipjack tuna, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1972–2006) from the equatorial model. The colour of the points is graduated from mauve (1972) to dark purple (2006) and the points are labelled at five-year intervals.

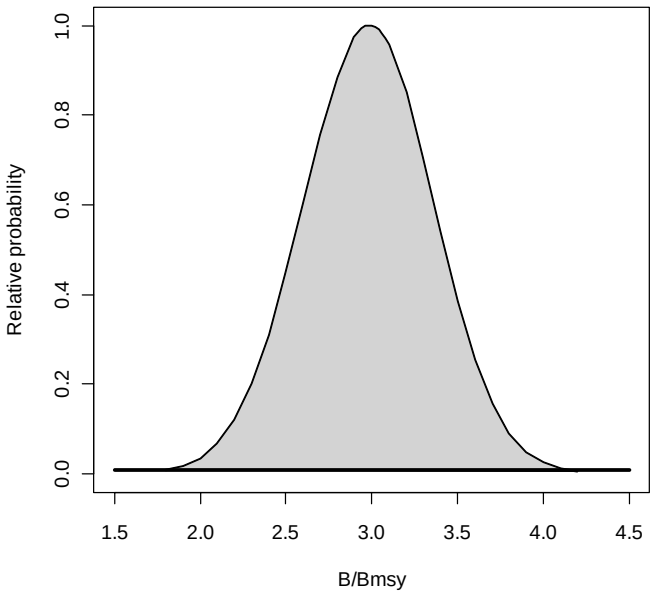

Figure 10. Likelihood profile for B/B_{MSY} from the equatorial model**.**

Management advice and implications

17. The SC acknowledged that skipjack catches in 2007 increased to a historical high of ~1.7 million metric tonnes. The SC noted the increasing trend in estimated recruitment throughout the entire time series of the fishery. This trend may reflect skipjack tunas' high productivity relative to other tuna species, as well as its position in the ecosystem. These high recent catches are considered to be sustainable unless recruitment falls persistently below the long-term average. However, any increases in purse-seine catches of skipjack may result in a corresponding increase in fishing mortality for bigeye and yellowfin tunas.

South Pacific albacore

Status and trends

18. The assessment results from the base-case model differ substantially from those of the 2006 assessment (Table 3), due to changes in relative abundance indices, selectivity and biological parameters for natural mortality and reproductive potential. These changes represent both refinements to the model and substantive changes to model structure, which reduced biomass estimates and raised fishing mortality.

19. Table 3 compares reference points between the 2008 and 2006 assessments. The key conclusions of the models presented are that overfishing is not occurring and the stock is not in an overfished state (Fig. 11). Reference point levels estimated for the 2008 assessment were more pessimistic than for the 2006 assessment, depletion levels estimated in 2008 were 0.70 compared with 0.90 in 2006, $F_{current}/\widetilde{F}_{MSY}$ was 0.44 compared with 0.04 in 2006, $B_{current}/\widetilde{B}_{MSY}$ was 1.26 compared with 1.34 in 2006 and $SB_{current}/\widetilde{SB}_{MSY}$ was 2.21 compared with 4.10 in 2006 (Table 3).

Table 3. Estimates of reference points from the 2008 and 2006 South Pacific albacore tuna stock assessments (WCPFC and IATTC RFMO regions[1]). Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, the ranges shown for each reference point should not be compared across years. They should not be considered as confidence intervals.

Management Quantity	2008 Assessment	2006 Assessment
Most recent catch	59,495 mt (2007[2])	60,440 mt (2005[2])
MSY	Base case: 64,000 mt Range: 64,000 ~ 75,000 mt	Base case: 180,800 mt Range: 90,080 ~ 201,800 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Base case: 0.86 Range: 0.72 ~ 0.86	Base case: 0.33 Range: 0.28 ~ 0.59
$\mathbf{B_{current}/B_{current,\ F=0}}$	Base case: 0.70 Range: 0.70 ~ 0.77	Base case: 0.91 Range: 0.79 ~ 0.93
$\mathbf{F_{current}/F_{MSY}}$	Base case: 0.44 Range: 0.25 ~ 0.44	Base case: 0.04 Range: 0.03 ~ 0.11
$\mathbf{B_{current}/B_{MSY}}$	Base case: 1.26 Range: 1.26 ~ 1.50	Base case: 1.34 Range: 1.13 ~ 1.48
$\mathbf{SB_{current}/SB_{MSY}}$	Base case: 2.21 Range: 2.21 ~ 2.90	Base case: 4.10 Range: 2.86 ~ 6.11

[1] IATTC = Inter-American Tropical Tuna Commission; RFMO = regional fisheries management organization

[2] entire South Pacific Ocean

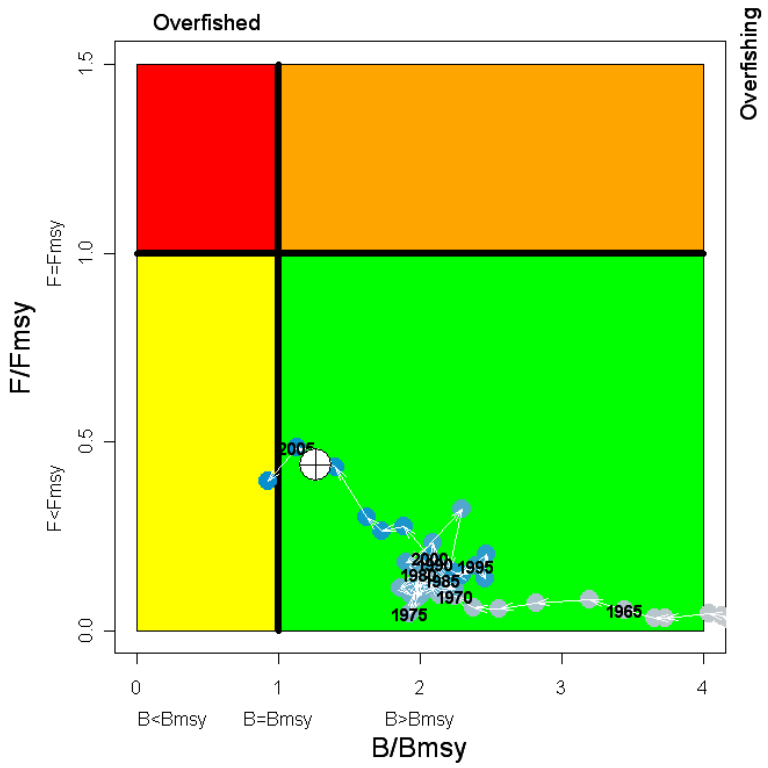

Figure 11. Temporal trend in annual stock status for South Pacific albacore tuna, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1960–2006) for the four main alternative models. The colour of the points is graduated from pale blue (1960) to blue (2006) and the points are labelled at five-year intervals. The last year of the model (2007) is excluded as it is highly uncertain.

Management advice and implications

20. The current assessment indicates lower levels of stock size and maximum sustainable yield, which appear to be more realistic than previous assessments. There is uncertainty regarding the sustainability of the South Pacific albacore stock and the SC recommended that catches of South Pacific albacore remain at current levels, considering the current rates of fishing mortality on adult albacore.

Southwest and south-central Pacific swordfish

Status and trends

21. Stock assessments were undertaken for two areas: the southwest Pacific (140°E–175°W) and the south-central Pacific (175°W–130°W), both separately and combined.

22. The current status of biomass and fishing mortality (relative to MSY levels) for southwest Pacific swordfish are shown for a subset of plausible models in Fig. 12. Table 4 compares reference points between the 2008 and 2006 assessments. The subset of models represents the most extreme (highest and lowest) of the models in terms of a set of reference points. The 2008 estimates appear to be much more certain than in 2006, and near the centre of

the distribution of estimates provided in 2006. This reduction in uncertainty is what might have been predicted given that the recent reduction in fishing effort seems to have been sufficient to break the "one-way-trip" nature of the fishery that was observed up to 2003–2004, and hence appears to now provide informative contrast with which to improve the estimation of stock productivity. The model predicts that following a period of continued decline, the southwest Pacific swordfish biomass has recently increased.

23. The key conclusions of the models presented indicate that in the southwest Pacific, overfishing is not occurring and the stock is not in an overfished state (Fig. 12). Reference point levels estimated in the 2008 assessment were more optimistic than the 2006 assessment, $F_{current}/\widetilde{F}_{MSY}$ was 0.44 compared with 0.71 in 2006, although $B_{current}/\widetilde{B}_{MSY}$ was 1.57 compared with 1.70 in 2006 (Table 4) and the range estimated in the 2006 assessment included more pessimistic estimates.

24. The stock assessment attempted for swordfish in the south-central Pacific was unable to determine the current stock status. It was also noted that the available data do not indicate evidence of significant fishery impacts in the south-central Pacific, but catches have increased in recent years to levels exceeding those in the southwest Pacific.

Table 4. Estimates of reference points from the 2008 and 2006 southwest Pacific swordfish stock assessments. Values shown in the table correspond to the median of the maximum posterior density (MPD) estimates for the most plausible ensemble of models for each assessment (the minimum and maximum values are indicated below). Note that the swordfish assessment paper reported in trunked mass, although this table reports whole mass assuming that trunked mass = 0.723 (whole mass), and the average catch in mass is derived from numbers assuming 67.2 kg per fish in 2004 and 61.1 kg per fish in 2007 (which may differ from the model estimates).

Management Quantity	2008 Assessment	2006 Assessment
Most recent catch[1] (mt)	2580 (final year = 2007[2])	3760 (final year = 2004)
MSY (mt)	Median: 3310 Range: 2390–5720	not reported
C_{2007}/MSY	Median: 0.77 Range: 0.45–1.08	n/a
$B_{2007}/B_{2007,\ F=0}$ (B=total biomass)	Median: 0.58 Range: 0.45–0.79	n/a
$B_{2004}/B_{2004,\ F=0}$ (B=total biomass)	Median: 0.55 Range: 0.44–0.74	Median: 0.59 Range: 0.31–0.69
F_{2007}/F_{MSY}	Median: 0.44 Range: 0.18–0.67	n/a
F_{2004}/F_{MSY}	Median: 0.71 Range: 0.37–1.13	Median: 0.70 Range: 0.33–2.2
B_{2007}/B_{MSY} (B=total biomass)	Median: 1.57 Range: 1.22 – 2.06	n/a
B_{2004}/B_{MSY} (B=total biomass)	Median: 1.47 Range: 1.18–1.94	Median: 1.7 Range: 0.87–3.0

[1] Catch in mass for this table was not derived from the model results and may not be entirely compatible with other reference points.

[2] 2007 catches are provisional, with 2007 catches from some fleets assumed to be equal to 2006.

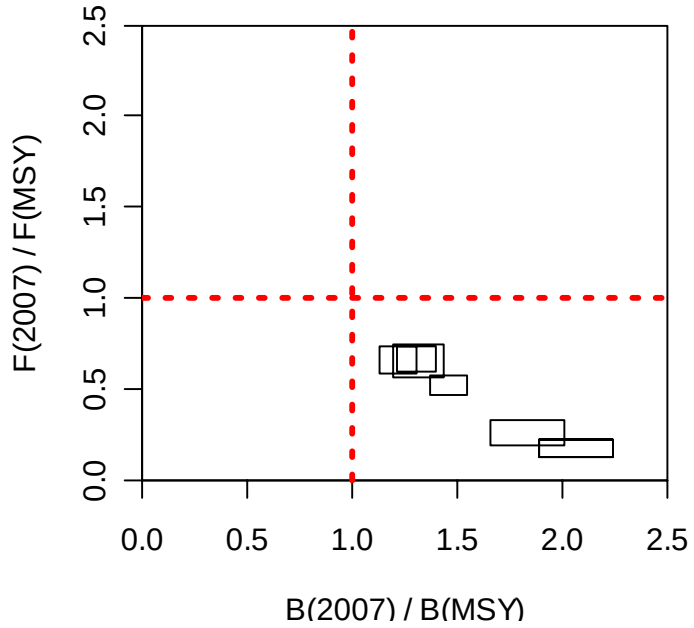

Figure 12. Summary plot comparing southwest Pacific fishing mortality, F(2007)/F(MSY), and total stock biomass, B(2007)/B(MSY), for southwest Pacific swordfish from a subset of plausible MULTIFAN-CL models. Boxes indicate the upper and lower 95% confidence limits (but not the covariance) for each individual model.

Management advice and implications

25. The assessment undertaken for swordfish in the southwestern Pacific region indicated an increase in stock abundance in recent years, and model projections predict further increases at current fishing mortality levels. Plausible assessment results indicate that overfishing is not occurring and that the stock is not in an overfished state. However, due to the uncertainty in the assessment, the SC recommended that there be no further increase in catch or effort in order to keep the stock above its associated reference points.

26. The SC recommended that there be no increases in fishing mortality for south-central Pacific swordfish as a precautionary measure, given the lack of a formal assessment. Constraining fishing mortality to current levels is recommended until there is a better understanding of fishing impacts in the south-central Pacific stock and the relationship between this stock and other South Pacific stocks is more certain.

Southwest Pacific striped marlin

27. No stock assessment was undertaken for striped marlin in the southwestern Pacific Ocean in 2008. Thus, the stock status description and management recommendations from SC2 are still current.

Northern stocks

28. The SC invited the Chairman of the International Scientific Committee (ISC) to summarize the 8th Meeting of the ISC and the status of northern stocks.

North Pacific albacore

Status and trends

29. No stock assessment was conducted for this species in the past year.

Management advice and implications

30. The management advice presented by the ISC to the SC last year still holds. The key point of this advice — that F should not be increased from the current level (F=0.75, based on 2002-2004) — is still valid.

Pacific bluefin tuna

Status and trends

31. The Stock Synthesis model was used for the 2008 assessment of Pacific bluefin, where the assessment spans the period 1952–2005. The main fisheries occur around Japan, including longline fisheries in the spawning season, purse-seine fisheries, set net fisheries, and troll fisheries. Recent catches have been dominated by small fish (0+ and 1+ years old) and there have been recent increases in catch by Mexico and Korea. Total annual catches are currently about 23,000 mt per year.

32. The stock assessment model estimates variable recruitment through the model period, resulting in three major peaks in spawning biomass through the model period. There has been an increase in fishing mortality rates during the last 10 years, principally for the youngest age classes. A retrospective analysis indicated that the model is underestimating the most recent year's (2005) recruitment. This in turn affects the reliability of stock projections. Assumptions regarding the magnitude of the 2005 recruitment influence the stock status (spawning biomass) in the medium term. Projections also investigated the affect of increasing or decreasing fishing mortality.

Management advice and implications

33. The ISC provided the following conservation advice, which the SC believes is appropriate for managers to consider:

- Given the conclusions of the May–June 2008 stock assessment — with regards to the current level of F relative to potential target and limit reference points, and residual uncertainties associated with key model parameters — it is important that the current level of F is not increased.
- If F remains at the current level and environmental conditions remain favourable, then recruitment should be sufficient to maintain current yields well into the future.
- A reduction in F, in combination with favourable environmental conditions, should lead to greater yield per recruit (Y/R) and spawning stock biomass per recruit (SPR) and, after some lag, greater sustained yield.

- Increases in F above the current level, and/or unfavourable changes in environmental conditions, may result in recruitment levels that are insufficient to sustain the current productivity of the stock.

North Pacific striped marlin

The inclusion of North Pacific striped marlin into the list of northern stocks

34. The ISC Chair reported on the analysis conducted by the ISC on estimating the striped marlin stock biomass north of 20° N latitude in the western and central North Pacific Ocean. Results indicate that a majority (65–70%) of the estimated biomass of striped marlin in the western and central North Pacific Ocean occur north of 20° N latitude. This conclusion is consistent with the distribution of fishery catches.

Review of a draft CMM on NP striped marlin

35. The SC Chair explained that the Commission had requested that the Northern Committee (NC) form a working group with a view towards developing a conservation and management measure (CMM) on North Pacific striped marlin with SPC, and FFA input, for consideration by SC4. However, this NC working group had been unable to collate the required information or draft a CMM for the SC to evaluate.

Management advice and implications

36. The previous management advice for North Pacific striped marlin is retained: that is, the fishing mortality rate should be reduced from the current level — 2003 or before — taking into consideration various factors associated with this species and its fishery, and until appropriate measures in this regard are taken, the fishing mortality rate should not be increased. The information presented was not sufficient to demonstrate that North Pacific striped marlin be classified as a northern stock.

North Pacific swordfish

Status and trends

37. A North Pacific swordfish stock assessment is scheduled for 2009.

Management advice and implications

38. Because there is no currently available North Pacific swordfish stock assessment, no management advice is offered.

Review of stock assessment and management-related matters

Review of "A comprehensive review and proposed investigation of the age, growth, and reproductive biology of bigeye tuna in the Pacific Ocean"

39. The SC generally supported future research on bigeye tuna age, growth and reproductive biology, including temporal-spatial variation in spawning, as this is important in reducing uncertainty in model estimates of stock status. The SC recommended that the Commission approve funding for this work, particularly phase 1, so work could commence as early as possible.

Review of "A scoping study on reference points and management strategy evaluation (MSE)"

40. The SC received a presentation prepared in response to the Commission's request to develop a report on "Approaches for identification of appropriate reference points and implementation of management strategy evaluation within the WCPO", as described in the terms of reference attached as Appendix 1 to WCPFC-SC4-2008/GN-WP-10.

41. Having reviewed the working paper "Approaches for identification of appropriate reference points and implementation of MSE within the WCPO" (WCPFC-SC4-2008/GN-WP-10), the SC made the following recommendations:

- The SC reaffirmed the recommendations made at SC3 in relation to reference points and approaches to evaluating them.
- CCMs be given an opportunity to provide comment on the scoping paper and work plan to the WCPFC Secretariat and for those comments to be submitted by 15 October 2008.
- A revised version of the scoping paper and work plan that accounts for comments received should be presented to the upcoming Commission meeting to inform the Commission about the use of reference points (and approaches of evaluating them) in the management of highly migratory fish stocks in the WCPO.
- In progressing work on reference points, the Commission should establish a parallel/joint process for establishing key management objectives for each target species including the possibility of holding an intersessional workshop on management objectives in 2009; and
- Agencies such as the WCPFC, the Pacific Islands Forum Fisheries Agency (FFA), and the Secretariat of the Pacific Community Oceanic Fisheries Programme (SPC-OFP) should work together on a strategy to increase the capacity of Members, Cooperating Non-members and participating Territories (CCMs) to participate in the revised work plan for 2009 and beyond.

42. As a means of progressing the work programme that commenced in 2007 on this topic, the SC also recommended that a technical intersessional workshop be held in 2009 (in conjunction with the intersessional pre-assessment workshop) to review the numerical and technical properties of candidate reference points that may be used as default reference points in the WCPO. In particular:

- Consider the estimation properties of candidate reference points;
- Consider the stability in candidate reference points from one year's assessment to the next;
- Compare these with MSY-based reference points and consider their implications for SPR, spawning stock biomass (SSB) and biomass (B);
- Document any major concerns about the use of MSY-based reference points and any major advantages of using a different type of reference point;
- Identify alternative means of operationalizing candidate reference points.

43. It was proposed that the report of this technical workshop be discussed at SC5, from which the SC will make recommendations to the Commission on suitable reference points for managing key target species within the WCPO.

44. The SC recommended that the implementation of the management strategy evaluation (MSE) approach via case studies in the WCPO (e.g. broadbill swordfish, South Pacific albacore

or the complex multi-species skipjack, bigeye, yellowfin tuna fishery) be added as high priority research tasks to the SC's work programme for 2009–2011.

BYCATCH MITIGATION

Seabirds

45. The SC noted that as of 18 August 2008, 26 out of 34 CCMs had submitted a Part 1 report. Sixteen of those 26 reports indicated that observers had been deployed by the CCM in 2007. Seven of the 26 reports included estimates of seabird catches required by CMM-2007-04. It was noted that for some CCMs, the data in Part 1 of the Annual Reports are provisional.

46. The SC recommended that the WCPFC Secretariat seek advice from other regional fisheries management organizations (RFMOs) on the wording of CMM-2007-04 (Attachment O of WCPFC4 Summary Report), Annex 1, 1 a) (iv) and 1 b) (iv) to ensure that tori lines include branch streamers along the aerial extent of the line and that in 1 a) (iv) the branch streamers are of a length that ensures that they would touch the surface of the water in the absence of wind and swell. The issue will be further discussed by the Fourth Regular Session of the Technical and Compliance Committee.

Sharks

47. The SC noted that the current limit on shark fin landings (5% shark fin-carcass ratio) was reviewed at last year's meeting and found to be appropriate. No additional information was presented to the SC this year, so it was not necessary to modify that advice.

48. The SC noted that, based on the ecological risk assessment (ERA) work presented in WCPFC-SC4-2008/EB-WP-1, there is no apparent difference in catch rates for sharks by longliners above and below 24 m overall length. The SC recognized that there appears to be no scientific basis to justify the current exemption for small vessels. The SC recommended that the shark measure be revised to include vessels under 24 m.

49. The SC noted that as of 18 August 2008, 11 of the 26 Part 1 annual reports included estimates of shark catches as required by CMM-2006-05 and as recommended by SC3. It was noted that for some CCMs, the data in Part 1 of the Annual Reports are provisional.

50. The SC recommended that CCMs report on a minimum list of shark species, consisting of blue shark, oceanic whitetip shark, mako sharks and thresher sharks, which were easily identified by fishermen. These and other sharks should be identified to the lowest possible taxonomic level, especially by observer programmes, and these four easily identified types of sharks should be recorded even in logbooks by fishermen.

51. The SC noted that under CMM-2006-05, CCMs are encouraged to cooperate in the development of stock assessments for key shark species within the Convention Area. The SC recommended that a review of data gaps and the general feasibility of single species stock assessment for sharks be carried out.

Small tuna on floating objects

52. Recommendations for further study or industry-associated work endorsed by the SC included:

- A comparative analysis of the proportions of small tuna on floating objects (STFO) in the WCPO, as the purse-seine CPUE for bigeye tuna appears to be higher in the central Pacific, although it is an area with relatively low purse-seine effort.
- A detailed characterization of vessels or fleets that have high catch rates of STFO and bigeye tuna in particular.
- Monitoring and reporting to SC5 the results of European Community acoustic selectivity project and IATTC pilot study on pre-set estimation of floating object aggregations.
- CCMs are encouraged to develop industry-associated projects to address STFO reduction, emphasizing means to avoid encircling STFO.
- CCMs are encouraged to continue work on fine-scale characterization of tuna behaviour on floating objects, particularly on horizontal movements of tuna species.
- The convening of a workshop or working group consisting of scientists, observer programme representatives, vessel owners and fishing captains to develop collaborative projects to seek ways to avoid STFO and bigeye tuna in particular on floating object sets.
- The operational research plan for 2008–2009 and medium term work plan of the FT-SWG as adopted under Agenda Item 3.1.

Sea turtles

53. The SC noted that as of 18 August 2008, 7 of the 26 Part 1 annual reports included estimates of sea turtle catches as recommended by Resolution 2005-04.

54. The SC noted that FFA members have developed an action plan to reduce the impact of fishing on sea turtles as a responsible step under the flexible approach embodied in the WCPFC Resolution. FFA members also highlighted the environmental and cultural importance of turtles to many CCMs and looked forward to presenting information on implementing the action plan at future meetings of the SC.

55. With the exception of WCPFC-SC4-2008/EB-IP-5, which tabled preliminary estimates of bycatch by Spanish fleets targeting swordfish, no new research on sea turtle interactions was presented and the SC offered no recommendations on those measures.

Ecological risk assessment (ERA)

56. SC recognized that the ERA project has provided several outputs that have helped formulate recommendations under other agenda items.

57. SC recognized:

- the role of ERA in identifying at-risk bycatch species, including “key shark species”, for further research or management action, and encourages further work in this area.
- that further work to determine catches and catch rates of non-target species is also strongly encouraged. CCMs were invited to collaborate with SPC-OFP in order to facilitate this work.

- that in purse-seine fisheries, unassociated sets catch the smallest number of non-target species in the smallest proportion relative to target species.
- that CCMs are encouraged to produce identification and handling guides for bycatch species such as sharks, turtles and seabirds, for distribution to observers and fishers. CCMs were invited to discuss the translation and printing of existing guides with SPC-OFP.

Other matters

58. The SC noted that the development of the WCPFC bycatch mitigation database system had progressed during the past year and test data have been added to the system. Access to and dissemination of these data will be governed by the Commission's data security policies.

DATA AND INFORMATION

Issues related to data gaps

Data gaps website and achievements toward filing gaps

59. The SC noted that many gaps in data remain. It is common for CCMs to not meet the specification for "Scientific Data to be provided to the Commission", which was adopted at WCPFC4. SC4 urged:

- CCMs that have not yet provided both current and historical operational (and other) data to the Commission to do so as a matter of urgency, in accordance with the specification for Scientific Data to be provided to the Commission; and
- CCMs that have not already done so to provide SPC with formal authority to release their historical data, including operational data, to the WCPFC.

Review of "A study to identify causes of data gaps in the work of the WCPFC"

60. The SC recommended that all CCMs complete and submit responses to the data gaps questionnaire by email by 31 August 2008, and that an updated analysis be presented for information at WCPFC5.

Species composition of purse-seine catches

61. Paper WCPFC-SC4-2008/ST-WP-2 noted that multi-species sampling is of key importance in estimating the true catch of tuna species taken by surface fisheries, as some species are widely misidentified in most logbook and landing statistics. This misidentification artificially increases the catch estimates for some species and artificially decreases estimates for other species.

62. The SC recommended that catch sampling programmes should be designed to overcome sampling biases and other issues raised by WCPFC-SC4-2008/ST-WP-2 and WCPFC-SC4-2008/ST-WP-3. Sampling designs should build on further comparative trials, which should include both observer sampling versus port sampling, and also comparison among different techniques within observer and port samplings.

63. The SC encouraged CCMs and the fishing industry to support the trials.

64. The SC recommended that the Commission's scientific service provider review ways of correcting historical catch sampling data, and that a future meeting of the SC consider that review.

Information on seabird mortality

65. The SC:

- Recommended that seabird identification guides be made available to observers and vessel masters; and
- Emphasised the recommendation made at SC2 that the objective of the Regional Observer Programme should initially be to attain a minimum coverage of 5% of fishing effort across all strata; and the distribution of observer effort is to be representative of species of interest, fishing areas, seasons, and fishing fleets.

Information on shark catches

66. No new information or recommendations on shark catches was available.

Regional Observer Programme

67. SC4 thanked the second Intersessional Working Group for the Regional Observer Programme (IWG-ROP2), which met in Nadi, Fiji, 7–10 July 2008, for their work in progressing the draft minimum data fields required for the ROP. No changes were proposed to the data elements documented in WCPFC-SC4-2008/ST-IP-5.

Indonesia and Philippines Data Collection Project (IPDCP)

68. The fifth meeting of the Steering Committee on the Indonesia and Philippines Data Collection Project (IPDCP) was held 12–13 August 2008, in Port Moresby, Papua New Guinea. The Steering Committee accepted a financial report for the project through July 31 2008 prepared by the Secretariat, and reviewed current and planned project activities in both the Philippines and Indonesia during 2008–2011.

69. The SC agreed to recommend to the Commission a request for USD100,000 from the WCPFC 2009 core budget to continue supporting this work in 2009 and place this as a matter of high priority in the SC's 2009 work programme.

Tagging initiatives

70. The Pacific Tuna Tagging Programme (PTTP) Steering Committee met on 16 August 2008 to review PTTP's progress and further plans for implementation. Phase 1 of the PTTP in Papua New Guinea and Solomon Islands resulted in the release of approximately 103,000 conventional and 318 archival tags. Tag recovery rates are currently 12% and 14%, respectively. A successful first cruise was conducted in the central Pacific, targeting bigeye tuna aggregations beneath Tropical Atmosphere Ocean (TAO) moorings. In total, 1,909 conventional and 50 archival tags (90% bigeye tuna in both cases) were deployed. Phase 2 of the PTTP is now underway. Of the original USD9.8 million budget, funding commitments of approximately USD6.4 million have now been obtained. Upcoming plans for 2008–2009 (Phase 2) include three five-month cruises in the western equatorial Pacific, using a chartered pole-and-line vessel, two central Pacific cruises, and a range of tag recovery and data quality enhancement activities.

Data confidentiality, security, and dissemination

Scientific needs for VMS data

71. At the request of the Ad-Hoc Task Group-Data (AHTG [Data]), SC4 considered what kind of VMS data are needed and the purpose of scientific research.

Impact of the three vessel restriction on public domain data

72. The SC recommended that the WCPFC Secretariat write to CCMs encouraging them to use para 34 of the Rules and Procedures for the Protection, Access to, and Dissemination of Data Compiled by the Commission to voluntarily authorise the Commission to waive the three vessel restriction for catch and effort data that they have provided and that the classification of public domain catch and effort data should be reviewed at SC5.

Requests from the Commission on purse-seine fishing effort

73. In response to a request from WCPFC4, reflected in para 325(d) of the Summary Report, and following discussion at SC4 in the ST-SWG, the SC:

- Noted the data contained in WCPFC-SC4-2008/ST-WP-4 represent the best assessment of purse-seine fishing effort on the high seas and in the zones on non-Parties to the Nauru Agreement (PNA) members available at this time (August 2008);
- Recommended the working paper (WCPFC-SC4-2008/ST-WP-4) should be forwarded to TCC4 and the Commission;
- Recommended any CCM that believes it has additional data that should be included in this paper, should provide its proposed changes (along with supporting documentation) to the WCPFC Secretariat by 15 September 2008.

COOPERATION WITH OTHER ORGANIZATIONS

Review of existing MOUs and relations

74. The SC4 noted existing formal relations and proposed the development of no new relationships.

CONSIDERATION OF THE SPECIAL REQUIREMENTS OF DEVELOPING STATES AND PARTICIPATING TERRITORIES

Special Requirements Fund

Review of 2007/2008 activities

75. The SC4 received a status report for the Commission's Special Requirements Fund (SRF), noting the recent voluntary contribution of USD50,000 from the United States.

FUTURE WORK PROGRAMME

Process of formulating the work programme of the Scientific Committee

76. The SC adopted new guidelines for formulating its work programme.

Strategic Research Plan 2007–2011 for Scientific Committee

77. The SC committee noted that the current 2007–2011 Strategic Research Plan is in its second year and there is no current need to update it.

Review of 2008 work programme

78. The SC reviewed the 28 projects carried out under the MOU with SPC-OFC and noted that nearly all were successfully completed. The SC noted that there were no issues with the progress of 10 independent consultancies conducted in 2008.

2009 Work programme and budget, and 2010–2011 provisional work programme and indicative budget

79. The SC considered budget allocations for existing activities and provided an indicative budget for 2009, 2010 and 2011 (Table 5).

Table 5. List of SC work programme titles and budget for 2009 and indicative budget for 2010–2011 that require funding from the Commission's core budget (in USD). Table 6 in the SC4 Summary Report includes a detailed description of each project.

Strategic Research Activity or Project with priority identified at SC3[1]	2009		2010		2011	
	Core	Other	Core	Other	Core	Other
Project 14. (Priority = High) Indonesia and Philippines Data Collection Project (IPDCP)	100,000		75,000		25,000	
Project 16. (Priority = Medium) Publication and distribution of Commission's training and educational materials.	7,500		7,500		7,500	
Project 35. (Priority = High) Refinement of bigeye parameters Pacific-wide: A comprehensive review and study of bigeye tuna reproductive biology.	30,000		30,000		62,000	
Project 39. (Priority = High) Regional study of the stock structure and life-history characteristics of South Pacific albacore.	25,000	500,000	25,000	500,000	0	0
Project 42. (Priority = High) Pacific-wide tagging project	10,000	2,500,000	10,000	2,500,000	10,000	500,000
Project 56. (Priority = Medium) — Extended Utilize underwater videos and other tools to characterize species, size composition and spatial distribution of tunas aggregating around floating objects.	2,000		0		0	

Project 57. (Priority = High) **Technical workshop to consider suitability of MSY-based reference points as default limit reference points and how they may be operationalised.**	10,000		10,000		10,000	
Project 60. (Priority = High) — NEW **Collection and evaluation of purse-seine species composition data**						
Project 61. (Priority =High) — NEW **N. Pacific striped marlin mitigation methods**						
UNALLOCATED BUDGET	60500		66,550[a]		230,505[a1]	
SUB-TOTAL FROM THE SC PROJECTS (NON SPC-OFP SERVICES, excluding ERA and unallocated budget)	184,500	3,000,000	157,500	3,000,000	114,500	500,000
SUB-TOTAL (SPC-OFP SERVICES, including ERA until 2010)	550,000		605,000[a]		508,200	
NEW PROJECT FROM THE SC4						
GRAND TOTAL, including unallocated budget	795,000[b]	3,000,000	829,050	3,000,000	853,205	500,000

[a] An annual increase of 10% was applied from the previous year.
[a1] Annual budget for completed ERA was incorporated for new project(s)
[b] An indicative budget was 745,500.

[1] Project numbers and priorities are from Attachment O of the SC3 Summary Report. Projects 60 and 61 are new projects from SC4.

Work plan for 2009

80. The SC agreed that the work plan for 2009 will be a full yellowfin tuna stock assessment and a streamlined South Pacific albacore assessment.

ADMINISTRATIVE MATTERS

Rules of procedure

81. The SC4 received no proposals for the development of separate rules of procedure for the SC.

Independent review of the Science Structure and Function of the Commission

82. G. Parkes (MRAG, UK) presented a progress report on the Independent Review of the Commission's Interim Arrangements for Science Structure and Functions. A draft report of the review will be presented at the Commission meeting in December 2008, and a revised report prepared in January 2009. No further activities are currently anticipated in 2009.

Future operation of the Scientific Committee

83. The SC4 proposed several means to improve its operation and function.

Review of Part 1 of the Annual Report to the Commission

84. The SC adopted a revised Part 1 Report template.

Election of the Chairman of the Scientific Committee

85. No nominations were forthcoming.

Next meeting

86. The SC4 recommended that SC5 be held in Palau from 10–21 August 2009.

Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

SUMMARY REPORT

AGENDA ITEM 1 — OPENING OF MEETING

1. The Chair, D.Y. Moon (Korea) opened the Fourth Regular Session of the Scientific Committee, which took place in Port Moresby, Papua New Guinea (PNG) from 11–22 August 2008. The Chair welcomed participants to the meeting.

2. The matters considered by the Scientific Committee (SC) and its six Specialist Working Groups — Biology (BI-SWG), Ecosystem and Bycatch (EB-SWG), Fishing Technology (FT-SWG), Methods (ME-SWG), Statistics (ST-SWG), and Stock Assessment (SA-SWG) — included:

- a review of the fisheries in the western and central Pacific Ocean (WCPO) and the eastern Pacific Ocean (EPO);
- a review of the status of stocks of bigeye tuna, skipjack and southern albacore tuna stocks in the Convention Area, swordfish stocks in the southwest and south central Pacific with a focus on requests for advice and recommendations arising from the Fourth Regular Session of the Commission in Guam, USA in December 2007;
- a summary of the most recent information and assessments for tuna and billfish stocks in the North Pacific;
- bycatch mitigation issues associated with seabirds, sea turtles, sharks, juvenile bigeye and yellowfin tunas, and ecological risk assessment (ERA);
- issues associated with the data available to the Commission and initiatives to address data gaps, the status of the Indonesia and Philippines Data Collection Project, and the Pacific Tuna Tagging Programme;
- cooperation with other organizations;
- the special requirements of small island developing states and territories;
- a review of interim arrangements for science structure and function;
- the process for developing the programme of work for the SC and the 2009-2011 work programme for the SC; and
- administrative matters associated with the functioning of the SC.

3. The following countries attended the session as members of the Commission and as participating territories: Australia, Canada, China, Cook Islands, European Union, Federated States of Micronesia, Fiji, French Polynesia, Japan, Kiribati, Korea, Marshall Islands, Nauru, New Caledonia, New Zealand, Palau, Papua New Guinea, Philippines, Samoa, Solomon Islands, Chinese Taipei, Tonga, Tuvalu, United States of America (USA) and Vanuatu. American Samoa, Belize, Commonwealth of the Northern Mariana Islands, Guam, Niue, Tokelau, and Wallis and Futuna were unable to attend.

4. Indonesia attended as a Cooperating Non-member. The Pacific Islands Forum Fisheries Agency (FFA), Secretariat of the Pacific Community (SPC), Inter-American Tropical Tuna Commission (IATTC), International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), Birdlife International, and World Wildlife Fund (WWF) attended as Observers.

5. A list of participants is appended as Attachment A.

1.1 Welcoming address

6. A. Wright, Executive Director of the Western and Central Pacific Fisheries Commission (WCPFC), gave the opening statement (Attachment B). He introduced the Hon Ben Semri, Minister for Fisheries in Papua New Guinea, who delivered a welcome address (Attachment C).

1.2 Adoption of agenda

7. The agenda, with minor amendments, was adopted by the SC (Attachment D).

1.3 Meeting arrangements

8. The SC adopted a work schedule to support discussions in the SWGs during the first week of the meeting, while the second week was reserved for plenary discussions. In addition, four informal small groups (ISGs) were selected to progress the following agenda issues outside of session:

- The process for preparing the SC's work programme;
- The formulation of the 2009–2011 work programme and budget;
- Review of the Part 1 component of the Annual Report;
- North Pacific striped marlin.

1.4 Reporting arrangements

9. The Chair advised the session on expectations in relation to the preparation of formal reports for each SWG, the reporting of the SWGs to the plenary session during the second week of the meeting, and the preparation of an Executive Summary that would serve as the basis for the report, advice and recommendations of the SC to the Commission.

10. A list of abbreviations and acronyms used in this report and a list of documents for the SC are included as Attachment E and Attachment F, respectively.

1.5 Intercessional activities of the SC

11. The Chair made a brief report on the intercessional activities of the SC for the last 12 months (WCPFC-SC4-2008/GN-IP-6).

AGENDA ITEM 2 — REVIEWS OF FISHERIES

2.1 Overview of the western and central Pacific Ocean (WCPO) fisheries

12. P. Williams (SPC-OFP) and P. Terawasi (FFA) co-presented an "Overview of Tuna Fisheries in the Western and Central Pacific Ocean, Including Economic Conditions – 2007" (WCPFC-SC4-2008/GN-WP-1).

a. General overview

13. The provisional total Convention Area tuna catch for 2007 was estimated at 2,396,815 mt, clearly the highest annual catch recorded, and more than 120,000 mt higher than the previous record in 2006 (2,273,322 mt; Fig. 1). During 2007, the purse-seine fishery accounted for an estimated 1,739,859 mt (73% of the total catch, and a record for this fishery), with the pole-and-line fishery taking an estimated 214,935 mt (9%), the longline fishery an estimated 232,388 mt (10%), and the remainder (8%) taken by troll gear and a variety of artisanal gear, mostly in eastern Indonesia and the Philippines. The Convention Area tuna catch (2,396,815 mt) for 2007 represented 84% of the total Pacific Ocean catch of 2,800,740 mt, and 55% of the global tuna catch (the provisional estimate for 2007 is just under 4.4 million mt).

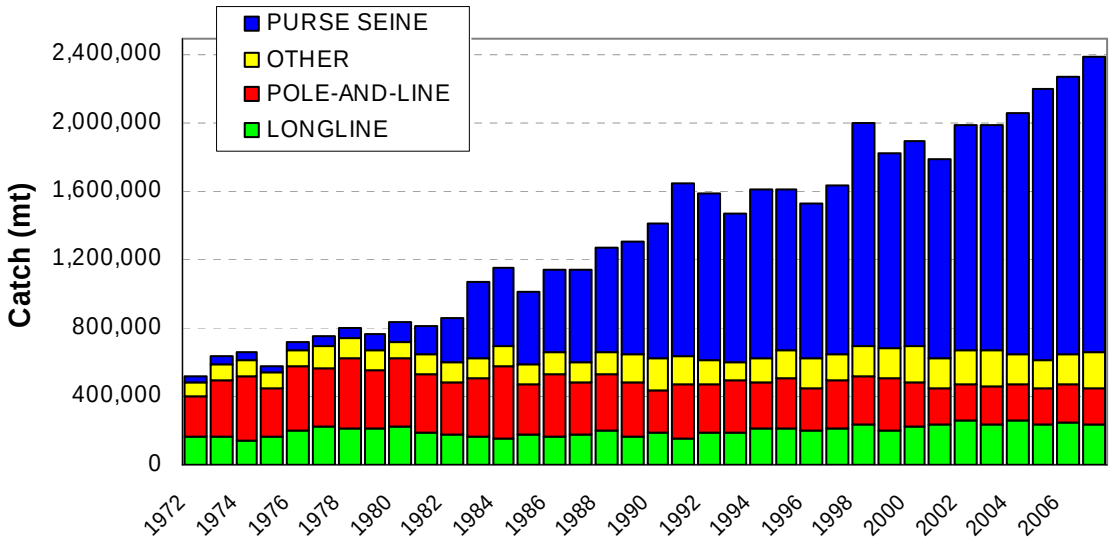

Figure 1. Catch (mt) of albacore, bigeye, skipjack and yellowfin tunas in the Convention Area, by longline, pole-and-line, purse seine and other gear types.

14. The 2007 Convention Area catch of skipjack (1,726,702 mt – 72% of the total catch) was the highest ever, continuing the trend of consecutive record catches since 2002 (Fig. 2). The Convention Area yellowfin tuna catch for 2007 (431,814 mt – 18%) was lower than in 2006 (442,288 mt), but higher than the average catch level for the period since 2000 (~424,000 mt). The Convention Area bigeye tuna catch for 2007 (143,059 mt – 6%) was the second highest on record (after the catch in 2004, which was 156,768 mt). This was mainly due to a relatively high estimated bigeye tuna catch from the purse-seine fishery, although observer data for 2007, used to estimate the purse-seine bigeye tuna catch, are very preliminary. The 2007 Convention Area albacore catch (95,240 mt – 4%] was the lowest in over 10 years, primarily due to the continuing trend of low catches in the North Pacific in recent years.

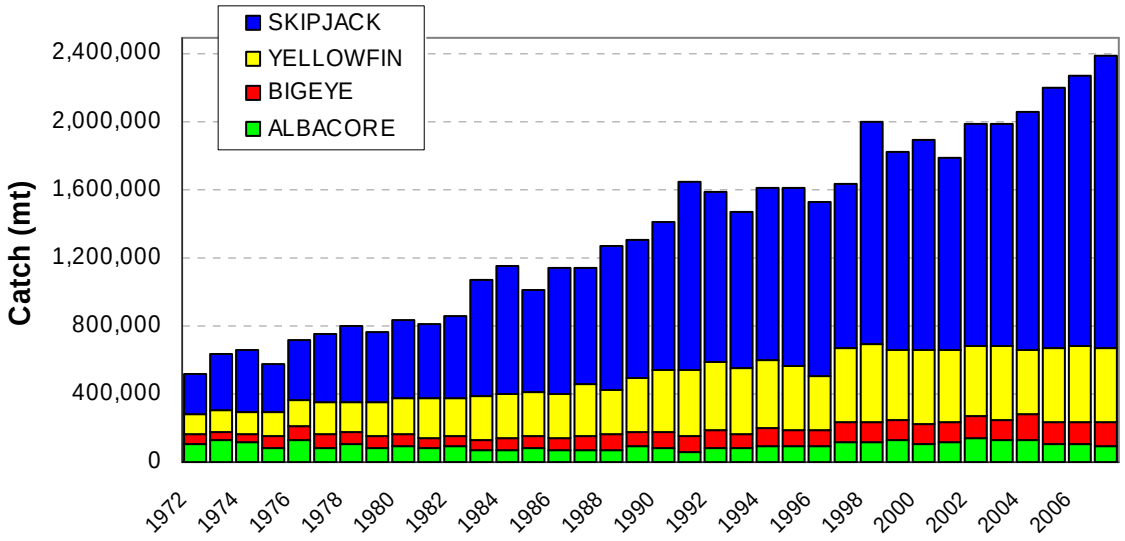

Figure 2. Catch (mt) of albacore, bigeye, skipjack and yellowfin tunas in the Convention Area by species for all gear types combined.

15. The provisional 2007 purse-seine catch of 1,739,859 mt was the highest on record, with most fleets catching more than in 2006, particularly fleets from Chinese Taipei, PNG and Marshall Islands. The 2007 purse-seine catch was dominated by a record catch of skipjack tuna (1,472,746 mt – 85% of the total catch). The annual purse-seine skipjack catch has increased by more than 500,000 mt since 2001, at an average of about 90,000 mt per year. The 2007 purse-seine catch of yellowfin tuna (228,426 mt – 13%) was lower than catches in recent years, but still higher than the average for the period since 2000 (~218,000 mt). The provisional catch estimate for bigeye tuna for 2007 (38,324 mt – 2%) was the second highest on record but may be revised once all observer data for 2007 have been received and processed.

16. The 2007 catch estimates for the key pole-and-line fleets operating in the Convention Area have yet to be provided, although the total catch estimate is expected to be similar to levels in recent years (i.e. 200,000–220,000 mt). Skipjack tuna tends to account for the vast majority of the catch (typically more than 85% of the total catch in tropical areas), while the remainder of the catch consists of albacore tuna, taken by the Japanese coastal and offshore fleets in the temperate waters of the north Pacific, yellowfin tuna (5–7%), and a small component of bigeye tuna (1–4%).

17. The provisional Convention Area longline catch (232,388 mt) for 2007 was the lowest since 2000, and around 12% lower than the highest on record, which was attained in 2004 (264,465 mt). The Convention Area albacore longline catch (76,151 mt – 33%) for 2007 was the lowest since 2000. The provisional bigeye tuna catch (82,735 mt – 36%) for 2007 was close to the average for the period 2000–2007, and the yellowfin tuna catch (69,857 mt – 30%) was the lowest in eight years.

b. Economic conditions

Purse-seine fishery

18. In 2007, Thai imports of frozen skipjack averaged USD1,319 per mt and monthly prices at Yaizu averaged USD1,256 per mt. Over the first half of 2008, Bangkok skipjack prices rose

from over USD1,500 per mt in January to over USD1,900 per mt by the end of June, and Yaizu monthly average prices rose from USD1,555 per mt in January to USD1,960 per mt in June. Yellowfin tuna prices in 2007 averaged USD1,773 per mt and have continued to increase in 2008 with the June average of USD2,200 per mt. Yaizu purse seine-caught yellowfin tuna prices in 2007 in US dollar terms ranged between USD1,524 per mt in March and USD2,429 per mt in May, with a full year average of USD1,935 per mt.

19. The estimated delivered value of the purse-seine tuna catch in the WCPFC area for 2007 is USD2,373 million — the highest level since at least 1997. This represents an increase of USD743 million or 43% on the estimated delivered value of the catch in 2006. This increase was driven by a USD680 million (54%) increase in delivered value of the skipjack catch, which was estimated to be worth USD1,249 million in 2007, resulting from a 9% increase in catch and a 42% increase in the composite delivered price. The value of the yellowfin tuna catch also rose to around USD393 million with a rise of 21% in the composite price being offset by an 8% decline in catch.

Longline fishery

20. Longline caught yellowfin tuna prices landed at Yaizu rose marginally by 1% to JPY561 per kg, and average fresh yellowfin tuna prices at selected Japanese ports rose 16% to JPY735 per kg. Frozen bigeye tuna prices at selected major Japanese ports rose 10% in 2007 to JPY799 per kg while fresh bigeye tuna prices rose 30% to JPY1129 per kg. Thai imports of frozen albacore prices declined by 27% to USD1,948 from USD2,674 per mt.

21. The estimated delivered value of the longline tuna catch in the WCPFC Convention Area for 2007 is USD1,160 million. This value represents a decrease of USD103 million on the estimated value in 2006. The value of the albacore catch decreased significantly by USD78 million (35%) while the value of the bigeye tuna catch increased by USD33 million (5%), and the value of the yellowfin tuna catch declined by USD28 million (6%). The albacore catch was estimated to be worth USD148 million in 2007 with the 35% decline being driven by 27% decrease in the composite price and a 10% decrease in catch. The bigeye tuna catch was estimated to be worth USD668 million with the catch declining 2% and the composite price increasing 7%. The estimated delivered value of the yellowfin tuna catch was at USD422 million as the 7% decline in catch more than offset the 1% rise in the composite price.

Pole-and-line fishery

22. During 2007, the Yaizu price of pole-and-line caught skipjack in waters off Japan averaged JPY282/kg (USD2,390/mt) an increase of 22% on 2006. By contrast, the Yaizu price of pole and line caught skipjack in waters south of Japan decreased averaging JPY190 per kg (USD1,610 per mt) during 2007, a decrease of 10%.

23. The estimated delivered value of the total catch in the WCPFC pole-and-line fishery for 2007 is USD362 million. This value represents a 1% decrease on the estimated value of the catch in 2006, with prices unchanged although the catch also dropped by 1%. The estimated delivered value of the skipjack catch for 2007 is USD286 million. This represents a similar level on the estimated value of the catch in 2006 with a 1% increase in prices offset by a 1% decrease in catch.

Discussion

24. A range of general issues affecting WCPO tuna fisheries from 2007 until the present, were discussed: a) the continuing capacity of the WCPO purse-seine fishery to produce record catches, b) the sustainability of the recent high prices for raw material for canning, c) the influence of depressed catches in other oceans on world tuna prices, and d) the impact of high fuel costs on global longline fisheries.

25. Papua New Guinea noted that some data for distant water pole-and-line and longline fisheries were yet to be received for 2007, and as a result, the information presented was provisional. While acknowledging that it is important to ensure that submitted data are of a high quality, the SC urged all members, participating territories and cooperating non-members (CCMs) to make best efforts to ensure the timely provision of data. Regarding the recent increase in purse-seine fishing activity in the eastern part of the WCPFC Convention Area, SPC-OFP advised that all data that had been provided to SPC by vessels active in that central region had been incorporated in the overview.

2.2 Overview of the eastern Pacific Ocean (EPO) fisheries

26. K. Schaefer (IATTC Secretariat) presented a review of the "Eastern Pacific Ocean Fishery for the 2007 Fishing Year" (WCPFC-SC4-2008/GN-WP-2). The fishing capacity of the purse-seine fleet fishing in the EPO has increased over the last 10 years, but stabilized in mid-2006. Longline fishing effort has fluctuated between about 150 million and 300 million hooks set annually during the last 30 years; current effort is near the low end of the range. Total tuna catches increased, starting in 1995, peaking in 2003, and declining to levels of about 10 years ago.

27. Yellowfin tuna catches increased substantially in the mid-1980s, which is due to increased recruitment from a regime shift in productivity, but could also have been due to increased recruitment caused by increases in the spawning stock. Catches remained fairly stable after the mid-1980s, except for a peak in 2001 through 2003, followed by a substantial decline in 2006. Catches in 2006 and through the first half of 2008 have been low. The catch distribution across the gear types has remained fairly constant since the start of the assessment in 1975. Presently, there are fewer large fish in the catches, and catches are concentrated more in the coastal areas. Catch changes are reflected in the recruitment and abundance estimated by the assessment model. Both exploitation and environmental variation have greatly impacted the population. The yellowfin tuna spawning stock in the EPO appears to be above the maximum sustainable yield (MSY) level, and fishing mortality below that level, although there is considerable uncertainty in the estimates. Stock status is estimated to be worse when a stock recruitment relationship is used. A moderate increase in yield could be gained if fewer smaller fish and more larger fish were caught.

28. Purse-seine catches of bigeye tuna have shown a steep increase, beginning in the mid-1990s when the purse-seine fishery on floating objects expanded into waters west of the Galapagos Islands. During this later period, longline catches generally decreased. There are typically few large fish in the current purse-seine catches, and the spatial distribution of the catches is extended farther to the west. The longline catch is distributed across the entire Pacific Ocean. Tagging has shown some long-distance movements between the EPO and WCPO, but movement is generally limited. Bigeye recruitment increased in the late 1990s, declined, and has recently increased again. Both fishing and the environment have impacted the population. Since about 1995, the purse-seine fishery on floating objects has had an increasing impact on the

population, and in recent years, purse-seine catches have exceeded longline catches. The bigeye tuna population in the EPO has been overfished for several years. The stock status is estimated to be worse when a stock–recruitment relationship is used. A substantial increase in yield could be gained if fewer smaller and larger fish were caught.

29. Skipjack catches have been increasing since the late 1990s when the purse-seine fishery on floating objects started expanding. The spatial distribution of current purse-seine catches has extended farther to the west. In 2004, the ASCALA model was used to assess the skipjack stock in the EPO, and more recently, data and model-based indicators have been used to evaluate the stock status. The main concern with the skipjack stock is the constantly increasing exploitation rate. However, the data and model-based indicators have yet to detect any adverse consequences of this increase in exploitation.

30. The proposed conservation measures in the EPO for purse-seine fishing for the three-year period (2008–2010) consist of a 12-week closure in the entire EPO (20 June–11 September), delayed for 25 days in 2008, along with a 14-week closure of an offshore area (12 September–31 December), shortened by 25 days in 2008. For longline vessels, proposed conservation measures include fish catch limits for China, Japan, Korea and Chinese Taipei, and other limits for other CPCs (IATTC Party, cooperating non-Party, fishing entity or regional economic integration organization are collectively called "CPCs"), not to exceed 500 mt or 83% of their respective catches in 2001, whichever is higher.

31. No official agreement was reached by the IATTC regarding the proposed conservation measures for 2008 and beyond. The next IATTC meeting will be held in October 2008, at which time this concern will be addressed.

2.3 Fishery reports from members, participating territories and cooperating non-members (CCMs)

Australia

32. Domestic longline activity off eastern Australia continued to decline, with the number of active vessels falling from 152 in 1999 to 61 vessels in 2007. Longline fishing effort also declined, from 12.5 million hooks in 2003 to 8.4 million hooks in 2007. The decreased activity is attributed to high operating costs (driven mainly by high fuel prices and the high cost of squid bait), the strength of the Australian dollar, and reduced swordfish catch rates in inshore areas and around seamounts. Structural adjustment in Australian government-managed fisheries resulted in the surrender of almost 100 of the more than 200 longline permits originally available in the fishery.

33. The yellowfin tuna catch by domestic longliners in 2007 was 1380 mt, which was a substantial decline from the 2003 peak catch of 3096 mt. The 2007 bigeye tuna catch (998 mt) was double the previous year's catch and close to the peak catch (1,050 mt) reported in 2001. The striped marlin catch was 358 mt, which was down from the 2003 catch (634 mt). The broadbill swordfish catch remained at low levels (1,349 mt), partly reflecting catch level limits placed on this species. Interest in albacore tuna has waned as a result of poor market prices, with landings falling from 2,591 mt in 2006, to 1,916 mt in 2007.

34. The proportion of swordfish taken from outside the Australian Fishing Zone (AFZ) continues to decrease with a decline in the fleet and increased fuel costs. The proportion taken from outside the zone decreased from 12% of the total weight in 2005 to 3% in 2007.

35. Few purse seiners, troll and pole-and-line vessels operated off southern New South Wales in 2007. Catch levels were low and cannot be reported here because of confidentiality restrictions (<5 vessels).

36. Recreational anglers fish for a wide variety of pelagic species. Recreational catches of marlin continued to be patchy during 2007. Striped marlin catches have been declining since the early 2000s. The heavy tackle fishery for large black marlin off Cairns reported a very poor season in 2007, with few smaller black marlin hooked southwards along the Queensland coast.

37. The Eastern Tuna and Billfish Fishery Statutory Management Plan (including individual allocation of fishing rights in the form of hook limits) is being implemented. Management methods include input controls (such as limited entry, gear and area restrictions) and restrictions on byproduct and bycatch. A maximum catch limit, bycatch limits, and a series of trigger catch levels have been introduced to limit swordfish and albacore catches. Mitigation measures are in place to reduce the take of seabirds. A harvest strategy is in development for the fishery.

Belize

38. Belize's longline tuna fishing fleet operating in the WCPFC Convention Area has shown a steady decrease in its catch and effort from 2003 to 2007. There has been a reduction from 30 vessels in 2003 to 5 in 2007. Four of these vessels were licensed exclusively for operation in the WCPFC Convention Area and one was also licensed to fish in other convention areas. Four other longliners were also licensed to fish in the WCPFC Convention Area but did not do so in 2007. Due to the reduction in fishing effort, all catches have decreased from earlier years. There has been an 80% reduction in overall catches from 3446 mt in 2003 to 684 mt in 2007. Albacore was the main target species from 2003–to 2006. However, our catches of yellowfin tuna exceeded those of albacore in 2007. The average size of our vessels has also risen, from 191 gross tons (GT) in 2003 to 646 GT in 2007. The majority of the vessels operating during the period 2003–2006 were between 51 GT and 200 GT. In 2007, all of our vessels were over 500 GT.

39. Blue shark is the most common non-tuna bycatch in the Belize longline fishery followed by sailfish and skipjack. The large reductions in longline effort have also resulted in the reduction of major bycatch species.

40. There were no reports of seabird and sea turtle interaction by vessels in 2007. In 2008, measures were introduced to mitigate the impact of highly migratory fish stocks on seabirds and sea turtles. The Secretariat was advised of measures currently being used by our vessels.

41. Our fishing vessel owners/operators are required to submit data on their fishing operations based on its own format for such reporting and in compliance with WCPFC's reporting guidelines. For the purpose of ensuring compliance, surveillance is conducted on a regular basis or as a result of an investigation.

42. In the future, Belize intends to re-expand its longline fishing fleet to eight active fishing vessels exclusively in the Convention Area to fish within the limits set by WCPFC.

Canada

43. Data on catch, effort and catch per unit of effort (CPUE) for the Canadian albacore tuna fishery in the WCPFC Convention Area for 2007 is summarized in this document (WCPFC-SC4-

2008/AR-WP-3). The Canadian fishery is a troll fishery that uses tuna jigs to target albacore exclusively. One Canadian-flagged vessel actively fished in the WCPFC Convention Area in 2007 between 38°S and 41°S, and 130°W and 167°W. No effort or catch data were reported from the Convention Area north of the equator.

44. Preliminary estimates of 2007 catch and effort within the WCPFC convention area are 36.5 mt and 56 vessel-days (v-d), respectively, which represent a 73% decline in catch and a 47% decline in effort relative to 2006. The total Pacific albacore tuna catch from 2002–2007 by the Canadian albacore troll fishery ranged from 83 mt in 2005 to 453 mt in 2003 and effort has) ranged from 56 v-d in 2007 to 408 v-d in 2002 and have followed decreasing trends over this period. The preliminary estimate of CPUE for 2007 is 652 kg/v-d – a 49% decline relative to 2006. CPUE follows a decreasing trend from 2003–2005, then increased in 2006 and has resumed declining in 2007.

45. The Canadian fishery in the WCPFC Convention Area did not report bycatch or interactions with sharks, seabirds and sea turtles in 2007. A technical report describing the Canadian albacore tuna catch and effort database was published in 2007.

China

46. In 2007, China was involved in two types of tuna fisheries in the WCPFC Convention Area, longline and purse seine. There were 86 longline vessels operating in 2007, and of these, 36 were ice fresh tuna longline vessels (IFLL) and 50 deep frozen tuna longline vessels (DFLL). The IFLL vessels mainly operated in the exclusive economic zone (EEZ) of Pacific Island countries (PICs), and targeted bigeye and albacore tunas. The major fishing grounds were distributed among the EEZs of the Federated States of Micronesia, Marshall Islands, Fiji and other PICs. Most DFLL vessels targeted bigeye tuna on the high seas and within the EEZs of PICs. Longline vessels ranged from 67 gross registered tons (GRT) to 742 GRT. In 2007, the number of purse-seine vessels increased to 10.

47. The total catch of tuna and tuna-like species by Chinese longline and purse-seine vessels in 2007 was 73,428 mt. The catch mainly comprised albacore (5,453 mt), bigeye tuna (7,821 mt), yellowfin tuna (7,776 mt) and skipjack tuna (48,745 mt). The Chinese longline and purse-seine catch was 18,487 mt and 54,941 mt, respectively. The catch by IFLL and DFLL vessels was 9,087 mt and 9,400 mt, respectively. The IFLL catch composition was 53% albacore tuna (4,835t mt), bigeye tuna (22%, 2,024 mt), yellowfin tuna (2%, 183 mt) and swordfish (13%, 1,221 mt). The DFLL catch composition comprised albacore tuna (7%, 618 mt), bigeye tuna (62%, 5,797 mt), 15% yellowfin tuna (1,397 mt) and 9% swordfish (892 mt). The purse-seine catch composition was skipjack tuna (86.9%, 47,745 mt), yellowfin tuna (11.3%, 6,196 mt) and bigeye tuna (1.8%, 1,000 mt).

48. Data coverage of catch and effort was 100%. Scientific observer programmes have been carried out, and three observers were sent to longline vessels on the high seas in early 2008. Observers collect data on tunas and other pelagic fish, and size-frequency data on all pelagic fish.

Cook Islands

49. The total longline catch within the WCPFC Convention Area was about 2,800 mt, a decrease of approximately 200 mt from 2006. About 82% of the total catch was caught within the Cook Islands' EEZ.

50. In total, 35 longline vessels and 1 troll vessel were active within the WCPFC Convention Area in 2007. There was a decrease in fishing effort due to the Cook Islands government halting all licensing in the third quarter of 2007 and limiting fishing effort when the new fisheries management regimes were implemented.

51. Albacore remains the main catch species, making up 76% of the total catch. Bigeye and yellowfin tunas constituted 6.8% and 9.1% of the total catch, respectively. The total swordfish catch declined in 2007 by over 50%, compared with the 2006 catch, due to a reduction in effort by vessels operating out of Port Avatiu, Rarotonga.

52. The Ministry of Marine Resources recruited a port sampler in March 2007 to improve port sampling coverage of vessels unloading in Avatiu. The national observer programme was re-established in May 2008, with an observer recruited from the Solomon Islands.

European Union

53. In 2007, three European Community (Spain) purse seiners, all over 1,500 GRT, fished in the WCPFC Convention Area. Data from observers of the Agreement on the International Dolphin Conservation Program (100% coverage) indicate a nominal catch of 19,747 mt, consisting of 3,040 mt of bigeye tuna, 12,688 mt of skipjack tuna, and 4,019 mt of yellowfin tuna. Effort, aggregated catches, and bycatch data are also presented.

54. In total, 15 Spanish-flagged longline vessels targeting swordfish were fishing in the WCPFC Convention Area, either year round or occasionally. The average weight, engine power and size of vessels operating in the fishery in 2007 were: 291.8 GRT, 861.8 hp, and 40.8 m, respectively. The gear used was the monofilament surface longline "American-style" (Florida style modified), which uses an average of 1,055 hooks per set. Due to the fishery's characteristics, only preliminary estimates of landings are available for 2007. These estimates indicate a total swordfish catch of around 8,500 mt for the entire Pacific Ocean, from which around 4,200 mt were from the WCPFC Convention Area. Final estimates will be available around September 2008. The definitive 2006 swordfish landings, as well as estimates of bycatch, aggregated catches and effort distribution, are provided.

Federated States of Micronesia

55. In 2007, the fishing fleet of the Federated States of Micronesia (FSM) comprised 33 vessels, of which 29 were longliners and 4 were purse seiners. Of the 29 longliners, only 26 were actively fishing in the WCPO, while all 4 purse seiners were actively fishing in the WCPO. The total 2007 WCPO catch for FSM purse seiners and longliners is reported to be 15,439 mt, which consisted of the three target species skipjack, yellowfin and bigeye tunas. Purse seiners caught 87% (13,497 mt) of the total catch, and longliners 13% (1,942 mt). Skipjack tuna accounted for 78% of the total catch, while yellowfin tuna was 19% and bigeye tuna was 3%. Logsheet data are still provisional.

56. In 2007, 303 vessels were licensed to fish: 133 longliners, 8 pole-and-line, and 162 purse seiners. Eleven distant water fishing nation fleets operated in FSM's EEZ in 2007.

57. The total 2007 catch in FSM's was 139,119 mt, down 75,781 mt from 2006. Purse-seine catches accounted for 97% (134,489 mt) of the total catch, and longline catches accounted for 3% (4,630 mt). No catch numbers were reported by for pole-and-line vessels in 2007. Skipjack accounted for 90% (121,325 mt) of the total purse-seine catch, while yellowfin tuna accounted for

only 9% (12,550 mt), and bigeye tuna accounted for <1% (598 mt). Logsheet data are still provisional and it is expected that these catches may increase over time.

58. FSM has operated a national observer programme since its establishment. In 2007, FSM's observer programme had 10 fisheries observers and carried out 42 observer trips on both longline and purse-seine vessels. Longline coverage was 24%, while purse-seine coverage was only 17.7%. This, however, is provisional because logsheets are incomplete and some observer trips did not enter FSM waters. Coverage estimates may decline as data are updated. Species composition based on observer data for 2007 is unavailable because observer data have not yet been processed by SPC-OFP.

59. Pohnpei remains the only transhipment port for purse seiners in FSM. Port sampling is carried out for both purse-seine and longline unloadings. Coverage of purse-seine transshipment was 61%, while longline coverage was relatively high at 88%. There were 162 purse-seine unloadings, which equalled 131,476 mt, in Pohnpei Port in 2007, and 486 longline unloadings, which equalled 2,372 mt.

Fiji

60. The Fiji fishing zone area has attracted foreign fishing vessels since the early 1950s. Local participation in commercial tuna fishing increased in the mid-1970s, with a focus on pole-and-line fishing. Taiwanese and Korean longline activity began in the 1980s, and since then, longlining has become the predominant fishing method, targeting albacore tuna and providing an average of 17,000 mt of tuna and tuna-like species per year. In 2007, the total catch from the domestic longline fishery was 12,417 mt, 70% of which was from inside Fiji's waters.

61. Pole-and-line fishing is conducted on a very small scale, averaging around 4,000 mt in previous years. Presently, pole-and-line fishing is conducted only occasionally by Japanese vessels on trip-based licenses.

62. Monitoring developments include continuing Fiji's observer programme to try to reach 20% coverage on domestic longline vessels; current observer coverage is around 5%. The observer programme also encompasses port sampling during unloadings and transhipments. In 2007, port samplers covered 144 trips, sampling all fish caught on each trip, including those reserved for crew consumption.

French Polynesia

63. The tuna fishery is a major component of French Polynesia's economy. The overall nominal catches for commercial tuna fisheries in 2007 are estimated to be 8,000 mt, in which, 73% were caught by longliners. Albacore accounted for 46% of the overall catch, yellowfin tuna 13%, skipjack 10%, and bigeye tuna 6%. The longline fleet, which is almost entirely based in Tahiti, usually exploits one-half to two-thirds of French Polynesia's EEZ, although the core fishing ground has historically been in the northern part of the EEZ (10°–20° S, 140°–150°W). In 2007, longline catches were still lower than those from 2002, mainly because of poor albacore catches.

Indonesia

64. The main tuna fishing grounds in eastern Indonesia are the Sulu Sea, Ceram Sea and Banda Sea, which are included in the WCPFC Convention Area. The tuna fisheries in this area of

Indonesia developed rapidly in the 1970s when the global economy started to influence the region. Higher prices for fish commodities abroad (compared to the local market) resulted in a boom of fisheries exports from coastal states. The high demand for tuna on the international market has led to the development of pole-and-line, longline and purse-seine fisheries in this region.

65. Although the fishery in this area is dominated by small-scale operators, pole-and-line fisheries are well developed in eastern Indonesia, because of the availability of live bait (anchovies). The Indonesian government built three state companies for pole-and-line fishing in the 1970s in Bitung, Ambon and Sorong. Two kinds of purse-seine activities are operating in eastern Indonesian waters: industrial purse seining for tunas, mainly based in Bitung; and small-scale purse seining, locally called *pajeko* (in northern Sulawesi), gae (in southern Sulawesi) and giop (in Ambon).

66. The Indonesian government, through its Ministry of Marine Affairs, is actively working towards improving the quality of catch information for tuna fisheries in eastern Indonesia. This is being undertaken with the support of the WCPFC Indonesian Philippine Data Collection Project.

Japan

67. The total number of longline vessels operating in 2006 was 1,208, which was 25 vessels (2%) less than in 2005. In 2006, 335 pole-and-line vessels were operating, which was 52 vessels (13%) less than that in 2005. In 2006, the number of purse-seine vessels over 200 GRT, operating in equatorial waters, was 35, which was equivalent to the number in 2005. The number of the purse-seine vessels between 50 GRT and 200 GRT, operating to catch tunas north of 20°N, was 84 in 2006, three vessels less than that in 2005.

68. In 2006, the total WCPFC Convention Area catch of tunas (Pacific bluefin, albacore, bigeye, yellowfin and skipjack) by Japanese vessels was 460,000 mt, which amounted to 92% of the 2005 catch (which was 501,000 mt). In 2006, the purse-seine catch was 257,000 mt (56% of the total tuna catch), the pole-and-line catch was 124,000 mt (27% of the total tuna catch), the longline catch was 67,000 mt (15% of the total tuna catch), and the remaining 2% by other gear types.

69. In 2007 and 2008, Japan conducted several research activities relating to tuna in the Convention Area, including a tagging study for tropical tunas and sharks, and a research cruise to collect tuna larvae. In addition, experimental longline cruises were conducted to evaluate the effectiveness of circle hooks in reducing sea turtle mortality due to fishing activity, and experiments with tori lines were made, and a sea turtle nesting survey was conducted.

Kiribati

70. In 2007, fishing in Kiribati's three fishing zones was dominated by foreign vessels operating under bilateral and multi-lateral fishing agreements.

71. Kiribati has only one domestic purse-seine vessel, which fishes under the regional FSM Access Arrangement. In 2007, there was a substantial increase in the number of foreign vessels fishing in Kiribati, including 16 carriers and 2 tanker vessels.

72. The largest catch by domestic vessels was made in 2005 with over 7,000 mt taken from PNG, FSM and high seas waters. In 2006, catches dropped significantly to around 4,700 mt and

continued to fall in 2007. Catch data from 2007 is provisional and more logsheets are expected to be submitted to SPC for processing.

73. During the past five years, the foreign fleet has predominantly comprised longline vessels. However, in 2007, purse seine has become the dominant fishing gear. In 2007, around 350 foreign fishing vessels were licensed to fish in Kiribati's waters, representing a relative increase of 15% from 2006.

74. Purse-seine vessels continued to dominate the foreign catch in Kiribati, accounting for over 90% of the catch. This was followed by longlining, with no pole-and-line catch reported in Kiribati over the last three years.

75. Korean purse-seine vessels have dominated transhipment in port for the past five years. The port sampling programme continues to operate and all data are provided to SPC-OFP for processing.

76. As of 2007, Korean longline vessels transhipping in Kiribati's waters are monitored by Kiribati fisheries observers.

Korea

77. Over 90% of Korea's total Pacific Ocean tuna catches are taken from the WCPFC Convention Area. Convention Area catches fluctuated between 216,000 mt and 281,000 mt, and averaged 251,000 mt. Purse-seine catches during the last five years ranged from 183,000–258,000 mt, averaging 219,000 mt. Skipjack and yellowfin tuna comprised 74.4% and 19.2% of this catch, respectively. The Korean longline fishery targets bigeye and yellowfin tunas, with minor catches of albacore, and comprises 86.3% of Korea's total catch. Billfish and other fish species are incidentally caught in the longline fishery. Total annual longline catches over the last five years in the WCPO ranged from 23,000–39,000 mt. The number of longliners and purse seiners fishing in 2007 was 122 and 26–28, respectively, which represents a decrease of 10 longliners compared to 2006.

78. In 2002, Korea's Ministry for Food, Agriculture, Forestry and Fisheries initiated the development of an observer programme for distant water fisheries, including tuna fisheries. In 2007, 12 observer trips representing 958 days were conducted in order to monitor Korean tuna longline and purse seine fisheries. Five of these trips were carried out in the Pacific Ocean.

79. Since 1993, monthly biological sampling of purse-seine catches has been carried out at a domestic landing site to obtain size data and information on the reproductive biology of yellowfin and skipjack tunas. In total, 316 skipjack, 1,207 bigeye, 772 yellowfin and 341 albacore tunas were sampled for morphometric measurements and GSI index during 2007.

80. Because concerns regarding sea turtle bycatch in longline fisheries have been raised in various international meetings, the Korean government has funded an experiment to investigate whether circle hooks can solve the problem of sea turtle mortality caused by longline fishing activity. The experiment was carried out by scientists from Korea's National Fisheries Research and Development Institute (NFRDI) aboard a commercial Korean longliner operating in the eastern Pacific from July–August 2005 and September–October 2006. This experimental survey was repeated with various types of circle hooks from August–September 2007. To solve practical problems that fishermen encounter when recording bycatch species, NFRDI issued the second edition of the atlas of "Fishes of the Pacific Ocean" in 2007.

Marshall Islands

81. The Republic of the Marshall Islands (RMI) has five purse-seine vessels that have been fishing throughout the WCPO for the past few years, and four newly flagged longline vessels that entered the fishery in late 2007, fishing primarily within RMI's EEZ. Total catch by the national purse-seine fleet was 59,489 mt, and as expected, the majority of the catch comprised skipjack tuna.

82. Although the overall number of foreign vessels licensed to fish within RMI's EEZ declined to 216 in 2007, purse-seine vessels still constituted more than half the numbers. Available 2007 catch estimates for foreign purse-seine and longline vessels indicated a decline in the in-zone catch. Conversely, there was resurgence in the pole-and-line fleet, with a significant increase in catch compared to previous years.

83. Recognizing the importance of monitoring activities for compliance purposes, the RMI observer and port sampling programmes have endeavoured to remain active, despite the loss of eight observers in 2007. In fact, observers completed 1,881 days at sea, most of which were carried out on national trips due the ease of placing observers on these vessels. Port sampling staff continued to increase the numbers of fish measured from more than 52,000 in 2006 to more than 71,000 in 2007. The observer programme is currently in the process of preparing for a new training, and is optimistic that new recruits will assist the programme in future collaborative efforts with the WCPFC Regional Observer Programme.

Nauru

84. Nauru's tuna fishery involves artisanal and commercial fishing activities. The artisanal fleet comprises small skiffs and canoes operated by local artisanal fishermen. Fishery data have recently been collected by the Coastal Department of the Nauru Fisheries and Marine Resources Authority with assistance from SPC, which provided FAD fishing logbooks for local fishermen to report their catches. Data collection is still new and is in the process of refinement to suit local conditions.

85. In 2007, 131 foreign purse seiners were licensed to fish in Nauru. In support of some of these purse-seine fleets, Nauru licensed an additional six bunker vessels. The majority (76) of purse-seine vessels fall within the 1,001–1,500 GRT category, followed by smaller vessels (40) in the 501–1,000 GRT size group, and vessels that fall within the super-seiner category (15) of over 1,500 GRT. The total purse-seine catch in 2007 was 53,720 mt, down almost 6,000 mt from 2006.

New Caledonia

86. In 2007, 23 domestic longliners fished within New Caledonia's EEZ. No foreign vessels have been licensed to fish since early 2001.

87. Despite a slight increase in fishing effort in 2007, the total catch of 2,122 mt is similar to that of 2006. Albacore represented almost two-thirds of the total catch (1,324 mt) and yellowfin 19% (393 mt). Shark catches have been decreasing since 2006, probably due to the increased use of monofilament mainlines.

88. Port sampling and observer activities will continue in 2008 under a new EC-funded project, and will add scientific data to logsheets currently collected on a regular basis.

89. In recent years, several initiatives, both pertaining to scientific and technical aspects of the tuna fishery, have been implemented on a local scale so as to contribute to regional efforts to improve and disseminate knowledge about the spatial distribution of target tuna species and links to environmental factors.

New Zealand

90. Since 2002, nearly all skipjack tuna are taken by purse seine. Skipjack comprise the greatest part of the catch of all tuna species, both within and beyond New Zealand fisheries waters. In 2007, 26,487 mt of skipjack were caught. Outside New Zealand fisheries waters, yellowfin tuna makes up most of the balance. Yellowfin tuna are rarely part of the purse-seine catch within New Zealand fisheries waters because the domestic purse-seine fleet focuses almost exclusively on free schools of skipjack. In 2007, 1,874 mt of yellowfin tuna were caught. The next most important component of New Zealand's domestic fisheries are albacore, which are taken mostly by troll gear, but are also landed as target and bycatch in the longline fishery. In 2007, 2,092 mt of albacore were caught. The domestic longline fleet mostly targets bigeye and southern bluefin tunas, and more recently swordfish, but the greatest part of the catch consists of albacore. Over 200 mt of striped marlin are caught annually by the recreational fleet, with well over half the fish are tagged and released. Most tuna caught in New Zealand waters are exported, and the destination of exports varies depending on the species.

91. New Zealand has four New Zealand-flagged Class-6 purse seiners fishing offshore. These vessels have fished in the EEZs of Pacific Island states and in the high seas areas of the equatorial WCPO since 2000. These vessels also fish in domestic waters along with six smaller capacity domestic-based purse seiners. The number of purse seiners has been stable, at around 10 vessels. The New Zealand longline tuna fleet consists of approximately 100 domestically owned and operated vessels (mostly between 15 m and 25 m in length). The number of longline vessels operating in New Zealand has declined from 151 vessels in 2002 to 44 in 2007.

92. Blue shark is the most common non-tuna bycatch species in the longline fishery, followed by Ray's bream. The recent large reductions in longline effort have resulted in reductions in landings of major bycatch species.

93. New Zealand longline vessels fishing south of 30^{o}S are required to use tori lines to reduce seabird catches during setting. In addition, longline vessels fishing for tuna or swordfish in New Zealand fisheries waters may only set their lines at night and must use tori lines while setting. Because the purse-seine fishery is based on free schools of skipjack, bycatch is minimal (i.e. 1% by mass). No interactions with non-fish bycatch (e.g. seabirds, turtles, marine mammals) were observed in the purse-seine fishery.

94. New Zealand has an observer programme and two active port sampling programmes. In the 2006–2007 fishing season, 25.5% of the longline effort (measured by the number of hooks deployed) was observed; in 2007, 14% of the New Zealand purse-seine sets were observed. A considerable amount of research in New Zealand is directed at tunas and tuna-like species. Both fishing permit holders (fishers) and fish receivers are required to furnish returns to New Zealand's Ministry of Fisheries. New Zealand has four data collection systems in place to collect catch and effort data, and also has a system for collecting information on non-fish bycatch from fishers.

Palau

95. From 1950–1980, the tuna fishery within Palau's EEZ was dominated by distant water longline fleets from Japan and Chinese Taipei. Fishing effort increased in the late 1950s and exceeded 10 millions hooks per year by 1979. Tuna catches exceeded 6,000 mt in 1979, and were dominated by yellowfin tuna, with bigeye tuna catches averaging 1,000 mt per year between 1950 and 1980. Catches of other species exceeded 1,500 mt per year by the mid 1970s, and were dominated by shark, black marlin and Indo-Pacific sailfish. Japanese longline effort in Palau's EEZ began to decline in the early 1980s, although effort has been increasing since 2005. Since 1990, longline fishing effort has been dominated by fleets from Chinese Taipei and China. Up to 300 vessels have operated within the EEZ in any given year, fluctuating between 85 and 164 vessels since 2000. Since 2000, total longline effort in Palau's EEZ has varied between 6.1 and 17.2 million hooks per year, with the highest estimates of effort reported in 2005 and 2006.

96. Total catches from within Palau's EEZ have displayed a similar trend as effort, with total catches exceeding 5,000 mt in 2006. Bigeye tuna have dominated catches since the late 1980s, likely due to longline fleets switching their focus from yellowfin to bigeye tuna. Bigeye tuna catches exceeded 2,000 mt in 2005 and 3,300 mt in 2006, which were much higher than historic levels. Recent catches have also increased in median size, with very large bigeye tuna dominating catches. Yellowfin tuna catches exceeded 1,700 mt in 2005 and 2006, which were much lower than the high historic catches estimated in the late 1970s. Catches of other species are much smaller than for yellowfin or bigeye, and are dominated by blue marlin and swordfish, although catches of these latter two species have been less than 100 mt each in recent years.

97. There has been large inter-annual variation in catch and effort by the purse-seine fishery operating in Palau's EEZ, and catches declined to very low levels between 1997 and 2002. However, there has been an increase in purse-seine catch and effort since 2003. Most effort has been recorded by the Japanese fleet, and has been dominated by associated sets (logs, FADs) in most years. Low levels of pole-and-line effort have been reported since 1979.

Papua New Guinea

98. In 2007, 222 fishing vessels had access to Papua New Guinea (PNG) waters. Of these, 200 were purse seiners and 22 were longliners. There were 16 more purse-seiners in 2007 than in 2006, and these were USA-flagged vessels.

99. Total catches in the WCPFC Convention Area by PNG-associated vessels were 223,279 mt, of which 3,225 mt were from longliners, and 220,054 mt from purse seiners. Of the 220,054 mt purse-seine catch, 142,851 mt was caught within PNG waters. In terms of fishing effort (days fishing and searching), PNG vessels fished for 9,900 days, 72% of that time was spent in PNG waters and 28% of the time was spent outside PNG waters. Although there was an increase in effort, the overall number of sets was down 23% compared with 2006, with the greatest reduction in associated sets (24%). The total 2007 catch was the second highest, just under the 2005 catch, although there was a 66% reduction in bigeye catches compared with 2006. There was also a 50% reduction in the catch of other species in 2007 compared with 2006.

100. Catches by foreign fleets in PNG waters were a record high of 320,132 mt. For the last five years, the foreign catch has been dominated by Chinese Taipei (36%) and Korea (30%). The combined total 2007 catch by all fleets in PNG waters was a record high of 466,208 mt. Almost all of the catch (99.99%) was from purse seiners.

101. Data coverage for logsheets is very high (86%) for all vessels. Good reporting is one factor in the record high catch.

Philippines

102. The Philippine fishing industry consists of municipal and commercial fishing sectors, with the former involving vessels less than 3 GT in size, and falling under the jurisdiction of local government units (LGUs). The larger commercial vessels (> 3 GT) are required to fish outside municipal waters (15 km beyond the shoreline) and are required to secure a commercial fishing vessel license (CFVL) from the Bureau of Fisheries and Aquatic Resources (BFAR). Fishing vessels fishing in the high seas are also required to secure an international fishing license from BFAR. Republic Act 9379, or the Handline Fishing Law, formally recognized a separate category for handline vessels that target large pelagic fish. Over 1.5 million people in the Philippines depend on the fishing industry for their livelihood.

103. Provisional catch estimates for 2007 are as follows: skipjack tuna – 185,864 mt; yellowfin tuna – 134,492 mt; and bigeye tuna – 34,216 mt. The 2007 total catch estimate reflects the actual tuna production. However, the breakdown by species needs further review and verification. The recent increase in catch was, in fact, not the result of increased fishing effort, but was due to the fishing sector realizing the importance of accurate catch data for fisheries management.

104. Ongoing research activities of the National Stock Assessment Program (NSAP) and the WCPFC supported project, the Indonesia-Philippine Data Collection Project (IPDCP), has ensured continuous coverage of key tuna landing centers, which collect data on species composition, length-frequency, vessel catch and effort information. The United Nations Environment Programme–Global Environment Facility project — Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand — initiated the establishment of fish refugia as a management tool to protect spawning populations and commercially exploited juvenile fish species in the South China Sea. The project will address the issues of growth overfishing and recruitment overfishing. This scheme will also be implemented in the Moro Gulf in 2009 to mitigate the impact of growth overfishing in tuna fisheries.

Samoa

105. Samoa's domestic tuna fishery, particularly the tuna longline fishery, has shown progressive recovery in catch rates, from persistently low catch rates experienced from 2003 to mid-2005. In 2007, 60 vessels engaged in tuna longlining, targeted albacore tuna, and landed an estimated 3,755.4 mt of fish, an increase of over 38% from 2006. Yellowfin and bigeye tunas are also important components of the longline catch, with an estimated 400 mt (combined weight) landed in 2007. The troll fishery, which uses small vessels, landed an estimated 115.7 mt of fish in 2007, with skipjack constituting the bulk of the catch. FFA has facilitated the implementation of the ecosystem approach to fisheries management process for Samoa's tuna fishery, and has provided assistance for the fisheries legislation review that is in progress. The operational costs of the domestic fishing fleet have been extremely high and increasing fuel prices will greatly impact the viability of the tuna fishery in the medium term.

Solomon Islands

106. The Solomon Islands fleet consists of five purse-seine vessels and nine pole-and-line vessels. Catch and effort coverage for the Solomon Islands fleet has been high, but the size data

coverage is uncertain. Within the Solomon Islands' EEZ, the foreign fleets with high catch and effort data coverage are Korea, Japan, Taiwan, Vanuatu, and the USA, while fleets from Belize and Fiji also have significant catch and effort data coverage.

107. From 2002–2007, annual catch estimates for the Solomon Islands fleet have generally increased, especially for the purse-seine fleet. It has been noted that there were more sets on associated fish schools than on unassociated schools.

108. Total purse-seine catches have increased from 6,782 mt in 2002 to 22,313 mt in 2006, and comprise 60% skipjack, 39% yellowfin and 1% bigeye tunas. In 2007, catches drop to 17,306 mt mainly because of a change in fleet size. In 2006, provisional data indicate that catches of all major tuna species have increased to over 12,333 mt skipjack, 8,256 mt yellowfin, and 669 mt bigeye. The major tuna species in the pole-and-line fleet catch was skipjack (89%), followed by yellowfin (10%) and bigeye (1%). Raised and provisional estimates for the longline fleet in 2004, the highest in the last six years, were 207 mt albacore, 294 mt bigeye and 440 mt yellowfin, but if all logsheets are raised, the annual catch could be higher.

109. Data for the Solomon Islands' EEZ were based on logsheet data, mainly from foreign fishing companies in China, Fiji, Japan, Korea, New Zealand, Taiwan Vanuatu and the USA. The fleet size for all these countries has increased rapidly since 2004, based on the number of licenses issued from 2004–2007 (as shown in Table 4 of Part 1 of the 2007 Annual Report to the Commission). Unfortunately, the 2007 catch and effort distribution for the Solomon Islands EEZ is incomplete and unsatisfactory due to some fishing companies not submitting their operational data to the Solomon Islands Fisheries Department.

Chinese Taipei

110. Three types of Taiwanese tuna fishing vessels operate in the WCPFC Convention Area: large tuna longliners, distant water purse seiners and small tuna longliners. In 2007, total catches from large tuna longliners and distant water purse seiners were 10,538 mt and 232, 535 mt, respectively. Total catches of tuna and tuna-like species in 2007 from small tuna longliners was 36,624 mt. In 2007, 23 large tuna longline vessels were scrapped, 10 of which were from the Pacific Ocean. In order to monitor and control fishing activity of its vessels, large longliners are requested to install two sets of vessel monitoring systems. In 2007, 20 observers were deployed to the Pacific Ocean onboard large longliners and distant water purse seiners to collect fishing and biological data. Three research programmes were carried out in 2007, including experiments on circle hooks, acoustic methods for evaluating fish schools, and a tagging and recapture study.

Tonga

111. Tonga's tuna longline fleet continued operations in 2007, with more fishing vessels than in 2006. Tonga has only a domestic longline fleet, which mainly fishes within Tonga's EEZ.

112. The catch rate (CPUE) and total catch (in terms of quantity and value) for 2007 has increased since 2004 and 2005, but is still much lower than the highest catch level reached in 2001 (nearly 2,000 mt). Albacore made up the highest percentage of tuna in the total catch in 2007, with increasing percentages of bigeye and yellowfin tunas. The tuna catch composition indicates that most longline vessels and the structure of the fleet are targeting bigeye and yellowfin tuna for the fresh fish market, with high proportion of albacore tuna.

113. SPC-OFP continued to provide Tonga's Fisheries Department with relevant information about tuna stocks in Tongan waters, relative to the whole stock in the WCPO. The total tuna catch by the Tongan fleet in 2007 remains insignificant and has no major impact on the entire stock within the region and the WCPO. Despite the potential for improving and developing Tonga's tuna fleet, high fuel costs have restricted fishing operations to areas near the main fishing port, Nuku'alofa.

114. Tonga's Fisheries Department continues to improve its tuna data collection, which began several years ago with assistance from SPC and FFA, and more recently from the WCPFC. The coverage of port samplers increased from 56% in 2006 to 70% in 2007. However, a shortage of certified observers to carry out observer-related duties when requested has resulted in a decline in observer coverage for 2007. At the same time, measures and resolutions of the WCPFC are being implemented and monitored by Tonga's Fisheries Department.

Tuvalu

115. Tuvalu's tuna resources are targeted by both local and foreign fishing fleets. The local fleet operates on a very small scale, supplying only the domestic market. In contrast, the foreign fleet, with their highly sophisticated vessels, account for most of the catch.

116. A record total of 33,181.5 mt of fish were reported in 2007, of which 99.9% were landed by foreign fishing vessels. The purse-seine fleet alone constituted 98% of the total reported catch. Longline catch totals were not readily available.

117. Tuvalu licensed a record number of foreign fishing boats this year, the highest ever registered. Of these, 60% were purse seiners, 37% longliners and the remaining 3% pole-and-line boats.

118. Monitoring foreign fleets remained a challenge for the Tuvalu government, especially with the recent increase in world fuel prices. The recent adoption by the Parties to the Nauru Agreement (to which Tuvalu is a signatory) of conservation and management measures to protect tuna stocks will certainly improve Tuvalu's capacity with regard to monitoring and surveillance.

USA

119. Large-scale USA fisheries for highly migratory species in the Pacific include purse-seine fisheries for skipjack and yellowfin tunas; longline fisheries for bigeye tuna, swordfish, and associated species; and a troll fishery for albacore. Small-scale fisheries include troll fisheries for a wide variety of tropical tunas and associated species; handline fisheries for yellowfin and bigeye tunas, and a pole-and-line fishery for skipjack tuna.

120. Associated species include other tunas and billfishes, mahimahi and wahoo. The large-scale fisheries operate on the high seas, within the USA's EEZ, and within the EEZs of other states. The small-scale fisheries operate in nearshore waters in the EEZs of American Samoa, the Commonwealth of the Northern Mariana Islands, Guam and Hawaii.

121. The increase in total USA landings in the WCPFC statistical area in 2007 was primarily a result of increased purse-seine and longline activity. The purse-seine industry responded to improved skipjack tuna prices. Longline landings increased in 2007 after decreasing in 2006 when the fishery sector targeting swordfish was closed from April–December to limit the bycatch of sea turtles. Bigeye tuna landings by longliners reached a record high of 6,449 mt in 2007.

Swordfish landings increased to 1,443 mt in 2007, from 1,113 mt in 2006. Small-scale (tropical) trollers and handliners operating in Pacific Island waters represented the largest number of vessels but contributed a small fraction of the catch. The longline fleet was the next largest fleet, numbering 156 in 2007, up from 154 in 2006. The troll fishery for albacore declined, with active vessels reduced from eight in 2006, to six in 2007.

122. The National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NOAA Fisheries Service) conducted research on Pacific tuna and associated species at its Southwest and Pacific Islands Fisheries Science Centers in collaboration with scientists from other organizations. Fisheries monitoring and economics work included a continuing survey of recreational billfish anglers, indicating improved catch rates in recent years.

123. Improvements were made to the integration of fisheries statistics from fishermen's reports with data from fish sales. Monitoring of Honolulu's retail fish market was initiated to investigate consumer choices with regard to raw tuna products prepared from fresh tuna and tuna treated with carbon monoxide. Stock assessment research was conducted in collaboration with member scientists of international regional fisheries management organizations, including the WCPFC and the ISC.

124. NOAA Fisheries Service's biological and oceanographic research on tunas, billfishes, and sharks addressed fish movements, habitat choices, post-capture survival, feeding habits, and age and growth. Salient results include a model analysis of bigeye tuna habitat depth derived from archival tag studies that predicts the high CPUE found in the fourth quarter in the Hawaii-based longline fishery. Another study suggests that the South Equatorial Counter Current strongly influences American Samoa's longline fishery for albacore and changes strength in concert with seasonal and El Niño-Southern Oscillation (ENSO) cycles. Research on bycatch and fishing technology included testing of circle hooks and the development of a near real-time advisory to help longline vessels avoid areas in the North Pacific Subtropical Frontal Zone with a high potential for interaction with loggerhead sea turtles. Other studies were carried out to test a promising technique to reduce shark bycatch by attaching electropositive metal ingots to longline fishing gear.

Vanuatu

125. Vanuatu is a member of regional fisheries management organizations (RFMOs) such as the IATTC, the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC) and the WCPFC. Vanuatu's membership in these RFMOs has enabled Vanuatu's fishing fleet to fish in these RFMOs' waters for tuna and other highly migratory fish species. Vanuatu's fleet comprises 27 purse seiners and 64 longliners. Catch and effort coverage for Vanuatu's fleet have been high, but size data coverage is uncertain due to a lack of observers onboard the vessels, and also because of a lack of unloadings data sought from landing ports.

126. In Vanuatu's EEZ, the only foreign fleet with high catch and effort data coverage is the Fijian fleet. From 2001–2007, the annual catch estimates of Vanuatu's fleet have generally increased as has fishing effort (sets) and the number of fish per 100 hooks. As for purse seiners, there were more sets on unassociated schools than on associated schools. The purse-seine fleet's total catches have increased from 11,196 mt to 140,989 mt, and consist of 85% skipjack, 14% yellowfin and 2% bigeye tunas. Unraised and provisional 2007 data show that catches of all major tuna species have increased, with over 160,000 mt of skipjack, 20,000 mt yellowfin, and 3,000 mt of bigeye tunas harvested. Some of these purse-seine vessels fished under the FSM

Arrangement "home party" criteria as Papua New Guinea, and therefore may have been included in PNG fleet catch statistics.

127. The major tuna species caught by the longline fleet were albacore (60%), yellowfin (16%) and bigeye (10%). Unraised and provisional estimates for the longline fleet in 2006 were 9,339 mt for albacore, 1,558 mt for bigeye and 936 mt for yellowfin, but if raised, could be higher. Data for the Vanuatu EEZ were based on unraised logsheet data. Fishing in Vanuatu's EEZ was by foreign fleets from China, Fiji, Taiwan and Korea. The Taiwanese fleet has decreased but the Chinese and Fijian fleet have increased rapidly, based on the number of license issued in 2007.

General comments

128. The presentation of Annual Reports (Part 1) resulted in participants raising a variety of issues. Key among these was the reporting of yellowfin and bigeye tunas taken by commercial longliners flagged to CCMs targeting southern bluefin tuna, and the reporting of the recreational catch of southern bluefin tuna in New Zealand. In all cases, yellowfin and bigeye tuna catches are reported to WCPFC, and southern bluefin catches are reported to the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). In addition, there was general discussion about the slow provision of data by several CCMs. Some CCMs had not included 2007 data or information on seabirds, sea turtles or sharks in their Part 1 reports, noting that some CCMs data are provisional. The SC urged all CCMs to make better efforts to comply with the WCPFC's data reporting obligations.

2.4 Reports from regional fisheries bodies and other organizations

129. No reports were received from regional fisheries bodies or other organizations under this agenda item.

AGENDA ITEM 3 — SPECIALIST WORKING GROUPS (SWGs)

3.1 SWG reports

a. Report of the Biology SWG

130. The Biology SWG (BI-SWG) met for half a day on 16 August 2008, and was convened by H. Honda (Japan). Seven working papers and two information papers were submitted by participants. The seven working papers covered research on age, growth, stock structure, behaviour, movement and reproductive biology, including review of the research project, early life history and recruitment strategy. The BI-SWG recommends that the methods for a Pacific-wide study of bigeye tuna reproductive and growth biology are appropriate; a two-year pilot study is required and should be included in the "BI-SWG short- to medium-term research plan"; and this pilot study should be supported by the SC. The full report of the BI-SWG is provided as Attachment G.

b. Report of the Ecosystem and Bycatch SWG

131. The Ecosystem and Bycatch Specialist Working Group (EB-SWG) met on 14 August 2008, and was convened by P. Ward (Australia). Eleven working papers were presented, covering ERAs, ecosystem models, observer programmes, seabird distribution, and trials of mitigation measures. The EB-SWG provided advice to the SC for consideration under agenda item 5 (Bycatch mitigation). The full report of the EB-SWG is provided as Attachment H.

c. Report of the Fishing Technology SWG

132. The Fishing Technology SWG (FT-SWG) met during the morning session of 15 August 2008, and was convened by D. Itano (USA). Four working papers and five information papers were submitted by participants and presented or noted during the session. The papers described research or descriptive material on gear effects, acoustic selectivity, and the development of industry-related technical solutions to improve selectivity on floating object associations. The meeting was also informed about a recent workshop on aspects related to the development of rights-based management systems and buybacks in tuna fisheries, and recent initiatives of the IATTC related to FAD-based research and selectivity. The FT-SWG provided advice to the SC, an operational research plan for 2008/2009, and a medium-term work programme, which were developed and endorsed by the FT-SWG. The full report of the FT-SWG is provided as Attachment I.

d. Report of the Methods SWG

133. The Methods Specialist Working Group (ME-SWG) met during the morning session on Tuesday, 12 August 2008, and was convened by R. Campbell (Australia). Under the terms of reference for the ME-SWG, this SWG will coordinate research and make recommendations to the SC on technical questions related to analytical methods used for fishery management. For this meeting it had as specific tasks the review of research undertaken to address issues identified at SC3 as relevant to the ME-SWG. Four working papers were presented to, and reviewed by, the meeting while one additional information paper was also noted. These papers covered issues relating to the sensitivity of bigeye tuna and albacore tuna stock assessments to alternative biological and reproductive assumptions; the use of data from fleets targeting albacore tuna to improve indices of abundance used in the assessment of South Pacific albacore; and research directed at quantifying the operational characteristics of the Australian longline fleet to improve the utility of the habitat-based method used to standardize catch rates. The full report of the ME-SWG is attached as Attachment J.

e. Report of the Statistics SWG

134. The Statistics SWG (ST-SWG) met for two hours on 11 August 2008, two hours on 12 August and for three hours on 15 August. K. Duckworth (New Zealand) served as convener. The ST-SWG considered nine items on its agenda, and presentations were received on eight documents. The ST-SWG reached consensus on all issues that it considered. The full report of the ST-SWG is attached as Attachment K to this report. Of particular note are the recommendations that:

- Catch sampling programmes should be designed to overcome sampling biases and other issues identified in WCPFC-SC4-2008/ST-WP-2 and WCPFC-SC4-2008/ST-WP-3. Sampling designs should build on further comparative trials, which should include both observer sampling versus port sampling, and also comparison among different techniques within observer and port sampling; and

- The data contained in WCPFC-SC4-2008/ST-WP-4 represented the best assessment of purse-seine fishing effort on the high seas and in the zones of non-PNA members available at this time (August 2008). Any CCM who believes that they have additional data that should be included in this paper should provide their proposed changes (along with supporting documentation) to the Secretariat by 15 September 2008.

f. Report of the Stock Assessment SWG

135. The meeting of the Stock Assessment Specialist Working Group (SA-SWG) took place from 12–13 August 2008, with N. Miyabe (Japan) and K. Bigelow (USA) serving as conveners. Nine working papers were presented to the SA-SWG, including stock assessments for WCPO bigeye and skipjack tuna, South Pacific albacore and southwest/south-central swordfish. Parallel assessments were conducted for bigeye tuna (MULTIFAN-CL, MFCL; Stock Synthesis 3, SS3) and swordfish (MFCL and CASAL). A compendium of fisheries indicators for target tuna species was produced for the first time. The SA-SWG discussed responses to the Commission's requests, discussed the required frequency and prioritization of species' assessments, and identified short- to medium-term research items to advance stock assessments. On the basis of the presentation of the stock assessment working papers, and the discussions of the SA-SWG, stock status descriptions and management advice were formulated for four species: WCPO bigeye tuna; WCPO skipjack tuna; South Pacific albacore; and southwest and south-central Pacific swordfish. The full report of the SA-SWG is provided as Attachment L.

3.2 Adoption of the reports of the SWGs, including advice and recommendations

136. The SC adopted all six SWG reports, including advice and recommendations. These are appended as Attachments G–L.

AGENDA ITEM 4 — STATUS OF THE STOCKS AND MANAGEMENT ADVICE AND IMPLICATIONS

137. The Chair introduced agenda item 4, reminding the SC that the purpose of this item is to seek the endorsement of findings that arise from the presentations and discussions in the SWGs (Attachments G–L).

4.1 WCPO bigeye tuna

a. Status and trends

138. The assessment results from the base-case model closely approximate the results from the 2006 assessment (Table 1), with inclusion of additional fisheries and changes in fishery configurations. These changes represent refinements to the model rather than substantive changes to model structure and result in only minor changes to biomass trajectories. The key conclusions of the models presented are similar to the comparative model runs from the 2006 base-case assessment: depletion levels estimated in the base-case (0.26) were slightly lower than the 2006 (LOWSAMP) assessment (0.29), $F_{current}/\widetilde{F}_{MSY}$ was more pessimistic (1.44, Figs. 3 and 4, compared with 1.32 for 2006) and $B_{current}/\widetilde{B}_{MSY}$ was higher (1.37, Figs. 3 and 5, compared with 1.27), while $SB_{current}/\widetilde{SB}_{MSY}$ was comparable (1.19 compared with 1.20). These metrics

indicate that recent fishing mortality has continued to increase unless fishing patterns and MSY have changed, although biomass levels have continued to be sustained by higher recruitment. However, the MSY-based reference points are not directly comparable as there has been a shift in the age-specific fishing mortality in recent years due to the recent decline in the longline catch.

139. The estimate of $F_{current}/\widetilde{F}_{MSY}$ indicates that overfishing of bigeye tuna is occurring in the WCPO with a very high probability (100% for the scenario shown in Fig. 4). While the stock is not yet in an overfished state with respect to total biomass ($B_{current}/\widetilde{B}_{MSY} > 1$), the situation is less optimistic with respect to adult biomass, and a number of plausible model options indicate that adult biomass has been below the $S\widetilde{B}_{MSY}$ level for a considerable period ($SB_{current}/S\widetilde{B}_{MSY} < 1$). For the base-case model, there is also a 42.8% probability that the $SB_{2006}/S\widetilde{B}_{MSY}$ is less than 1.0. Further, both the adult and total biomass are predicted to become overfished at 2003-2006 average fishing mortality levels and long-term average recruitment levels. This is consistent with a recent decline in biomass under increasing fishing mortality levels, resulting in an increase in the probability of the stock becoming overfished over time.

140. Recent catches are high relative to the estimated MSY, both because of high recent fishing mortality and because the stock has benefited from above-average recruitment over the past 15 years.

Table 1. Estimates of reference points from the 2008 and 2006 bigeye tuna stock assessments. Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, the ranges shown for each reference point should not be compared across years, nor be considered as confidence intervals.

Management Quantity	**2008 Assessment**	**2006 Assessment**
Most recent catch	143,059 mt (2007)	156,768 mt (2004)
MSY	Base case: 64,600 mt Range: 56,800 ~ 65,520 mt	Base case: 72,880 mt Range: 64,600 ~ 91,400 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Base case: 0.94 Range: 0.50 ~ 0.97	Base case: 0.96 Range: 0.94 ~ 0.99
$\mathbf{B_{current}/B_{current,\ F=0}}$	Base case: 0.26 Range: 0.20 ~ 0.28	Base case: 0.29 Range: 0.28 ~ 0.44
$\mathbf{F_{current}/F_{MSY}}$	Base case: 1.44 Range: 1.33 ~ 2.09	Base case: 1.32 Range: 0.87 ~ 1.48
$\mathbf{B_{current}/B_{MSY}}$	Base case: 1.37 Range: 1.02 ~ 1.37	Base case: 1.27 Range: 1.27 ~ 1.59
$\mathbf{SB_{current}/SB_{MSY}}$	Base case: 1.19 Range: 0.76 ~ 1.20	Base case: 1.20 Range: 1.10 ~ 1.74

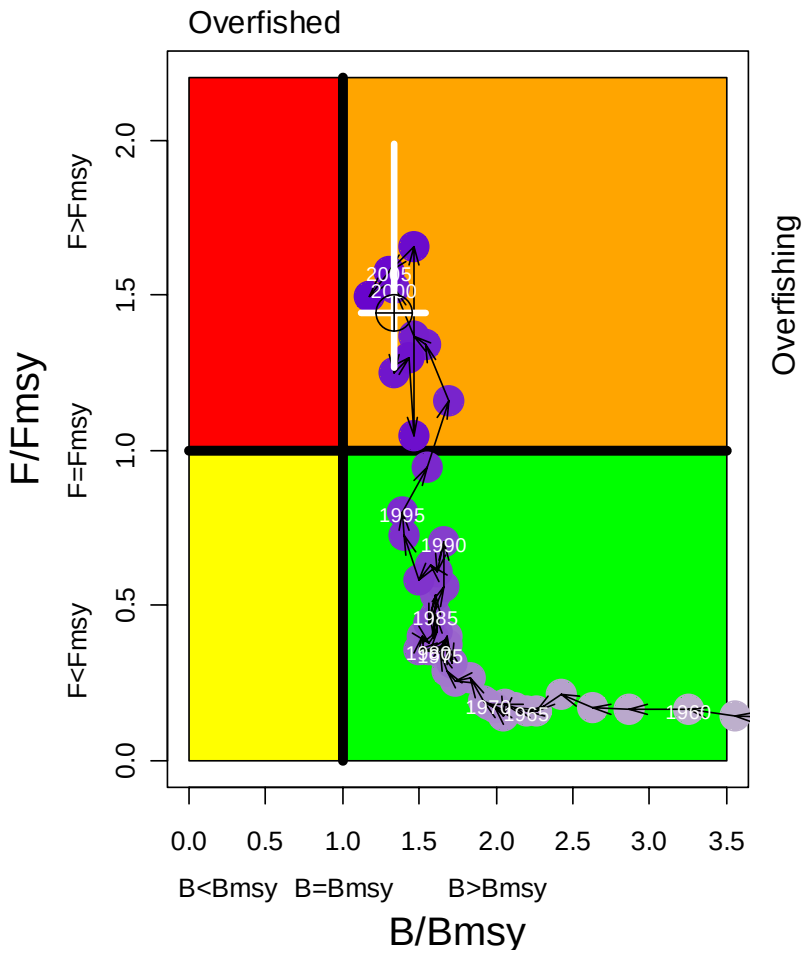

Figure 3. Temporal trend in annual stock status for bigeye tuna, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1952–2006) from the base-case model (run 4). The colour of the points is graduated from mauve (1952) to dark purple (2006), and the points are labelled at five-year intervals. White lines represent the confidence interval associated with F/F_{MSY} and B/B_{MSY}. The last year of the model (2007) is excluded because it is highly uncertain.

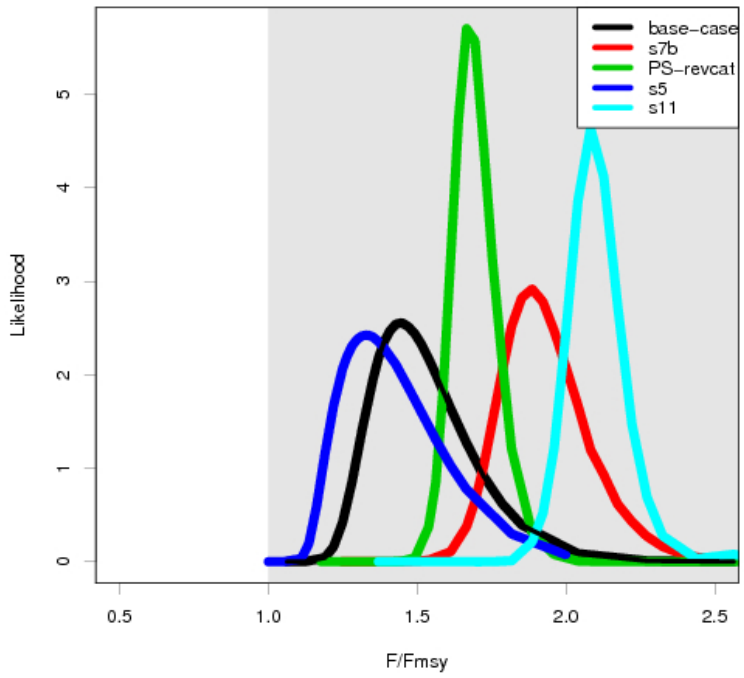

Figure 4. Probability distributions of $F_{current}/\widetilde{F}_{MSY}$ for bigeye tuna based on the likelihood profile method for the base-case model and main sensitivity analyses.

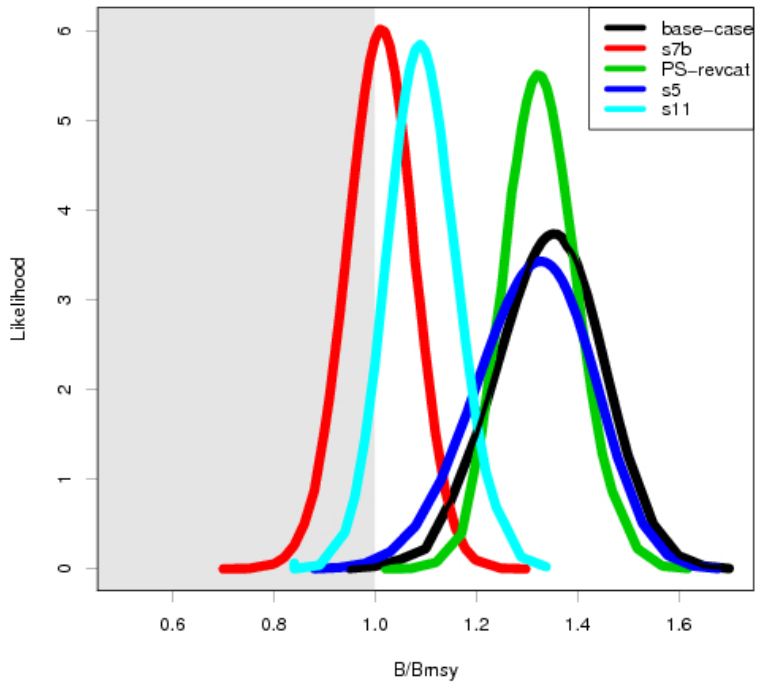

Figure 5. Probability distributions of $B_{current}/\widetilde{B}_{MSY}$ for bigeye tuna based on the likelihood profile method for the base-case model and main sensitivity analyses.

141. Three projection runs were considered to illustrate stock status in relation to biomass quantities: i) status quo of continuing the $F_{current\ (2003–2006)}$; ii) reducing $F_{current}$ from the status quo by 30% at start of projection (2008); and iii) reducing $F_{current}$ from the status quo by 10% per year over three years. Fig. 6 illustrates three projections of $F_{current} / \widetilde{F}_{MSY}$.

142. All projection runs from 2008–2018 indicate that the stock will be overfished after 2013 with regard to both total biomass ($B_{current} / \widetilde{B}_{MSY}$ <1.0, Fig. 7) and spawning biomass ($SB_{current} / \widetilde{SB}_{MSY}$ <1.0, Fig. 8), although there is increasing uncertainty in projections through time. As expected, the stock is projected to be overfished sooner if $F_{current\ (2003–2006)}$ is maintained. Estimates of $F_{current} / \widetilde{F}_{MSY}$ (Attachment L, Table BET2), $B_{current} / \widetilde{B}_{MSY}$ (Attachment L, Table BET3) and $SB_{current} / \widetilde{SB}_{MSY}$ (Attachment L, Table BET4) were computed for three fishery groupings (longline, purse-seine associated, and Indonesian/Philippines) with decreases or increases in fishing effort (60%, 70%, 80%, 90%, 100%, 110% and 120%). Most multiples of reductions in fishing effort still result in overfishing (Attachment L, Table BET2) and a bigeye tuna stock that is overfished with regards to both biomass and spawning biomass (Attachment L, Tables BET3 and BET4).

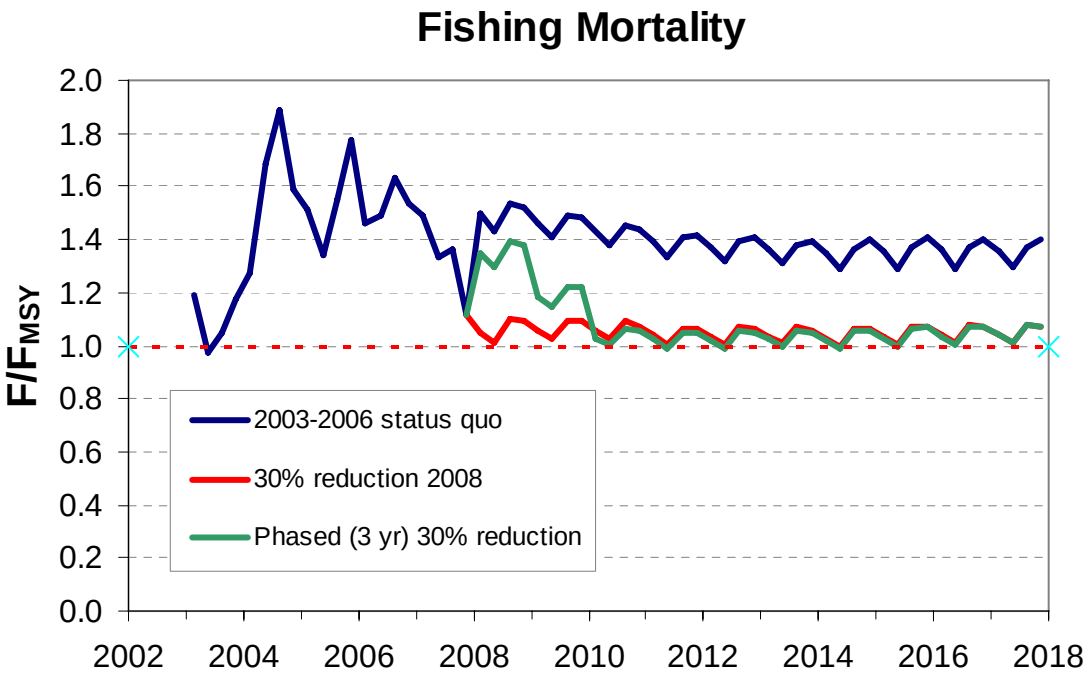

Figure 6. Estimated (2003–2006) and projected $F_{current} / \widetilde{F}_{MSY}$ for bigeye tuna based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at the start of projection (2008), and reducing $F_{current}$ from the status quo by 10% per year over three years.

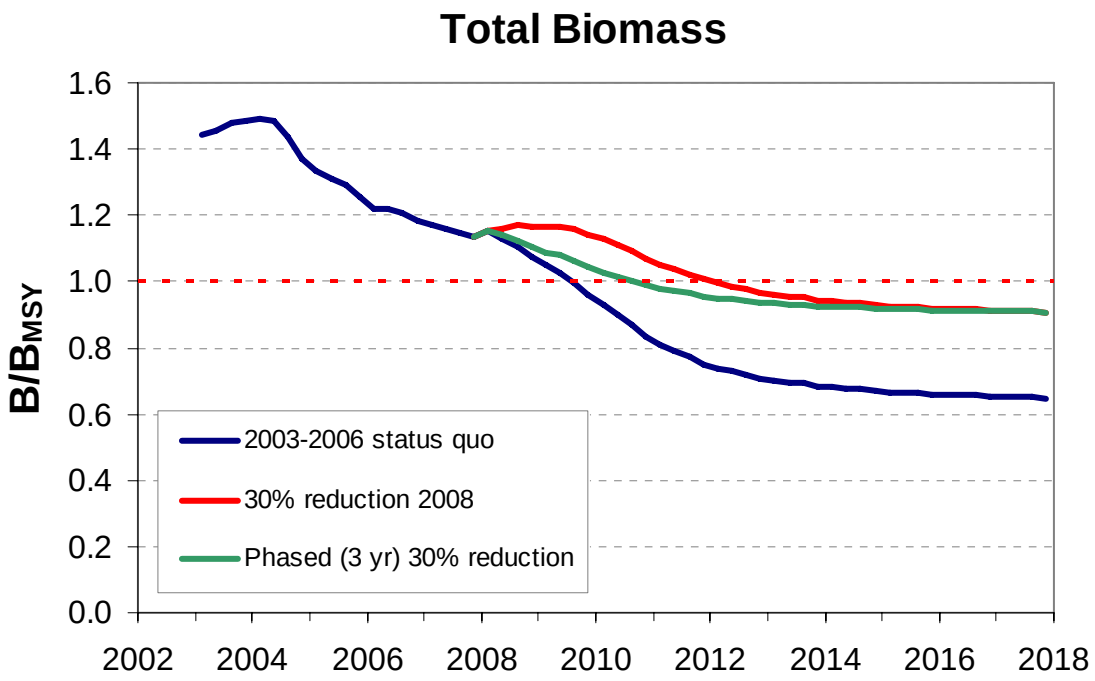

Figure 7. Estimated (2003–2006) and projected $B_{current}/\widetilde{B}_{MSY}$ for bigeye tuna based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at start of projection (2008), and reducing $F_{current}$ from the status quo by 10% per year over three years.

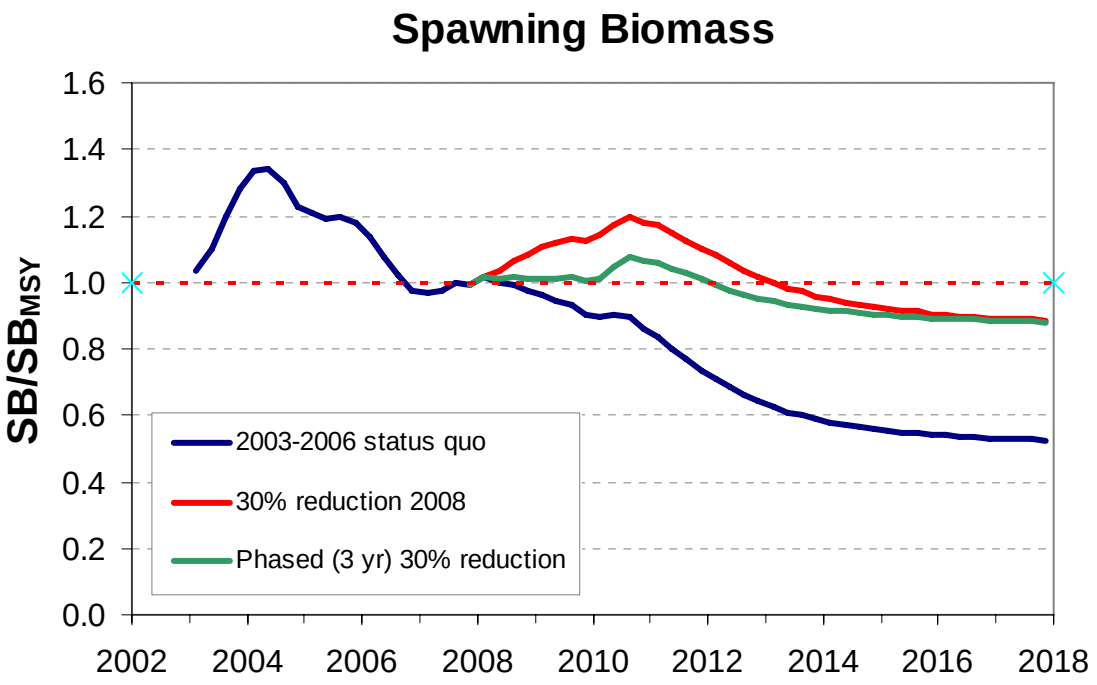

Figure 8. Estimated (2003–2006) and projected $SB_{current} / \widetilde{SB}_{MSY}$ for bigeye tuna based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at start of projection (2008), and reducing $F_{current}$ from the status quo by 10% per year over three years.

b. Management advice and implications

143. The SC recommended a minimum 30% reduction in fishing mortality from the average levels for 2003–2006 with the goal of returning the fishing mortality rate to F_{MSY}. The point estimate of the $F_{current\ (2003–2006)}/F_{MSY}$ ratio (1.44) in the 2008 assessment was higher than the point estimate (1.32) in the 2006 assessment. A recommendation of a 30% reduction in fishing mortality is consistent with the SC recommendation issued in 2006 of a 25% reduction. The SC acknowledged that projections indicate that the bigeye tuna stock may become overfished (biomass<B_{MSY}, spawning biomass<SB_{MSY}) in the future with regard to both total biomass and spawning biomass, even with a 30% reduction in fishing mortality. Therefore, it may be necessary to recommend additional reductions in fishing mortality in the future if assessments indicate that fishing mortality is greater than F_{MSY}.

144. The SC also provided alternative schemes (as shown in Attachment L, Figs. BET8–10 and Tables BET2–4) to achieve this reduction in fishing mortality and suggested that these results be seriously considered when management measures are discussed.

145. The SC reiterated SC2's advice that exploitation rates differ between regions and that exploitation rates are highest in the western equatorial region; therefore, the SC recommended a reduction in fishing mortality throughout the WCPO from all major fishing types with priority in the western equatorial region.

146. Regarding the Commission's request for advice on the potential for technological solutions to minimize the impact of fishing gear for small tuna on floating objects (or juvenile yellowfin and bigeye tunas) while minimizing the impact on the skipjack fishery (WCPFC4 Summary Report, paras 286–287), the SC noted that research was reviewed by the SC and is still ongoing in this area, but it had no further recommendations for the Commission beyond those provided by SC2. This issue was further discussed under agenda item 5.3.

147. In relation to the Commission's request that the SC will also provide information, analysis and evaluation of relevant management options (WCPFC4 Summary Report, paras 279–280), the SC noted that Tables BET2 and BET3 in Attachment L contain information on the impact of fishing effort reductions by the main categories of fishing fleets on F/F_{MSY} and B/B_{MSY}.

4.2 WCPO yellowfin tuna

148. No stock assessment was undertaken for WCPO yellowfin tuna in 2008. Therefore, the stock status description and management recommendations from SC3 are still current.

4.3 WCPO skipjack tuna

a. Status and trends

149. The major conclusions of the skipjack assessment are essentially unchanged from the last three assessments (2002, 2003 and 2005) and Table 2 compares reference points between the 2008 and 2005 assessments. According to the key conclusions of the models presented, overfishing is not occurring and the stock is not in an overfished state. These conclusions are similar to the model runs from the 2005 base-case assessment. Depletion levels estimated in the 2005 WCPO assessment (0.86) were similar to the current equatorial model (0.66), $F_{current}/\widetilde{F}_{MSY}$ was more optimistic (0.17 for 2005 compared with 0.26) and $B_{current}/\widetilde{B}_{MSY}$ was essentially the same (3.01 for 2005 compared with 2.99, Table 2, Fig. 9). There is a zero probability that $B_{current}/\widetilde{B}_{MSY}$ is below to 1.0 (Fig. 10).

Table 2. Estimates of reference points from the 2008 and 2005 skipjack tuna stock assessments. The spatial domain of the 2008 assessment is limited to the equatorial region of the WCPO. Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, the ranges shown for each reference point should not be compared across years. They should not be considered as confidence intervals.

Management Quantity	2008 Assessment	2005 Assessment
Most recent catch	1,546,436 mt (2007[1]) 1,726,702 mt (2007[2])	1,403,085 mt (2004[2])
MSY	Equatorial: 1,280,000 mt	Base case: 1,996,000 mt Range: 1,304,000 ~ 2,656,000 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Equatorial: 0.70	Base case: 0.46 Range: 0.45 ~ 0.63
$\mathbf{B_{current}/B_{current,\ F=0}}$	Equatorial: 0.66	Base case: 0.86 Range: 0.82 ~ 0.86
$\mathbf{F_{current}/F_{MSY}}$	Equatorial: 0.26	Base case: 0.17 Range: 0.08 ~ 0.34
$\mathbf{B_{current}/B_{MSY}}$	Equatorial: 2.99	Base case: 3.01 Range: 2.91 ~ 3.38
$\mathbf{SB_{current}/SB_{MSY}}$	Equatorial: 3.82	Base case: 3.72 Range: 3.21 ~ 5.00

[1] Equatorial region; [2] WCPFC Convention Area

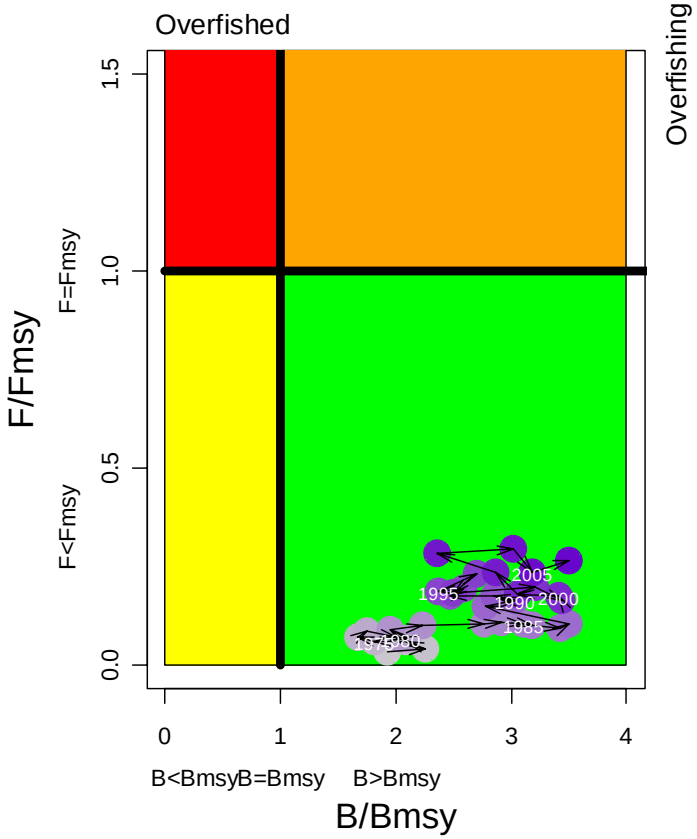

Figure 9. Temporal trend in annual stock status for skipjack tuna, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1972–2006) from the equatorial model. The color of the points is graduated from mauve (1972) to dark purple (2006) and the points are labelled at five-year intervals.

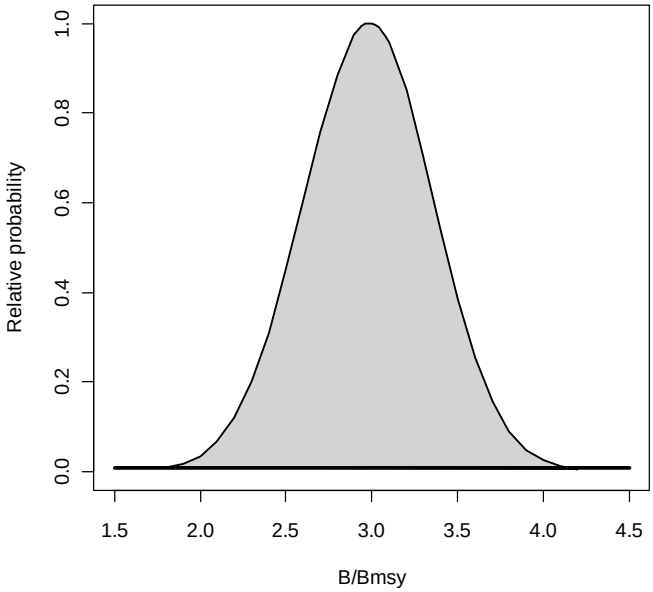

Figure 10. Likelihood profile for B/B_{MSY} from the equatorial model**.**

b. Management advice and implications

150. The SC acknowledged that skipjack catches in 2007 increased to a historical high of ~1.7 million metric tonnes. The SC noted the increasing trend in estimated recruitment throughout the entire time series of the fishery. This trend may reflect skipjack tunas' high productivity relative to other tuna species, as well as its position in the ecosystem. These high recent catches are considered to be sustainable unless recruitment falls persistently below the long-term average. However, any increases in purse-seine catches of skipjack may result in a corresponding increase in fishing mortality for bigeye and yellowfin tunas.

Discussion

151. The SC noted the increasing trend in recruitment throughout the fisheries' time series and the likely impact this trend has on the sustainability of current high catch levels. The SC discussed one potential ecological mechanism or theory to explain the increase in estimated biomass (and estimated recruitment) of skipjack tuna, despite the high catch levels. That theory suggests that the high productivity of the skipjack tuna stock might have allowed it to increase its component of the overall environmental carrying capacity, during the period in which the biomass of top predators (e.g. shark, billfish, and other tunas) has declined.

4.4 South Pacific albacore

a. Status and trends

152. The assessment results from the base-case model differ substantially from results from the 2006 assessment (Table 3), due to changes in relative abundance indices, selectivity and biological parameters for natural mortality and reproductive potential. These changes represent both refinements to the model and substantive changes to model structure, which reduced the biomass estimates and raised fishing mortality.

153. Table 3 compares reference points between the 2008 and 2006 assessments. The key conclusions of the models presented are that overfishing is not occurring and the stock is not in an overfished state (Fig. 11). Reference point levels estimated for the 2008 assessment were more pessimistic than for the 2006 assessment, depletion levels estimated in 2008 were 0.70 compared with 0.90 in 2006, $F_{current}/\widetilde{F}_{MSY}$ was 0.44 compared with 0.04 in 2006, $B_{current}/\widetilde{B}_{MSY}$ was 1.26 compared with 1.34 in 2006 and $SB_{current}/S\widetilde{B}_{MSY}$ was 2.21 compared with 4.10 in 2006 (Table 3).

Table 3. Estimates of reference points from the 2008 and 2006 South Pacific albacore tuna stock assessments (WCPFC and IATTC RFMO regions[1]). Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, the ranges shown for each reference point should not be compared across years. They should not be considered as confidence intervals.

Management Quantity	**2008 Assessment**	**2006 Assessment**
Most recent catch	59,495 mt (2007[2])	60,440 mt (2005[2])
MSY	Base case: 64,000 mt Range: 64,000 ~ 75,000 mt	Base case: 180,800 mt Range: 90,080 ~ 201,800 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Base case: 0.86 Range: 0.72 ~ 0.86	Base case: 0.33 Range: 0.28 ~ 0.59
$\mathbf{B_{current}/B_{current,\ F=0}}$	Base case: 0.70 Range: 0.70 ~ 0.77	Base case: 0.91 Range: 0.79 ~ 0.93
$\mathbf{F_{current}/F_{MSY}}$	Base case: 0.44 Range: 0.25 ~ 0.44	Base case: 0.04 Range: 0.03 ~ 0.11
$\mathbf{B_{current}/B_{MSY}}$	Base case: 1.26 Range: 1.26 ~ 1.50	Base case: 1.34 Range: 1.13 ~ 1.48
$\mathbf{SB_{current}/SB_{MSY}}$	Base case: 2.21 Range: 2.21 ~ 2.90	Base case: 4.10 Range: 2.86 ~ 6.11

[1] IATTC = Inter-American Tropical Tuna Commission; RFMO = regional fisheries management organizations

[2] entire South Pacific Ocean

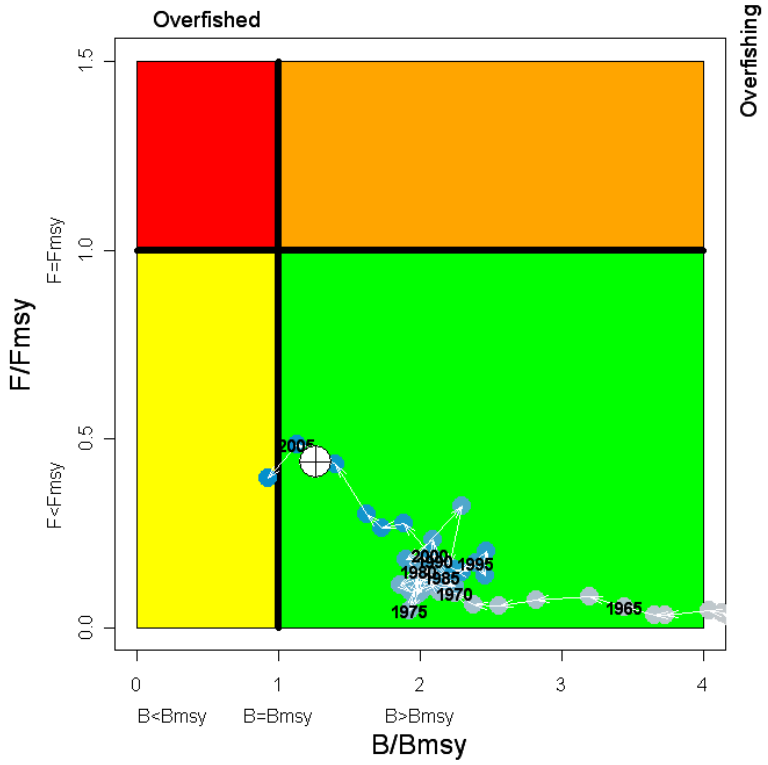

Figure 11. Temporal trend in annual stock status for South Pacific albacore tuna, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1960–2006) for the four main alternative models. The color of the points is graduated from pale blue (1960) to blue (2006) and the points are labelled at five-year intervals. The last year of the model (2007) is excluded as it is highly uncertain.

b. Management advice and implications

154. The current assessment indicates lower levels of stock size and maximum sustainable yield, which appear to be more realistic than previous assessments. There is uncertainty regarding the sustainability of the South Pacific albacore stock, and the SC recommended that catches of South Pacific albacore remain at current levels, considering the current rates of fishing mortality on adult albacore.

Discussion

155. The SC noted that despite improvements to model fit, and the removal of some biases, significant fitting problems remain, with the conflict between size and CPUE data still being apparent. In particular, recent fishing mortality estimates are uncertain, and $F_{current}/F_{MSY}$ is strongly affected by the structural uncertainty.

156. It was the general consensus that future work aimed at reducing parameter uncertainties for South Pacific albacore, including selectivity, and a better understanding of the recent CPUE trends (including oceanographic considerations and biological processes) is a high priority, and this should be reflected in the SC's future work programme. The need for an updated South Pacific albacore tuna assessment in 2009 was also acknowledged.

4.5 Southwest and south-central Pacific swordfish

a. Status and trends

157. Stock assessments were undertaken for two areas: the southwest Pacific (140^0E–175°W) and the south-central Pacific (175°W–130°W), both separately and combined.

158. The current status of biomass and fishing mortality (relative to MSY levels) for southwest Pacific swordfish are shown for a subset of plausible models in Fig. 12. Table 4 compares reference points between the 2008 and 2006 assessments. The subset of models represents the most extreme (highest and lowest) of the models in terms of a set of reference points. The 2008 estimates appear to be much more certain than in 2006, and near the center of the distribution of estimates provided in 2006. This reduction in uncertainty is what might have been predicted given that the recent reduction in fishing effort seems to have been sufficient to break the "one-way-trip" nature of the fishery that was observed up to 2003–2004, and hence appears to now provide informative contrast with which to improve the estimation of stock productivity. The model predicts that following a period of continued decline, the southwest Pacific swordfish biomass has recently increased.

159. The key conclusions of the models presented indicate that in the southwest Pacific, overfishing is not occurring and the stock is not in an overfished state (Fig. 12). Reference point levels estimated in the 2008 assessment were more optimistic than the 2006 assessment, $F_{current}/\widetilde{F}_{MSY}$ was 0.44 compared with 0.71 in 2006, although $B_{current}/\widetilde{B}_{MSY}$ was 1.57 compared with 1.70 in 2006 (Table 4) and the range estimated in the 2006 assessment included more pessimistic estimates.

160. The stock assessment attempted for swordfish in the south-central Pacific was unable to determine the current stock status. It was also noted that the available data do not indicate evidence of significant fishery impacts in the south-central Pacific, but catches have increased in recent years to levels exceeding those in the southwest Pacific.

Table 4. Estimates of reference points from the 2008 and 2006 southwest Pacific swordfish stock assessments. Values shown correspond to the median of the maximum posterior density (MPD) estimates for the most plausible ensemble of models for each assessment (the minimum and maximum values are indicated below). Note that the swordfish assessment paper reported in trunked mass, although this table reports whole mass assuming that trunked mass = 0.723 (whole mass), and the average catch in mass is derived from numbers assuming 67.2 kg per fish in 2004 and 61.1 kg per fish in 2007 (which may differ from the model estimates).

Management Quantity	2008 Assessment	2006 Assessment
Most recent catch[1] (mt)	2580 (final year = 2007[2])	3760 (final year = 2004)
MSY (mt)	Median: 3310 Range: 2390–5720	not reported
C_{2007}/MSY	Median: 0.77 Range: 0.45–1.08	n/a
$B_{2007}/B_{2007,\ F=0}$ (B=total biomass)	Median: 0.58 Range: 0.45–0.79	n/a
$B_{2004}/B_{2004,\ F=0}$ (B=total biomass)	Median: 0.55 Range: 0.44–0.74	Median: 0.59 Range: 0.31–0.69
F_{2007}/F_{MSY}	Median: 0.44 Range: 0.18–0.67	n/a
F_{2004}/F_{MSY}	Median: 0.71 Range: 0.37–1.13	Median: 0.70 Range: 0.33–2.2
B_{2007}/B_{MSY} (B=total biomass)	Median: 1.57 Range: 1.22–2.06	n/a
B_{2004}/B_{MSY} (B=total biomass)	Median: 1.47 Range: 1.18–1.94	Median: 1.7 Range: 0.87–3.0

[1] Catch in mass for this table was not derived from the model results and may not be entirely compatible with other reference points.

[2] 2007 catches are provisional, with 2007 catches from some fleets assumed to be equal to 2006.

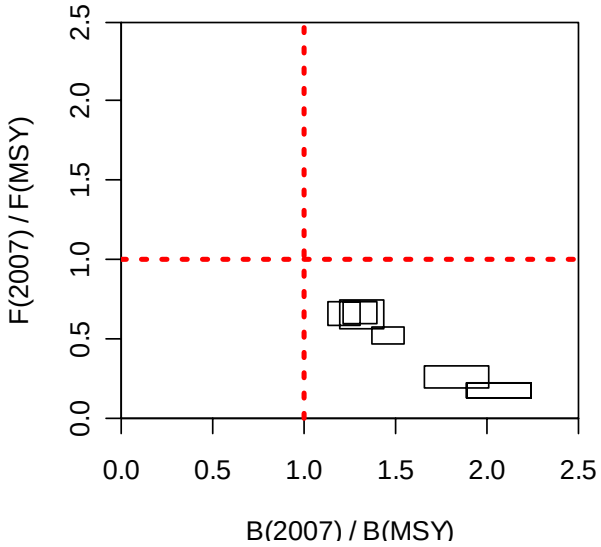

Figure 12. Summary plot comparing southwest Pacific fishing mortality, F(2007)/F(MSY), and total stock biomass, B(2007)/B(MSY), for southwest Pacific swordfish from a subset of plausible MULTIFAN-CL models. Boxes indicate the upper and lower 95% confidence limits (but not the covariance) for each individual model.

b. Management advice and implications

161. The assessment undertaken for swordfish in the southwestern Pacific region indicated an increase in stock abundance in recent years, and model projections predict further increases at current fishing mortality levels. Plausible assessment results indicate that overfishing is not occurring and that the stock is not in an overfished state. However, due to the uncertainty in the assessment, the SC recommended that there be no further increase in catch or effort in order to keep the stock above its associated reference points.

162. The SC recommended that there be no increases in fishing mortality for south-central Pacific swordfish as a precautionary measure, given the lack of a formal assessment. Constraining fishing mortality to current levels is recommended until there is a better understanding of fishing impacts in the south-central Pacific stock and the relationship between this stock and other South Pacific stocks is more certain.

4.6 Southwest Pacific striped marlin

163. No stock assessment was undertaken for striped marlin in the southwestern Pacific Ocean in 2008. Thus, the stock status description and management recommendations from SC2 are still current.

4.7 Northern stocks

164. G. Sakagawa, Chair of the ISC, summarized the 8th Meeting of the ISC and the status of northern stocks. He noted that the report of the recent 8th plenary session, including seven reports from intercessional meetings as annexes, was available on ISC's website. Highlights for the past year included completing an assessment of Pacific bluefin tuna, an analysis of the geographic

center of abundance for North Pacific striped marlin, and progress on development of potential biological reference points for North Pacific albacore.

4.7.1 North Pacific albacore

a. Status and trends

165. No stock assessment was conducted for this species in the past year. However, Kobe plots were produced for various biological reference points. As discussed in the ISC working group reports, this exercise demonstrated some of the difficulties faced when constructing such plots, particularly when stock assessment models change, projection timeframes may differ between short- and long-term, and there remains a lack of definition of management objectives.

b. Management advice and implications

166. The management advice presented by the ISC to the SC last year still holds. The key point of this advice — that F should not be increased from the current level (F=0.75, based on 2002-2004) — is still valid. The full text of the management advice can be found in the ISC8 plenary report.

Discussion

167. The SC highlighted the potential benefits of improving both northern and southern albacore assessments through running a single assessment for the Pacific through collaboration between scientists currently working on both assessments. The SC expressed concern about the continuing problem of data gaps and data access, which continue to hinder the ISC in undertaking comprehensive assessments; and whether the ISC is pursuing a process to ensure alignment of its data standards and processes with those adopted for the Commission.

4.7.2 Pacific bluefin tuna

a. Status and trends

168. N. Miyabe presented the results of the Pacific bluefin assessment, completed in May–June 2008, using the Stock Synthesis model. New age and growth data from otolith annuli were available for inclusion in the assessment. The assessment spans the period 1952–2005 and incorporates troll and longline CPUE indices; a fixed growth curve; age specific natural mortality (fixed) with very high natural mortality for youngest age class; and full maturity at age five years. The main fisheries occur around Japan, including longline fisheries in the spawning season, purse-seine fisheries, set net fisheries, and troll fisheries. Recent catches have been dominated by small fish (0+ and 1+ years old) and there have been recent catch increases by Mexico and Korea. Total annual catches are currently about 23,000 mt per year.

169. Longline CPUE has been strongly influenced by changes in the operation of the fishery, particularly changes in species targeted and areas fished. There is no single CPUE index spanning the entire time period of the model and a number of separate indices, covering different and, in some cases, non overlapping periods are incorporated in the model.

170. The stock assessment model estimates variable recruitment through the model period, resulting in three major peaks in spawning biomass through the model period. There has been an increase in fishing mortality rates during the last 10 years, principally for the youngest age classes.

Sensitivities with respect to the natural mortality schedule revealed that recruitment and spawning biomass was strongly influenced by the model assumptions. Other key sources of uncertainties are the level of fishing mortality and recruitment estimates for the recent year classes. A retrospective analysis indicated that the model is underestimating the most recent year's (2005) recruitment. This in turn affects the reliability of stock projections. Assumptions regarding the magnitude of the 2005 recruitment influence the stock status (spawning biomass) in the medium term. Projections also investigated the affect of increasing or decreasing fishing mortality.

b. Management advice and implications

171. The ISC provided the following conservation advice, which the SC believes is appropriate for managers to consider:

- Given the conclusions of the May–June 2008 stock assessment — with regards to the current level of F relative to potential target and limit reference points, and residual uncertainties associated with key model parameters — it is important that the current level of F is not increased.
- If F remains at the current level and environmental conditions remain favorable, then recruitment should be sufficient to maintain current yields well into the future.
- A reduction in F, in combination with favorable environmental conditions, should lead to greater yield per recruit (Y/R) and spawning stock biomass per recruit (SPR) and, after some lag, greater sustained yield.
- Increases in F above the current level, and/or unfavorable changes in environmental conditions, may result in recruitment levels that are insufficient to sustain the current productivity of the stock.

Discussion

172. Several points were raised regarding recent patterns and trends in Pacific bluefin catches. In response to a question about recent higher catches in Korea, the presenter noted that periods of high recruitment, including in 1994, 2004 and 2006, have been observed. It was explained that recent observations of Pacific bluefin off New Zealand also have an historical basis and that Pacific bluefin have been found off Australia, in the eastern Pacific and off Palau.

173. There was some discussion on the situation with regard to Pacific bluefin catches off Mexico. Concerns were expressed about limited size-frequency data available from Pacific bluefin catches transferred to Mexican aquaculture operations and it was suggested that efforts be made to increase sampling of these catches. In response to comments that the Mexican fishery has had poor catches in recent years, the presenter noted that catches were high in 2006 and it is difficult to use catch as an index of recruitment strength.

174. With regard to future assessment work, the presenter clarified that data through mid-2007 had been used in the recent assessment. Recently implemented reporting systems for Japanese longliners will now allow receipt of catch reports at 10-day intervals and thus facilitate the use of the latest data in assessments. The Pacific Bluefin Working Group will review the biological hypotheses as well as several problems encountered during the assessment in a planned series of workshop beginning in December 2008. An invitation was extended to SC participants to become involved in the next assessment.

175. Clarification was requested regarding uncertainty in the yield curve particularly for levels of fishing mortality less than the current level of F. The presenter indicated this may be related to

the uncertainty regarding natural mortality. In response to a suggestion that these uncertainties could be explored using historical tagging data, the presenter noted that the utility of these data would be limited due to a lack of information on reporting rates of tags from recaptured fish.

4.7.3 North Pacific striped marlin

a. Status and trends

176. The ISC Chair reported on the analysis conducted by the ISC on estimating the striped marlin stock biomass north of 20°N latitude in the western and central North Pacific Ocean. This work was requested by the WCPFC's Northern Committee (NC) and SC in an effort to determine if striped marlin could be considered a northern stock on the basis of stock biomass concentration. Assessment estimates of population number-at-age from the 2006 assessment and selectivity patterns and CPUE catchability coefficients from the Japanese distant water longline fleet were used in the analysis. The Japanese distant water fleet was used because it is the most consistent data source, with spatially disaggregated and comparable data by regions for the analysis. Results indicate that a majority (65–70%) of the estimated biomass of striped marlin in the western and central North Pacific Ocean occur north of 20° N latitude. This conclusion is consistent with the distribution of fishery catches.

Discussion

177. CCMs raised several questions regarding the assessment and analyses. It was noted that the assessment did not include areas in the southern hemisphere, even though it did apply spatial units above and below 20°N. G. Sakagawa replied that ongoing research and future assessments will investigate these issues, as well as revisit the question of whether there are one or two stocks in the North Pacific.

178. Questions were raised regarding the high correlation and match in the two steepness curves for the proportion above 20°N by year and whether confidence intervals had been calculated. Other comments on the paper pertained to model sensitivity, data used, variations in the proportion of the stock distributed north and south of 20 °N, as shown in the plot, changes in catchability and other biological parameters between areas. Given that the paper presented was a summary and the authors were not present, some of these concerns could not be fully addressed.

179. Some CCMs stated that the paper was not distributed in sufficient time to properly study it, and called for future full disclosure of ISC papers and supporting documents. These CCMs noted that the level of detail provided on this issue is much less than that for other tuna stock assessments at the SC. G. Sakagawa noted that the results of the ISC workshops are contained in plenary reports, which are available through the ISC website.

180. Some CCMs supported the findings of the paper. It was pointed out that the ISC made considerable effort to carry out the analyses and provided sufficient detail to address the task it was given.

181. The SC Chair explained that the Commission had requested that the NC form a working group with a view towards developing a conservation and management measure (CMM) on North Pacific striped marlin with SPC and FFA input, for consideration by SC4. However, this NC working group had been unable to collate the required information or draft a CMM for the SC to evaluate. It was noted that non-NC members agreed to the formation of this NC working group, only on the basis that participation was open and that the group delivered a draft CMM for

consideration by the SC. It was noted that this group failed to make any progress to date due to being formed late and a lack of active participation from CCMs. It was emphasized that only the SC can recommend to the Commission whether or not the North Pacific striped marlin can be classified as a northern stock.

182. It was noted that any CCM can submit a draft CMM if they are concerned about the status of a stock.

183. As a result, an informal small group (ISG) on striped marlin met during the SC. This group was facilitated by K. Bigelow (USA), and had the goal of progressing the work that had not yet been taken up by the NC working group. Background information available to the ISG included the 2007 ISC conservation advice, paras 32–40 of the NC3 Summary Report, paras 125–129 of the WCPFC4 Summary Report, a June 2008 letter from Australia to the WCPFC Secretariat, and a July 2008 letter from the WCPFC Secretariat to the NC Chair.

184. In order to facilitate developing a CMM for North Pacific striped marlin, the following concerns were noted by the ISG. There was active research by the ISC Billfish Working Group on North Pacific striped marlin; however, the lack of dissemination of working papers and assessments made it difficult to evaluate stock status and potential mitigation methods. An assessment summary from the ISC plenary indicates current high rates of fishing mortality on North Pacific striped marlin; however, there was no management guidance on a preferred reduction or range of fishing mortality reductions to consider in formulating mitigation measures, and the ISC noted the need for guidance on proxy biological reference points to focus that guidance. It was noted that CCMs are welcome to attend ISC meetings. The WCPFC Science Manager participated in this year's ISC meeting.

185. Due to this lack of information, the ISG produced a draft work plan addressing the issues requiring resolution for consideration by the SC. This outline work plan included the following elements.

i. Gear and operational modifications
   - Observer data indicate that striped marlin is primarily caught on shallow hooks in longline fisheries. Therefore, the magnitude of potential reductions in catching striped marlin by altering longline gear, such as removing hooks in proximity to floats and requiring longer floatlines and/or branchlines, must be evaluated.
   - Input from industry experts on methods for avoiding striped marlin is necessary.
   - Existing data (e.g. from Australia, Taiwan, USA) should be reviewed on hook type effects in longline fisheries that target striped marlin.

ii. Spatio-temporal and oceanographic considerations
   - targeting (shallow, deep and other) effects on longline catch rates should be analyzed.
   - survival rates during longline retrieval should be studied.

iii. Models must be developed to evaluate longline gear and operational modifications, spatio-temporal (time and/or area) closures and oceanographic effects in reducing fishing mortality.

186. Further discussion of the work plan focused on the existence of areas of localized abundance for striped marlin, which have been documented in the Indian Ocean, areas between Panama and the Galapagos, and off the Baja California peninsula. It was suggested that it might be possible to take management actions to protect these areas and thus minimize mortality.

187. The SC Chair suggested that the work plan could be further developed to include budgets and an implementation schedule, and could then be incorporated into the SC's work programme. Once further information is gathered, the aim will be to work towards reducing fishing mortality through specification of mitigation measures.

b. Management advice and implications

188. The previous management advice for North Pacific striped marlin is retained: that is, the fishing mortality rate should be reduced from the current level — 2003 or before — taking into consideration various factors associated with this species and its fishery, and until appropriate measures in this regard are taken, the fishing mortality rate should not be increased. The information presented was not sufficient to demonstrate that North Pacific striped marlin be classified as a northern stock.

4.7.4 North Pacific swordfish

a. Status and trends

189. A North Pacific swordfish stock assessment is scheduled for 2009.

b. Management advice and implications

190. Because there is no currently available North Pacific swordfish stock assessment, no management advice is offered.

4.8 Review of stock assessment and management related matters

a. Review of "A comprehensive review and proposed investigation of the age, growth, and reproductive biology of bigeye tuna in the Pacific Ocean"

191. S. Hoyle (SPC-OFP) presented a brief recap of the presentation given during the ME-SWG (WCPFC-SC4-2008/ME-WP-1). Outputs from mathematical and statistical models can be influenced by uncertainty in estimates of parameters used (known as parameter uncertainty) and by methods and assumptions used to construct and link parameters in a model (known as structural uncertainty). Sensitivity analysis was applied to the current bigeye tuna stock assessment to ascertain the influence of the structural assumptions on the reference point outputs of the model. The analysis examined the influence of alternative estimates of natural mortality, fecundity at length, spawning fraction at length and alternative maturity schedules. The effect of an alternative growth curve, and an alternative steepness assumption, were also assessed. The current stock assessment indicates that the fishing mortality exceeds F_{MSY}, and that the biomass is approaching B_{MSY} (WCPFC-SC4-2008//SA-WP-1). The model is more strongly influenced by precision in CPUE and length-frequency data than by the reproductive and growth parameters directly. This sensitivity analysis demonstrates that the model is also sensitive to the structural assumptions associated with estimating the reproductive and growth parameters. Alternative estimates for all reproductive and growth parameters and natural mortality influenced the spawning biomass reference points ($SB_{current}/SB_{MSY}$ and $SB_{current}/SB_0$) typically by more than 10% and influenced biomass (B/B_{MSY}) and the F-multiplier reference points by between 1% and 5%. The results support the need for further investment in knowledge acquisition to reduce the current level of uncertainty.

Discussion

192. It was noted that natural mortality-at-age for young fish is a potential source of parameter uncertainty in modeling bigeye tuna, and this has not been specifically examined in the sensitivity runs presented. It was explained that research on Indian Ocean bigeye tuna has indicated a two-stanza growth pattern, however when the WCPO model assumption for a von Bertalanffy growth pattern was relaxed, there was little deviation from the prior assumption indicating that a two-stanza pattern may not be applicable to Pacific bigeye tuna. It was also noted that tagging studies would help to reduce these uncertainties.

193. The SC generally supported future research on bigeye tuna age, growth and reproductive biology including temporal-spatial variation in spawning, as this is important in reducing uncertainty in model estimates of stock status. The SC recommended that the Commission approve funding for this work, particularly phase 1, so work could commence as early as possible.

b. Review of "A scoping study on reference points and management strategy evaluation (MSE)"

194. R. Campbell (Australia) reviewed the Commission's request to develop a report on "Approaches for identification of appropriate reference points and implementation of management strategy evaluation within the WCPO", as described in the terms of reference attached as Appendix 1 to WCPFC-SC4-2008/GN-WP-10.

195. This paper covered target and limit reference point definitions. It pointed out that reference points are ineffective without the appropriate management response and action by the fishing industry. The study found no strong reason not to use reference points based on MSY, and endorsed approaches used by the Commission's tuna assessments for evaluating stock status and its uncertainty. It recommended modest efforts to explore MSY-based reference points in relation to other candidate reference points, such as those based on SPR. The study suggests that target reference points should be set with buffers that take uncertainty into consideration. Management strategies need to be based on decision rules defining management actions to be taken when stock status approaches reference points. The study also suggests that when a harvest strategy is implemented without prior decision rules, projections can be very useful in illustrating potential outcomes from various management alternatives. The paper provided two overall recommendations for a work programme: a) the refinement and adoption of limit and target reference points and decision rules that would be used to guide management in the short term; and b) the implementation of the MSE approach for two case studies in the WCPO — broadbill swordfish and the complex multi-species skipjack, bigeye, yellowfin tuna fishery.

Discussion

196. The authors were thanked for providing very comprehensive work that addresses the terms of reference. However, some CCMs noted that due to the late availability of the paper, they required further time for review and requested that the authors present the work to the Commission.

197. Some concerns were expressed that several issues relating to the reference points and MSE work plan still remained to be addressed, such as a strategy for wider participation in the process, consideration for socioeconomic performance indicators, and the development of interim management strategies. It was also noted that substantial work is required to develop a management strategy, and that the proposed work plan was light on detail, especially in relation

to costs, benefits and difficulties. It was noted that for an MSE to be effective, full participation of all CCMs is required and that there must be initiatives to improve the understanding of the reference points and MSE approaches among all CCMs, particularly small island developing states (SIDS).

198. The choice of southwest Pacific swordfish as the one of the case studies was queried. The presenter responded that the authors had likely suggested this case study due to the fact that work presently underway in Australia on this species could provide much of the necessary data and modeling foundations to expedite an MSE application to swordfish in the broader WCPFC. Initiating an MSE on another species would take longer, but the priority of addressing other species such as South Pacific albacore was acknowledged. It was suggested that prioritizing species would be an efficient way to proceed.

199. There was discussion of the merits (or otherwise) of using different or the same operating and assessment models in MSE. It was suggested that one advantage of using separate assessment and operating models in MSE is that differences between the two models might provide a better reflection of the uncertainties in knowledge of the fishery and stock status.

200. The importance of the issue of specifying management objectives was discussed. It was noted that the complexity of progressing this issue had not been fully discussed in the paper, and it was suggested that a process to clarify management objectives was an urgently needed activity that should be progressed among and between commission members in parallel with the ongoing technical work on reference points and MSE. It was also suggested that achieving international consensus on management objectives would benefit from independent facilitation.

Recommendations

201. Having reviewed the working paper "Approaches for identification of appropriate reference points and implementation of MSE within the WCPO" (WCPFC-SC4-2008/GN-WP-10), the SC made the following recommendations:

- The SC reaffirmed the recommendations made at SC3 in relation to reference points and approaches to evaluating them.
- CCMs be given an opportunity to provide comment on the scoping paper and work plan to the WCPFC Secretariat and for those comments to be submitted by 15 October 2008.
- A revised version of the scoping paper and work plan that accounts for comments received should be presented to the upcoming Commission meeting to inform the Commission about the use of reference points (and approaches of evaluating them) in the management of highly migratory fish stocks in the WCPO.
- In progressing work on reference points the Commission should establish a parallel/joint process for establishing key management objectives for each target species, including the possibility of holding an intersessional workshop on management objectives in 2009; and
- Agencies such as the WCPFC and FFA Secretariats, and SPC-OFP should work together on a strategy to increase CCM capacity to participate in the revised work plan for 2009 and beyond.

202. As a means of progressing the work programme that commenced in 2007 on this topic, the SC also recommended that a technical intersessional workshop be held during 2009 (in conjunction with the intersessional pre-assessment workshop) to review the numerical and

technical properties of candidate reference points which may be used as default reference points in the WCPO. In particular:

- Consider the estimation properties of candidate reference points;
- Consider the stability in candidate reference points from one year's assessment to the next;
- Compare these with MSY-based reference points and consider their implications for SPR, SSB and B;
- Document any major concerns about the use of MSY-based reference points and any major advantages of using a different type of reference point;
- Identify alternative means of operationalizing candidate reference points.

203. It was proposed that the report of this technical workshop be discussed at SC5, from which the SC will make recommendations to the Commission on suitable reference points for managing key target species within the WCPO.

204. The SC recommended that the implementation of the MSE approach via case studies in the WCPO (e.g. broadbill swordfish, South Pacific albacore, or the complex multi-species skipjack, bigeye, yellowfin tuna fishery) be added as high priority research tasks to the SC's work programme for 2009–2011.

Implementation of the work plan

205. The SC discussed the two reference point work plan recommendations. The intersessional, pre-assessment workshop held at SPC-OFP was identified as the intended venue for the technical intercessional workshop on reference points. Provisional funding of USD10,000 was identified at SC3 to help facilitate progress on reference points and MSE during 2009, although it was noted that more funding may be needed to fully fund an additional three-day workshop on reference points and MSE. SPC agreed to estimate a budget for this for consideration under agenda item 9.

206. Concern was voiced that all involved parties need to have an understanding of the issues involved concerning reference points and MSE. In response, it was pointed out that the recommendation adopted above (in para 201) regarding increasing CCMs capacity to participate in the revised work plan, is intended to cover the issue of bringing all CCMs on board. Regarding the capacity building recommendation, it was noted that this could be facilitated via an additional intersessional training workshop, particularly if some capacity building expertise could be provided.

AGENDA ITEM 5 — BYCATCH MITIGATION

5.1 Seabirds

a. Review of CMM-2007-04 and CCM estimates of seabird mortality presented in Part 1 of Annual Report

207. Under CMM-2007-04, CCMs shall annually provide to the Commission, in Part 1 of their Annual Reports, all available information on interactions with seabirds, including bycatches and details of species, to enable the SC to estimate seabird mortality in all fisheries to which the WCPF Convention applies. The SC noted that SPC had initiated work in estimating catches of non-target species, including seabirds and sharks, based on available observer data.

208. The SC noted WCPFC-SC4-2008/EB-WP-3 and reported that there were particular areas that were likely to have a high risk of seabird interaction. In some areas with a high risk of seabird interactions, there is a need for greater observer coverage and management measures. While seabird interactions are greatest in high latitudes, the SC also recognized the potential for interactions in tropical areas, with some petrel species having been classified by the International Union for Conservation of Nature (IUCN) as threatened.

209. The SC reviewed the reporting of shark, seabird and sea turtle catches in Part 1 of Annual Reports as a useful way of summarizing bycatch information required by CMMs and Resolutions. It noted that as of 18 August 2008, 26 out of 34 CCMs had submitted a Part 1 of Annual Report. Sixteen of those 26 reports indicated that observers had been deployed by the CCM in 2007. Seven of the 26 reports included estimates of seabird catches required by CMM-2007-04. It was noted that data in Part 1 of the Annual Reports were provisional for some CCMs.

Discussion

210. One CCM expressed the opinion that seabird bycatch was only an issue in temperate areas, and not in tropical areas. Other CCMs noted that there had been observed seabird bycatches in both temperate and tropical areas, but that seabird bycatch occurred at a lower rate in tropical areas. It was clarified that, in relation to tropical seabirds of concern, the term "threatened" was being used in a technical context, with the IUCN ranking for risk of extinction used as a measure.

b. Review of research on seabird interactions and mitigation measures

211. Under CMM-2007-04, CCMs are encouraged to undertake research to further develop and refine measures to mitigate seabird bycatch (including mitigation measures for use during the hauling process) and should submit to the Commission any information derived from such efforts. The SC noted two studies of the effectiveness of tori line configurations in reducing seabird interactions. The SC encouraged Japan to continue to work on streamer-line design, in collaboration with other researchers.

c. Review of technical specifications of seabird mitigation measures

212. CMM-2007-04 directs CCMs to submit to the Commission detailed information describing the minimum technical specifications being used in fulfilment of this measure as well as any data resulting from research undertaken and/or monitoring measures to further develop and refine measures to mitigate seabird bycatch.

213. The SC noted that the EB-SWG had discussions on whether the experimental tori lines tested in WCPFC-SC4-2008/EB-WP-7 met specifications outlined in CMM-2007-04. Those discussions identified possible ambiguities in the wording of tori line specifications. The specifications do not indicate a minimum number of streamers or the aerial extent of streamer coverage. The SC recommended that the WCPFC Secretariat seek advice from other RFMOs on the wording of CMM-2007-04 [see WCPFC4 Summary Report, Attachment O, Annex 1, 1 a) (iv) and 1 b) (iv)] to ensure that tori lines include branch streamers along the aerial extent of the line and that in 1 a) (iv), the branch streamers are of a length that ensures that they would touch the surface of the water in the absence of wind and swell. The issue will be further discussed by TCC4, but the TCC will need to make sure that it has access to advice from an appropriate range of experts.

5.2 Sharks

a. Review of CMM-2006-05 and CCM reports on shark catches presented in Part 1 of Annual Reports

214. On the basis of advice from the SC, CCMs shall review the implementation and effectiveness of CMM-2006-05 and shall consider the application of additional measures for the management of shark stocks in the Convention Area, as appropriate. The SC noted that the current limit on shark fin landings (5% shark fin–carcass ratio) was reviewed at last year's meeting and found to be appropriate. No additional information was presented to the SC this year, so it was not necessary to modify that advice. A variety of other measures employed by national governments to limit shark mortality were noted, including bans on longline wire leaders, catch limits, and regulations to have sharks landed with the fins attached.

215. The SC noted that, based on the ERA work presented in WCPFC-SC4-2008/EB-WP-1, there is no apparent difference in the catch rates for sharks caught by longliners longer or shorter than 24 m overall length. The SC recognized that there appears to be no scientific basis to justify the current exemption for small vessels. The SC recommended that the shark measure be revised to include vessels under 24 m.

216. The SC noted that as of 18 August 2008, 11 of the 26 Part 1 Annual Reports included estimates of shark catches as required by CMM-2006-05 and recommended by SC3. It was noted that the data in Part 1 of Annual Reports are provisional for some CCMs.

b. Identification of key shark species for annual reporting to the Commission

217. Under CMM-2006-06, each CCM shall include key shark species, to be identified by the SC, in their annual reporting to the Commission of annual catches, and catch and fishing effort statistics by gear type, including available historical data, in accordance with the WCPF Convention and agreed reporting procedures. SC participants recognised that the identification of key shark species had at least two aspects: a) the requirement of CCMs to report shark catches; and b) the need to assess key shark species. SC3 recommended that CCMs report shark catches to the lowest possible taxonomic level. This recommendation recognized that fishermen cannot always be expected to accurately identify all shark species, while observers — with appropriate training — can provide that level of data. SC3 recognized that collecting catch data only on the most abundant species would bias analyses and assessments towards the more productive species and would potentially miss the less productive species that may be at higher risk.

218. The SC recommended that CCMs report on a minimum list of shark species, consisting of blue shark, oceanic whitetip shark, mako sharks and thresher sharks, which are easily identified by fishermen. These and other sharks should be identified to the lowest possible taxonomic level, especially by observer programmes, and these four easily identified sharks should be recorded even in logbooks by fishermen. The SC also suggested that, although it is not easy to identify, the silky shark, which appears to be prominent in the ERA, probably comprises the majority of other sharks caught. Therefore, all other sharks should be reported in aggregate in logbooks, if identification to a lower taxonomic level is not possible.

219. The SC acknowledged that it may be difficult to identify all of the proposed shark species in some fisheries because of harvesting practices and different levels of encounter rates. It was

suggested that when requiring the identification of certain shark species, a staged approach be used in implementation to ensure data quality.

c. Stock assessments for key shark species

220. The SC noted that under CMM-2006-05, CCMs are encouraged to cooperate in the development of stock assessments for key shark species within the Convention Area. The SC recognized that the identification of key shark species will be important for further assessment. The SC suggested that, while the ERA is underway, it would be important to start assembling the necessary biological and fisheries data so that a time-lag does not occur after the ERA is completed. Such information included studies of age, growth and maturity, observer data on size and sex ratio, and the standardization of catch rates. Preliminary ERA results suggest that silky sharks and oceanic whitetip sharks might require special attention. The SC recommended that a review of data gaps and the general feasibility of single species stock assessment for sharks be carried out.

d. Development of a Shark Research Programme

221. The SC noted that the feasibility study mentioned under agenda item 5.4.c would be an important step in developing a Shark Research Programme. Outputs of the feasibility study should be reviewed by future meetings of the SA-SWG and ME-SWG.

5.3 Small tuna on floating objects (STFO)

222. In response to CMM-2005-01 para 15, in relation to purse-seine effort on FADs and recommendations arising from SC1, SC2, SC3 and the SA-SWG session held during SC4, the SC reviewed research outcomes and information relevant to the reduction of fishing mortality on STFO. Summary of information considered by the FT-SWG session held at SC4 relevant to the reduction of fishing mortality on STFO was also presented. The current status of research and ongoing studies related to purse-seine selectivity was reviewed.

Advice to the Commission

223. Recommendations for further study or industry-associated work endorsed by the SC included:

- A comparative analysis of the proportions of STFO in the WCPO, as the purse-seine CPUE for bigeye tuna appears to be higher in the central Pacific, although it is an area with relatively low purse-seine effort.
- A detailed characterization of vessels or fleets that have high catch rates of STFO and bigeye tuna in particular.
- Monitoring and reporting to SC5 the results of the EC acoustic selectivity project and IATTC pilot study on pre-set estimation of floating object aggregations.
- CCMs are encouraged to develop industry-associated projects to address STFO reduction, emphasizing means to avoid encircling STFO.
- CCMs are encouraged to continue work on fine-scale characterization of tuna behaviour on floating objects, particularly on horizontal movements of tuna species.
- The convening of a workshop or working group consisting of scientists, observer programme representatives, vessel owners and fishing captains to develop collaborative projects to seek ways to avoid STFO and bigeye tuna in particular on floating object sets.

- The operational research plan for 2008–2009 and medium-term work plan of the FT-SWG as adopted under agenda item 3.1.

224. It was suggested that the SC note that the working group acknowledged that PNA members have adopted a package of measures, including seasonal closures of purse-seine fishing on floating objects within their EEZs to reduce fishing mortality on small bigeye and yellowfin tunas, including the provision for 100% observer coverage.

5.4 Sea turtles

a. Review of Research Programme and WCPFC2 Resolution

225. Resolution 2005-04 encourages CCMs to collect, and provide to the WCPFC, all available information on interactions with sea turtles in fisheries managed under the WCPF Convention. The SC noted that as of 18 August, 7 of the 26 Part 1 Annual Reports included estimates of sea turtle catches recommended by Resolution 2005-04. It was noted that for some CCMs the data in Part 1 of the Annual Reports are provisional.

226. The SC noted that FFA members have developed an Action Plan to reduce the impact of fishing on sea turtles as a responsible step under the flexible approach embodied in the WCPFC Resolution. FFA members also highlighted the environmental and cultural importance of turtles to many CCMs and looked forward to presenting information on implementation of the Action Plan at future meetings of the SC.

227. SC4 reiterates the recommendation of SC3 that a flexible approach to sea turtle bycatch mitigation be maintained.

b. Review of research on sea turtle interactions

228. With the exception of WCPFC-SC4-2008/EB-IP-5, which tabled preliminary estimates of bycatch by Spanish fleets targeting swordfish, no new research on sea turtle interactions was presented and the SC offered no recommendations on those measures. However, some participants did suggest that greater priority be given to educating fishers on releasing turtles, rather than simply focusing on hook type. The EB-SWG and SC last year did reach agreement that vessels should carry release equipment such as line cutters, de-hookers and dip nets. Participants noted that survival rates of entangled turtles can be very high if released appropriately, and that entanglement of leatherback turtles is more prevalent than mouth hooking. Some studies on hook types have suggested that large circle hooks can significantly decrease the incidence of entanglement because they reduce the chance of foul (flipper) hooking.

c. Review of mitigation measures

229. WCPFC4 requested that a small working group, under the leadership of R. Clarke (USA), map out a process through which momentum can be maintained to bring a draft measure to WCPFC5. The SC received a verbal report from R. Clarke on progress in developing a draft CMM on sea turtles.

230. The SC reviewed the results of large-scale experiments on the effects of circle hooks and bait type on longline catches. The SC noted the importance of ensuring that bycatch mitigation research also assesses impacts on other species, especially those that have management concerns of their own, and indicated that many circle hook trials have done this. The importance of giving

priority to those species that are vulnerable or at risk was noted. Other measures and practices are available to reduce mortality of many other non-target species, and often those measures and practices are quite effective and easy to implement compared to those for high-risk species such as sea turtles.

5.5 Ecological risk assessment (ERA)

231. D. Kirby (SPC) presented a summary of progress on the three-year (2008–2010) Ecological Risk Assessment (ERA) Research Plan, which was approved by SC3 in August 2007 and by WCPFC4 in December 2007. The purpose of the ERA project is to assist the Commission in meeting its obligations to assess and to minimize the risk of long-term or irreversible effects of fishing operations on non-target species. Details of this presentation are contained in paras 4–16 of the EB-SWG report (Attachment H).

Activities carried out in 2007/2008[1]

232. Since SC3, priority has been given to national-scale productivity-susceptibility analyses (PSAs) for SIDS, which have been carried out for Nauru, Federated States of Micronesia and Kiribati. In addition, collaborative analyses with colleagues in New Zealand and USA (Hawaii) have been carried out, which led to useful method development and results that can be applied in regional analyses. SC recognises the goodwill of these CCMs in consenting for their observer data to be analysed by SPC-OFP and presented to SC.

233. The PSA for fish species caught in Hawaii longline fisheries considered deep and shallow setting, for periods before and after a shark finning ban. The results show a significant decrease in shark mortality, from ca. 40% to >80%, which is reflected in the PSAs.

234. The PSA for seabird and marine mammals in New Zealand waters used the spatial overlap between species distributions and fishing effort to determine susceptibility. When the PSA results were mapped to fisheries statistical areas, they confirmed some known areas of high potential for fisheries interactions and also flagged other areas as being at relatively high risk. The analysis therefore indicated where observer effort could be directed to check whether seabird interactions really are higher there. This study demonstrates the potential utility of ERA in directing observer effort under the ROP.

235. Additional plots of observed interactions of WCPO longline fisheries with seabirds, sharks, turtles and marine mammals were presented. The general conclusions are that seabird interactions are of most concern in temperate waters, turtle encounters are of most concern in tropical waters, and shark and marine mammal encounters have been observed throughout the fisheries, though shark encounters are several orders of magnitude more common. However, present levels of observer coverage are not adequate to determine that seabird interactions are not occurring in tropical waters.

236. An evaluation of the WCPFC CMMs on sharks (CMM-2006-05) and seabirds (CMM-2007-04) was carried out. Presently these CMMs apply only to vessels >24 m in length (for seabirds this exemption only applies to the area north of 23ºN) but there is no scientific basis for this exemption. A previous study has estimated that of the 3500 longliners in the WCPO that are >14 m in length overall, only 500 are >24 m. SPC-OFP showed that catch rates for sharks do not

differ for longer vs. smaller vessels. Although there is an apparent difference in seabird catch rates depending on vessel size, this is likely to be confounded by the spatial heterogeneity of seabird distributions.

237. Estimates of declining catches and catch rates for several shark species were presented. More observer data and further analyses are necessary to improve the confidence in these results. However, the declining trends in catches and catch rates in the absence of effective mitigation measures across the Convention Area are of concern.

238. PSAs for purse seine fisheries were also presented. Unassociated sets catch the smallest number of non-target species in the smallest proportion relative to target species. Associated sets clearly impact upon a greater number of species and in greater proportion. PSA results indicate that silky shark and oceanic white-tip shark are at high apparent risk from tropical purse seine fisheries, as well as from longline fisheries.

239. SPC-OFP held a two-day ERA Training Workshop for colleagues from SIDS in June. SPC have also participated in an initiative in collaboration with FFA and SPREP to develop a Pacific Islands Regional Plan of Action (PI-RPOA) on Sharks.

Activities planned for 2008/2009

240. For the period 2008/2009 (i.e. from SC4 to SC5) national scale analyses are planned for Papua New Guinea, Samoa, Marshall Islands, New Caledonia and French Polynesia.

241. In further collaboration with CCMs and NGOs it is planned to extend the seabird ERA work into high seas areas.

242. Through further development of regional-scale PSAs, incorporating estimated trends in shark catches and catch rates, SPC-OFP will identify key shark species at high apparent risk from fishing.

243. SPC will carry out several turtle bycatch mitigation projects with FFA and certain CCMs.

Discussion

244. Draft recommendations were discussed by the SC. Some CCMs expressed concerns that the recommendations covered a wide range of issues, some of which are duplicated under other agenda items. In response, it was noted by several other participants that the intent of ERA work is to provide a wider focus and support many of the conclusions and recommendations associated with specific issues (e.g. seabirds and sharks).

245. It was noted that the ERA project represents a significant part of the Commission's scientific budget over three years, and that a high level of investment by the Commission needs to be matched by ongoing and widely focused results.

[1] The SC4 cleared the text associated with these two ERA activity sections but this was inadvertently omitted from the Draft Summary Report considered on Friday, 22 August 2008.

Advice to the Commission

246. The SC recognized that the ERA project has provided several outputs that have helped formulate recommendations under other agenda items.

247. The SC recognized:

- the role of ERA in identifying at-risk bycatch species, including "key shark species", for further research or management action, and encourages further work in this area.
- that further work to determine catches and catch rates of non-target species is also strongly encouraged. CCMs were invited to collaborate with SPC-OFP in order to facilitate this work.
- that in purse-seine fisheries, unassociated sets catch the smallest number of non-target species in the smallest proportion relative to target species.
- that CCMs are encouraged to produce identification and handling guides for bycatch species such as sharks, turtles and seabirds, for distribution to observers and fishers. CCMs were invited to discuss the translation and printing of existing guides with SPC-OFP.

5.6 Other matters

248. The SC noted that the development of the WCPFC bycatch mitigation database system had progressed during the past year and test data have been added to the system. Access to and dissemination of these data will be governed by the Commission's data security policies.

AGENDA ITEM 6 — DATA AND INFORMATION

6.1 Issues related to data gaps

a. Data gaps website and achievements toward filing gaps

249. The major developments over the past year with regard to filling data gaps include:

- Some progress has been made in improving the collection of data in the Philippines and Indonesian domestic fisheries.
- The size composition data provided by Chinese Taipei (2005–2007) and Korea (2007) for their distant water longline fleets now satisfy the criteria documented in the specification of Scientific Data to be provided to the Commission.
- Japan and Korea have provided updates to their aggregate longline catch and effort data (which now describe their operations over the entire Pacific Ocean).
- Formal authorizations for provision of historical operational data to the WCPFC have been received for New Zealand and the USA purse-seine treaty data.
- There were some improvements in the timeliness in the provisions of annual catch estimates and aggregate catch and effort data, but there were some provisions of data that did not satisfy the criteria documented in the specification of Scientific Data to be provided to the Commission.
- A prototype system has been developed to register the details of provisions of scientific data to the WCPFC.

250. Many data gaps remain. It is common for CCMs to not meet the specification for Scientific Data to be provided to the Commission, which was adopted at WCPFC4.

251. The SC noted that there are two issues: data that are required but have not been provided; and data that have been provided but which require administrative authorization to release. Of the two issues, the former was seen as a higher priority to resolve.

252. One CCM questioned whether it was not a priority to obtain data on illegal, unreported and unregulated (IUU) fisheries, rather than simply focusing on those data pertaining to CCMs' fishing activities.

Advice to the Commission

253. Based on the presentation and discussion, the SC urged:

- CCMs that have not yet provided both current and historical operational (and other) data to the Commission to do so as a matter of urgency, in accordance with the specification for Scientific Data to be provided to the Commission; and
- CCMs that have not already done so to provide SPC with formal authority to release their historical data, including operational data, to the WCPFC.

b. Review of "A study to identify causes of data gaps in the work of the WCPFC"

254. SC3 discussed the data required to support stock assessment and ecosystem and fishery management, and recommended that the WCPFC conduct a study to identify causes of data gaps. The study was endorsed by WCPFC4 in December 2007. FishServe Innovations New Zealand Ltd was engaged by the WCPFC Secretariat to undertake the data gaps study. The primary tool for gathering information on the causes of data gaps was a questionnaire. The questionnaire was circulated to all CCMs on 1 July 2008. Each CCM was prompted on at least three occasions to complete and return the questionnaire. Four CCMs responded to the questionnaire within the time frame specified (which would have allowed results to be presented at the SC4-ST-SWG). This low response rate limited the study's ability to make specific recommendations.

255. In response to appeals from the ST-SWG, a further 12 CCMs subsequently provided completed questionnaires in the week starting 11 August 2008.

256. It was suggested that, if necessary, the information requested in the questionnaires could be obtained through interviews with the relevant CCMs by telephone.

Advice to the Commission

257. The SC recommended that all CCMs complete and submit responses to the data gaps questionnaire by email by 31 August 2008, and that an updated analysis be presented for information at WCPFC5.

c. Species composition of purse-seine catches

258. Paper WCPFC-SC4-2008/ST-WP-2 noted that multi-species sampling is of key importance in estimating the true catch of tuna species taken by surface fisheries, as some species are widely misidentified in most logbook and landing statistics. This misidentification artificially increases the catch estimates for some species and artificially decreases estimates for other species. Both observer programmes and port sampling have been widely used to estimate the complex mixture of sizes and species that are observed on FAD schools. Historically, each sampling type has had inherent biases. Paper WCPFC-SC4-2008/ST-WP-3 (Factors affecting the use of species composition data collected by observers and port samplers from purse seiners in

the WCPO) identifies significant differences in species compositions of catches from associated schools, depending on the sampling method.

Table 5. Species composition of catches as determined by different sampling methods

Tuna Species	Observer Data	Port Sampling Data
Skipjack	55.3%	72.4%
Yellowfin	35.1%	19.8%
Bigeye	9.6%	7.8%

259. Several factors might explain the differences in estimates of species composition. Port sampling data may be subject to set weight bias, grab sample bias, and well mixing, all of which result in an over-estimation of the proportion of skipjack and an under-estimation of the proportion of yellowfin. Observer data may be subject to grab sample bias and size selection bias. A new sampling protocol was tested by SPC-OFP in March 2008. Under the "spill sample" protocol, fish were spilled from every tenth brail directly into a bin. The observer then measured all of the fish in the bin. Spill samples are three times larger than grab samples, and this may reduce the observer's ability to collect other types of data.

260. Observers have the unique ability to measure discards and interactions with species of concern, and are able to sample before the catch is sorted, layered in wells or transhipped. The Commission's commitment to a comprehensive Regional Observer Programme would mean that port sampling was an additional, not an alternative, cost.

261. The design and implementation of a reliable catch sampling methodology is a very high priority. Ideally, there would be a worldwide solution and a collaborative approach among tuna RFMOs.

Discussion

262. Some participants expressed their support for the spill sampling project and suggested that CCMs encourage their fishing vessel operators to cooperate with observer programmes as they take up the method. It was further noted that the spill sampling and port sampling methods both required cooperation from the fishing industry, and the recommendations needed to reflect this.

263. One CCM noted that the Commission needed advice on how to use the data thus collected to correct the catch estimates generated.

Advice to the Commission

264. The SC recommended that catch sampling programmes should be designed to overcome sampling biases and other issues raised by WCPFC-SC4-2008/ST-WP-2 and WCPFC-SC4-2008/ST-WP-3. Sampling designs should build on further comparative trials, which should include both observer sampling versus port sampling, and also comparison among different techniques within observer and port samplings.

265. The SC encouraged CCMs and the fishing industry to support the trials.

266. The SC recommended that the Commission's scientific service provider review ways of correcting historical catch sampling data, and that a future meeting of the SC consider that review.

d. Information on seabird mortality

267. Identifying seabirds can be a problem for observers and vessel masters. Additionally, SC2 (paras 192 and 197 of the SC2 Summary Report) recommended that:

- The objective of the regional observer programme should initially be to attain a minimum coverage of 5% of fishing effort (longline: total hooks deployed; purse seine: days fished and searched) across all strata to allow identification of specific issues. The distribution of observer effort is to be representative of species of interest, fishing areas, seasons, and fishing fleets (types); and
- The data collected from initial levels of coverage should be used to further determine the levels of coverage required to address specific issues of concern to the Commission. For example, coverage rates may need to be higher in certain areas or circumstances to obtain reliable estimates of the catch of some species (e.g. seabirds, sea turtles, marine mammals) or species populations that are particularly vulnerable, for fisheries for which information is currently unavailable, and for other specific issues of concern to the Commission.

Advice to the Commission

268. The SC:

- Recommended that seabird identification guides be made available to observers and vessel masters; and
- Emphasized the recommendation made at SC2 that the objective of the Regional Observer Programme should initially be to attain a minimum coverage of 5% of fishing effort across all strata; and the distribution of observer effort is to be representative of species of interest, fishing areas, seasons, and fishing fleets.

e. Information on shark catches

269. No new information or recommendations on shark catches was available during the ST-SWG discussions on shark catches, and no provisional text or recommendations were put forward to the SC on this topic under this agenda item. However, it was noted that the reporting of shark catches presented in Part 1 of Annual Reports by CCMs was discussed by the EB-SWG. The SC reviewed, but did not add to, the relevant section of EB-SWG report (5.2 a, para 10).

6.2 Regional Observer Programme (ROP)

270. The second Intersessional Working Group for the Regional Observer Programme met in Nadi, Fiji from 7–10 July, 2008. The IWG reviewed the draft minimum data fields for the ROP, and the outcome of their deliberations was presented in WCPFC-SC4-2008/ST-IP-5. CMM 2007-01 brings the ROP into force as of 31 December 2008. It is important to ensure that the early stages of the ROP are effectively implemented, and that particular importance is placed on the recommendations made by SC2 (paras 192 and 197 of the SC2 Summary Report).

Discussion

271. The SC thanked the IWG ROP2 for their work in progressing this important element of the data required for the Commission's work.

Advice to the Commission

272. No changes were proposed to the data elements documented in WCPFC-SC4-2008/ST-IP-5. The SC reiterated the recommendation of SC2 that,

> "The objective of the regional observer programme should initially be to attain a minimum coverage of 5% of fishing effort (longline: total hooks deployed; purse seine: days fished and searched) across all strata to allow identification of specific issues. The distribution of observer effort is to be representative of species of interest, fishing areas, seasons, and fishing fleets (types)".

6.3 Indonesia and Philippines Data Collections Project (IPDCP)

273. The fifth meeting of the Steering Committee on the Indonesia and Philippines Data Collection Project (IPDCP) was held 12–13 August 2008, in Port Moresby, Papua New Guinea. Twenty representatives of CCMs, the WCPFC Secretariat, SPC-OFP and WWF participated in the meeting. A full report of the Steering Committee is available as WCPFC-SC4-2008/GN-IP-10).

274. The Steering Committee accepted a financial report for the Project through until 31 July 2008 prepared by the Secretariat. Two streams of funding, totalling approximately USD190,000, is available to support IPDCP-related activities in 2008. Funding sources in 2008 are the WCPFC core budget (USD122,000) and the Global Environment Facility (GEF) USD68,000. The Committee noted the potential to draw upon additional GEF funding in 2008. In addition, the Committee noted with appreciation, a voluntary contribution of USD45,000 from the USA (National Marine Fisheries Service–NMFS) to support 2009 IPDCP-related activities.

275. The Committee reviewed Project activities in both the Philippines and Indonesia during 2008. Achievements in the Philippines during 2007–2008 included:

- the implementation of logsheet data collection and provision for purse-seine, ringnet and handline gear;
- the establishment of cannery receipt data collection;
- agreement on tuna catch estimates for the purse-seine, ringnet and "large-fish" gear developed during an annual review meeting attended by agencies responsible for data collection and the fishing industry; and
- recovery of historical data from 1997–2007 that has yet to be encoded.

276. The Indonesian component supported a workshop on data collection from the eastern Indonesian tuna fishery in May 2008. It developed procedures for the systematic sampling of vessels unloading tuna in eastern Indonesian ports that are most likely to fish in the WCPFC Convention Area. Two sampling sites have been selected in the pilot study: Bitung in north Sulawesi and Kendri in the south Sulawesi. Sampling guidelines developed include the decision to use the sampling protocol developed and implemented in Benoa for sampling longline vessels that operate in the Indian Ocean. Sampling data will be incorporated with vessel activity data, collected by the port authority, to facilitate the estimation of catches (the database system is in the

process of being updated by the Research Centre for Capture Fisheries database staff to incorporate these data with the assistance of SPC-OFP).

277. Future activities planned in the Philippines over the next year include:

- expansion of port sampling into other landing centers for gears offloading tuna;
- compilation of historical cannery receipt data;
- improving the coverage of logsheet data through capacity building with the fishing industry;
- further collaboration by the Bureau of Fisheries and Aquatic Resources (BFAR)/National Fisheries Research and Development Institute (NFRDI) with Bureau of Agricultural Statistics (BAS) to improve reporting and catch estimates.

278. The processing of historical data is proceeding as planned in Indonesia. The collection of logbook and observer data is currently undergoing review at the national level through the national data collection steering committee. Future IPDCP activities will include the implementation of these types of data collection in collaboration with relevant agencies. It is planned that sampling of eastern Indonesia tuna fisheries will target at least five key landing centers, which should cover approximately 80% of the catch coming from the Pacific-side of the Indonesian domestic fisheries.

279. The Steering Committee noted the efforts and success of the Secretariat to secure GEF funds, acknowledged SPC-OFP for its continuing assistance to the project, and thanked both organizations for their continued efforts. The SC agreed to recommend to the Commission a request for USD100,000 from the WCPFC core budget for 2009, and place this as a matter of high priority in the SC's 2009 work programme. The SC thanked Indonesia and the Philippines for their participation in the project.

6.4 Tagging initiatives

280. J. Hampton (SPC) presented an update on the Pacific Tuna Tagging Programme (PTTP). The Steering Committee met on Saturday 16 August 2008 to review PTTP progress and further plans for implementation. A full report of the meeting is available as WCPFC-SC4-2008/GN-WP-7.

281. Phase 1 of the PTTP in Papua New Guinea and Solomon Islands resulted in the release of approximately 103,000 conventional and 318 archival tags. Tag recovery rates are currently 12% and 14%, respectively. A successful first cruise was conducted in the central Pacific, targeting bigeye tuna aggregations beneath Tropical Atmosphere Ocean (TAO) moorings. A total of 1,909 conventional and 50 archival tags (90% bigeye tuna in both cases) were deployed.

282. Phase 2 of the PTTP is now underway. Of the original USD9.8 million budget, funding commitments of approximately USD6.4 million have now been obtained, with significant contributions by the New Zealand Agency for International Development and the European Community. CCMs were reminded that additional funding contributions are being sought and that a voluntary WCPFC fund exists for this purpose.

283. Upcoming plans for 2008–2009 (Phase 2) include three five-month cruises in the western equatorial Pacific using a chartered pole-and-line vessel, two central Pacific cruises, and a range of tag recovery and data quality enhancement activities.

284. Increasing the number of bigeye tuna tag releases was identified as a priority for phase 2 of the PTTP. The ways that this might be achieved include: a) continued tagging in the central Pacific, where the abundance and/or vulnerability of bigeye tuna to surface fishing is thought to be greater; b) further tagging of tuna aggregations associated with the equatorial TAO moorings, which may contain higher concentrations of bigeye tuna than elsewhere; and c) the development of methods to associate tuna with the tagging vessel, which has proved effective for increasing bigeye tuna tag release numbers in the Atlantic and Indian Oceans.

285. Reporting longline tag recaptures was also identified as a critical issue for the PTTP. The continued assistance of CCMs in raising awareness and encouraging the cooperation of their longline fleets in the return of tags was requested.

286. Separate tagging initiatives in Hawaii (funded by the Pelagic Fishery Research Program) and in the EPO (funded by the IATTC) were reported. The objectives and methods to be used by both projects are consistent with those of the PTTP, and it is expected that both projects will make a significant contribution to overall PTTP goals.

Discussion

287. The SC expressed its appreciation to SPC-OFP for the successful implementation of the PTTP to date, to donors for their financial support, and to the fishing industry and national fisheries agencies for their cooperation and assistance in the return of tags.

6.5 Data confidentiality, security, and dissemination

a. Scientific needs for VMS data

288. The Ad-Hoc Task Group – Data (AHTG [Data]) held informal discussions on 11 July 2008 following the ROP2 meeting in Nadi, Fiji. At that meeting CCMs requested the Chair of the AHTG [Data] to consult with the ST-SWG convenor regarding the release of vessel monitoring system (VMS) data for scientific purposes. The Chair of the AHTG [Data] prepared a paper WCPFC-SC4-2008/ST-IP-6 (Scientific issues related to the work of the AHTG [Data]) which notes the immediate task of the AHTG is to develop separate rules and procedures for the protection, access to and the dissemination of VMS data for scientific purposes. The paper put three questions to the ST-SWG and SC:

- What specific kinds of VMS data are needed?
- For what particular scientific purposes are these data needed?
- At what timescale are data needed?

Advice to the Ad Hoc Task Group – Data

289. The SC noted that participants had not had sufficient time to prepare for this agenda item, but offered the following provisional advice regarding the kinds of VMS data that are needed and their purpose. The following data were identified as needed: vessel identification, location, date and time. The purposes include:

- Estimating fine-scale distribution of fishing effort for use in oceanographic research;
- Planning short-term tagging operations;
- Estimating or validating the recapture positions of tag returns;
- Modeling the spatial dynamics of fishing effort for use in the operational models associated with any future MSE work;

- Estimating abundance indices using effective effort from fine-scale vessel specific data;
- Validating logbook data.

290. With regard to the timescale of the data, the SC considered that, as an interim arrangement, the timescale standard used by the ICCAT should be adopted by WCPFC.

b. Impact of the three vessel restriction on public domain data

291. The Chair of ST-SWG introduced this issue and referred the SC to the recommendation developed by ST-SWG.

292. SPC commented that there is a need to evaluate whether or not the proposed process to encourage voluntary dissemination of non-public domain data is effective or not, and suggested an addition to the recommendation regarding a review of the dissemination of public domain data at SC5.

293. In response, the Chair of ST-SWG suggested that this addition should refer to a review of the "classification" of non-public domain data, rather than its "dissemination" because it is not currently considered to be public domain data.

294. SPC suggested that both elements appear to be necessary because there are two distinct issues: the definition of public domain catch and effort data, and the dissemination of data under the current definition. SPC also suggested that the SC needs to consider both

Advice to the Commission

295. The SC recommended that the WCPFC Secretariat write to CCMs encouraging them to use para 34 of the Rules and Procedures to voluntarily authorize the Commission to waive the three vessel restrictions for catch and effort data that they have provided.

296. Public domain catch and effort data should be reviewed at SC5.

c. Requests from the Commission on purse-seine fishing effort

297. It was explained that this item concerns purse-seine fishing effort on the high seas and for the EEZs of CCMs that are not Parties to the Nauru Agreement (PNA). In response to a request from WCPFC4, reflected in para 325(d) of the Summary Record, the ST-SWG considered and discussed this issue under WCPFC-SC4-2008/ST-WP-4. The SC:

- Noted that the data contained in WCPFC-SC4-2008/ST-WP-4 represents the best assessment of purse-seine fishing effort on the high seas and in the EEZs on non-PNA members available at this time (August 2008);
- Recommended the working paper (WCPFC-SC4-2008/ST-WP-4) should be forwarded to TCC4 and the Commission;
- Recommended any CCM that believes it has additional data that should be included in this paper, should provide its proposed changes (along with supporting documentation) to the WCPFC Secretariat by 15 September 2008.

AGENDA ITEM 7 — COOPERATION WITH OTHER ORGANIZATIONS

7.1 Review of existing MOUs and relations

298. The WCPFC Executive Director provided an overview of existing MOUs and relations with other RFMOs, and referred to general paper WCPFC-SC4-2008/GN-IP-12, which reviews existing formal relations with the:

- Secretariat of the Pacific Community (SPC)
- Commission for the Conservation for Southern Bluefin Tuna (CCSBT),
- International Scientific Committee for Tunas and Tuna-like Species in the North Pacific Ocean (ISC).
- Inter-American Tropical Tuna Commission (IATTC),
- Pacific Islands Forum Fisheries Agency (FFA),
- Secretariat of the Pacific Regional Environment Programme (SPREP)
- Agreement for the Conservation of Albatross and Petrels (ACAP);
- UN Food and Agriculture Organization (FAO),
- Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR),
- Indian Ocean Tuna Commission (IOTC), and
- Commission for the Conservation of Atlantic Tunas (ICCAT).

299. There was little to report on developments or changes to these existing relations with the exception of those for SPC-OFP, IATTC and CCAMLR.

300. It was pointed out that under the SPC MOU, Annex I is an annual service agreement for the provision of data management services, research and stock assessment services, and web administration, which has been supported by the Commission since 2006. These services will be discussed later by the SC under agenda item 9.

301. Regarding the relationship with IATTC, following the second consultation held in Guam, a third consultation between the WCPFC and IATTC Secretariats was held at the 75th IATTC Meeting at Panama in late June 2008. The IATTC Secretariat has undertaken to circulate a draft data exchange agreement prepared by the WCPFC Secretariat, based on the Rules and Procedures for the Protection, Access to, and Dissemination of Data provided to the Commission, to its Members for consideration intersessionally.

302. The draft MOU with CCAMLR is scheduled for further consideration by CCAMLR members at its annual session in October 2008. The Executive Director presented WCPFC-SC4-2008/GN-IP-12, which summarizes the current status of existing MOUs between the WCPFC and other organizations. He advised that Annex 1 of the MOU with SPC-OFP will be revised once the 2009 work programme has been determined by SC4, and a budget to support the Commission's science function approved by the Commission, and that the proposed MOU with CCAMLR will be considered at CCAMLR's next annual meeting in October 2008.

7.2 Development of new MOUs

303. The Executive Director noted that although there were no new proposals for MOUs to present to the Commission for its consideration, the Secretariat is open to suggestions from CCMs for any new arrangements with organizations.

AGENDA ITEM 8 — CONSIDERATION OF THE SPECIAL REQUIREMENTS OF DEVELOPING STATES AND PARTICIPATING TERRITORIES

a. Review of 2007/2008 activities

304. The Executive Director summarized the financial status of the Commission's Special Requirements Fund (SRF), noting the recent voluntary contribution of USD50,000 from the USA. The current balance of the SRF is USD146,000, consisting of contributions from the Federated States of Micronesia and the USA only. The Executive Director noted that the Japan Trust Fund (JTF) has similar capacity building objectives as the SRF.

305. Palau and Nauru, on behalf of FFA members, expressed thanks to Japan for the JTF.

306. S. Nicol presented a summary of the workshops held using funding from the JTF. Tuna stock assessment workshops were initiated under another SPC-OFP project but have more recently been funded under the JTF funded WCPFC Project on Capacity Building in Fisheries Statistics, Regulation and Enforcement for Small Island Developing States. The purpose of the workshops was to improve in-country capacity to assimilate the highly technical papers presented to them towards meeting their obligations of sustainable utilization of their resources. With assistance from JTF, SPC-OFP developed a programme of stock assessment learning for fisheries officers from developing Pacific countries. In 2008 two workshops were held at SPC: one for new participants and a second for returning participants. Both were 5 days long and involved a total of 23 participants. There was positive feed back from participants of workshops. Importantly there was an increased belief by participants that they had a greater capacity for application of their knowledge in country.

307. PNG stated that the ERA style workshop needs to continue and that they had found the stock assessment workshops very useful. They recommended their continuance.

308. EC noted that the support would be better justified with a clear statement on the benefits to SIDS and to show why it is important to understand statistics and their appreciation for stock assessment.

309. The SC expressed appreciation to the USA for the recent additional contribution, and encouraged other CCMs to consider contributing to the SRF.

AGENDA ITEM 9 — FUTURE WORK PROGRAMME

9.1 Process of formulating the work programme of the Scientific Committee

310. The SC considered a recommendation from an ISG on guidelines for a process for formulating the SC's work programme and budget. After consideration, the Committee adopted the guidelines, which are appended to this report as Attachment M. In addition, the Committee recommended that some information on an indicative budget needed to be provided when soliciting expressions of interest. Also, the Secretariat was requested to further develop Table 2 of Attachment M, with consideration of increasing the weight given to cost factors, and to prepare a template for project proposals in consultation with the Chair of the SC and SWG conveners.

9.2 Strategic Research Plan 2007–2011 for Scientific Committee

311. The SC noted that the current 2007–2011 Strategic Research Plan is in its second year and was not in need of updating.

9.3 Review of 2008 work programme

312. The SC reviewed the 28 projects carried out under the MOU with SPC-OFC, and noted that nearly all were successfully completed. In relation to specific projects, SPC confirmed that new stock assessment software with documentation has now been made available on the Internet. It was also noted that related issues associated with the IPDCP were covered under agenda item 6.3.

313. The SC noted that there were no issues with the progress of 10 independent consultancies conducted in 2008. Two of these are complete, one will be extended, and the remaining seven are continuing projects.

9.4 2009 Work programme and budget, and 2010–2011 provisional work programme and indicative budget

314. The SC noted that there are 59 projects proposed for support under the Commission's science function currently identified from SC3: 33 are high priority, 22 are medium priority, and 4 are low priority. There are currently 26 unfunded projects, of which 8 are considered high priority, 14 are considered medium priority and 4 are low priority. The prioritization for these existing projects was not updated and it was agreed that an intersessional working group will meet prior to the plenary session of SC5 in order to recommend a revised prioritization.

315. Two new projects were proposed at SC4 (Projects 60 and 61) and both are considered to be a high priority.

316. Agenda item 4.8b recommended a technical workshop to develop reference points. This is covered by "Project 57–Technical workshop to consider the suitability of alternative reference points as limit reference points and how they may be operationalized". It was noted that SC3 had pre-allocated a budget of USD10,000 to this task. It was clarified that the workshop was intended to back onto the current SPC pre-assessment workshop and the USD10,000 was intended to cover the attendance of a small number of technical experts. Pre-assessment workshops are currently self-funded. The SC noted that if the reference point workshop was to be a SC-endorsed workshop, participation of SIDS would need to be funded and this was not currently budgeted and would likely cost around USD75,000. It was noted that some money may be available from the SRF for this purpose, if the reference point workshop meets the fund's objectives. It was also noted that this might be best funded separately through a parallel workshop.

317. The SC discussed the need for common management objectives. Several CCMs identified this as a very high priority.

318. The SC noted the need for capacity building among SIDS. The ME-SWG convener suggested that the ME-SWG held during SC5 be devoted to an educational forum on reference points and MSE in order to increase CCM understanding and capacity to participate in this important process.

319. The SC recommended that the Commission consider means for establishing a parallel/joint process for identifying key management objectives for each target species together with a strategy to increase CCM capacity to participate in the work plan on reference points and MSE during 2009 and beyond.

a. Budget

320. The SC considered budget allocations for existing activities and provided an indicative budget for 2010 and 2011 (Table 6).

Table 6. SC work programme and budget for 2009 and indicative budget for 2010–2011 that require funding from the Commission's core budget (in USD).

Strategic Research Activity or Project with priority identified at SC3[3]	2009		2010		2011	
	Core	**Other**	**Core**	**Other**	**Core**	**Other**
Project 14. (Priority = High) Indonesia and Philippines Data Collection Project (IPDCP)	**100,000**		**75,000**		**25,000**	
• Source: Report of the Fifth Steering Committee.						
Project 16. (Priority = Medium) Publication and distribution of Commission's training and educational materials.	**7,500**		**7,500**		**7,500**	
• Includes development, production and distribution of training materials to facilitate the identification of target and non-target species by fishermen, observers, and port samplers with the objective of improving data quality. • SWG conveners may recommend items to be published and distributed for the Commission's work. For example, during 2007 bycatch guides specific to longline and purse seine species and tuna ID guides developed by the FT-SWG were printed and distributed by SPC to support training of port samplers. The tuna ID guides are available in several languages useful to the Commission.						
Project 35. (Priority = High) Refinement of bigeye parameters Pacific-wide: A comprehensive review and study of bigeye tuna reproductive biology	**30,000**		**30,000**		**62,000**	
Objectives • To obtain accurate scientific information on age, growth and reproductive biology of bigeye tuna in the Pacific Ocean. Items to be considered as a joint research between IATTC and WCPFC • Based on tagging studies to date, the movements of bigeye are geographically restricted. The limited amount of mixing across the Pacific Ocean can create differences in life history characteristics as a function of differences in oceanography and genetic structure. Therefore, obtaining size and age based estimates of bigeye reproductive characteristics from spatial strata across the Pacific Ocean would be useful for inclusion in bigeye stock assessments, since current estimates are based on inadequate spatial strata and limited sample sizes to have much confidence for inclusion in Pacific-wide assessments. To implement the research plan a two-phase programme is proposed: • Phase 1 comprises implementation of a pilot study over a two-year period to determine the sampling needs and methodology of a Pacific-wide study. It is recommended that this occurs in the EEZs of Palau and Micronesia. The size distribution of fish caught from these areas is influential in the WCPO stock model. In addition to project planning, the age-growth information should be used to update the stock						

model for these areas.

- Phase 2 of the research plan will comprise the Pacific-wide component. This will provide information to spatially model the variance in reproduction and growth in currently used stock models (MFCL, Stock Synthesis, and SEAPODYM). The SC endorse this high priority research and encourage the WCPFC secretariat to pursue funding opportunities for this work.
- All nations involved in purse-seine and longline fisheries in the WCPO cooperate in implementation of both phase 1 and phase 2.
- Where possible associate national programs undertaken by CMMs within the implementation of Phase 2. This will require the application of the same methods as described in the document WCPFC-SC4-2008/BI-WP-7.

Funding

- Phase I (Pilot Study): Recommendation of USD30,000 for each 2009 and 2010 for coordination, sampling in Palau and FSM area, and power analysis was endorsed by the SC4.
- Phase II (Pacific-wide Study): Recommendation of funding USD62,000 in 2011, USD236,000 in 2012, USD350,000 in 2013 and USD129,000 in 2014 for coordination and CCM collaboration, Pacific-wide sampling, integration of CCM studies and data provision to stock models was endorsed by the SC4

Notes

- It is important to address some of the outstanding issues related to the biological parameters for bigeye, but we also need to ensure work is done on other species for which much less data are available. Hopefully, the priority species will identify themselves through the ERA process. In the WCPO, we have a range of similar or even more critical issues related to yellowfin and albacore tuna.
- Though this is a high priority project; there appears to be no expectations of SPC-OFP support here.

Project 39. (Priority = High) **Regional study of the stock structure and life-history characteristics of South Pacific albacore**	**25,000**	**500,000**	**25,000**	**500,000**	**0**	**0**

- This project was identified as a BI-SWG priority and a proposal to undertake this work is being developed by Australia in conjunction with New Zealand, SPC-OFP and other CCMs (e.g. New Caledonia, French Polynesia, FFA countries). It may directly address stock assessment needs for one of the principal target species in the WCPO and will be of direct benefit to a range of CCMs.
- Funding from the Commission would also help secure funds from Australia and New Zealand. A better description of the work and justification for the funding requested from WCPFC will be available during WCPFC4, if necessary.
- Approximate contributions of SPC, via our EU-funded SCIFISH project, to this research project will be USD 400,000 for each of 2009 and 2010, and USD 200,000 for 2011.

Project 42. (Priority = High) **Pacific-wide tagging project**	**10,000**	**2,500,000**	**10,000**	**2,500,000**	**10,000**	**500,000**

Objectives

The main objectives of these tuna tagging experiments are to obtain information on movement, stock structure, growth, mortality, behavior, habitat utilization, and vulnerability for use in stock assessments for yellowfin, bigeye and skipjack tuna.

[3] Project numbers and priorities were from Attachment O of the SC3 Summary Report. Project 60 and 61 are new projects from the SC4.

Progress of Pacific-wide tagging project (joint tagging project between IATTC and WCPFC)

- Phase 1 tagging project was done in PNG waters. A Phase 2 tagging project was proposed at SC3.
- IATTC held a tagging workshop in October 2007.

Level of budget and funding

- Funding is a limiting factor for Pacific Ocean tuna tagging experiments and should be sought from a broad range of sources, including member and non-member countries with substantial financial interests in these fisheries, GEF, and non-governmental organizations, particularly foundations interested in supporting scientifically based tuna conservation efforts.
- The budget required for a two-year pan-Pacific tagging project would need at least USD9 million to do a wide coverage project in the WCPFC-CA alone. Approximately USD2.4 million has been identified through SPC projects. To provide some additional perspective, the IOTC tagging project over three years in a much smaller area than the Pacific (or even the WCPFC-CA) cost USD 19 million.
- The core budget will be used for the coordination of the project, including having a workshop, consultancy, and travel fee for the participation of experts.

Sub-projects included

- Undertake a preliminary analysis of the vertical distribution of skipjack, yellowfin and bigeye tuna associated with fish aggregation devices, as indicated by acoustic tagging data. Scientists from other CCMs will participate in this project and related data analysis.
- Ongoing and newly funded research with sonic and archival tags in Hawaii, PNG and other areas.

Project 56. (Priority = Medium) - Extended Utilize underwater videos and other tools to characterize species, size composition and spatial distribution of tunas aggregating around floating objects.	**2,000**		**0**		**0**	

Utilize underwater videos and other tools to characterize species, size composition and spatial distribution of tunas aggregating around floating objects.

- A unit has been purchased from Commission funds that will be more thoroughly tested during 2008–2009.
- Costs associated with this testing to cover modifications to cable reel, carrying cases, transport and expendables will require additional funding during 2009.
- The deployment and use of the unit will take place on externally funded research cruises at no additional cost to the Commission.

Project 57. (Priority = High) - Extended Reference points and MSE: Technical workshop to consider suitability of MSY-based reference points as default limit reference points and how they may be operationalized.	**10,000**		**10,000**		**10,000**	

- This project was recommended by SC4 to be undertaken in 2009.
- The workshop will consider whether MSY-based reference points are suitable as default limit reference points by:
  - Considering changes in these and other candidate reference points from one year's assessment to the next;

o Calculate other reference points; o Compare these with MSY-based reference points and its implications for SPR, SSB and B. o Document any major concerns about the use of MSY-based reference points and any major advantages of using a different type of reference point. o Consider alternative means of operationalizing reference points.						
Project 60. (Priority = High) - NEW Collection and evaluation of purse-seine species composition data						
• Collection of fish weight data onboard longliners and purse seiners using "at sea" scales. • Continued study into sampling regimes for size and species composition of purse-seine catches. • Port sampling programmes to determine the accuracy of cannery receipts in Noro, Solomon Islands and possibly other ports. • Collaboration with other tuna RFMOs to examine factors affecting the sampling of purse-seine species composition.						
Project 61. (Priority =High) – NEW North Pacific striped marlin mitigation methods						
• Analyze catch rates with regard to gear and operational modifications, spatio-temporal and oceanographic considerations. • Modeling to incorporate gear and spatio-temporal effects to identify potential factors contributing to striped marlin catch reductions in North Pacific longline fisheries.						
UNALLOCATED BUDGET	**60500**		**66,550[a]**		**230,505[a1]**	
• This contingency fund is prepared for any scientific research, analysis or project as requested by the Commission. Based on the amount of USD55,000 for 2008, 10% of annual inflation rate was applied for 2009 and 2010.						
SUB-TOTAL FROM THE SC PROJECTS (NON SPC-OFP SERVICES, excluding ERA and unallocated budget)	**184,500**	**3,000,000**	**157,500**	**3,000,000**	**114,500**	**500,000**
SUB-TOTAL (SPC-OFP SERVICES, including ERA until 2010)	**550,000**		**605,000[a]**		**508,200**	
NEW PROJECT FROM THE SC4						
GRAND TOTAL, including unallocated budget	**795,000[b]**	**3,000,000**	**829,050**	**3,000,000**	**853,205**	**500,000**

[a] An annual increase of 10% was applied from the previous year.
[a1] Annual budget for completed ERA was incorporated for new project(s).
[b] An indicative budget was 745,500.

321. There was discussion about the overall budget of the SC, with some CCMs noting that there was difficulty funding the existing Commission budget and thus there should be a focus on reducing the budget in future. The SC noted that the value of the fishery was over USD3 billion and that the science component of the Commission's budget equated to only 0.02% of this amount.

322. The SC noted a suggestion that this year, the USD7,500 allocation for publication and distribution of training materials be spent on the printing and distribution of competency-based training guides for observers.

323. The SC recommended the 2009–2011 budget in Table 6 for consideration by the Commission.

b. Work plan for 2009

324. The SC agreed that the work plan for 2009 will be a full yellowfin tuna stock assessment and a streamlined South Pacific albacore assessment. The SC discussed whether it would be possible to conduct a streamlined bigeye tuna assessment, but considered that the work required meant it was not worthwhile and that indicators could be monitored (WCPFC-SC4-2008/SA-WP-9).

AGENDA ITEM 10 — ADMINISTRATIVE MATTERS

10.1 Rules of procedure

325. The Chair informed the SC that the subsidiary bodies of the Commission may formulate their own Rules of Procedure, but thus far, draft Rules of Procedure have been discussed but not agreed upon. The issue remained open for future consideration by the Committee should a CCM propose that this issue be formally addressed in future meetings.

10.2 Independent review of the science structure and function of the Commission

326. G. Parkes presented a progress report on the "Independent Review of the Commission's Interim Arrangements for Science Structure and Functions". The review is being undertaken by MRAG, an independent private consultancy company based in London. This review was part of the recommendation of the Final Report of Working Group II (WGII), which was adopted at the Inaugural Session of the Commission in December 2004. WGII recommended a provisional science structure that would undergo an independent review two years after entry into force of the Convention, to determine its effectiveness and to recommend changes as appropriate.

327. The review uses Articles 10 to 15 of the Convention as a basis, and is being undertaken in consultation with CCMs and other organizations. The two main subjects of the review are the scientific data functions and the science functions. Cutting across these is an analysis of the institutional arrangements, including contracted services (SPC-OFP and others), and the structure and processes of the SC.

328. Interviews and correspondence with individuals from CCMs and other interested parties were undertaken at the ISC meeting in July 2008 and during the SC4 meeting. A member of the review team will also attend the meeting of the Fourth Regular Session of the Northern Committee in September. A draft report of the review will be presented at the Commission

meeting in December 2008, and a revised report prepared in January 2009. No further activities are currently anticipated in 2009.

10.3 Future operation of the Scientific Committee

329. The Chair invited the SC to consider ways to improve the operation of its sessions.

330. Several CCMs were of the view that there had been some duplication of process presented to this session of the SC, and that there are opportunities for some rationalization and streamlining, particularly in relation to the material and format relayed, especially from the SA-SWG to the Committee. It was suggested that, in future, SWGs prepare an executive summary of the issues they discuss that are directly related to individual agenda items for the SC, so that those summaries, including draft recommendations, can be incorporated into the draft Summary Report for consideration by the Committee. The draft format and materials to be incorporated in the SWG executive summaries should be developed by the Secretariat in consultation with the SWG conveners.

331. It was also suggested that formal guidelines be prepared and made available to rapporteurs for both SWG and plenary sessions of the SC.

332. The Executive Director requested guidance from the SC in relation to the release of data sets used in stock assessments and the software used for those assessments. He noted that the late provision of data to the Commission had adverse implications for the time period available for assessments and preparation of related reports for each session of the SC. Noting that the software used for WCPFC assessments is available in the public domain on the MULTIFAN-CL website, he suggested that the Secretariat would be in a position to release the datasets used in annual assessments, upon request, after 30 June of each year. The SC approved this process and timeframe, subject to the Commission's Rules and Procedures for the Protection, Access to and Dissemination of Data Compiled by the Commission.

10.4 Review of Part 1 of the Annual Report to the Commission

333. An ISG, facilitated by L. Komoru (PNG), reviewed revisions to Part 1 of the Annual Report proposed by the ISG that met in the margins of SC3. The ISG reported on the work undertaken and presented a revised Part 1 Report to the SC with a recommendation that it be adopted. The SC adopted the revised Part 1 Report (Attachment N).

10.5 Election of the Chair of the Scientific Committee

334. The Chair called for nominations for a new Chair of the SC, who would commence their two-year term after WCPFC5 at Busan. No nominations were forthcoming and it was noted that factors such as workload, the burden of chairmanship on small delegations, absence of candidates at this meeting, concerns about sufficiency of expertise, and considerations with regard to the election of a new Commission Chair might all contribute to the lack of nominations.

10.6 Next meeting

335. Palau expressed interest in hosting SC5 in August 2009 and this offer was taken up by consensus. The fifth meeting of the SC will be held in Koror, Palau and is provisionally scheduled for 10–21 August 2009.

AGENDA ITEM 11 — OTHER MATTERS

336. No new issues were raised under this agenda item.

AGENDA ITEM 12 — ADOPTION OF REPORT

337. The SC adopted the Summary Report for the Fourth Regular Session. The Secretariat was requested to prepare an Executive Summary to assist with the presentation of this report to other subsidiary bodies and to the Commission.

AGENDA ITEM 13 — CLOSE OF MEETING

338. The Executive Director thanked the conveners of the SWGs and the SC Chair and Vice-Chair for their considerable effort in arranging this meeting. He also thanked the hotel management staff and liaison officers, and expressed his sincere appreciation to the fishing industry association of PNG and its members for providing valuable support to the meeting. He expressed appreciation to Norman Barnabas for his support and the WCPFC Secretariat staff in Pohnpei. He advised that the meeting had benefited from the considerable preparatory work and professionalism of several contractors, including the staff of SPC-OFP, MRAG (UK), and Shelley Clarke. He expressed appreciation for the high level of support delivered under the respective arrangements for the input of these individuals, organizations and corporations. He thanked the FFA Secretariat for assisting SIDS in preparing for the meeting, observers from inter-governmental organizations and non governmental organizations for their positive contribution to the meeting, and finally, the Managing Director and staff of the PNG National Fisheries Authority for their extremely high level of support. On behalf of the Scientific Committee he expressed appreciation to D.Y. Moon for his hard work as the Chair of the SC during the last three years.

339. The SC Chair expressed his special thanks to the government of PNG for the excellent arrangement of the meeting facilities, and expressed gratitude to the Vice-Chair, convenors of the SWGs, rapporteurs, the ISC Chair, and the WCPFC Secretariat.

340. On behalf of the Managing Director of the PNG NFA, Augustin Mobila thanked the Chair for his wonderful accomplishment. He also thanked the hotel staff.

341. The meeting closed on Friday, 22 August 2008.

Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea.
11–22 August 2008

ATTACHMENTS

Attachment A

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

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Attachment B

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

OPENING STATEMENT
WCPFC EXECUTIVE DIRECTOR

The Honorable Ben Semri, Minister for Fisheries in Papua New Guinea,
The Managing Director of the PNG National Fisheries Authority, Sylvester Pokajam, and NFA staff,
Delegations representing Commission CCMs,
The President, PNG Fishing Industry Association and industry representatives,
Chairman and Vice Chair of the Scientific Committee and Conveners of the Specialist Working Groups,
The Manager and staff from the SPC-Oceanic Fisheries Programme
Members of the FFA Secretariat,
Observers and Guests, Ladies and Gentlemen,

Minister Semri, we are grateful for the effort that you have made to be with us here this morning at the opening of the Fourth Regular Session of the WCPFC Scientific Committee. We look forward to hearing about your fascinating country, and its rapidly developing tuna industry shortly. Firstly, I hope that you can bear with me while I cover a few administrative issues associated with our meeting over the next 2 weeks — much of which I hope will be of interest to you.

It is my pleasure to welcome you all to the 2008 session of the WCPFC Scientific Committee. As at previous meetings, we have a challenging programme of work before us.

Today, after receiving a welcome from Minister Semri, we will start with a review of the latest tuna fleet and production information from the western and central Pacific prepared by the Commission's science and data services provider, the SPC-OFP. We also have provided an opportunity to receive a complementary report from our colleagues at the IATTC for the Eastern Pacific. We will then receive reports from members, cooperating non-members and participating territories that constitute the Part 1 component of their Annual Report to the Commission before breaking into our specialist working group sessions for the remainder of the week. As usual, this makes for an extremely busy first week for the Committee. But, your specialist working group conveners have been working diligently over the last 4 to 5 months to prepare for our discussions this week, so we are in good hands.

However, also as usual, there are several important activities many of you are involved in taking place in the margins of this meeting.

The Indonesian Philippines Data Collection Project Steering Committee will meet tomorrow and Wednesday lunchtime to review progress towards improving the data collection and fishery

monitoring work completed in these two countries during the last 12 months, and to identify priorities and resources required to support ongoing efforts with these endeavours in the western region of the Convention Area. As a light lunch will be provided here throughout the meeting, courtesy of a large number of generous sponsors here in PNG, I hope that many of you will find time to sit in on this steering committee meeting.

Next Saturday afternoon the Steering Committee of the Pacific Tuna Tagging Programme will meet to review the significant tagging achievements of the last 12 months and consider objectives and strategies for the next 12 months. From impressive beginnings here in PNG slightly more than 12 months ago tagging activities have since extended to Solomon Islands, the Federated States of Micronesia, and the high seas (including in the very eastern part of our Convention Area). Today, as we gather here, the charter vessel, *Soltai 105*, is operating out of Yap in western FSM before it moves south to Palau and then farther west into the Philippines and Indonesia.

Later this week we will be joined by Dr Graeme Parkes who is representing the team contracted to undertake the independent review of interim arrangements for the Commission's science structure and function. Graeme is keen to talk to as many of you as possible about how this Committee works, its relationships with other subsidiary bodies of the Commission, and the Commission itself, and seek your views on the most effective and efficient means to provide the best scientific evidence available to support the conservation and management decision-making of the Commission.

In addition, before the end of this meeting, we need to consider a recommendation to the Commission on the future chairmanship of this Committee. Although he still has this session to guide, including the presentation of its report, advice and recommendations to the Commission session in Busan in December, Dr Dae-Yeon Moon will complete his office this year. I am sure we will have an opportunity, at the appropriate time in our agenda, to express appreciation for the work Dr Moon has done on behalf of this Committee since taking on these responsibilities at SC2 in Manila in 2006. In advance of that I would like to thank Dr Moon, on behalf of the Secretariat, for the dedication and effort that he has bought to this demanding position.

Minister, I would like to take advantage of this opportunity to relay the deep gratitude of the Chairman of the Commission, Glenn Hurry, the Secretariat, and I am sure all CCMs for the much needed and exceptionally high quality locally crafted PNG furnishings that the Government of PNG recently donated to the Commission's headquarters building in Pohnpei. We all thank you, your government and all those involved at NFA for the very practical support that you have provided at a significant cost.

Minister, on behalf of all participants, I would also like to extend our gratitude and appreciation to the government and people of Papua New Guinea for hosting this important meeting. I would particularly like to thank the Managing Director and staff of the NFA for the professional logistical arrangements for this meeting, and the support and hospitality they have extended to us all since our arrival.

I would also like to thank the following PNG companies for their generous sponsorship of different events and meeting services during the next two weeks. With apologies in advance if I have missed anyone, but I extend our appreciation to:

- The PNG Fishing Industry Association;
- RD Tuna Canners Ltd;
- Frabelle (PNG) Ltd;

- South Seas Tuna Company
- Neptune Fishery Company Ltd;
- The International Food Corporation
- The National Development Bank
- PNG Ports Authority, and
- Digicel

I would also like to thank the very many people from many of our CCMs and affiliated organisations who have been working in various ways on preparations for this meeting since March this year. A meeting such as this takes considerable time and effort to organise. During that process, the goodwill of many people is called upon. The Secretariat, and I am sure the Commission as a whole, is very appreciative of the effort and sacrifices individuals have made to help ensure a successful meeting here in Port Moresby.

Before I call on the Minister to deliver his welcome address I would like to close on two notes of sadness.

During the last few months we have lost two people many of us have worked extremely closely with over a long period of time. Many of you had the pleasure of working with Joel Opnai during a career that took Joel from here in the fisheries administration of the PNG national government, to the SPC-OFP and also to the FFA Secretariat. Joel died 3 months ago at his home Province of New Ireland here in PNG. On behalf of the Scientific Committee, particularly the many of us that had the pleasure of working with and knowing Joel, it would be appreciated if our condolences and sympathies could be conveyed to Joel's family. He is very fondly remembered.

In addition, two weeks ago, we lost a respected senior member of SPC's management team, and someone who has been involved in regional fisheries matters at a senior level, mostly on behalf of Tokelau, for many years. Falani Aukuso was Deputy Director-General of SPC, and in charge of SPC's Fiji office, when he died. A small community such as Tokelau will feel this loss deeply — Falani was a determined and committed ambassador for Tokelau at both the regional and international level and a renowned champion of traditional values and the Pacific lifestyle. It would be appreciated, John, if the condolences of the Scientific Committee could be passed on to Dr Jimmie Rogers, Director-General of SPC, and to Falani's family and community.

Thank you Minister — it is a pleasure to pass the microphone to you and to invite you to deliver your welcome address.

Attachment C

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

KEYNOTE ADDRESS AND WELCOME

The Hon Ben Semri, MP
Minister for Fisheries
Papua New Guinea

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The Chairman and Vice Chair of the Scientific Committee and Committee officials,
The Executive Director, WCPFC Secretariat and staff,
The Managing Director of the PNG National Fisheries Authority and NFA staff
The Manager and staff of the Secretariat of the Pacific Community's Oceanic Fisheries Programme,
President, PNG Fishing Industry Association and industry representatives,
Representatives from inter-governmental and non-government organisations,
Observers and Guests,

Mornin olgeta,

It is my pleasure, on behalf of the Government of Papua New Guinea to be invited to open this meeting and welcome you to Port Moresby.

Papua New Guinea is blessed with one of the world's richest tuna resources. It is not ours alone — neither in terms of how we currently use it nor in terms of our responsibilities to ensure that future generations are able to share the benefits it bestows on us during our lifetimes. So we have two clear responsibilities.

One is to cooperate with others who have a demonstrated interest in the sustainable use, conservation and management of this shared resource.

The other is to ensure that cooperation provides a basis for the generations that will follow us so they receive similar benefits.

This meeting is about the science that will support these endeavors that Papua New Guinea continues to promote in the broader Commission and in our fisheries relations with our multilateral and bilateral partners.

Over the last 10 years, this progressive government has been very pro-active in promoting the local development of PNG's tuna industry. We have encouraged industry investors to establish in this country — offering significant incentives for them to do so.

While early on there were many skeptics who said that PNG involved too much sovereign risk, we have proven them wrong. Through a combination of close proximity to some of the world's most productive fishing grounds, sound government policy, an attractive investment climate and experienced industry partners we have built an industry that now makes an extremely valuable contribution to the social and economic development of our country.

I am proud to be the Minister in a developing Pacific Island country that now produces around 20% of the western and central Pacific Ocean purse-seine catch. The average catch over the last 5 years from this fishery now exceeds 300,000 mt — and exceeded 400,000 mt for the first time in 2006. Almost 150,000 mt of this catch is now processed on shore with the majority of our exports heading for Europe and the US.

This production is generated by a combination of local and foreign investors who have established onshore operations here and distant water fishing nation partners who have had long-term access arrangements to fish our large exclusive economic zone.

Based on our experience during the last decade there is little doubt that the future is definitely in further domestic development of our industry, and our formal policy now is to gradually phase out bilateral licensing arrangements.

As evidence of this, apart from the our longline industry now being 100% domesticated, the government is actively promoting the development of an industrial park at Madang that will accommodate additional processing and shore-side support facilities for the tuna industry.

In relation to management and government oversight, the management and conservation of our tuna fishery is guided by several regional and national policies.

At the national level we use the PNG National Tuna Fishery Management Plan, which has served us well since it came into effect in 1999.

This Plan, administered by the National Fisheries Authority, provides the implementing framework for several regional arrangements which PNG actively supports. These include the Parties to the Nauru Agreement (PNA), the Palau Arrangement, the Federated States of Micronesia Arrangement (FSMA) and, importantly, the decisions and conservation and management measures of the Commission.

Recent decisions in the PNA sub-regional body have significant implications for the regional tuna industry. These decisions, while having a conservation basis, also ensure that Pacific Island countries are the primary beneficiaries of the future management of the fishery. These decisions also have implications for the broader Commission.

Among these recent developments is the vessel day scheme and efforts by the PNA to address concerns about the sustainability of the current catch of bigeye and yellowfin tuna. All these initiatives respond to scientific information that has been discussed by this Committee at past sessions.

This session of the Scientific Committee will receive the latest assessment of the status of bigeye tuna and the impacts of different fleets and fisheries on this important component of the WCPO tuna industry. This assessment has been prepared by the Commission's science service provider who is also the long-term respected adviser to Pacific Island countries on data and scientific issues for regional tuna fisheries, the SPC-OFP. We are grateful to that organisation for the consistently high standard of work that it continues to do in this regard.

While this Committee is the appropriate forum to query these assessments, in reviewing the bigeye assessment this year, and in considering the advice and recommendations that you will subsequently forward to the Commission, I appeal to you all to maintain faith with the provisions of the WCPF Convention for supporting effective management, long-term conservation and sustainable use.

Your advice is to be based on the best scientific evidence available — not politics. That type of discussion is the responsibility of another body. So early in the establishment of this, the world's newest regional fisheries management body, we certainly do not want to bring on the types of crises that tuna stocks managed by the other RFMOs are experiencing.

I look forward to learning the outcomes of your deliberations — and to being able to act upon them when we meet for the next annual session of the Commission in December.

Again, on behalf of the government, I welcome you to Papua New Guinea. I know you have a very busy 2 weeks ahead of you, so now I will let you get on with your agenda.

Thank you so much again for this invitation — I am honoured. I now declare this Fourth Regular Session of the WCPFC Scientific Committee open.

Attachment D

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

AGENDA FOR THE FOURTH MEETING OF THE SCIENTIFIC COMMITTEE

AGENDA ITEM 1 OPENING OF THE MEETING
1.1 Welcome address
1.2 Adoption of agenda
1.3 Meeting arrangements
1.4 Reporting arrangements
1.5 Intersessional activities of the Scientific Committee

AGENDA ITEM 2 REVIEW OF FISHERIES
2.1 Overview of Western and Central Pacific Ocean (WCPO) fisheries*
2.2 Overview of Eastern Pacific Ocean (EPO) fisheries
2.3 Fishery reports from Members, Participating Territories and Cooperating Non-Members (CCMs)
2.4 Reports from regional fisheries bodies and other organizations

AGENDA ITEM 3 SPECIALIST WORKING GROUPS (SWGs)
3.1 Adoption of the all SWG reports, including advice and recommendations

AGENDA ITEM 4 STATUS OF THE STOCKS AND MANAGEMENT INFORMATION
4.1 WCPO bigeye tuna
  a. Status and trends*
  b. Management Advice and Implications*
4.2 WCPO yellowfin tuna
  a. Status and trends*
  b. Management Advice and Implications*
4.3 WCPO skipjack tuna
  a. Status and trends*
  b. Management Advice and Implications*
4.4 South Pacific albacore
  a. Status and trends*
  b. Management Advice and Implications*
4.5 Southwest Pacific swordfish
  a. Status and trends*
  b. Management Advice and Implications*
4.6 Southwest Pacific striped marlin

a. Status and trends*
b. Management Advice and Implications*

4.7 Northern stocks

4.7.1 North Pacific albacore

a. Status and trends*
b. Management Advice and Implications*

4.7.2 Pacific bluefin tuna

a. Status and trends*
b. Management Advice and Implications*

4.7.3 North Pacific striped marlin

a. Status and trends*
b. Management Advice and Implications*

4.7.4 North Pacific swordfish

a. Status and trends*
b. Management Advice and Implications*

4.8 Review of stock assessment and management-related matters*

a. Review of 'A comprehensive review and proposed investigation of the age, growth, and reproductive biology of bigeye tuna in the Pacific Ocean'
b. Review of 'A scoping study on reference points and management strategy evaluation (MSE)'

AGENDA ITEM 5 BYCATCH MITIGATION

5.1 Seabirds*
5.2 Sharks*
5.3 Small tuna on floating objects (STFO)*
5.4 Sea turtles*
5.5 Ecological Risk Assessment (ERA)

AGENDA ITEM 6 DATA AND INFORMATION

6.1 Issues related to data gaps

a. Progress in filling gaps
b. Review of 'A study to identify causes of data gaps in the work of the WCPFC'
c. Species composition of purse-seine catches
d. Information on seabird mortality
e. Information on shark catches

6.2 Regional Observer Programme (ROP)
6.3 Indonesia and Philippines Data Collection Project (IPDCP)
6.4 Tagging initiatives
6.5 Data confidentiality, security, and dissemination

AGENDA ITEM 7 COOPERATION WITH OTHER ORGANISATIONS

7.1 Review of existing MOUs and relations
7.2 Development of new MOUs*

a. SPC-OFP (Annex 1. Agreement for the Provision of Scientific Services to the Commission and Assistance to Members by the Secretariat of the Pacific Community)

AGENDA ITEM 8 CONSIDERATION OF THE SPECIAL REQUIREMENTS OF DEVELOPING STATES AND PARTICIPATING TERRITORIES

8.1 Special Requirements Fund

a. Review of 2007/2008 activities
b. Advice and recommendations to the Commission*

AGENDA ITEM 9 FUTURE WORK PROGRAM AND BUDGET

9.1 Process of formulating the work programme of the Scientific Committee
9.2 Strategic Research Plan 2007-2011 for Scientific Committee
9.3 Review of 2008 Work Programme
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Attachment E

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

ABBREVIATIONS AND ACRONYMS USED BY THE WCPFC

ACAP	Agreement for the Conservation of Albatross and Petrels
AFMA	Australian Fisheries Management Authority
AHTG [Data]	Ad Hoc Task Group on Data
ALB	albacore (*Thunnus alalunga*)
$B_{current}$	average biomass over the period 2003–2006
B_t	biomass at year t (used in projections)
BET	bigeye tuna (*Thunnus obesus*)
BI-SWG	Biology Specialist Working Group
B_{MSY}	biomass that will support the maximum sustainable yield
CASAL	C++ algorithmic stock assessment laboratory (a stock assessment modeling approach)
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCM	Members, participating Territories, and Cooperating Non-members
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
the Commission	The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
the Convention	The Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
the Convention Area	The area of competence of the Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean
CPUE	catch per unit of effort

CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
EB-SWG	Ecosystems and Bycatch Specialist Working Group
EEZ	exclusive economic zone
ENSO	El Niño-Southern Oscillation
EPO	Eastern Pacific Ocean
ETBF	Eastern Tuna and Billfish Fishery (Australia)
ERA	ecological risk assessment
EU	European Union
F	fishing mortality rate
FAD	fish aggregating device
$F_{current}$	Average fishing mortality rate over the period 2003–2006
FFA	Pacific Islands Forum Fisheries Agency
FL	fork length
F_{MSY}	fishing mortality that will support the maximum sustainable yield
AR	annual reports
FSM	Federated States of Micronesia
FT-SWG	Fishing Technology Specialist Working Group
GEF	Global Environment Facility
GLM	general linear model
GRT	gross registered tonnage
GSI	gonad somatic index
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IPDCP	Indonesia and Philippines Data Collection Project
ISC	International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean
IUU	illegal, unregulated and unreported fishing
LJFL	lower jaw fork length
m	meters
ME-SWG	Methods Specialist Working Group
MFCL	MULTIFAN-CL (a stock assessment modeling approach)

MOU	memorandum of understanding
MSE	management strategy evaluation
MSY	maximum sustainable yield
mt	metric tons
PFRP	Pelagic Fisheries Research Program (Hawaii, USA)
PNA	Parties to the Nauru Agreement
PNG	Papua New Guinea
PSA	productivity susceptibility analysis
RFMO	regional fisheries management organization
RMI	Republic of the Marshall Islands
SA-SWG	Stock Assessment Specialist Working Group
SPR	Spawning stock biomass per recruit
SEAPODYM	spatial ecosystem and population dynamics model
SKJ	skipjack tuna (*Katsuwonus pelamis*)
SPC-OFP	Oceanic Fisheries Programme of the Secretariat of the Pacific Community
SSB	spawning stock biomass
SST	sea surface temperature
STFO	small tuna on floating objects
ST-SWG	Statistics Specialist Working Group
SWG	Specialist Working Group
TAO	Tropical Atmosphere Ocean
TCC	Technical and Compliance Committee of the WCPFC
TDR	time and depth recorder
TUFMAN	Tuna Fisheries Management Database
UNCLOS	1982 United Nations Convention on the Law of the Sea
USA	United States of America
VMS	vessel monitoring system
WCPFC	Western and Central Pacific Fisheries Commission
WCPO	Western and Central Pacific Ocean
WWF	World Wildlife Fund
YFT	yellowfin tuna (*Thunnus albacares*)
Y/R	Yield per recruit

Attachment F

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
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LIST OF DOCUMENTS

MEETING INFORMATION

WCPFC-SC4-2008/01	Meeting notice and information
WCPFC-SC4-2008/02	Provisional agenda for the meeting
WCPFC-SC4-2008/03	Provisional annotated agenda for the meeting
WCPFC-SC4-2008/04	Indicative schedule for the meeting
WCPFC-SC4-2008/05	Registration form
WCPFC-SC4-2008/06	Guidelines in submitting Specialist Working Group (SWG) papers
WCPFC-SC4-2008/07	List of documents
WCPFC-SC4-2008/08	Provisional agenda and schedule of the Steering Committee [IPDCP] Meeting
WCPFC-SC4-2008/09	Provisional agenda and schedule of the Steering Committee [PTTP] Meeting

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GN-WP-1 Williams, P. [1] and P. Terawasi [2]. **Overview of tuna fisheries in the western and central Pacific Ocean, including economic conditions – 2007.** [1] SPC, Noumea, New Caledonia, [2] FFA, Honiara, Solomon Islands.

GN-WP-2 IATTC. **The fishery for tunas and billfishes in the Eastern Pacific Ocean in 2007**

GN-WP-3 Secretariat. **Guidelines outlining the process for formulating the work programme and budget of the Scientific Committee**

GN-WP-4 Indonesia. **IPDCP progress report [Indonesia]**

GN-WP-5 Philippines. **IPDCP progress report [Philippines]**

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GN-WP-8 Secretariat. **Summary of 2007/2008 IPDCP activities supported by the Secretariat**

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GN-IP-5 Kumasi, P. [1], B. Leroy [1], J. Hampton [1], S. Nicol [1], A. Lewis [1], D. Itano [2]. **PTTP tag recovery issues.** [1] SPC, Noumea, New Caledonia, [2] Pelagic Fisheries Research Program, University of Hawaii, Honolulu, Hawaii.

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GN-IP-12 Secretariat. **Cooperation with other organizations**

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EB-WP–4	Waugh, S. **Stages in the process of managing seabird mortality in RFMO fisheries**. Birdlife International, New Zealand.	
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EB-IP–2	Ministry of Fisheries, New Zealand. **Draft New Zealand NPOA Shark**s. Ministry of Fisheries, Wellington, New Zealand.	
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FT-WP–4	Moon, D-Y, D-H An, S-J Hwang and S-S Kim. **Catch of small-sized tuna by set types of Korean tuna purse-seine fishery in the WCPO.** National Fisheries Research and Development Institute, Busan, Korea.	Moved to FT-IP-5

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ST-WP-1	Jones, M. and B. Shallard**. Interim report on causes of data gaps.** FishServe Innovations New Zealand Ltd, Wellington, New Zealand.	
ST-WP-2	Fonteneau, A. **Species composition of tuna catches taken by purse seiners**. IRD, Sete, France.	
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ST-IP-3	Hoyle, S. and P. Sharples. **Length-frequency sampling data and its influence on the south Pacific albacore stock assessment.** Secretariat of the Pacific Community, Noumea, New Caledonia.	
ST-IP-4	SPC. **Review of the WCPFC transhipment reporting form for collection data for scientific purposes**. Secretariat of the Pacific Community, Noumea, New Caledonia.	
ST-IP-5	Secretariat. **Draft minimum data fields as revised and proposed by the Second Inter-Sessional Working Group Regional Observer Programme** (Rev. 1)	
ST-IP-6	Secretariat. **Scientific issues related to the work of the AHTG [Data]**	

STOCK ASSESSMENT SPECIALIST WORKING GROUP (SA-SWG)

SA-SWG Working Papers		
SA-WP-1	Langley, A. [1], J. Hampton [1], P. Kleiber [2] and S. Hoyle [1]. **Stock assessment of bigeye tuna in the western and central Pacific Ocean, including an analysis of management options.** [1] SPC, Noumea, New Caledonia, [2] PIFSC, NOAA, Honolulu.	
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SA-WP–5	Mejuto, J., B. García-Cortés, and A. Ramos-Cartelle. **Standardized catch rates in biomass for the south central and western Pacific swordfish (*Xiphias gladius*) from the Spanish longline fleet for the period 2004-2006.** Instituto Español de Oceanografía. Spain.	
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SA-WP-8	Hoyle, S., A. Langley and J. Hampton. **Stock assessment of Albacore tuna in the south Pacific Ocean.** SPC, Noumea, New Caledonia.	
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SA-IP–3	Campbell, R. **Data summary pertaining to the catch of swordfish by longline fleets operating in the**	

	southern WCPO. CSIRO, Australia.	
SA-IP–4	Campbell, R. [1], M. Unwin [1], N. Davis [2] and N. Miyabe [3]. **Swordfish CPUE trends across the southern WCPO.** [1] CSIRO, Australia, [2] SPC, Noumea, New Caledonia, [3] NRIFSF, Japan.	
SA-IP-5	Langley, A. and S. Hoyle. **Report from the stock assessment preparatory workshop, Noumea, February 2008**. SPC, Noumea, New Caledonia.	

ANNUAL REPORTS (PART 1) FROM MEMBERS AND COOPERATING NON-MEMBERS

(Annual Report, Part 1 – Information on Fisheries, Research, and Statistics)

AR-WP-1	**American Samoa**
AR-WP-2	**Australia**
AR-WP-3	**Canada**
AR-WP-4	**China**
AR-WP-5	**Cook Islands**
AR-WP-6	**European Union**
AR-WP-7	**Federated States of Micronesia**
AR-WP-8	**Fiji Islands**
AR-WP-9	**France**
AR-WP-10	**Guam**
AR-WP-11	**French Polynesia**
AR-WP-12	**Indonesia (cooperating non-member)**
AR-WP-13	**Japan**
AR-WP-14	**Republic of Kiribati**
AR-WP-15	**Republic of Korea**
AR-WP-16	**Republic of the Marshall Islands**

AR-WP-17	**Republic of Nauru**
AR-WP-18	**New Caledonia**
AR-WP-19	**New Zealand**
AR-WP-20	**Niue**
AR-WP-21	**Northern Mariana Islands**
AR-WP-22	**Republic of Palau**
AR-WP-23	**Independent State of Papua New Guinea**
AR-WP-24	**Republic of the Philippines**
AR-WP-25	**Independent State of Samoa**
AR-WP-26	**Solomon Islands**
AR-WP-27	**Chinese Taipei**
AR-WP-28	**Tokelau**
AR-WP-29	**Kingdom of Tonga**
AR-WP-30	**Tuvalu**
AR-WP-31	**United States of America**
AR-WP-32	**Republic of Vanuatu**
AR-WP-33	**Wallis and Futuna**
AR-WP-34	**Belize (cooperating non-member)**

OBSERVERS

Greenpeace	Greenpeace International. **Time and tuna are running out**.

Attachment G

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

REPORT OF THE BIOLOGY SPECIALIST WORKING GROUP

1. Opening of meeting

1. The convener of the Biology Specialist Working Group (BI-SWG), H. Honda (Japan), opened the meeting and thanked participants for their attendance on a Saturday morning. He also addressed there was a recognition that the BI-SWG could continue as an SWG because of its necessity and vital activities.

2. Selection of rapporteurs

2. T. Matsumoto (National Research Institute of Far Seas Fisheries – NRIFSF), K. Uosaki (NRIFSF), D. Kirby (SPC) and S. Nicol (SPC) were appointed rapporteurs for the meeting.

3. Adoption of agenda

3. The agenda circulated for the meeting was accepted with no modification.

4. Research

4. a. Age and growth

SC4-BI-WP-1: Xulio, V., J. Mejuto and M. Ruiz. ***Age and growth of swordfish (Xiphias gladius) in the North Pacific.***

4. F. Abascal-Crespo (EC) summarized this paper. In total, 450 anal fin spines from North Pacific swordfish were analyzed from 2005–2006 for ageing and growth studies. The lower jaw fork length (LJFL) of aged individuals ranged from 74–235 cm for males, and from 71–294 cm for females. Fish ages ranged from 0–13 years and the mean lengths by age were calculated for males and females. Growth parameter estimates were calculated from 406 cut spine sections, which provided readable growth annuli by sex. The preliminary growth parameters based on standard Von Bertalanffy (VB) growth function are the following: for males, $L\infty$ (asymptotic length) = 271.4 cm, k (growth coefficient) = 0.121, t0 (age at zero length) = -1.543; for females, $L\infty$ = 376 cm, k = 0.0701, t0 = -2.162. The relationships between LJFL and anal fin spine radius were calculated for both sexes. The trend in the monthly marginal increment ratio was not conclusive regarding growth bands formation during the year.

Discussion

5. The presenter noted that, regarding the difference in the estimated growth curve between this work and previous works, the cause of this may come from methodological difference rather than differences between areas, which was also discussed in the documents (BI-IP-2). The presenter also noted that no pattern was observed in the monthly marginal increment ratio, probably due to the fact that sampling was restricted from June to January. The presenter also indicated the similarity in estimates of the paper and recent studies carried out by CSIRO in Australian waters.

4. b. Stock Structure

SC4-BI-WP-2: Itano, D. R.J. David Wells, and J.R. Rooker. ***Origin of yellowfin tuna (Thunnus albacares) in the Hawaiian Islands: Preliminary assessment of natal signatures in otoliths.***

6. D. Itano (USA) presented this paper. The purpose of this project is to examine the potential for using tuna hard parts as natural markers to refine our understanding of the population structure of tropical tuna. Yellowfin tuna were selected for study because tagging data and recent studies suggest that the movement patterns of yellowfin may be highly variable and more restricted than other tunas. Hawaiian yellowfin provide a good test case because local spawning is well documented, but immigration of yellowfin from other areas is likely. This study will provide information on the source(s) of yellowfin recruits (age-1 and age-2) to Hawaii-based surface fisheries through the analysis of natural tracers (stable isotopes) in otoliths. The first step will be to develop a baseline that describes the chemical signatures in the otoliths of age-0 yellowfin from putative spawning and/or nursery areas in Hawaii and the broader WCPO. The isotopic composition of age-0 bigeye tuna will also be analyzed to provide a comparison with a species that, contrary to yellowfin, is not known to spawn in Hawaiian waters. Preliminary data from age-0 yellowfin tuna indicate stable isotopic composition in otoliths of individuals from the Hawaiian Islands, an offshore seamount area, and the equatorial western and central Pacific were significantly different. In general, otoliths of yellowfin tuna from equatorial regions were depleted relative to areas in and around Hawaii, with intermediate values observed for individuals collected from an offshore seamount in the Hawaii EEZ. Cross validated classification success from quadratic discriminant function analysis was 88%, indicating the approach has promise for identifying yellowfin tuna from different spawning sites. After building a baseline dataset to include likely nursery areas, otolith core material from age-1 and age-2 yellowfin tuna from the Hawaii-based fisheries will be compared with baseline data using mix-stock procedures. This will allow, for the first time, investigation of the relative contribution of locally spawned versus transient yellowfin tuna to Hawaii-based fisheries.

Discussion

7. A CCM noted the otolith trace element results, and asked if the author was discouraged by getting such different results from areas so close together, in terms of the large number of variables that might have to be considered in trying to map a large area.

8. The presenter replied that he was encouraged by getting two groups in Hawaii because USA scientists have asked themselves where yellowfin come from for some time and this work suggested that there were both locally spawned and immigrant fish. The Philippines samples were shown as outliers, not to infer sources of recruitment to Hawaii. The author recognized that doing a thorough study would require a very large amount of samples. A good test case will be analysis of samples collected over the same time frame as fish collected in the Line Islands and Palmyra, which will

take place in September 2008.

9. It was asked where there were specific facilities to analyse stable isotopes at the same time as otolith micro-increment analysis is carried out. The presenter confirmed that the analysis is outsourced.

10. It was asked whether it would ultimately be possible to link chemical signature work to movement. Older individuals could be used to track changes in chemical signature and thus movement. The presenter noted that this has been considered possible if there are strong signals that persist over time in a region, but there are so many influences on signatures. The priority for now is to identify the proportion of resident/immigrant fish because this would determine the extent to which local management is possible.

SC4-BI-WP-3: Fonteneau, A. and J. Ariz. ***Note on the stock structure of Pacific bigeye tuna to be used in stock assessments.***

11. A. Fonteneau (EC) presented this paper, which reviews and discusses the stock structure of Pacific bigeye tuna in relation to the prospects of stock assessment analysis of this population. The analysis of fishery data, mainly the spatio-temporal bigeye tuna catches by gear and by sizes, tend to indicate that the present 150°W boundary, based on historical and administrative choices, does not appear to be a convenient biological boundary. This paper considers that the present lack of significant tag recoveries across the 150°W boundary should not be considered as being significant, due to the limited numbers of bigeye tuna presently tagged, and to the great distances between present tagging locations. North–south movements of adult bigeye tuna are also a potential source of mixing between eastern and western bigeye tuna populations. It is also hypothesized that there could be an increased net flow of juvenile bigeye tuna towards the WCPO due to the increased number of FADs in the western EPO. The conclusion is that all bigeye tuna stock assessments by WCPFC and the IATTC should preferably be conducted in a unified best model and at a Pacific-wide scale. The large-scale tagging programme presently planned by WCPFC and IATTC would be necessary to obtain realistic and age specific movement patterns of bigeye tuna at a Pacific-wide level. The paper also discussed the conclusion that management actions of the Pacific bigeye tuna stocks should also be fully coordinated between the IATTC and WCPFC, because of the probably weak biological boundary and also because of the long lifespan of bigeye tuna, such that the long-term potential management benefits or failures will probably be shared by WCPFC and IATTC.

Discussion

12. The statement that the 150°W boundary between the IATTC and WCPFC management areas is inappropriate for conducting regional bigeye tuna stock assessments, but that it is appropriate for yellowfin and skipjack tunas was criticized due to two misconceptions regarding bigeye tuna biology and behavior: horizontal movements and associative behavior with drifting FADs.

13. Results from IATTC bigeye tuna tagging experiments from 2000–2005 in the EPO for about 19,000 fish of 1 to 4 years of age (and at liberty from months to several years), show restricted movements, with 95% of recaptures less than 1,000 nm (linear displacements) from release locations. These displacements are similar to those observed for yellowfin tuna tagged in the same area and time and are less than skipjack displacements.

14. In addition to the linear displacements from conventional plastic dart tags, the IATTC has

recovered over 100 geolocating archival tags deployed in bigeye tuna over a large size and age range in this area at liberty for more than one month, many in excess of six months, and several in excess of one year. Detailed analyses of these data, including reconstruction of most probable movement paths and parameters, also indicate restricted movements with fidelity to the highly productive EPO and quite low dispersive movement parameters.

15. The high importance of conducting further bigeye tuna tagging experiments in additional areas across the equatorial Pacific was emphasized.

16. Regarding the "ecological trap hypothesis" that bigeye tuna remain associated with drifting FADs and are transported significant distances westward into the WCPO, it was noted that this is not justified by IATTC tagging data. The analyses of archival tag depth and temperature data for 98 archival tags and a total of 18,069 days (ca. 50 years) of data indicate that only 12% of the days at liberty are spent associated with floating objects and the average residence time is 2.5 days.

17. A response to these criticisms was that the cited data are limited because the tagging location was more than 5,000 km from 150°W, the duration of recoveries was short compared with the 10–15 year lifespan of bigeye tuna, and although FAD effect is controversial, there is a good publication confirming the ecological trap effect.

18. Another comment was that the suggested north–south movement, to feeding and spawning grounds respectively, implies that bigeye go north during winter to feed and come back in summer to spawn; but that this is probably too simple an explanation as there is no variability in CPUE in equatorial waters, so there must be only a small proportion migrating north. With regard to tagging location, considerable resources have been allocated to the central Pacific area. It was pointed out that no physical barrier is hypothesized to exist between IATTC and WCPFC areas; rather the question is to what extent it is possible and realistic to undertake separate assessments. Pacific-wide assessments have been done and compared with east and west Pacific assessments, and the results are consistent. Given the management context, it therefore makes sense to maintain the separate assessments, but Pacific-wide work can still be carried out, including using SEAPODYM for basin-scale stock assessments.

19. There was some agreement on this but some doubt was expressed as to whether separate management actions will ever be effective.

20. A response was that in the EPO, the catch is mostly by purse seine and is well east, therefore, distant from the WCPO, and there is probably not much interaction between the effects of management action in different areas.

21. The convenor thanked the author for an interesting presentation and discussions and recognized the tagging work proposed for bigeye tuna in the central region during 2009.

SC4-BI-WP-4: Kasapidis, P., A. Magoulas, B. García-Cortés and J.Mejuto. *Stock structure of swordfish (Xiphias gladius) in the Pacific Ocean using microsatellite DNA markers*.

22. F. Abascal-Crespo (EC) summarized this paper. The genetic structure of swordfish in the Pacific Ocean was assessed by analyzing 594 individuals from 6 different regions, genotyped with 13 microsatellite loci. The results showed very low genetic differentiation among the different geographical areas, which was not statistically significant. There was slight evidence for isolation by distance across a U-shaped corridor, as had been demonstrated by Reeb et al. (2000) using

mtDNA, but more samples and a better geographical coverage are necessary to support this finding. These data confirmed the low genetic differentiation of swordfish within the Pacific, which has already been found with other genetic markers.

Discussion

23. SPC stated that it was pleased to see this kind of work being done. This paper was discussed at the swordfish workshop earlier this year, where it was recognized that there are some discrepancies with work done at IATTC, which found more evidence for spatial separation of swordfish. It appears that there is still some more work to do.

24. The author recognized that some studies have found differences, but noted that there is a lack of consistency among studies. Genetics may be powerful enough to detect differences among populations, and management needs to know if different populations need to be separately managed. There may be different mixing rates but this is less important for management.

25. The convenor noted that large differences among individuals may mask differences among groups.

26. The presenter agreed with the convenor, and larger sampling would address this issue.

27. A CCM pointed out that microsatellite genetic markers use neutral loci that are influenced by genetic drift and are particularly weak genetic methods for stock differentiation of marine species. The reason for this is because of the large population size of marine species and that very low levels of exchange can neutralize any differences. So these techniques are most appropriately used for freshwater species that live in areas where they have been physically separated for long periods of time. What is needed for marine species is high resolution genomic techniques that use selected loci that are influenced by natural selection. An example of these differences are seen in a paper by Pampoulie et al. (2006) who showed FST values of Atlantic cod from 9 microsatellite loci = 0.003, which is highly insignificant and similar to the values shown here, but when using high resolution DNA markers, such as genomics, the FST was found to be closer to 0.261, which is highly significant and Hemmer Hansen et al. (2007) found similar results for European flounder. As a result of this the use of microsatellite genetics is inappropriate for stock differentiation of swordfish and we should not use these data to make inferences with respect to the stock status of swordfish.

28. The presenter stated that there have been several studies using different techniques, none of which provide compelling answers

4. c. Behavior and movement

SC4-BI-WP-5: Matsumoto, T. and H. Okamoto. *Overview of Japanese tagging project on tropical tunas in the temperate area of Japanese waters*.

29. T. Matsumoto (Japan) presented this paper. A tropical tuna tagging project targeting bigeye and yellowfin tunas in the temperate area of Japanese waters (east of Honshu) was conducted by Japan's National Research Institute of Far Seas Fisheries in cooperation with Miyagi Prefecture this year (between late June and mid-July). It was the first practical tagging effort that targeted bigeye and yellowfin tunas in this area, and was conducted using pole-and-line gear by the research vessel *Shin-Miyagi Maru*. During the research cruise, 1,000 tropical tunas (892 bigeye, 49–109 cm FL; 34

yellowfin, 48–65 cm FL; and 74 skipjack, 40–61 cm FL) were tagged and released, including 28 archival and 3 pop-up taggings for bigeye. Pop-up tagging of yellowfin tunas (10 individuals, 111–142 cm FL) caught by longliner was also conducted in the area south of Kyushu (around 29°N, 130°E) between June and July 2008. It is expected that new information on the movement and behavior of tropical tunas will be obtained, based on the information from the recapture of tags.

Discussion

30. Participants expected further progress, based on analyses of recapture data.

31. There was a brief discussion about premature pop off for pop-up satellite tags because the author mentioned that some tags popped off prematurely. The cause of premature pop off is estimated to be tag shedding, but it should be examined more in detail.

4.d. Reproductive biology, including review of the research project, early life history and recruitment strategy

SC4-BI-WP-6: Mejuto, J. B. García-Cortés and A. Ramos-Cartelle1. ***Reproductive activity of swordfish (Xiphias gladius) in the Pacific Ocean on the basis of different macroscopic indicators.***

32. F. Abascal-Crespo (EC) summarized this paper. In total, 23,639 swordfish females were analyzed. The percentage of females larger than 145 cm shows important differences among areas. Maximum percentages were obtained in temperate waters south of 25º S and the lowest values in warm areas where small females were observed. The overall sex ratio obtained was 51%. The sex ratios at size suggest that females are predominant around 170 cm, although different patterns of sex ratio at size were obtained between zones. The gonad index detects areas as producing the most intense maturation activity in females, ranging from the central Pacific between 10ºN and 10ºS to the west of 120ºW, where the greatest gonad development was observed. The results would indicate that reproductive activity is mostly carried out in certain areas of the central-western Pacific but that there may also be sporadic seasonal or moderate reproductive events in some of the other areas adjacent to these. At the same time, the southeast Pacific shows resting females with active feeding behavior. The most active areas with maturity events are linked to warm waters where the characteristic spawning patters of sex ratio at size are caused by the higher abundance/catchability of males over females within particular size ranges. The results match well with similar indicators observed for the Atlantic swordfish. However, the Pacific shows somewhat broader warm areas than the Atlantic, suggesting that potential spawning areas for the Pacific swordfish could be relatively broader and eastern than those reported for the Atlantic.

Discussion

33. A CCM commented that sampling effort appears biased and perhaps unrepresentative (e.g. 53% of samples collected from PAC 43 (see Fig. 1, SC4-BI-WP-6) and only 19% from the southwest Pacific). (1) There is a need to present this information, partitioned by month or quarter, to identify missing gaps and areas with low sampling to evaluate whether statistical inference from this study is valid; and (2) Finer resolution of data is needed to understand variation in reproductive biology.

34. The presenter showed that gonadal index (GI) information was partitioned by month and area but not all months and area were covered by this study.

35. It was acknowledged that these results are only preliminary at this stage and should be interpreted with this caveat. However, the presenter noted that this study covered a large area, and indicated several applications of the study: including that the results do not support a hypothesis of a "southeastern stock", and that reproduction was only detected in the western equatorial area in this study. It was noted that other studies do indicate a level of stock partitioning and other spawning areas across the Pacific.

36. It was also commented that maturity was estimated using gonadal indices, which is an unreliable method except for mapping spawning distribution, and that sampling should also include sea surface temperature (SST) as a covariate.

37. The presenter responded and agreed that histology is the preferred method, but is unrealistic for 20,000 plus samples in this study. What the authors have attempted to do is apply the macroscopic methods to identify spawning areas. Once identified, these can be used to prioritize future sampling regimes for histology. The presenter agreed that SST is an important covariate.

38. It was asked whether the authors have compared the results with other studies.

39. The presenter responded that he is the authors' representative and was not familiar with the work referred to by the question so could not comment further.

40. F. Abascal-Crespo was thanked for presenting the work on behalf of the authors and the EC was encouraged by a CCM to send the authors of papers in the future. It was also noted that the authors made a great effort to present this paper to the SC, and this effort should be acknowledged, and that it is not easy for the authors to attend the SC meeting.

SC4-BI-WP-7: Nicol S., S. Hoyle, B. Molony, D. Itano, K. Schaefer, A. Aires-Da-Silva, C. Sun, H. Honda, M. Maunder, A. Langley, V. Allain, A. Williams, P. Williams, J. Hampton and C. Millar. *A research plan for a Pacific-wide study of bigeye reproductive and growth biology*.

41. S. Nicol (SPC) presented this paper. The Third Regular Session of the Western and Central Pacific Fisheries Commission Scientific Committee recommended that a project on bigeye growth and reproductive biology be implemented to help reduce uncertainty in these parameters and improve the precision of stock assessments. The Fourth Regular Session of the Commission in December 2007 endorsed funding to prepare a comprehensive research plan on Pacific-wide bigeye growth and reproductive biology. This document articulates this plan. The review of information demonstrates considerable knowledge uncertainty in the WCPO with information from the central Pacific scant; an investigation of age, growth, sex ratio at size and reproductive biology of bigeye is required. Existing information however supports the hypothesis that reproductive and growth parameters used in current stock assessment models are strongly influenced by prevailing oceanography, and variation in estimates can be expected both in longitudinal and latitudinal dimensions. Sensitivity analysis of reproductive parameters used in stock assessment demonstrates that current knowledge uncertainty has influence on spawning biomass and biomass reference points and the F multiplier. Variation in growth rate recently tested was less influential. The research plan outlines important hypotheses, experimental design considerations, preferred methods, sampling strategy, expected timelines and projected budget (split by RFMO jurisdictions) for implementing a Pacific-wide study to reduce current reproductive and growth uncertainties for bigeye. The importance of collaboration and cooperation between all WCPFC members, participating territories, and co-operating non-member countries will be critical to the effective

implementation of the research plan. Options for fine and coarse scale data resolution are presented. Implementation of the study will take four years after a two-year pilot study is completed. The pilot study is proposed for the EEZ's of Palau and Micronesia in Region 3 of the WCPO stock assessment model. A determination of sampling requirements for the broader Pacific-wide phase 2 of the study will occur at the completion of the pilot study.

Discussion

42. It was commented that the EC experience is that tuna spawning activity is often highly dependent on sampling gear.

43. The presenter responded that he agreed, and that the research plan documents that both longline and purse-seine gear are required to avoid confounding and bias in data analysis.

44. It was commented that how certain the authors are that a sample size of six per strata will be adequate to collect the necessary number of gonads.

45. The presenter responded that it is hoped that the question of sample size can be confirmed during the pilot study and the research plan updated before implementation of the Pacific-wide study. Also the design applies an estimation approach to the analysis of the data rather than a statistical significance test. Estimation approaches are typically more powerful and less reliant upon large sample sizes.

46. It was commented that the stock assessment model for bigeye tuna in the WCPO indicates overfishing. There was general support for undertaking of the pilot study to reduce uncertainty in the biological parameters used in stock assessment models over the equatorial and sub regional range of bigeye and the need to progress the implementation of the research plan. It was also noted that delays in approval and sourcing of funds will only result in delays in collecting this necessary information and will impair future stock assessments. The study was identified as important for FFA countries.

47. A CCM seconded the CCM and asked about the possibility of a Pacific-wide study being undertaken in a shorter time frame.

48. The presenter responded that it was possible through wide collaboration, but that the experience of IATTC and SPC is that collection of biological samples by observers at sea is time consuming and that two years is most likely the minimum timeframe required for collecting samples, leaving 12 months for laboratory analysis and another 12 months for data analysis. Collaboration is necessary and encouraged for the successful implementation of what has been planned.

49. There was a question about how much the contribution could be expected from new information on the stock assessments.

50. IATTC commented that there was a large effect in the EPO bigeye tuna stock assessment model results when accurate information on age and growth and reproductive biology were included.

51. It was commented that the inclusion of the data will allow regional parameterization of models. It was commented that this type of biological information is always of key scientific importance, even if its short-term impact on stock assessment is difficult to evaluate.

52. Most CCMs commented that they would like to support implementation of this research and that SC should recommend that it commence with urgency, and noted (with regret) that this work hadn't commenced already.

4. e. **Other (supporting documents)**

IP-1: Farley, J. and N. Clear. *Preliminary study of age, growth, and spawning activity of albacore in Australia's eastern tuna and billfish fishery*.

IP-2: Young, J., R. Humphreys, J. Uchiyama and N. Clear. *Comparison of swordfish maturity and ageing from Hawaiian and Australian waters*.

53. No additional explanation and information was provided from SC4-BI-IP-1 and SC4-BI-IP-2.

5. Research planning

5. a. Short-term and medium-term research plan

54. The reduction of uncertainty in knowledge about bigeye tuna reproductive and growth biology is a high priority issue identified by the SC (Attachment O, SC3 Summary Report). To reduce this uncertainty and to tailor data to the needs of existing stock models, a Pacific-wide study of bigeye reproductive and growth biology is required. This will require the implementation of an extensive biological sampling programme that will rely on obtaining samples from longline and purse-seine fisheries by observers at sea. Port sampling will be possible when samples have reliable location information for the collection of otoliths for ageing.

55. To implement the research plan, the BI-SWG recommends a two-phase research programme:

i. Phase 1 comprises implementation of a pilot study over a two-year period to determine the sampling needs and methodology of a Pacific-wide study. It is recommended that this occurs in the EEZ's of Palau and Micronesia because the size distribution of fish caught from these areas is influential in the WCPO stock model. In addition to project planning, the age-growth information should be used to update the stock model for these areas.

ii. Phase 2 of a three-year research plan will comprise the Pacific-wide component, where cooperation with the IATTC will be necessary. This will provide information to spatially model the variance in reproduction and growth in currently used stock models (Multifan-CL, Stock Synthesis, and SEAPODYM).

56. The BI-SWG recognizes that all CCMs involved in purse-seine and longline fisheries in the WCPO should cooperate in the implementation of both Phase 1 and Phase 2. Where possible, it also recommends to associate national programmes undertaken by CMMs within the implementation of Phase 2. This will require the application of the same methods as described in the document WCPFC-SC4-BI-WP-7. The estimated budget for the two-year pilot study is shown below.

Year	Research targets	Key outputs	Estimated budget
2009	Collection of samples	Samples collected with CMM assistance. Progress report.	USD29,592
2010	Analysis of samples and Phase 2 feasibility determined	Pilot study report and power analysis for Phase 2.	USD29,000

Discussion

57. It was noted that the sensitivity analysis demonstrates that reproductive parameters strongly impact spawning biomass (up to 40%) but have a lower effect (10%) on reference points. It was asked how certain it is that this is a priority investment that will remove uncertainty.

58. A response was that growth information will be very influential in stock assessment and reference point calculations. And that was also worth expanding the sample collection to yellowfin where we note from past stock assessments that regional growth differences are very influential. While reproduction does not strongly influence MSY-based reference points, they do influence other indicators such as spawning biomass.

59. It was pointed out that the EPO result was very significant when reproductive parameters were updated, and methodological questions were raised at the time to confirm that the methods were robust, before accepting the output of the much more pessimistic assessment.

60. It was responded that the design as described in the research plan is robust to assumptions. The authors would advise SC to only endorse a robust design.

61. It was commented that the research plan is not expensive in relation to the value of the fishery given the importance of this information for stock assessment and biological understanding.

62. It was recommended that the research plan as described in the working paper is included in the short- and medium-term plan (i.e. the pilot study is funded and implemented and reported back to the SC, and then based on SC recommendations implement the Pacific-wide study).

63. The convenor summarized the discussion. The SWG recommended that the methods for a Pacific-wide study are appropriate and that a two-year pilot study is required and should be included in the "BI-SWG short- to medium-term research plan", and should be supported by the SC.

5. b. Work programme for 2010–2011

64. This will be considered in plenary under agenda item 9.

6. Administrative matters

65. There was no particular topic regarding administrative matters. H. Honda will serve as a convener for two more years.

7. Adoption of report (including a one page summary)

66. This report was adopted by SC4 on 18 August 2008.

8. Close of meeting

67. In closing the meeting, the convenor thanked SWG participants, presenters and rapporteurs for their contributions.

Attachment G, Appendix 1

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

AGENDA FOR THE BIOLOGY SPECIALIST WORKING GROUP

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1. Opening of meeting

2. Selection of rapporteurs

3. Adoption of agenda

4. Research

a. Age and growth

WP-1: Age and growth of swordfish (*Xiphias gladius*) in the North Pacific. Valeiras, X., J. Mejuto & M. Ruíz

b. Stock structure

WP-2: Origin of yellowfin tuna (*Thunnus albacares*) in the Hawaiian Islands: Preliminary assessment of natal signatures in otoliths. Itano, D., R.J. David Wells, J.R. Rooker

WP-3: Note on the stock structure of Pacific bigeye tuna to be used in stock assessments. Fonteneau, A. and J. Ariz

WP-4: Stock structure of swordfish (*Xiphias gladius*) in the Pacific Ocean using microsatellite DNA markers. Kasapidis, P., A. Magoulas, B. García-Cortés and J. Mejuto

c. Behaviour and movement

WP-5: Overview of Japanese tagging project on tropical tunas in the temperate area of Japanese water. Matsumoto, T. and H. Okamoto

d. Reproductive biology including review of the research project, early life history and recruitment strategy

WP-6: Reproductive activity of swordfish (*Xiphias gladius*) in the Pacific Ocean on the basis of different macroscopic indicators. Mejuto, J., B. García-Cortés and A. Ramos-Cartelle

WP-7: A research plan for a pacific-wide study of bigeye reproductive and growth biology. Nicol S., S. Hoyle, B. Molony, D. Itano, K. Schaefer, A. Aires-Da-Silva, C. Sun, H. Honda, M. Maunder, A. Langley, V. Allain, A. Williams, P. Williams, J. Hampton and C. Millar

e. Other (supporting document)

IP-1: Preliminary study of age, growth, and spawning activity of albacore in Australia's Eastern Tuna & Billfish Fishery. Farley, J. and N. Clear

IP-2: Comparison of swordfish maturity and ageing from Hawaiian and Australian waters. Young, J., R. Humphreys, J. Uchiyama and N. Clear

5. Research planning

a. Short-term and medium-term research plan

b. Work programme for 2010–2011

6. Administrative matters

7. Adoption of report (including a one page summary)

8. Close of meeting

Attachment H

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

REPORT OF THE ECOSYSTEM AND BYCATCH SPECIALIST WORKING GROUP

1. Opening of meeting

1. P. Ward (Australia) opened the meeting of the Ecosystem and Bycatch Specialist Working Group (EB-SWG), noting that P. Dalzell, the EB-SWG co-convenor, was unable to attend because of personal commitments. P. Ward acknowledged the work and support provided by P. Dalzell in preparing for the meeting.

2. Selection of rapporteurs

2. The following participants acted as rapporteurs: S. Waugh (agenda item 4), R. Clarke (agenda item 5), K. Duckworth (agenda item 6), and W. Norris (agenda items 7–10).

3. Adoption of agenda

3. The EB-SWG adopted the meeting agenda with the addition of agenda item 9(c) Strategic Research Plan (Appendix 1).

4. Ecosystem effects of fishing

a. Progress of Ecological Risk Assessment Project

EB-WP-1: Kirby, D. ***Ecological Risk Assessment (ERA) progress report (2007/2008) and work plan (2008/2009)*** **jointly presented with EB-WP-2 Waugh et al.** ***Preliminary results of an ecological risk assessment for New Zealand fisheries interactions with seabirds and marine mammals.***

4. D. Kirby (SPC-OFP) presented EB-WP-1 and EB-WP-2. D. Kirby briefly reviewed the context of the Ecological Risk Assessment (ERA) project, in terms of the requirements under the Convention, both to assess and to minimize the risk to non-target species of adverse effects due to fishing. He recalled that a three-year (2008–2010) ERA Research Plan was approved by SC3 in August 2007 and by WCPFC4 in December 2007. This now allows work to proceed from one SC meeting to the next, with funding from WCPFC for one full-time equivalent research scientist position at SPC-OFP for the duration of the plan period. Additional funding has been received from Australia, the French Pacific Fund and Papua New Guinea for activities including travel, training and integration of national and regional analyses. In-kind support has also been received

from the Agreement on the Conservation of Albatrosses and Petrels (ACAP), BirdLife International, New Zealand and USA.

5. The ERA Research Plan has the following high-level outcome: Identification of highly migratory species and associated/dependent species that are at relatively high risk of adverse effects due to fishing, for consideration by the SC in terms of further research or management responses. In pursuit of that outcome, the following research outputs were identified in the Research Plan: (i) enhanced productivity-susceptibility analyses (PSAs) that are comparable, transferable and for which uncertainty has been quantified; (ii) identification of highly migratory species, or associated/dependent species at high apparent risk that can be assessed using existing data and models; (iii) identification of data requirements, through fisheries monitoring or bio/ecological research, in order for other high-risk species to be assessed; (iv) scientific support for small island developing States (SIDS) in implementing ERA/EAFM (ecosystem approach to fisheries management) at the national level, as requested by countries/territories and in collaboration with FFA.

6. Since SC3, priority has been given to outputs (1) and (4): national analyses have been carried out for Nauru, Federated States of Micronesia (FSM) and Kiribati, and collaborative analyses have also been carried out with/by colleagues in New Zealand and USA (Hawaii). The results of national-scale PSAs were presented for Kiribati purse-seine and longline fisheries. There was not enough time to consider PSAs for Nauru and FSM, but EB-SWG recognized the goodwill of these CCMs in consenting to their observer data to be analyzed by SPC-OFP and presented to SC.

7. The PSA for fish species caught in Hawaiian longline fisheries was stratified by deep and shallow set fisheries, and for time periods before (1994–2001) and after (2004–2007) a shark finning ban (2001). Percent mortality estimates were derived from observer data by W. Walsh (USA) and a new method for estimating vulnerability of species to gear by depth was developed by K. Bigelow (USA). The results show a significant decrease in shark mortality after the shark finning ban, from ca. 40%–>80%, which is reflected in the PSAs. This demonstrates the effectiveness of the ban and the importance of including percent mortality in analyses of fisheries interactions with bycatch.

8. The PSA for seabird and marine mammals in New Zealand waters (EB-WP2) used the spatial overlap between species distributions and fishing effort to determine susceptibility. The work used GIS layers for species distributions, calibrated by tracking data where possible, and operational level fishing effort data. The preliminary results of the PSA determined that *Procellaria* petrels were at the highest relative risk, followed by albatrosses, small petrels, seals and boobies. When the PSA results were mapped to fisheries statistical areas, they confirmed some known areas of high potential for fisheries interactions, and also flagged other areas as being at relatively high risk. The analysis indicated where observer effort could be directed in order to check whether seabird interactions really are higher there. This study demonstrates the potential utility of ERA in directing observer effort under the ROP.

9. Additional plots of observed interactions of WCPO longline fisheries with seabirds, sharks, turtles and marine mammals were presented. The general conclusions are that seabird interactions are of most concern in temperate waters, turtle encounters are of most concern in tropical waters, and shark and marine mammal encounters have been observed throughout the fisheries, although shark encounters are several orders of magnitude more common. Further work on seabird spatial overlaps with fishing effort was presented later by S. Waugh for BirdLife International.

10. PSAs for purse-seine fisheries were also presented to EB-SWG. Purse-seine fisheries were shown to have different impacts on bycatch depending on set type. Unassociated sets catch the smallest number of non-target species in the smallest proportion relative to target species. Associated sets clearly impact on a greater number of species and in greater proportion. PSA results indicate that the silky shark and oceanic white-tip shark are at high apparent risk from tropical purse-seine fisheries, as well as from longline fisheries.

11. Estimates of declining catches and catch rates for several shark species were presented (ST-IP1). Although the implications of the Hawaii shark finning ban and the weight of the Hawaii observer data in determining those estimates is still to be determined, the declining trends in catches and catch rates in the absence of mitigation measures across the Convention Area are of concern. Further work to determine catches and catch rates of non-target species is strongly encouraged. The feasibility of stock assessment for key shark species should also be investigated.

12. Some potential definitions of "key shark species" were suggested. The definitions recognized that "key shark species" might usefully have different definitions, depending on the context. These definitions were discussed again under the agenda item on sharks.

13. An evaluation of the WCPFC CMMs on sharks (CMM-2006-05) and seabirds (CMM-2007-04) was carried out. Presently these CMMs apply only to vessels >24 m in length. The implications of this exemption — in terms of percentage of effort covered, catch rates of vessels either side of the length threshold, and the overall effectiveness of CMMs —had not thus far been considered. A previous study commissioned by the USA estimated that of the 3,500 longliners in the WCPO that are >14 m in length overall, only 500 are >24 m. Using available observer data linked to vessel information, SPC-OFP showed that catch rates for sharks do not differ for longer vs. smaller vessels. Although there is an apparent difference in seabird catch rates depending on vessel size, this is likely to be confounded by the spatial heterogeneity of seabird distributions, and catch rates were presented as birds per set, rather than birds per number of hooks. The present CMMs are, therefore, unlikely to be effective in minimizing shark and seabird bycatch.

14. In addition to activities carried out under the ERA Research Plan, SPC-OFP held a two-day ERA training workshop in June for 25 colleagues from Pacific Island countries and territories. SPC has also participated in an initiative (in collaboration with FFA and SPREP) to develop a Pacific Islands Regional Plan of Action (PI-RPOA) on Sharks.

15. For the period 2008/2009 (i.e. from SC4 to SC5), national-scale analyses are planned for Papua New Guinea, Samoa, Marshall Islands, New Caledonia and French Polynesia. In further collaboration with New Zealand and relevant NGOs it is planned to extend the seabird ERA work into high seas areas, considering finer-scale and more up-to-date fishing effort data. Through further work on PSAs and the estimation of trends in shark catches and catch rates, SPC-OFP will identify key shark species at high apparent risk from fishing. SPC-OFP will also carry out several turtle bycatch mitigation projects in collaboration with FFA and certain CCMs.

16. Finally, SPC has previously developed bycatch identification and handling guides with funding from Australia, France, New Zealand and USA. These have been published in English and French. Other CCMs, particularly distant water fishing nations, are encouraged to discuss with SPC-OFP arrangements for the translation and production of these materials into their own languages so that their scientific observers and fishers can benefit from their use.

Discussion

17. The convenor reminded participants that the ERA was central to the WCPFC in prioritizing and structuring its work on non-target, associated and dependant species. WCPFC4 adopted SC3's recommendation to extend the ERA project through to 2010.

18. Kiribati thanked SPC for its involvement in the ERA projects, highlighting the successful outcomes of the in-country work. Kiribati strongly supported the use of ERA methodologies that can be used in fishery management and research, and noted the particular utility of ERA research in the preservation of biodiversity. Kiribati supported the budget and work plan of the ERA project and thanked those countries that had contributed funds.

19. Participants noted that the ERA work was essential for understanding the effects of fishing on vulnerable species, and noted strong support for the work plan of the ERA project. They stressed the importance of CCMs working on the agreed work plan and highlighted the need for continued funding for this project. New Zealand thanked SPC for its contribution to its national seabird ERA, and noted the utility of the work in evaluating CMMs and allowing the prioritization of future research and monitoring. New Zealand encouraged other CCMs to work with SPC in developing ERA programmes for their own fisheries.

20. PNG highlighted its appreciation for the work, and was particularly interested in having ERA work developed before resources were dedicated to more detailed research. PNG felt that ERA analyses were particularly useful in enabling a good overview of what key issues were for a particular fishery or group of target or not-target species. It thanked SPC for its comprehensive work on the project and looked forward to additional ERA work.

21. The convenor asked how ERA studies treated situations where detailed species information was lacking. The presenter advised that, contrary to CSIRO analyses typically used in Australian fisheries, the ERA methodology applied in WCPFC fisheries used proxy values for species biological parameters, borrowed from closely related species, where possible, obtained from the Pacific area. This removed the tendency to have inflated risk values for species where data were lacking or poor.

b. Biology of high risk species

22. No working papers were presented under this agenda item. D. Bromhead (SPC) provided a brief overview of EB-IP-6 (Fisheries biology and ecology of highly migratory species). The EB-SWG noted the utility of this work. SPC indicated that it will be publishing a series of individual species profiles now that this research has been completed, which will be available to CCMs for the species of most interest to them.

c. Fishery impacts on ecosystem

EB-WP-10: Lehodey et al. SEAPODYM. V2: *A Spatial ecosystem and population dynamics model with parameter optimization providing a new tool for tuna management.*

23. J. Hampton (SPC) presented paper WCPFC-SC4-2008/EB-WP-10. He noted that its main applications were in a) stock assessments, particularly for skipjack and bigeye tuna, noting that the model currently uses 5x5 degree fisheries catch and effort data, but that the model would benefit from higher resolution data, which would allow fine-tuning of the model; b) in predicting

natural mortality rates for tunas, which vary in time and space and are one of the principal drivers of stock dynamics, c) defining spawning habitat and d) identifying adult tuna habitat.

24. The capacity exists within the model to compare time series of abundance with MULTIFAN-CL (MFCL) models, and to hindcast the abundance estimates for periods in the past. The model comparative results comparing MFCL and SEAPODYM outputs showed good predicted and observed outcomes for both skipjack and bigeye tuna, particularly in the WCPO, but less so in the eastern Pacific.

25. The presenter noted that important future tasks in the development of the model included: a) integrating archival and conventional tagging data, especially for yellowfin tuna and swordfish; b) using it to understand the effect of climate variability on tuna stocks, especially skipjack tuna and ENSO, which are considered likely to fluctuate together; c) providing global warming predictions for tuna stock status and distribution of adult tuna habitat; d) for management strategy evaluation, for example assessing the effect of marine protected area development and changes in fishing intensity or management interventions. In summary, J. Hampton noted that the SEAPODYM model was useful for assessing fine-scale spatial effects on tuna stocks as well as large-scale and climate effects, both short to long term, and was a very important tool for future stock assessment.

Discussion

26. The presenter noted that, if real, the relationship between ENSO and skipjack biomass dictated by the model would be of particular use for hindcasting and prediction of fishing conditions a half-year in advance. Other participants noted that trends in estimates of tuna abundance and recruitment are model generated, taking regional oceanography into account. Therefore, the apparent relationship of ENSO to skipjack tuna abundance is not surprising.

27. Participants asked whether it was possible to provide a comparison of empirical estimates of recruitment between MFCL and SEAPODYM. Long-term trends in catchability would also be a useful model output. Participants were interested to know whether it was possible to estimate quantities, such as catchability, on a small-scale, at regional or smaller scales into the model. The presenter responded that: i) It may be possible to infer environmental impacts on recruitment estimated in the SEAPODYM model that could then be incorporated into the MFCL model; and ii) In the SEAPODYM model, like MFCL, it is necessary to make strong assumptions about the temporal stability of longline catchability in particular. However, future iterations of SEAPODYM may be able to incorporate and estimate environmental impacts on catchability that could then be incorporated into MFCL. Also, unaccounted-for spatial heterogeneity in stock distribution in the MFCL model may give the impression of varying catchability. The extent to which this occurs could be investigated using SEAPODYM because of the greater spatial resolution of that model.

28. The EB-SWG considered how SEAPODYM predicts increases in larval skipjack and bigeye tuna distribution, as the model predicted a strong decrease in the adult biomass in bigeye tuna. The presenter noted that larval increases output by the model were likely to be driven by ocean warming and preferred habitat moving away from tropical areas.

29. Participants asked whether the modeling could provide assessments of small-scale changes, such as sea surface temperature (SST) changes around particular regions. The presenter indicated that while large-scale effects could be examined, the accuracy of the model in predicting the effects of climate variability and change at smaller scales was untested.

30. The EB-SWG convenor summarized the discussions under agenda item 4, noting that there was strong support for the ERA and SEAPODYM projects and existing work programmes. Some participants supported those comments, and the continuing work on these projects, both for region-wide and in-country work.

5. Sharks

31. The convenor noted that there were no working papers for this session, but that CMM-2006-05 had come into force at the beginning of 2008. Its adoption required the SC to provide input on a variety of shark-related matters.

a. Review of CMM-2006-05 and CCM reports on shark catches presented in Part 1 of Annual Report

32. The convenor indicated that the current limit on shark fin landings (5% shark fin–carcass ratio) was reviewed at last year's meeting and found to be appropriate. No additional information was presented to the EB-SWG this year, so it was not necessary to modify that advice. A variety of other measures employed by national governments to limit shark mortality were noted, including bans on longline wire leaders, catch limits, and regulations to have sharks landed with their fins attached.

33. Analyses presented in EB-WP-1 suggested that there is no apparent difference in the catch rates for sharks by longliners above and below 24 m overall length. The EB-SWG recognized that there appears to be no scientific basis to justify the current exemption for small vessels. Some participants recommended that the shark measure be revised to include vessels under 24 m.

34. The EB-SWG noted that several CCMs were actively developing National Plans of Action (NPOA-Sharks) that will be used to guide research and management within each respective jurisdiction. The Philippines NPOA-Sharks, for example, had been finalized earlier in August.

35. A draft table summarizing the reporting of shark, seabird and sea turtle catches in Part 1 of Annual Reports was compiled as a useful way of summarizing bycatch information required by CMMs and Resolutions (Table H-1).

TABLE H-1: Summary of bycatch data in 2008 Annual Reports. Ticks (✓) confirm the submission of the report and the provision of estimates for 2007; a cross may indicate either that observations were not recorded or that estimates were not derived

CCM	Part 1 Report submitted	Observer coverage	Estimates of shark catches	Estimates of seabird catches	Estimates of turtle catches	Notes
American Samoa	×					Some observer coverage
Australia	✓	✓	✓	✓	✓	
Belize	✓	×	✓	✓	✓	
Canada	✓	×	✓	✓	✓	Troll fishery only
China	✓	×	×	×	×	Observers deployed in

CCM	Part 1 Report submitted	Observer coverage	Estimates of shark catches	Estimates of seabird catches	Estimates of turtle catches	Notes
						2003, 2006 & 2008
CNMI	×	×	×	×	×	
Cook Islands	✓	×	×	×	×	Observer recruited for 2008
European Community	✓	✓	✓	×	×	EB-IP-5 presents 1990–2005 estimates
FSM	✓	✓	×	×	×	Report presents 2004–2006 estimates
Fiji	✓	✓				Some observers in 2007 & 2008
France	×					
French Polynesia	✓	✓	✓	×	×	
Guam	×					
Indonesia	✓	×	×	×	×	
Japan	✓	✓	×	×	×	Longline observers in 2008
Kiribati	✓	✓	×	×	×	
Korea	✓	✓	×	×	×	EB-IP-4 presents 2002–2007 estimates
Marshall Islands	✓	✓	✓	×	×	Seabird interactions assumed negligible; turtle data yet to be analyzed
Nauru	✓	✓	×	×	×	
New Caledonia	✓	✓	✓	✓	✓	Observer coverage to be increased 2008–2010
New Zealand	✓	✓	✓	✓	✓	
Niue	×					
Palau	✓	×	×	×	×	Observer programme starting late

CCM	Part 1 Report submitted	Observer coverage	Estimates of shark catches	Estimates of seabird catches	Estimates of turtle catches	Notes
						2008
PNG	✓	✓	✓	✓	✓	
Philippines	✓	×	×	×	×	
Samoa	✓	×	✓	×	×	Shark catch estimates from port sampling
Solomon Islands	✓	×	×	×	×	Observer programme active until 2005
Chinese Taipei	✓	✓	×	×	×	EB-WP-6 presents bycatch estimates for 2002–2006
Tokelau	×					
Tonga	✓	✓	×	×	×	
Tuvalu	✓	×	×	×	×	
United States of America	✓	✓	✓	✓	✓	Shark catches included for American Samoa, Guam & CNMI
Vanuatu	✓	×	×	×	×	Observer programme starting 2009
Wallis and Futuna	×					

b. Identification of key shark species for annual reporting to the Commission

36. The convenor indicated that the identification of key shark species had at least two aspects: i) the requirement of CCMs to report shark catches; and ii) the need to assess key shark species. SC3 had taken a sensible approach in recommending that CCMs report shark catches to the lowest possible taxonomic level. This recognized that fishermen cannot always be expected to accurately identify all shark species, while observers — with appropriate training — can provide that level of data. SC3 recognized that collecting catch data only on the most abundant species would bias analyses and assessments towards the more productive species and potentially miss less productive species that may be at higher risk.

37. SPC suggested two approaches to identifying key shark species: i) for the purposes of catch reporting, key shark species should be those shark species identified in UNCLOS Annex 1, plus associated species, present in the catch; and ii) for the purposes of single species analysis, population modeling and stock assessments, those species determined by a process of ecological risk assessment (ERA) as being at high apparent risk of adverse effects due to fishing. SPC also

emphasized the need to know fully what data sources are available — especially with regard to observer-generated data — and the relative skill level of those identifying the species.

38. The EB-SWG suggested that CCMs report on a minimum list of shark species, consisting of blue shark, oceanic whitetip shark, mako sharks and thresher sharks, which are easily identified by fishermen. These and other sharks should be identified to the lowest possible taxonomic level, especially by observer programmes, and these four easily identified sharks should be recorded even in logbooks by fishermen. Participants also suggested that, although not easy to identify, the silky shark, which appears to be prominent in the ERA, probably comprises the majority of other sharks caught. Therefore, all other sharks should be reported in aggregate in logbooks if identification to a lower taxonomic level is not possible.

39. The EB-SWG acknowledged that it may be difficult to identify all of the proposed shark species in some fisheries because of harvesting practices and different levels of encounter rates. It was suggested that when requiring the identification of certain shark species, a staged approach be used in implementation to ensure data quality.

c. Stock assessments for key shark species

40. The EB-SWG recognized that the identification of key shark species will be important for further assessment. The convenor suggested that while the ERA is underway, it would be important to start assembling the necessary biological and fisheries data so that a time-lag does not occur after the ERA is completed. Such information included studies of age, growth and maturity, observer data on size and sex ratio, and the standardization of catch rates. Preliminary results of the ERA suggest that silky sharks and oceanic whitetip sharks might require special attention. A review of data gaps and the general feasibility of single species stock assessment for sharks would be a useful way forward.

41. The USA announced that a stock assessment of blue shark in the North Pacific has been completed in collaboration with Japan, and will be published in the near future.

d. Development of a Shark Research Programme

42. The convenor indicated there had been little progress in the development of the Shark Research Programme since SC2. SPC suggested that there were a variety of activities that would meet the Commission's shark conservation and management needs related to stock assessments. Initial activities included feasibility studies to evaluate the available data, its quality, biological parameters and associated gaps, the fishery operational information and its shortcomings, the potential assessment methods, and utility of models. The EB-SWG supported this suggestion, noting that outputs might also be reviewed by future meetings of the Stock Assessment SWG and Methods SWG.

43. New Zealand outlined their National Plan of Action (NPOA) on Sharks (EB-IP-2). The Convenor suggested that a review of this NPOA, along with those of other CCMs, would be relevant to the EB-SWG's work, especially in the development of the WCPFC's Shark Research Programme.

6. Seabirds

a. Review of CMM-2007-04 and CCM estimates of seabird mortality presented in Part 1 of Annual Report

EB-WP-3: Papworth, W. ***Albatross and petrel distribution within the WCPFC area: Spatial and seasonal overlap with fishing effort.***

44. S. Waugh (BirdLife International) presented EB-WP-3. This paper presents an analysis of the seasonal distribution of albatrosses and petrels within the WCPFC area, using remote tracking data from the BirdLife Global Procellariiform Tracking Database. The WCPFC Convention Area overlaps with the distribution of 18 of the 22 species of albatross, and the Global Procellariiform Tracking Database holds relevant remote tracking data for 14 of these. This analysis highlights the high importance of the WCPFC area for global albatross distribution, with 11 species having over 50% of their distribution in the WCPFC Convention Area in one or more seasons of the year, and 9 species having over 40% of their distribution in one or more seasons in areas in which WCPFC longline fishing effort occurs. Fewer data are available for petrel and shearwater species, but at least sooty shearwaters and westland petrels also have high overlap with WCPFC longline effort.

45. Seasonally, the three North Pacific albatross species (Laysan, Black-footed and Short-tailed) have a high overlap with the WCPFC Convention Area throughout the year. In the South Pacific, the distribution of some species varies markedly by season. However, species vary in the timing of these migrations, such that overlap between albatross distribution and WCPFC longline fishing effort occurs throughout the year.

46. The analysis indicates that the mitigation areas defined in WCPFC-CMM-2007-04 incorporates a high proportion of the distribution of albatrosses, petrels and shearwaters (the species considered most at risk of bycatch in longline fisheries) in the WCPO. Less than 20% of WCPFC longline fishing effort is distributed in these areas.

47. The analysis presented here is based on available remote tracking data, and key data gaps remain. In relation to the WCPFC Convention Area, priority tracking data gaps (in terms of those species most likely to have high overlap with WCPFC longline fishing effort), including the distributions of several species of albatross during the non-breeding season, for some temperate albatross species during all parts of their life-cycle, and for some major colonies of Laysan and Black-footed albatrosses. Data from petrel species was poorly represented with only 5 of 60 species present in the WCPFC zone. The EB-SWG noted that SC-2006-EBSWG-WP4 had identified 40 species with threatened status occurring within tropical regions of the WCPFC. More data on the likely interactions of these species would be beneficial to assess the risk of adverse effects of fishing. The collection of tracking data or other distributional data to fill these gaps would improve the analysis. Seabird-at-sea observations are also an important source of distribution data for other seabird species within the WCPFC Convention Area.

48. Conclusions regarding the particular relevance of the analyses for WCPFC management of seabird mortality in its fisheries, were that there were particular areas that were likely to have high risk of seabird interaction, namely the Tasman Sea, Central Pacific Ocean south of 20^0S, and areas between 20^0 and 40^0 degrees latitude across the Pacific Ocean, where several longline fleets were known to operate large-scale fisheries. The study allows the identification of these areas as targets for more intensive observer monitoring and increase in mitigation efforts to reduce seabird mortality to minimal levels. New data presented in the report allow the possibility of exploring seasonal (quarterly) overlap of fisheries and seabird activity. It remains uncertain as to whether substantial overlap of albatrosses, and in particular, vulnerable tropical petrel populations, is occurring in tropical regions due to a lack of data for this region.

49. Follow up studies, of the type presented in WCPFC-SC4-2008 EB-WP-1 and 2 would be desirable, to further explore where the most intensive interaction of seabirds (and other species of special interest) and longline fishing effort from particular fleets were likely to be occurring. This kind of detailed analysis would be beneficial in allowing a targeting of future monitoring and management requirements.

Discussion

50. Some participants noted that EB-WP-3 fulfills an important information need identified by SC3. The convener highlighted the need to identify fishery hotspots— seabird interactions at the regional level. While seabird interactions are greatest at high latitudes, the EB-SWG also recognized the potential for interactions with some IUCN-ranked "threatened" petrels in tropical areas.

EB-WP-5: Chung, K-N. ***Overview of the interaction between seabird and Taiwanese longline fisheries in the Pacific Ocean.***

51. In order to collect scientific information for target species as well as incidental catch species, Chinese Taipei launched observer programmes in 2002. There were 23 observer trips from 2002–2006 on large-scale tuna longline vessels operating in the Pacific Ocean. The coverage rate by trips was 3.5% on average. The observed days were 1,590. According to the data collected, the incidental catch was highest in the areas between 25ºN and 40ºN and 165ºW and 165ºE, and in areas between 25ºS and 35ºS and 165ºW and 180W. In comparison, the incidental catch was low in tropical area. The incidental bycatch catch rate (bycatch per unit of effort – BPUE) in each 10×15 degree grid square varied from 0 to 0.65 per 1,000 hooks, with an average BPUE of 0.045 per 1,000 hooks, with variation of species incidentally caught by areas. Black-footed albatrosses and Laysan albatrosses were the major incidental catch species in the northern area. By using the total effort data estimated from logbooks and the seabird BPUE from observers, the preliminary estimated annual seabird incidental catch was around 1,700 from 2002–2006. Since 2007, Chinese Taipei has required fishermen operating north of 23°N and south of 30°S to use tori lines. The observer programme was ongoing, with one of the main purposes being the collection of seabird incidental catch data.

Discussion

52. The EB-SWG complimented Chinese Taipei on the establishment and expansion of its observer programme and the presentation of these results. Participants sought clarification on the sizes of vessels that had been observed. The presenter indicated that the observations had occurred on large, distant water longline vessels.

53. The convenor noted that it was desirable for future analyses to include confidence intervals on estimates, and queried whether a modeling approach would be more appropriate than raising stratified samples. SPC noted that generalized linear models (GLMs) are used to predict the CPUE of bycatch species based on observer coverage (GN-IP-1), and commented that Chinese Taipei observer datasets are currently the most extensive covering distant water longliners. The presenter indicated that observers are trained and instructed to record most species, but that time constraints meant that this was not always possible.

EB-WP-6: Chung, K-N. ***Overview of Taiwanese observer programme for large-scale tuna longline fisheries in Pacific Ocean from 2002–2006.***

54. Chinese Taipei began deploying observers on distant water fishing vessels in 2002 to collect fisheries data for scientific purposes. Observers were trained to collect fisheries data and biological samples. Data recorded includes fishing activities, catch numbers and weight, species identification, bycatch species, status, and biological samples for some species. This report provides a general overview of the Chinese Taipei observer programme and a summary of data collected. From 2002–2006, 23 observer trips on large-scale tuna longline fishing vessels were made in the Pacific Ocean. There were 1,590 observations days, with an average coverage rate of 3.5% on all trips. More than 20 species were recorded, and 98,055 fish were sampled. Catch composition varied by area. In the tropical area, over 50% of the catch consisted of bigeye. In temperate waters, albacore accounted for over 87% in the northern area, and 71% in the southern area. In addition, length-frequency data on major species were recorded, the sighting and incidental catch of vulnerable species were recorded, and biological samples were collected for biological research.

Discussion

55. Participants congratulated Chinese Taipei on the establishment and expansion of their high seas longline observer programme and encouraged Chinese Taipei to share data that had been collected by this programme. In response to a question, the presenter advised that most of the sea turtles that had been observed were in the ocean beside the vessel (and not caught); it was difficult to reliably identify these free-swimming turtles.

EB-WP-8: Black, A. *Seabird bycatch rates in WCPFC fisheries.*

56. S. Waugh (Birdlife International) presented EB-WP-8. Noting that CMM 2007-04 tasks the Scientific Committee with estimating seabird mortality in WCPFC fisheries (CMM-2007-04 para 9), this paper reviews the most recent rates of seabird bycatch reported for fisheries within the WCPFC Convention Area in published accounts. We note that there are significant gaps in the available seabird bycatch data. In particular: i) there are limited data on seabird bycatch rates from the Japanese and Korean distant water fleets operating north of 20°N and south of 30°S in the Pacific Ocean, areas where seabird bycatch is known to be a significant problem; ii) EU longline fisheries in the central Pacific Ocean have recently increased in effort in areas where there are significant seabird foraging zones; iii) seabird bycatch rates are believed to be lower in tropical longline fisheries, and observer data remain very limited in this zone, despite high fishing effort in this region. The means of monitoring whether seabird bycatch in these areas need to be developed, such as through rotational coverage of fisheries. It is particularly important for monitoring fisheries effects on the many vulnerable species of petrel present in this zone (40 species of threatened petrel occur in tropical waters), as seabird mortality, if occurring even at a low level, may be deleterious for species populations status; iv) high seas areas throughout the WCPFC Convention Area present significant data gaps.

57. Currently the observer coverage within the WCPFC longline fisheries is very low (covering less than 1% of effort). Combined with the non-random distribution of observer effort throughout the area, this leads to severe restrictions in the ability to make estimates of overall seabird bycatch. Previous studies have shown that to estimate the bycatch of species of special interest, such as seabirds and turtles, coverage levels in areas of capture risk of these species need to be over 20% of effort. An improvement in the level and spread of observer coverage would greatly enhance WCPFC's ability to estimate seabird mortality in its fisheries, and to effectively reduce seabird bycatch. Models combining fishing effort data, available bycatch rates and seabird distributions have been used to determine overall seabird bycatch within ICCAT longline fisheries (Klaer et al. 2008). A similar approach may be appropriate for WCPFC.

Discussion

58. The convener asked whether the SEAPODYM model could be used to predict areas of seabird foraging. The presenter indicated that this was theoretically possible, but would require a definition of forage and parameters defining seabird habitat. It was noted that seabirds sometimes travel thousands of miles to forage in distant nearshore habitats that may not be well-modelled by SEAPODYM.

59. There was discussion on whether higher rates of observer coverage may be required in tropical areas, and it was suggested that it would be useful to understand the impact of longline fisheries in the vicinity of conservation areas. Some participants suggested that seabird bycatch was only an issue in temperate waters, but it was noted that the disproportionately low observer coverage in those areas suggests that data collection is needed in the tropics to confirm this.

60. The convenor drew participants' attention to EB-IP-5 (Bycatch of the Spanish longline fleet) and invited comments on that paper. The convenor also noted EB-IP-7 (Estimates of seabird population sizes and trends), submitted by ACAP.

b. Review of research on seabird interactions and mitigation measures

EB-WP-7: Minami, H. ***Direct comparison of seabird avoidance effect between two types of tori lines in experimental longline operations.***

61. Seabird avoidance performance of two types of tori lines specified in the WCPFC seabirds conservation and management measure — "1a) Tori line" and "1b) Tori line (light streamer)" — was compared in designed experiments of longline fishing using commercial and research vessels in the western North Pacific. Two types of tori lines were used according to specifications for tori lines defined in CMM 2007–04 (type A: 150 m tori line length; long streamers were attached every 5 m by using swivels; type B: 150 m tori line length, short streamers were attached to the line every 1 m, without using swivels, but braided into the line). The frequency of bait-taking behavior and seabird bycatch rates were examined using generalized liner mixed models (GLMMs). Results of the analysis indicated that "1b) Tori line (light streamer)" further reduce both bait-taking behavior and seabird bycatch compared to "1a) Tori line". Considering its better performance in seabird avoidance as well as its practical utility due to numerous tangle-free streamers and light-weight structure, "1b) Tori line (light streamer)" stands as a good option for avoiding seabird bycatch in longline fishery.

Discussion

62. It was clarified that a measure of interaction used in the study (bait-taking behavior) equated to the number of times that seabirds took bait. The presenter also indicated that branch lines had not been weighted.

63. A concern was noted that the Type A tori line used in the trials did not comply with the standards for tori lines defined in CMM2007-04. Therefore it was not clear how the type B (light) tori line performed in comparison to the WCPFC's standard tori line. Additional concern was voiced about the length of the attached streamers and the extent to which the tori line had streamers attached. The presenter explained that the tori lines for Vessel 1 were attached to the pole about 10 m above the water.

64. Participants also noted that application of results was limited to the area and species (Laysan albatross) studied. New Zealand expressed a concern that there was not enough detail provided in the paper to allow the experiments to be replicated. New Zealand and BirdLife International offered to work jointly with Japan to trial the effectiveness of various types of tori lines aboard Japanese longliners operating in New Zealand waters. BirdLife emphasized the need for tori lines to be effective in preventing the capture of deep-diving seabird species such as petrels. The presenter explained that the experiments were conducted to focus on the comparison of seabird avoidance performance between two types of tori lines.

65. The EB-SWG noted that the results of a study at SC3 (EB-WP-13) showed that the length of tori lines was the most important variable explaining efficacy of tori lines used under operational fishing conditions, presumably because improved aerial extent of longer tori lines led to more effective protection of baited hooks from bird attacks. Participants noted that in the study discussed in EB-WP-7, the type B tori lines (light weight type) had a significantly greater aerial extent (70–90 m) than the type A tori lines (with long streamers, 46–60 m aerial extent). The apparent better performance for the lightweight tori lines noted in the study could have been due to confounding in the experiment between differences in aerial extent, and the branch streamer length and type. Thus, it was suggested that the results on the branch streamer length and type were inconclusive, and Japan was encouraged to continue to work on streamer-line design, in collaboration with other researchers.

EB-IP-3: Brouwer, S. and N. Walker. ***Use of light streamer lines and line weighting on longline vessels and the implications for seabird bycatch.***

66. S. Brouwer (New Zealand) presented EB-IP-3. The research examined two commercial longline fishing vessels' seabird bycatch rates before and after gear was re-configured in an attempt to reduce incidental seabird capture. Data were collected using fishery observers. Both vessels set longlines at night and used multiple light streamer lines to deter seabirds from diving on baited hooks during the set. Vessel 1 used three light streamer lines attached to poles of varying heights, and initially had no line weighting. Vessel 2 used two light streamer lines to deter seabirds and used line weighting to increase hook sink rates. Vessel 1 added line weighting and added long streamers to the streamer line. The result was a reduction of seabird captures from 12 captures in 12 sets, to 1 capture in the subsequent 26 sets. Vessel 2 used streamer lines with long streamers and a line-weighting regime. This vessel caught 10 seabirds, 8 of which were thought to have been caught on the haul. The implications of these results are discussed and the advantages of using fishery observers on commercial longline fishing vessels as a platform for research are highlighted.

EB-WP-4: Waugh, S. ***Stages in the process of managing seabird mortality in RFMO fisheries.***

67. S. Waugh presented EB-WP-4. The study compared processes for managing seabird mortality in six fishery management organizations operating in the Southern Hemisphere that had similar structures and mechanisms. The key stages in dealing with seabird mortality were to: a) recognize the problem of seabird incidental catch through the establishment of a resolution on minimizing seabird mortality with only the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and Indian Ocean Tuna Commission (IOTC) having a strongly worded resolution; b) gather information specific to the fishery in order to characterize the nature and magnitude of the problem, which has been carried out with varying levels of detail by different organizations, and those with the most effective systems (e.g. CCAMLR) having vessel-by-vessel and shot-by-shot reporting of incidental seabird catches; c) establish regulatory mechanisms (e.g. CMMs) for seabird mortality mitigation, noting that the mix of mandatory and

voluntary measures in place by WCPFC was considered to be the most effective means of implementing measures, and allowing flexibility for fishers. It was important that any measures were established with an associated set of penalties, along with associated compliance monitoring, and that their introduction was supported by robust scientific evidence of their efficacy; d) develop effective mitigation strategies and assessment of ongoing performance via a technical review panel who should be tasked with: i) assessing risk and identifying highest priority areas for management regularly (e.g. at annual intervals); ii) review incidental levels across the fishery areas of concern at the level of the Convention in question; iii) review the effectiveness of measures by examining research on mitigation measures, and recommend modifications to CMMs as necessary. The BirdLife International review identified areas where WCPFC could bring its seabird bycatch management framework in line with best practices through a) reinforcement of CMM-2007-04 by including as an objective the reduction of seabird mortality to near zero levels; b) gathering and analyzing data on seabird mortality at the scale of the WCPFC Convention Area, with a necessary increase in observer coverage levels to at least 20% high risk areas for seabird mortality; implementing a centralized database of bycatch mortality and associated fishery data; and analyzing these data for the entire WCPFC Convention Area, stratified into sub-areas as necessary. This step was considered essential for assessing the relative importance of seabird mortality in different regions, and providing consistency in the analyses of seabird mortality and associated error estimates; c) reinforcing the work of the EB-SWG on seabird incidental mortality by i) conducting an annual risk assessment of the Convention Area for seabird mortality risk, which was a particularly dynamic field with improving mitigation technologies, knowledge of bycatch hotspots and of species distributions; ii) a specialist subgroup to review mitigation technology and the applicability of these methods to different areas within the WCPFC Convention Area; iii) reviewing the fine-scale information on incidental catch rates and types within the WCPFC fisheries in order to identify problem fishery practices and areas, and propose possible mitigation options; iv) recommend bycatch monitoring requirements for observers, including details of mitigation practices used and injury types and species identification; v) recommending training and reporting materials for fishers and observers.

68. The presenter referred to EB-IP-1 (CCAMLR process of risk assessment to minimize the effects of longline fishing mortality on seabirds), which provided an operational example of a highly effective bycatch mitigation framework that had been in operation for over 10 years. This example provided many structures and methods that could be used by the WCPFC, due to similarities in relevant structures of the two fisheries agreements. It was noted that CCAMLR had the most advanced system of management among RFMOs reviewed in the study, and had made the most demonstrable progress in reducing seabird bycatch levels in its longline fisheries. This had been achieved through a combination of proven mitigation measures, extensive monitoring by independent observers, annual expert review of seabird bycatch rates, and evolving fishery and mitigation practices, all of which had been instrumental in reducing seabird bycatch in CCAMLR fisheries.

Discussion

69. Participants noted improvements in the attention given to seabirds over the past decade; at least now there is full recognition of the seabird bycatch problem, and that progress is being made to mitigate this problem. In some cases, more progress is being made on protecting seabirds than on ensuring the sustainability of tunas. The presenter stated that although there was significant progress in some areas, it was not rapid enough. Ten years ago we did not know how to protect seabirds, but now we do and the priority is to act upon that knowledge. SPC stated that they looked forward to further collaborations and the use of data beyond that which is currently in the public domain.

c. Review of technical specifications of seabird mitigation measures

70. No new research on technical specifications was presented, and the EB-SWG offered no recommendations on those measures.

7. Sea turtles

a. Review of Research Programme and WCPFC2 Resolution

71. The Research Programme and WCPFC2 Resolution were not reviewed in detail, but were considered under other agenda items.

b. Review of research on sea turtle interactions

72. No new research on sea turtle interactions was presented, and the EB-SWG offered no recommendations on those measures.

73. In response to a question from the convenor, SPC noted that little regional work has been done to estimate sea turtle catch rates because the available limited resources have focussed on estimating finfish bycatch. SPC indicated that some work has been conducted on estimating sea turtle catch rates through national research programmes.

c. Review of mitigation measures

74. The convenor noted that this item was closely related to the Intersessional Working Group on sea turtles being led by R. Clarke (USA).

EB-WP-9: Ward, P. et al. ***Implementation of bycatch mitigation measures in Australia's pelagic longline fisheries: The effects of circle hooks on target and non-target catches.***

75. P. Ward (Australia) presented EB-WP-9. Experiments were conducted from 2005–2008 to test the effects of circle hooks on longline catches. The experiments involved eastern tuna and billfish fisheries (ETBF) longliners fishing primarily for yellowfin tuna, bigeye tuna and swordfish. Crew members alternated similar-sized circle hooks and control hooks along each longline. The control hooks were Japanese tuna hooks that ETBF longliners traditionally used. Observers monitored hook deployment and recorded the hook type, species, life status, hooking position and length of each animal caught. The experimental design, combined with the large sample size (> 95,000 hooks), provided a substantial dataset for investigating the effects of circle hooks on target and non-target catches. The study was not designed to investigate the efficacy of circle hooks in reducing marine turtle bycatch because turtle interactions are quite rare in this fishery.

76. For most species, catch rates on circle hooks exceeded those on tuna hooks. The elevated catch rates were statistically significant for several commercially targeted species, including albacore tuna, yellowfin tuna, black oilfish, striped marlin and swordfish. Variations in catch rates between longliners, trips and operations were often larger than the differences attributed to hook type. For most species, there was no difference in the average size caught on the different hook types. Striped marlin caught on tuna hooks were, on average, 10 kg larger than those caught on circle hooks. Differences in catch rates were large enough to affect catch levels of most species and financial returns. These predictions relate only to longliners participating in

the study. Other longliners and fishery sectors will have different mixes of species, which could result in different catch rates and financial returns than those predicted by these results.

77. Most species had an equal or significantly lower probability of being alive on circle hooks compared with tuna hooks. Analyses of hooking location partly explain these unexpected results. Regardless of hook type, most animals were hooked in the lip or jaw. Very few were hooked in locations that are likely to be fatal, such as the throat, gills or stomach. Differences between these results and other studies might be related to the fact that many of the circle hooks used in this study were relatively small.

Discussion

78. Participants noted that in order to assess the benefits of mitigation measures on turtles, it is often necessary to focus trials on areas, seasons and times where sea turtle catch rates are high. Part 1 of the Australian Report indicated generally low catch rates of sea turtles, but this could amount to a significant number of interactions if the fishery's size is taken into account. It may be possible to identify areas of high catch rates to investigate the merits of circle hooks in the mitigation of sea turtle bycatch. The presenter noted that the study's objective was to assess the effects of circle hooks on target and non-target species catch rates, so it was considered more appropriate to spread experimental fishing across the fishery.

79. Participants noted the importance of ensuring that bycatch mitigation research also assesses impacts on other species, especially those that have management concerns of their own, and indicated that many circle hook trials have done this. The importance of giving priority to those species that are vulnerable or at risk was noted. Other measures and practices to reduce mortality of many other non-target species are available, and often those measures and practices are quite effective and easy to implement compared with those for high-risk species such as sea turtles.

80. Korea provided a brief summary of a circle hook trial, which tested different sized circle hooks against Japanese tuna hooks. That study showed some similar results to the Australian trials, with small to medium circle hooks having similar or slightly higher catch rates of target species, than did the tuna hooks. However, that trial showed lower catch rates with large circle hooks. Consultation with industry on the results has lead to the voluntary uptake of small to medium sized circle hooks with positive feedback to date. Korea also noted concerns about elevating catch rates on other bycatch species of concern.

81. The presenter indicated that there was resistance from Australian fishers to the implementation of large circle hooks due to concerns about decreased catch rates and the need to purchase larger bait. USA has completed a trial on larger circle hooks and will report results soon. After this study, contracted fishers did not want to give back the circle hooks used in the trial, indicating some enthusiasm for their performance.

82. Participants noted that FFA members have developed an action plan to reduce the impact of fishing on sea turtles (EB-IP-8) as a responsible step under the flexible approach embodied in the WCPFC resolution. FFA members also highlighted the environmental and cultural importance of turtles to many CCMs and looked forward to presenting information on implementation of the Action Plan at future meetings of the SC.

FT-WP-5: An, D-H et al. ***Effect of fishery factors on bigeye and yellowfin tuna catch rates in the tuna longline fishery***, including **EB-IP-4 An, D-H.** ***A summary of the Korean tuna fishery observer programme for the Pacific Ocean in 2007.***

83. D.H. An (Korea) presented FT-WP-5 and EB-IP-4. A pelagic tuna longline research cruise in the WCPO in August 2007 was conducted by Korea's National Fisheries Research and Development Institute (NFRDI) to compare catch rates with the use of various fishery factors. Those factors included hook type, bait type and hook number. Traditional tuna hooks and six circle hook types with straight and offset types, along with five bait types (artificial squid, chub mackerel, jack mackerel sardine and squid) and hook number as a proxy for hook depth were evaluated for their effect on bigeye and yellowfin tuna catch rates using GLMs. Results from 21 sets indicated significant differences in bigeye tuna catch rates between individual set and hook number while yellowfin tuna catch rate indicated significant effect on hook number and hook type. Hook number (depth) was the paramount operational factor in explaining bigeye tuna catch rate. On the other hand, yellowfin tuna catch rates indicated an equal effect from both hook number and hook type. High catch rates with intermediate hook numbers are consistent with the tropical oceanography of the eastern and central Pacific Ocean where the thermocline and oxycline are relatively shallow compared with higher latitudes and the western Pacific. The deepest hooks in the longline monitoring study may have fished at depths of 300 m, which is deeper than the thermocline and oxycline, thus resulting in lower catch rates compared with the higher catch rates obtained by hooks fishing at intermediate depths.

Discussion

84. The convenor noted that this study was more complex than the Australian study because it examines greater combinations of hook type, fishing depth and bait. Participants noted that hook location for different bait types did not vary sufficiently in this study and that it would therefore be very difficult to assess the independent effect that bait and hook type had on catch rates. The presenter agreed that contrasting bait-depth combinations would be required to adequately assess the independent impact of each factor.

EB-IP-9: Dai, X-J and Zhu, J.F. ***Species Composition and size frequency data based on Chinese observer Program in Central Pacific Ocean in 2008***

85. From May–July 2008, the Chinese observer programme, covered the area of 2–12ºN, 178ºE–165ºW, with a total of 34 sets (totaling 96,070 deployed hooks). In total, 31 species were caught during the trips, including 30 species of fish and 1 species of sea turtle (leatherback turtle). The turtle was hooked in the mouth and released alive by cutting the line before it was hauled onboard. No seabird was hooked during the trip, although interactions occurred occasionally when setting or hauling.

Draft CMM on sea turtle bycatch mitigation measures

86. The convenor invited R. Clarke to provide the EB-SWG with an update on progress in intersessional work in developing a draft CMM on sea turtle bycatch mitigation measures. R. Clarke indicated that, based on TCC3 Summary Report (paras 117–124), the USA developed a proposed sea turtle CMM (WCPFC4-2007-DP-13). In summary, that measure proposed that the handling measures of Column A be made binding for all longline vessels and that that for the sector of the longline fishery that has been shown to have the highest turtle bycatch rates, or what is called the shallow set or swordfish fishery. The USA proposed that circle hooks and other measures related to bait be required. Also included were some measures that parallel those

adopted at the Inter-American Tropical Tuna Commission (IATTC) for purse-seine vessels operating in the eastern tropical Pacific.

87. However, based on consultations with some Pacific Island CCMs prior to the annual meeting, the USA decided not to pursue active discussion of the proposal at the meeting. These CCMs indicated that hook research was currently underway and that there was continued concern on the impact of some of the proposed measures on the catch of species of concern in specific fisheries.

88. At WCPFC4, the Chair expressed an interest in the future adoption of a binding measure for sea turtles, and requested that the USA attempt to progress the work intersessionally (see para 242 of the Summary Report).

89. The USA disseminated a circular through the Secretariat earlier this year, inviting all CCMs to participate in an electronic working group. After some outreach activities, the group was established, with representatives from Vanuatu, Australia, New Zealand, Japan, and the USA. There is also some private sector and NGO representation.

90. The group started with some exchange of recent information that had been generated on sea turtle bycatch mitigation, most notably an "Action Plan for Sea Turtle Bycatch Mitigation" developed by FFA members, and the results of an EU study on hooks. There has been active discussion on the issue of circle hooks and the need for a prescriptive measure dictating them as well as a way to measure and identify them. The group agreed that detailed efforts at proscribing circle hooks in a CMM would be problematic from several perspectives.

91. More recently, we have started to re-examine the USA proposal WCPFC4-2007-DP-13, tabled in Guam.

92. There was some hope that, based on those discussions, a modified proposal could have been reviewed by the SC, however there has not been much feedback on this. Therefore, in light of the current situation, I have been meeting informally with delegations here at the SC to determine what research and activities are ongoing.

93. There are a couple of papers from Korea and Australia that report on recent results, and we expect there will be some further work in the Cook Islands later this year.

94. At this point it is not clear what the USA will be doing with the current measure, and the decision to re-float the proposal will be based on upcoming larger decisions at the policy level regarding USA priorities for the annual meeting, although there is a strong likelihood this decision will be made prior to the TCC.

95. In the meantime, we invite any and all to participate in the electronic working group, and we plan to continue to use that venue to inform participants of the eventual outcome on the USA decision regarding what should be done at the annual meeting. We invite all to send their comments or concerns

Discussion

96. It was suggested that greater priority be given to educating fishers on releasing sea turtles, rather than simply focussing on hook type. The EB-SWG and SC last year did reach agreement that vessels should carry release equipment such as line cutters, de-hookers and dip

nets. Participants noted that survival rates of entangled turtles can be very high if released appropriately, and noted that the entanglement of leatherback turtles is more prevalent than mouth hooking. Some studies on hook types have shown that large circle hooks can significantly decrease the incidence of entanglement because they reduce the chance of foul (flipper) hooking.

97. Participants recalled that several FFA members are in the process of developing national plans or strategies for sea turtle management and that the FFA action plan provided excellent tools to assist in implementing those.

8. Access to bycatch information

a. Bycatch page on the WCPFC website

98. P. Williams (SPC) reported on the bycatch mitigation database. He reminded meeting participants of the paper presented during SC3 on the specification of the WCPFC bycatch mitigation database, which had the objectives of facilitating the organization and access of available public domain information on mitigation measures and methods relevant to WCPFC fisheries, the species they relate to, and how they are linked to WCPFC decisions, where relevant.

99. Development of the WCPFC bycatch database system progressed during the past year and test data have been added to the system (a brief demonstration of the current version of the database system was provided to participants during SC4). The work proposed for the coming year will include the completion of the database system and the development of webpages that will facilitate the dissemination of information in the bycatch mitigation database. The WCPFC Secretariat has been provided with funds from the USA government to engage a specialist to populate the bycatch mitigation database over the coming year. While most existing information will be available from past meetings and the literature, CCMs and non-governmental organizations (NGOs) were encouraged to become involved in providing any relevant information available in the public domain for inclusion in the bycatch mitigation database. It was noted that only data that are in the public domain, as defined in the Commission's Rules and Procedures, will be included in the database system and on the WCPFC website.

Discussion

100. The Executive Director thanked SPC for designing the database system and for further development work that has been undertaken. Noting that the system is nearly ready for testing, he encouraged all CCMs to attend the session for the demonstration and to provide advice for further development. The Executive Director also thanked the USA for voluntary funding contributions to allow population of database tables.

101. It was noted that data and information about non-target species can be a very sensitive issue and can sometimes require explanation to avoid confusion and misunderstanding. There may, therefore, be a need for limited access and further guidance on database use. It was suggested that great care be taken in the way that such information is handled.

9. Future research plan

a. Detailed operational research plan for 2008/2009 with budget

102. The convenor reviewed several new and existing research activities identified by this meeting of the EB-SWG. These included strong support for SPC's ERA and SEAPODYM, the initiation of a study of data gaps and the feasibility of shark stock assessments, collaboration in

studies of seabird mitigation, and identification of overlaps between fisheries and seabird distributions.

b. Work programme for 2010–2011 with indicative budget

103. The convenor reviewed EB-SWG priority projects in the 2008–10 draft Work Plan:

- ***Project 3. For catches for which estimates are not otherwise available, conduct statistical analyses to estimate catches, particularly in regard to (a) purse-seine catches of bigeye tuna and yellowfin tuna, (b) discards of target tuna species, and (c) catches of non-target species.***

104. SPC had initiated work in estimating catches of non-target species (GN-IP-1).

- ***Project 52. Shark Research Programme***

105. The EB-SWG considered that shark NPOAs and a study of the general feasibility of stock assessments of sharks would provide a basis for the future development of the Shark Research Programme.

- ***Project 53. Investigation into the fishing activities and catch composition of small vessels (e.g. longliners < 24m) should be undertaken***

106. The EB-SWG considered that observer coverage of vessels less than 24 m was required in order to gather information on interactions with sea turtles, seabirds and sharks so that appropriate mitigation measures could be developed, if necessary.

- ***Project 54. Review scientific data to assess in a holistic manner the effects of bycatch management measures using the different longline gears and mitigation measures on the catch of turtle, shark and other target and non-target longline species.***

107. At the present meeting, CCMs had presented results of research on the effects of circle hooks and bait type on catches of target and non-target species.

c. Strategic Research Plan

108. The convenor urged participants to review the Strategic Research Plan and to consider possible modifications to it. He noted that the Strategic Research Plan included several key activities, but did not include the development of bycatch mitigation measures or monitoring of bycatch levels. It was noted that while WCPFC has funded some work relevant to the EB-SWG, such as through the ERA project, much of the groundwork was conducted by individual CCMs. Participants expressed gratitude to those CCMs for undertaking work, and it was suggested that the EB-SWG request CCMs to continue to do so.

109. It was noted that progress in research will depend on the availability of catch data to species level.

10. Other matters

110. The convenor reminded participants to check and update Table H-1, which summarizes bycatch data presented in Annual Reports (Part 1).

11. Adoption of report (including a one-page summary)

111. This report was adopted by SC4 on 18 August 2008.

12. Close of meeting

112. In closing the meeting, the convenor thanked presenters, rapporteurs and participants for their contributions.

Attachment H, **Appendix 1**

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

AGENDA FOR THE ECOSYSTEM AND BYCATCH SPECIALIST WORKING GROUP

1. Opening of meeting
2. Selection of rapporteurs
3. Adoption of agenda
4. Ecosystem effects of fishing
   a. Progress of ecological risk assessment
   b. Biology of high risk species
   c. Fishery impacts on ecosystem
5. Sharks
   a. Review of CMM-2006-05 and CCM reports on shark catches presented in Part 1 of Annual Report
   b. Identification of key shark species for annual reporting to the Commission
   c. Stock assessments for key shark species
   d. Development of a Shark Research Plan
6. Seabirds
   a. Review of CMM-2007-04 and CCM estimates of seabird mortality presented in Part 1 of Annual Report
   b. Review of research on seabird interactions and mitigation measures
   c. Review of technical specifications of seabird mitigation measures
7. Sea Turtles
   a. Review of Research Programme and WCPFC2 Resolution
   b. Review of research on sea turtle interactions
   c. Review of mitigation measures
8. Access to bycatch information
   a. Bycatch page on the WCPFC website
9. Future research plan
   a. Detailed operational research plan for 2008/09 with budget

b. Work programme for 2010–2011 with indicative budget

c. Strategic Research Plan

10. Other matters

11. Adoption of report (including a one-page summary)

12. Close of meeting

Attachment I

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

REPORT OF THE FISHING TECHNOLOGY SPECIALIST WORKING GROUP

PRELIMINARIES

1. The meeting of the Fishing Technology Specialist Working Group (FT-SWG) was opened by D. Itano who also convened the session. The agenda was adopted and is attached as Appendix 1 to this report. The adopted agenda was modified from the original to reflect the movement of FT-WP-4 to FT-IP-5 due to the preliminary nature of the study findings to date and the fact that FT-WP-5 had already been presented and discussed in the Ecosystems and Bycatch SWG. Session rapporteurs for the Fishing Technology SWG (FT-SWG) were K. Schaefer, N. Davies and D. Cameron.

REVIEW OF INFORMATION AND RELATED STUDIES

2. Four working papers and five information papers were made available to the FT-SWG for consideration by SC4. All papers were either presented or noted briefly during the session. The papers described research or descriptive materials on the influence of gear effects on floating object associations, acoustic selectivity and discrimination, operational characterization of fleets, and information requirements for port sampling and observer programmes. The meeting was also informed about a recent workshop on aspects related to the development of rights-based management systems and recent initiatives of the IATTC related to FAD-based research and management.

Agenda item 4.1: Gear effects and the influence of FADs and FAD design on target and non-target species.

SC4-FT-WP-1: Satoh, K. et al. ***Effects of depth of underwater structures of FADs on catch of bigeye tuna (Thunnus obesus) in the tropical waters of the western Pacific Ocean.***

3. H. Okamoto (National Research Institute of Far Seas Fisheries (NRIFSF), Japan) presented FT-WP-1. The effect of drifting FAD depth on purse-seine bigeye catches was assessed using port sampling and logbook data with FAD depth data submitted by purse seiners. The depth of FADs, season, and total amount of catch of both datasets was distributed widely to cover the actual situation of the fisheries with adequate sample numbers. Three analyses for each dataset were conducted to assess the effects of FAD depth on i) the presence and/or absence of bigeye, the ratio of bigeye to total catch per set, and 3) amount of bigeye catch per set using GENMOD and GLM procedures of SAS. Bigeye is more likely to be caught in the southeast part of the

Japanese purse-seine fishing ground. The effect of season varies with location. The bigeye catch is less in summer and in the western part of the fishing ground. Although significant effects of FAD depth were found in some scenarios, the expected trend — that bigeye was more likely to be caught with deeper FADs — was not supported by the results. Therefore, from the results of this study, it seems that shortening the depth of FADs is not very effective in reducing bigeye catches in actual operation, at least in the western Pacific Ocean.

4. This investigation was conducted as a collaborative effort between the Japan Far Seas Purse Seine Fishing Association, two fish markets (Yaizu and Makurazaki ports), Japan Fisheries Resource Conservation Association, and the NRIFSF, Fisheries Research Agency, led by Japan's Fisheries Agency.

Discussion

5. The collaboration on this project between scientists and the Japanese fishing industry was recognized as a positive attempt to reduce fishing mortality on small bigeye tuna. Japan noted that this particular FAD depth study was complete, but that further investigations to seek other ways to reduce catches of small tuna would continue.

6. The convenor noted that a similar study of FAD, gear and environmental influences on bigeye catches by the IATTC was available to the meeting as SC4-FT-IP-1. This study did detect a positive relationship between FAD depth and bigeye catches, but seasonal and areal effects were found to be more significant. Data quality issues related to the reliability of FAD depth information and the lack of information on how long each FAD had been deployed, were also noted.

7. Participants commended Japan on its efforts, and supported further studies by all CCMs on the impact of purse-seine net depth on bigeye catches. The convenor supported the suggestion, noting that the actual depth of purse seines should be validated on a fleet-by-fleet basis, using net depth or time-depth recorder (TDR) equipment.

SC4-FT-IP-5: Moon, D.Y. et al. ***Preliminary information on the catch of small-sized tuna by set type of Korean tuna purse-seine fishery in the WCPO.***

8. D.Y. Moon (NFRDI – Korea) described ongoing research on the effect of set type on the small bigeye and yellowfin tuna catches by the Korean purse-seine fishery. The study began in June 2008 with onboard observers monitoring fishing operations of two Korean tuna purse seiners in the WCPO. Fifty experimental FADs with hanging nets of various lengths were deployed to compare the effect of underwater structure on the catches of bigeye and yellowfin tuna. It was noted that the paper represented data recently collected during June and July 2008, and should be considered preliminary. Of 51 observed sets, 37 sets were from unassociated tuna schools and 14 sets from FAD-associated schools, accounting for 27% of the total sets. FAD sets resulted in catches of small-sized bigeye tuna with fork lengths smaller than 60 cm. There were no significant differences in catch and size of bigeye and yellowfin tuna by the depth of the underwater structures of FADs. However, more meaningful results from a larger dataset will be provided to SC5.

Discussion

9. The paper indicated that Korean purse-seine operators have increased their dependence on drifting FADs due to a perceived decrease in availability of large fish school. The presenter

agreed with the statement, which was supported by other CCMs who noted that free swimming schools had declined as a result of the expansion of FAD-based effort in other regions.

Agenda item 4.2: Improvements in targeting and avoidance of STFO

SC4-FT-WP-2: Morón, J. ***Research on acoustic selectivity on FAD associated tropical purse-seine fisheries.***

10. J. Morón (Organization de Productores Asociados de Grandes Atuneros Congeladores, OPAGAC, EU) presented FT-WP-2, which describes a project on acoustic selectivity that is being developed through the collaboration of the Instituto Español de Oceanografía, the Secretaría General del Mar, and industry entities of OPAGAC, ALBACORA SA and AITZUGANA SA. It was explained that the paper consisted solely of a presentation on the experimental design and objectives of a three-month study that is expected to begin in early 2009, and that no actual research paper was provided. The study will use two large Spanish flag purse-seine vessels that operate mainly in the area of the eastern Pacific Ocean (EPO) drifting FAD fishery where high proportions of bigeye are caught by purse-seine fleets. Scientific echo sounders will be used in conjunction with commercial grade depth sounders and sonar to make acoustic estimates of species, size and biomass. Intensive size and species composition sampling from the subsequent set will be used to verify acoustic estimates.

Discussion

11. The IATTC indicated general support for the experimental design of the study while recommending the incorporation of a standardized pre-set form within the project framework. This form would be filled out by a scientist or observer after consulting the fishing captain regarding his estimates of species composition, sizes and quantities. A pilot project incorporating this experimental design is currently being tested by the IATTC in the EPO. Collaboration between the two programmes was recommended.

12. Information on purse-seine technology, FAD monitoring and FAD numbers used by purse-seine vessels was raised. The convenor noted that a recent paper resulting from interviews of purse-seine captains in the Indian Ocean (SC3-FT-WP-5) indicated that Spanish purse seiners operating in the western Indian Ocean maintain an average of 60 drifting FADs at a time, and that the FADs are marked with a combination of GPS buoy types. The presenter noted that echo sounding and transmitting GPS buoys are used in conjunction with standard GPS buoys, but are less common due to expense. It was noted that earlier models of echo sounding GPS buoys were regarded as highly unreliable but improved models have become available in recent years. One CCM indicated that preliminary experiments using echo sounding satellite transmitting radio buoys were able to differentiate skipjack from bigeye. However, the buoy was apparently stolen at sea; a common problem in the fishery.

13. The convenor indicated admiration for the collaborative nature of the Spanish acoustic selectivity project and requested information on the project's administrative and financial structure. J. Morón responded that the project was initially an initiative by the fishing industry, which approached the Spanish government which then contributed funds to reduce catches of small bigeye tuna. Spanish Institute of Oceanography (IEO) technicians will be onboard during the study, with EU and government funds made available to vessels to offset financial losses resulting from time lost and fishing efficiency during the project period. It was further clarified that the project would also collaborate closely with the IATTC.

SC4-FT-WP-3: Itano, D. ***The use of underwater video to characterize the species, size composition and vertical distribution of tunas and non-tuna bycatch around floating objects.***

14. The convener presented SC4-FT-WP-3, which describes an initial trial of an underwater video system to verify acoustic images of fish aggregated to an anchored FAD. He noted that SC4–FT-IP-2, which describes acoustic imaging and identification of tuna aggregations on floating objects in the EPO, provided the inspiration for this project. The WCPFC provided USD5,000 for the purchase of a self-contained underwater color video viewing and recording system, with 240 m of cable. The project proposed to use the video gear on an opportunistic basis during tuna tagging and field operations at no additional expense to the Commission.

15. The camera system was tested on an SPC-funded 30-day tagging cruise to the central Pacific. The camera was lowered into tuna schools aggregated to TAO oceanographic buoys at 155°W and 2°N–5°N. Digital images of the echo sounder image of the same school were also recorded. Skipjack were easily differentiated from bigeye and yellowfin tuna by color, behaviour and general morphology. When clear images were available, bigeye tuna were identifiable by a combination of morphological and behavioral features. The positive identification of yellowfin tuna proved to be more difficult, but a general lack of yellowfin during the cruise hampered these efforts. Unfortunately, the images secured on the cruise were very low in resolution due to a malfunction of the first camera, which was supplied by the manufacturer and which was replaced after the completion of the cruise.

16. It was noted that video validation of species can be used to: i) avoid setting on schools with high concentrations of bigeye and small tuna on floating objects (STFO); ii) verify and refine acoustic estimates of fish size and species; and iii) test the ability of fishermen to interpret acoustic images relevant to the potential development of STFO-specific management measures. The presenter noted that video trials will continue in Hawaii and onboard the SPC Pacific Tuna Tagging Programme (PTTP) vessel during 2008/2009. He also supported the collaborative use of the system on commercial purse-seine vessels if opportunities arise. It was further noted that active avoidance of STFO by industry will be facilitated by the development of management options that institute tangible incentives or restrictive limits on landing STFO.

Discussion

17. CCMs questioned whether digital still cameras or digital imaging instruments and software were considered. The presenter noted previous experience with a timer-activated digital still camera system used in the EU Indian Ocean project Fish Aggregating Devices as Instrumented Observatories (FADIO), but felt that video images were superior for identification purposes. The use of digital imaging gear was recognized as highly desirable, especially in its ability to impartially analyze track pattern and movement data. However, the presenter noted that this particular project had very limited funding, and more expensive units were not initially an option.

18. The Federated States of Micronesia, on behalf of the Forum states, noted their interest in all papers presented during the session and voiced general support of the work of the FT-SWG and noted the importance of exploring technical solutions for reducing fishing mortality on STFO, particularly bigeye and yellowfin.

Agenda item 4.3. Catch characteristics of WCPO purse-seine and longline fisheries

SC4-FT-WP-5: An, D.H. ***Effect of fishery factors on bigeye and yellowfin tuna catch rates in the tuna longline fishery.***

19. The convener noted that FT-WP-5 had already been presented in the Ecosystems and Bycatch SWG (EB-SWG) due to its relevance to other EB-SWG working papers and would not be discussed further.

Agenda item 4.4: Current status and recent developments in WCPO fishing gear, practices and capacity in relation to changes in fishing effort

20. No specific working papers relating to this topic was submitted to SC4.

Discussion

21. The convenor advised that a report on longline and pole-and-line fishing capacity (Report of a survey to establish the capacity of longline and pole-and-line fleets in the western and central Pacific Ocean) had been produced by Gillett, Preston and Associates in 2008, and that this report had been circulated at WCPFC4 in Guam. The report contained useful information on WCPO capacity and current estimates but also highlighted some difficulties in obtaining relevant data to complete the study. The convenor also emphasized the importance of documenting the effective operating depth of purse-seine nets currently in use, as some reports have indicated that recent entrants to the fishery use nets considerably deeper than previously reported.

SC4-FT-IP-2: Schaefer, K. et al. ***Report of a workshop on rights-based management and buybacks in international tuna fisheries.***

22. Reference was made to SC4-FT-IP-2 — Report of a workshop on rights based management and buybacks in international tuna fisheries. On request from the convenor, R. Clark (National Marine Fisheries Service – USA), who had attended the workshop commented on the meeting report, making specific reference to the importance of a background paper on "International fisheries law and transferability of quota: Principles and precedents" by A. Serdy. However, it was noted that inclusion of FT-IP-2 within the SC4 meeting in no way inferred express endorsement or support of items described therein. The convenor suggested that CCMs examine the workshop report and its associated working papers at their convenience for information purposes. There was no further discussion related to this agenda item.

Agenda item 4.5: Assistance to port sampling and observer programmes

23. There were no specific working papers related to this topic. The convenor advised of the prior development and availability of extension materials and identification guides for tuna and bycatch species that were useful for training port samplers and observers. CCMs were encouraged to approach him if interested in obtaining electronic files of these materials. No further comments were made.

Agenda item 4.6: The development of research projects with industry and observer and port sampling programmes

SC4-FT-WP-6: Itano, D. ***The development of Industry-related technical solutions to reduce bycatch and fishing mortality of STFO.***

24. The convenor presented FT-WP-6. The main recommendations of this paper were to collaborate with observer programmes using more experienced observers and/or consultants to address specific tasks of concern; strengthen research and industry links via cooperative meetings; and explore ways to enable valuable fishing vessel time to be accessed for collaborative studies between science and industry.

Discussion

25. The WCPFC Secretariat indicated strong support for science/industry collaborations to address issues of mutual concern, including STFO mitigation efforts. However, it was stated that the responsibility to progress such collaboration ultimately resided with CCMs. Papua New Guinea (PNG) advised that it had a very positive scientific working relationship with its industrial fishing partners. PNG also stated that technological advances in fisheries, including those linked to purse-seine fishing on FADs needed to be considered in management systems, and that practical solutions will likely evolve through close industry cooperation and collaboration. The convenor recognized PNG's leadership in purse-seine related industry collaborative research through the SPC/PNG Tuna Tagging Project and other initiatives such as the spill sampling pilot project discussed at SC4.

26. The substantial benefits of scientists working in collaboration with fishers were communicated by the convenor. CCMs were encouraged to approach industry to undertake such work. The convenor also requested that CCMs maintain contact regarding the possible organization and venue where scientists and industry may meet, to discuss and propose options to reduce fishing mortality on STFOs.

27. CCMs advised that close industry collaboration was extremely important, but that incentives and compensation need to be considered when trying to develop collaborative research. The EU advised that science and industry collaboration was essential to developing practical solutions to reduce STFO, and that industry is open to collaboration when scientists propose practical and achievable experiments. Other CCMs advised the meeting of various science and industry collaborations relating to STFO, with industry motivated to investigate all practical measures to reduce catches of STFO. The convenor reiterated the need for a collaborative bottom up approach from industry and fishers, thus investing industry in management systems that they perceive as practical and promising.

Agenda item 4.7: Other studies

SC4-FT-IP-3: IATTC. *FAD-related research.*

28. The convenor noted the inclusion of FT-IP-3 in the FT-SWG session due to its relevance to addressing issues of common concern regarding FAD-related studies and FAD-based management options. At the convenor's request, K. Schaefer — representing the IATTC — provided a brief explanation of the paper and information on one of the described studies currently taking place. A brief overview follows.

29. The document was originally prepared for the 9th Stock Assessment Review Meeting of the IATTC held in La Jolla, California from 12–16 May 2008, and was made available to SC4 as FT-IP-3 with permission from IATTC. The document describes several diverse research topics and proposals intended, among other objectives, to reduce fishing mortality on small bigeye tuna, particularly in relation to FAD sets. K. Schaefer noted that of the available options, avoidance is

considered the most practical method to research and develop, versus post-capture approaches, and can be achieved by improving species selectivity for skipjack tuna, the main target species.

30. SC4-FT-IP-2 and industry sources suggest that many purse-seine operators are very competent at pre-set acoustic discrimination of species and the quantification of the size of tuna school aggregations associated with drifting objects, using commercial echo sounders and sonar units. Preliminary research indicates that this knowledge could be useful in avoiding setting on floating objects that have a high proportion of bigeye tuna or fish considered by management as undesirable for retention. In order to investigate this potential, the IATTC began a pilot project in 2008 to identify some EPO purse-seine captains with years of FAD fishing experience to cooperate, by providing scientific observers aboard their vessels with pre-set estimates of species composition, quantities and sizes, on a form designed by the IATTC scientific staff using acoustic, visual and other means at their disposal. In order to validate catches for comparison to pre-set estimates requires the intensive sampling of fish from those sets, which is also part of the experimental design. This pilot project has been conducted on four different purse-seine vessels and the data collected are currently being analyzed.

Discussion

31. It was clarified that the pilot study results should be available soon and could be made available to SC5. The convenor acknowledged the value of this pilot study and questioned whether a similar study could be established in the WCPO. SPC's port sampling and observer coordinator recognized the merit of similar work but had reservations as to the ability of most regional observers to undertake the work without additional training. The convenor agreed that specific studies like this may require the use of more experienced or specially trained personnel.

WORK PROGRAMME REVIEW

32. The convenor reviewed the FT-SWG's work programme for 2008–2010 (as listed in SC3 report) as an introduction to providing advice to the SC and the development of FT work programmes. Project 56 — to characterize species, size composition and spatial distribution of tunas aggregating around floating objects using underwater video and other tools — as presented in SC4 FT-WP-3, was the only FT-linked project that had been funded by the Commission in the current work programme. However, progress was made on a number of other work programme projects through external sources. Projects 16, 19, 20. 21, 55 and 56 were noted as relevant to the FT-SWG terms of reference.

ADVICE TO THE SCIENTIFIC COMMITTEE

33. The convenor asked whether there was any particular advice that should be provided to the Scientific Committee arising from issues discussed by the FT SWG. A suggested list of items was proposed with some modification by CCMs. The increasing demands being placed on observers, and the importance of maintaining the integrity of observer data collection standards, were noted. Training, recruitment and retention of observers is a critical issue to the Commission and CCMs were urged to nominate qualified and motivated observer trainees. This point was well noted. Also noted was that observer remuneration levels add to retention problems, and that better employment conditions and benefits for observers should be explored. The FT-SWG provided the following advice to the SC:

- Promote collaboration between the SC and the fishing industry to address issues of mutual concern. In particular, promote collaborative access to commercial fishing vessels

for conducting scientific research studies to better use accumulated experience and their ability to simulate fully commercial conditions.

- Promote assistance from observer programmes to better characterize fleets and fishing practices of special concern.

- Investigate the development of FAD-based management and bycatch reduction options that are practical and supportable by industry.

- Investigate the development of self-regulating, rights-based management frameworks that work toward eventual alignment of capacity with resource levels.

RESEARCH PLANNING AND COORDINATION

OPERATIONAL RESEARCH PLAN FOR 2008/2009

34. The convenor reviewed the existing set of operational research plans/tasks and took suggestions from the SC to add additional advice to a draft list for circulation to the SC in the FT-SWG's draft report, for their consideration. The convenor noted that the listed included the work with the underwater video camera to verify acoustic estimates of tuna and bycatch associated with floating objects.

35. The WCPFC Secretariat supported linking potential research projects with the database generated from bycatch mitigation work undertaken in the WCPO (and maintained by SPC). The following operational research plan for 2008/2009 for the FT-SWG was endorsed by the meeting.

- Continuing field trials with underwater video gear.

- Document identifying characteristics of tuna and bycatch species from video images.

- Promote better characterization of the depth characteristics of longline gear and the pursing depth of purse-seine nets by fleet through collaboration with existing observer programmes and suitable equipment (e.g. purchase of TDRs, net depth recorders, etc.).

- Conduct studies on the behavior of target and non-target species influenced by different association types and floating objects in particular, in relation to reducing effort on bycatch and small tuna.

- Examine, review and inform the SC regarding studies on technical aspects of capacity measurement and monitoring of large-scale fisheries and long-term management solutions to excess capacity.

MEDIUM-TERM RESEARCH PLAN

36. The EC noted the importance of documenting historical changes in fishing technology, which are useful for quantifying increases in fishing efficiency, particularly for purse-seine gear. The EC project ESTHER (Efficiency of Tuna Purse Seiners and Effective Effort) was noted as an example of the type of project that should be repeated in the WCPO. The convenor noted that the FT-SWG and its predecessor research group in the Standing Committee on Tuna and Billfish, has documented advances in purse-seine and longline technology, electronics and FADs but that

nothing of the scale of the ESTHER project has been funded or attempted. However, support for such work can be included in the FT-SWG research plan.

37. A list of medium-term research objectives for the FT-SWG was proposed by the convenor for consideration by the meeting. A proposal was made to include an explicit statement to promote the collaboration and use of commercial fishing vessels for scientific surveys. Delegates also requested additional time to consider both research task lists. The following medium-term research plan for the FT-SWG was endorsed by the meeting.

- Information on the characterization of major WCPO fishing fleets, including historical and current details of fishing, electronic and FAD gear and practices, will be used in standardizing catch rates, specifically to document changes in efficiency, primarily for longline and purse-seine gear.

- In collaboration with the Methods SWG, promote, review, report and conduct effort standardization analyses using technical, biological and other data inputs.

- Work to identify and refine lists of necessary technical data inputs for effort standardization.

- Monitor and report on new developments in fishing gear and practices, fishing modes and related shoreside developments as they relate to changes in fishing power.

- Develop training materials to improve species-specific identification of target and non-target species to improve the quality of submitted data and data collection programmes.

- Investigate, promote and report studies on socioeconomic influences on fishing strategies, spatio-temporal fishing patterns, and influences on effective fishing effort.

- Examine and review technical aspects of capacity measurement and monitoring of fisheries within the WCP-CA.

- Develop collaborative research projects with industry to address issues regarding management. In particular, develop mechanisms to access commercial fishing vessels on a cost-effective basis or ways to fund vessel time to conduct scientific investigations.

OTHER MATTERS ARISING

Format, review and clearance procedures of the FT-SWG report.

38. The convener noted that the draft FT-SWG meeting report will be provided to the Secretariat on Saturday, 16 August 2008 for copy and distribution to delegations for comment and review.

Other matters

39. No other matters were raised.

ADOPTION OF REPORT

40. The report of the FT-SWG was adopted by SC4, subject to editing by the Secretariat.

CLOSE OF MEETING

41. The convenor thanked all CCMs for their support and contributions to the session and closed the meeting.

Attachment I, Appendix 1

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

AGENDA FOR THE FISHING TECHNOLOGY SPECIALIST WORKING GROUP

1. **Opening of the meeting**
2. **Selection of rapporteurs**
3. **Adoption of agenda**
4. **Review of information and related studies**

   4.1. Gear effects and the influence of FADs and FAD design on target and non-target species

   a) **FT-WP-1**: Satoh, K. et al. **Effects of depth of underwater structures of FADs on catch of bigeye tuna (*Thunnus obesus*) in the tropical waters of the western Pacific Ocean**

   b) **FT IP-5**: Moon, D.Y. et al. **Preliminary information on the catch of small-sized tuna by set type of Korean tuna purse seine fishery in the WCPO**

   Supporting documents

   FT IP-1: Lennert-Cody, C.E. et al. **Effects of gear characteristics on the presence of bigeye tuna (Thunnus obesus) in the catches of the purse-seine fishery of the eastern Pacific Ocean**

   4.2. Improvements in targeting and avoidance of STFO

   a) Acoustic selectivity

   FT-WP-2: Morón J. et al. **Research on acoustic selectivity on FAD associated tropical purse-seine fisheries**

   b) Underwater video and imaging

   FT-WP-3: Itano, D. **The use of underwater video to characterize the species, size composition and vertical distribution of tunas and non-tuna bycatch around floating objects**

   c) Other (discussion)

   Supporting documents

   FT IP-2: Schaefer, K. and D.W. Fuller. **Acoustic imaging, visual observations, and other information used for classification of tuna aggregations associated with floating objects in the Pacific Ocean**

4.3. Catch characteristics of WCPO purse-seine and longline fisheries

FT-WP-5: An et al**. <moved to Ecosystems and Bycatch SWG session>**

4.3. Current status and recent developments in WCPO fishing gear, practices and capacity in relation to changes in fishing effort

a) Discussion

Supporting documents

FT-IP-4: IATTC and World Bank. **Report of a workshop on rights-based management and buybacks in international tuna fisheries**

4.4. Assistance to port sampling and observer programmes

4.5. The development of research projects with industry and observer and port sampling programmes

a) FT-WP-6: Itano, D. **The development of Industry-related technical solutions to reduce bycatch and fishing mortality of STFO**

4.6. Other studies

Supporting documents

FT IP-3: IATTC. **FAD-related research**

4.7. Advice to the Scientific Committee

5. Research planning and coordination

5.1. Operational Research Plan for 2008/09 with budget

5.2. Medium-Term Research Plan

6. Other matters arising

6.1. Format, review and clearance procedures of the FT-SWG report

6.2. Other matters

7. Adoption of report

8. Close of the meeting

Attachment J

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

REPORT OF THE METHODS SPECIALIST WORKING GROUP

1-3. OPENING OF MEETING

1. The Methods Specialist Working Group (ME-SWG) met during the morning session on Tuesday, 12 August 2008. R. Campbell (Australia) served as convenor of the meeting with A. Langley and S. Nicol serving as rapporteurs.

2. Under the terms of reference for the ME-SWG, the group will coordinate research and make recommendations to the WCPFC Scientific Committee on technical questions relating to analytical methods used for fishery management.

3. For this meeting, the ME-SWG had the specific task of reviewing the research undertaken during the past year, addressing issues identified at the Third Regular Session of the Scientific Committee (SC3) as relevant to the ME-SWG.

4. A provisional agenda was circulated for review prior to the meeting, and was adopted as attached in Appendix 1 to this report. Four working papers (WP) were presented to and reviewed by the meeting while an additional information paper (IP) was also noted.

4. PROGRESS ON RESEARCH TASKS IDENTIFIED AT SC3

4.1 Review of information

a) Continued refinement of stock assessment models (including designing a more efficient recruitment parameterisation with MFCL).

5. Working paper ME-WP-2 — "Adjusted biological parameters and spawning biomass calculations for albacore tuna in the South Pacific, and their implications for stock assessments" — was presented by S. Hoyle.

6. Stock assessments require estimates of a number of biological parameters that describe population dynamics. However, some of the estimates currently used require updating, are uncertain, or are unknown. This paper re-estimates some biological parameters based on recent data, and reconsiders the base-case assumptions for unknown parameters based on information from other tuna species. It also examines the effects of these changes on the reference point outputs from the 2006 albacore stock assessment model. Sustainable fisheries depend on continued reproductive output, which is the reason for reference points that include spawning

biomass. Reference points based on spawning potential rather than on spawning biomass are more appropriate indicators of sustainability. For albacore they differ significantly from one another. The re-estimated parameters changed the reference points by up to 40%. MSY-related reference points from the albacore stock assessment are sensitive to both the steepness assumption and to spawning potential, because SB_{MSY}/SB_{ZERO} is low at 0.16 in the 2006 assessment and 0.18 in the 2008 assessment. Parameters for which there are currently no information (rate of change in fecundity and spawning fraction with size) were influential and resulted in a more pessimistic assessment.

Discussion

7. During the discussion of WP-2, a question was asked on the value of obtaining better absolute estimates of natural mortality. In reply, it was noted that this would be good to do because currently, M at age is assumed to be constant. However, it was explained that this is less of an issue for albacore tuna as the fishery is targeting larger fish where changes in M are relatively small in comparison to younger fish. It was also noted that movement and migration had not been considered in the estimation of M because movement had not been explicitly modelled in the current stock assessment.

8. In response to a question as to what other hypotheses may explain the observed differences in sex-ratio with age data (apart from higher M in mature females due to reproduction) it was noted that these include differential growth rates (although this had not been detected for albacore tuna) and different vulnerabilities, although such differences had not yet been observed in the gear types used for albacore. It was nevertheless agreed that it would be worthwhile examining the implications of these other hypotheses to explain the differences in sex ratio in the albacore catch.

9. In reply to a question on the effect of including fecundity in the stock assessment, it was explained that fecundity at length was tested by using the yellowfin tuna relationship in the sensitivity analysis and was found to be influential. However, fecundity at length is not used in the current stock assessment as no information on fecundity at length is available for albacore tuna.

10. The convenor noted that WP-2 had identified a need for more biological work on albacore tuna and asked what work was currently underway in this regard. S. Hoyle explained that a CSIRO study, which is currently awaiting full funding, has commenced collecting gonads and otoliths and that SPC-OFP is currently undertaking a three-year project to examine age, reproductive biology, movement and fishing mortality.

b) Continued development of models used to standardize CPUE and the abundance indices used within the stock assessments.

11. Working paper ME-WP-3 — "Standardized CPUE for distant-water fleets targeting south Pacific albacore" — was presented by K. Bigelow.

12. Previous South Pacific albacore assessments have used nominal CPUE based on aggregated 5°-month distant water fleets (Japan, Korea and Taiwan) and nominal CPUE from logsheet data of domestic longline fisheries. A new standardized CPUE index was developed for distant water fleets targeting South Pacific albacore (east of 110°W) by analyzing an operational level dataset of vessels landing at the two major canneries (Pago Pago and Levuka). In total, 1,163 vessels conducted 8,909 trips and 475,019 sets. Data were spatially stratified into four

regions at 25ºS and 180º and 12 (three fleets and four regions) generalized linear models (GLMs) were conducted. Analyses proceeded by identifying active vessels in the fishery that fished in four quarters or more. In total, 10 predictors were used in the GLM analysis, such as year_quarter as an index of relative abundance, location (latitude and longitude), unique vessel names, oceanographic variables of sea surface temperature and the depth of the 15º isotherm and four interactions. There were substantial spatial differences in catch, effort and CPUE between aggregated 5º-month data previously used in the assessment (2005) and operational level data from albacore targeting vessels. There was good coherence in nominal CPUE among albacore targeting fleets. Nominal CPUE for aggregated 5º-month data in particular had little coherence among fleets and regions due to a change in targeting from albacore to yellowfin and bigeye. Four of the 10 predictors were included in the GLM formulations: year_quarter, vessel identification and interactions between month and latitude, and latitude and longitude. Only Taiwanese vessels were actively targeting albacore through most of the time series. The Japanese time series was short (~10 years) while the Korean time series was of longer duration (~35 years). Standardized CPUE differed from nominal CPUE, especially in regions 1 and 2. In general, the current GLM indices for Japan and Korea have less variability than the 2005 indices. The current Taiwanese indices were similar to the 2005 indices as the Taiwanese fleet has consistently targeted south Pacific albacore. Taiwanese indices for all regions were highest in the 1960s, declined moderately until 1975 with a smaller decline thereafter.

Discussion

13. In the discussion of WP-3, it was noted that the GLM analyses did not include information on changes to gear configuration, which may indicate changes in targeting from albacore tuna to bigeye tuna. A small proportion of the available logsheet data did record the number of hooks between floats and there was no evidence from these data to indicate a substantive change in gear configuration. Further, there was no evidence of a change in the spatial distribution of fishing effort in the last decade, in particular a shift in fishing effort to the area of the main bigeye target fishery. It was noted that the logsheet data also included information regarding the catch of 10 different species and it was suggested that an analysis of these data may help determine whether or not the fleet has changed targeting practices. It was also noted that the analysis indicated that aggregating fleets was not appropriate and given varying size data distributions among fleets supports potentially different fishing practices and selectivities, and possibly different catchabilities, between fleets.

14. Working paper ME-WP-4 — "Monitoring hook and catch-at-depth profiles and application of a habitat-based CPUE standardization to the Australian Eastern Tuna and Billfish fishery" — was presented by R. Campbell.

15. This paper describes some of the results of a monitoring programme that deployed temperature-depth recorders (TDRs) and hook-timers on longline vessels fishing in the eastern tuna and billfish fishery (ETBF) between August 2004 and May 2007. TDRs were deployed on a total of 248 sets from which 2,040 individual TDR recordings were obtained. Depth profiles were calculated for each gear configuration (hooks-per-float) observed and combined with the catch data to estimate indices of species availability by depth. The data on the depth profiles of hooks was also combined with information on the depth and temperature preference for bigeye data obtained from archival tags deployed in the ETBF to apply the habitat based-method for standardizing CPUE. A number of separate models were compared, including the deterministic and statistical HBS models used in past assessments in the WCPO, and which make use of ocean global circulation models (OGCMs) to map bigeye habitat, and several simpler models which assumed the habitat preferences (as indicated by the archival tag data) were constant across the

ETBF but allowed for seasonal or diurnal changes. Effective effort was found to be highly influenced by the diurnal shifts in the time of deployment but not by season. The detHBS model was also found to be the most dissimilar of the calculated indices and questions the appropriateness of using OGCM data to map the habitat within small regions of the WCPO such as the ETBF.

Discussion

16. During the discussion of WP4, concern was expressed that participants had not had sufficient time to review the paper in advance of the meeting as it was not available on the website. Differences in the depth of longline gear between Japanese and Australian fleets were also noted. It was speculated that these differences may be due to operational differences between the fleets as well as differences in gear configuration (monofilament vs. rope gear). It was noted that the dataset had information on fish size and it would be interesting to investigate the relationship between gear depth and the size of fish caught. This may have some ramifications for stock assessments if changes in fishing depth have resulted in a change in the selectivity of longline gear.

17. It was queried whether the capture time of fish had been used in estimating the availability profiles as other studies had observed higher catch rates of some species during the hauling process. It was explained that hook-timer data was not comprehensive enough to have been used in this estimation process and so profiles were based on combining catch rates for sets with the overall depth profiles for a given gear configuration. However, hook-timer data that was collected during the project did not show any preference for species such as yellowfin to be caught preferentially during the haul.

18. The convenor also noted information paper ME-IP-1 which investigates the use of principal components analyses to assist in selecting variables to include in catch rate standardisations.

c) Continued exploration of sensitivity of stock assessment models to model assumptions and data issues (including a comparison of MFCL, SS-2 and other stock assessment models for yellowfin or bigeye tuna).

19. Working paper ME-WP-1 — "Sensitivity of the bigeye tuna stock assessment to alternative biological and reproductive assumptions" — was presented by S. Hoyle.

20. Outputs from mathematical and statistical models can be influenced by uncertainty in estimates of parameters used (known as parameter uncertainty) and by methods and assumptions used to construct and link parameters in a model (known as structural uncertainty). Sensitivity analysis was applied to the current bigeye stock assessment to ascertain the influence of structural assumptions on reference point outputs of the model. The analysis examined the influence of alternative estimates of natural mortality, fecundity at length, spawning fraction at length, and alternative maturity schedules. The effect of an alternative growth curve, and an alternative steepness assumption, were also assessed. The current stock assessment indicates that fishing mortality exceeds F_{MSY}, and that the biomass is approaching MSY (Langley et al. 2008). The model is more strongly influenced by precision in CPUE and length-frequency data than by the reproductive and growth parameters directly. This sensitivity analysis demonstrates that the model is also sensitive to structural assumptions associated with estimating reproductive and growth parameters. Alternative estimates for all reproductive and growth parameters and natural mortality influenced the spawning biomass reference points ($SB_{current}/SB_{MSY}$ and $SB_{current}/SB_0$)

typically by more than 10%, and influenced biomass (B/B_{MSY}) and $F_{multiplier}$ reference points by between 1% and 5%. The results support the need for further investment in knowledge acquisition to reduce the current level of uncertainty.

Discussion

21. In the discussion of WP-1, it was suggested that it may be more appropriate to use log likelihood diagnostics to evaluate the effects of each parameter examined in the paper. In response, it was explained that using the log likelihood diagnostics might be problematic as parameters associated with the reproductive potential all impact the log likelihood through the stock recruitment relationship, and the assessment is very uninformative about the stock recruitment relationship, since the stock is assumed to affect recruitment, but recruitment also affects the stock. In addition, trends in recruitment are often due to structural problems in the model, and these trends affect the stock recruitment relationship. In such cases, it is advisable to place more emphasis on biological knowledge than on log likelihood diagnostics.

22. In reply to a question as to why the MSY values in Table 4 are low (and inconsistent with those shown in SA-WP-1), it was explained that there was an error in the Table where the MSY values were given by quarter, and that the MSY values should be multiplied by 4 to give the annual estimate of MSY. However, this error does not alter the comparative reference point relationships between the various models.

4.2. Advice and recommendations to the SC

23. The ME-SWG endorsed the sensitivity analyses undertaken in working papers ME-WP-1 and ME-WP-2 in helping to elucidate the sensitivity of stock assessment model outcomes and reference points to alternative assumptions concerning natural maturity and reproductive schedules. The ME-SWG recommended the continued use of this approach in future research, and that the alternative biological and reproductive assumptions be included in the stock assessment models for these species. It was also recommended that this approach be adopted in the next yellowfin assessment in the WCPO. The ME-SWG also recommended that the additional research recommended in these papers to improve our understanding of the reproductive biology of both bigeye and albacore tunas be noted by both the BI-SWG and the SC in framing future research tasks.

24. The ME-SWG also endorsed the research described in working paper ME-WP-3 — using landings data from fishing fleets targeting albacore tuna — to provide improved abundance indices for South Pacific albacore, and noted that these indices had been included in the most recent stock assessment conducted on south Pacific albacore (c.f. SA-WP-8). The ME-SWG also noted that additional research can hopefully be undertaken using these data to characterize changes in targeting practices (by noting changes in the species composition of the catch) and further assist improving these indices.

25. The ME-SWG also noted the results of the research described in ME-WP-4 and recommended that a similar approach be taken to help describe the operational characteristics of other longline fleets fishing in the WCPO and improve our understanding of the utility of the habitat-based method for standardizing catch rates for these fleets.

5. REFERENCE POINTS

26. The convenor informed the SWG that SC3 had made a number of recommendations in relation to reference points. In particular, the following recommendations were made:

- A future work programme should be commenced to guide the WCPFC on appropriate reference points and the implementation of the precautionary approach in the management of the western and central Pacific fisheries.
- A scoping paper, and draft work plan, should be developed over the next year to inform both the SC and the Commission on the potential costs, benefits and difficulties of alternative approaches to the identification of appropriate reference points (e.g. MSY) within the WCPO.

27. The convenor informed the SWG that the report of the consultancy on the scoping paper and draft work plan had been delayed, but a working paper would hopefully be available to be discussed during the SC plenary.

6. RESEARCH PLANNING

28. The meeting reviewed the tasks identified by the ME-SWG at SC3. It was noted that work had been undertaken on aspects of three of the four short-term tasks, although it was also noted that further research is needed on many of these tasks. It was also noted that no presentations had specifically addressed any of the medium-term tasks identified at SC3.

29. Taking into account the work completed over the past year, and the recommendations for additional research stemming from this work, the ME-SWG noted the following tasks that should be addressed over the next year and reported to SC5 in 2009:

a) Continued refinement of stock assessment models, including simulation testing of new developments as appropriate.

b) Improve existing, and explore alternative, models used to standardize CPUE and construct abundance indices used within stock assessments, including simulation testing of methods as appropriate (including the continued identification of factors that influence CPUE, understanding and quantification of the changes in catchability over time not included in the CPUE standardization models, and identification of alternative catchability trends for inclusion in stock assessment models.).

c) Continued exploration of sensitivity of stock assessment outcomes to structural assumptions in models and data issues (including a comparison of MFCL, stock synthesis and other stock assessment models for the principal target species).

d) Identification and evaluation of appropriate reference points for the principal target species in the WCPO.

e) Development of methods to evaluate and approaches to present future projection outcomes and management options.

30. It was noted that other SWGs can also direct tasks to the ME-SWG. As was the case in past years, it was suggested that some of the above tasks may be facilitated via an intersessional working group meeting.

31. The ME-SWG also noted the following additional tasks that should be addressed on a medium-term basis:

a) Further identification and development of methods to evaluate potential management strategies, including MSE development and uncertainty.

b) Further consideration of how to reflect uncertainty in projections.

c) Development and/or review of models for evaluating impacts on an ecosystem, and the development of reference points for ecosystem-based management.

d) Development of recruitment indices for incorporation into stock assessment models (e.g. for yellowfin tuna based on further investigation of the relationship between oceanography and recruitment estimates from MFCL).

e) Development of new stock assessment models and associated software.

32. The ME-SWG recommended that the SC take note of the above research tasks and priorities when formulating an overall research plan for the Commission.

7. ADOPTION OF REPORT

33. The meeting was informed that the draft report of the meeting would be made available to participants on Friday, 15 August, and would be cleared by the SC on the following Monday. The ME-SWG report was adopted by SC4 on 18 August.

8. CLOSE OF MEETING

34. The convenor thanked all presenters and rapporteurs together with all participants in the ME-SWG.

Attachment J, Appendix 1

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

AGENDA FOR THE METHODS SPECIALIST WORKING GROUP

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1. **Opening of meeting**

2. **Selection of rapporteurs**

3. **Adoption of agenda**

4. **Progress on ME-SWG research issues identified at SC3:**

   4.1. Review of information

   a) Continued refinement of stock assessment models (incl. designing a more efficient recruitment parameterisation with MFCL).

      ME-WP2: Hoyle, S. *Adjusted biological parameters and spawning biomass calculations for albacore tuna in the south Pacific, and their implications for stock assessments*

   b) Continued development of models used to standardise CPUE and the abundance indices used within the stock assessments.

      ME-WP3: Bigelow, K. and S. Hoyle. *Standardized CPUE for distant-water fleets targeting south Pacific albacore.*

      ME-WP4: Campbell, R., J. Young and K. Bigelow. *Monitoring hook and catch-at-depth profiles and application of a habitat-based CPUE standardization to the Australian Eastern Tuna and Billfish fishery.*

      ME-IP1. Molony, B. and K. Sisior. *The use of principal components analyses to assist in selecting variables to include in a catch rate standardisations.*

   c) Continued exploration of sensitivity of stock assessment models to model assumptions and data issues.

      ME-WP1: Hoyle, S. and S. Nicol. *Sensitivity of the bigeye tuna stock assessment to alternative biological and reproductive assumptions*

   4.2. Advice and recommendations to the Scientific Committee

5. **Reference points**

6. **Research planning**

7. **Adoption of report**

8. **Close of meeting**

Attachment K

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

REPORT OF THE STATISTICS SPECIALIST WORKING GROUP

INTRODUCTION

1. The Statistics Specialist Working Group (ST-SWG) was held on the afternoon of Monday, 11 August, morning of Tuesday, 12 August and the afternoon of Friday, 15 August. K. Duckworth was convener. C. Boggs (August 11–12) and R. Clarke (August 15) were rapporteurs.

2. The agenda was adopted as published except for:

- Item 7, relating to the Pacific Tuna Tagging Programme (PTTP) Steering Committee, was removed because the Committee was not scheduled to meet soon enough to report as scheduled;
- A request from the Ad Hoc Task Group – Data for advice on the use of vessel monitoring system (VMS) data for scientific purposes was added under "Other matters";
- A request from the Secretariat for CCMs to voluntarily waive the application of the three vessel rule (for public domain data), was added under "Other matters".

The agenda as adopted is attached as Appendix 1 of this report.

ISSUES RELATING TO GAPS IN DATA

Progress in filling data gaps

3. P. Williams (Secretariat of the Pacific Community - Oceanic Fisheries Programme, SPC-OFP) reported on recent developments in regard to data gaps, referring to SC4-ST-IP-2 (Scientific Data Available to the Commission). With respect to major developments concerning the resolution of data gaps over the past year, he noted that some progress had been made in improving data collection in the Philippines and Indonesian domestic fisheries, and that details would be discussed in the Indonesia and *Philippine* Data Collection Program (IPDCP) Steering Committee meeting to be held in subsequent days. Other developments concerning the resolution of data gaps over the past year include:

(a) Size composition data provided by Chinese Taipei (2005–2007) and Korea (2007) for their distant water longline fleets now satisfy the criteria specified in the guidelines for the provision of scientific data to the WCPFC;

(b) In the past year, Japan and Korea have provided updates to their aggregate longline catch and effort data (which now cover the entire Pacific Ocean);
(c) Formal authorizations for the provision of historical operational data to the WCPFC were received for New Zealand fleets and the USA purse-seine treaty data.

4. There were some improvements in the timeliness in the provision of annual catch estimates and aggregate catch and effort data this year, when compared to last year, but there were some provisions of data that did not satisfy the criteria specified in the guidelines for the provision of scientific data to the Commission.

5. During the past year, a prototype system was developed to register the details of provisions of scientific data to the WCPFC and produce summarized tables of provisions, thereby providing a mechanism for identifying data gaps. The component of the prototype system developed to disseminate summarized tables on the provisions of data is now available at the following URL :
http://www.spc.int/oceanfish/html/wcpfc/statistics/StatProv.asp

6. The main intention of this system is to:
(a) provide the WCPFC Secretariat, the Scientific Committee and data managers with a broad indication of the status of data collected and provided to the WCPFC (i.e. identify data gaps);
(b) provide CCMs with a concise summary of what data have or have not been provided to the WCPFC, and any deficiencies with the data provided;
(c) serve as a reference for the WCPFC Secretariat and data managers when following up with CCMs on any outstanding issues with respect to the collection and provision of data to the WCPFC (e.g. identify data gaps which may prompt "data rescues"); and
(d) provide users (e.g. researchers) with a concise summary of what data are available and inform them about any apparent problems with the data provided.

7. CCMs were asked to review the webpages on the provision of data for their fleets, and report to the Secretariat if there are any inaccuracies.

Discussion

8. The noted improvements in data submission were welcomed by the ST-SWG, however the many remaining gaps and the need for complete and timely submission of operational data (needed for accurate stock assessment) was emphasized. It was noted that the Commission's reporting requirements are comprehensive in comparison to those of other tuna regional fisheries management organizations (RFMOs).

9. Some CCMs that are currently providing operational data were critical of the delays and gaps of other CCMs. Reasons for delays and gaps in data included: vessels being away from home ports for years, the cost of requiring many types of data systems (logbooks, port sampling, observers), and the importance of thorough quality control to maintain critically important time series. The importance of data quality assurance was widely recognized by participants, and it was suggested that timely submission followed by subsequent correction is a useful approach. In response to suggestions that data requirements be reduced or prioritized, it was emphasized that they were previously agreed to by all CCMs. An initiative by one participant to develop near-real-time logbook updating from vessels at sea was praised. The issue of apparent gaps on the website where data were provided earlier to SPC but not to WCPFC was acknowledged.

10. The ST-SWG urged that:

(a) CCMs provide SPC with formal authority to release their historical data, including operational data, to the WCPFC; and

(b) CCMs that have not yet provided both current and historical operational (and other) data to the Commission do so as a matter of urgency, in accordance with the guidelines for the provision of scientific data to the Commission.

Review of "A study to identify causes of data gaps in the work of the WCPFC"

11. D. Wright (WCPFC Secretariat) presented SC4-ST-WP-1 (Interim report on causes of data gaps). The paper was authored by M. Jones and B. Shallard (FishServe Innovations New Zealand Limited). SC3 discussed gaps in data required to support stock assessment, and ecosystem and fishery management, and recommended that the WCPFC conduct a study to identify causes of data gaps. The study was endorsed by WCPFC4 in December 2007. The scope of the data gaps study was expressed as - with reference to the Scientific Data to be provided to the Commission:

- identify what data have been provided to the Commission;
- identify what data have not been provided to the Commission;
- if scientific data have not been provided, identify possible causes; and
- identify options to realistically improve the provision of data.

12. FishServe Innovations New Zealand Limited (FINNZ) was engaged by the WCPFC Secretariat to undertake the data gaps study. The process for investigating the data gaps was to:

- Assess and review the nature of the Scientific Data to be provided to the Commission.
- Review the status of data provision to the Commission.
- Obtain necessary context on the current state of data provision through discussions with key personnel.
- Ascertain key data gaps and indicative reasons for gaps.
- Develop a questionnaire to obtain member feedback on data provision and test indicative reasons for data gaps. The questionnaire examined:
    a) What fisheries are CCMs actively participating in?
    b) What is the level of operational catch data coverage for those fisheries (i.e. how much activity is being recorded)?
    c) What level of data recorded is being provided to the Commission?
    d) What reasons exist that limit the recording of operational catch data?
    e) What reasons exist that restrict the provision of operational catch data to the Commission?
    f) What can the Commission do to assist with the provision of data?
- Analyze questionnaire results.
- Provide recommendations for consideration by the Commission.

13. Despite being prompted on at least three occasions, only four CCMs responded to the questionnaire. This low response rate limited the ability to make specific recommendations. For this reason SC4-ST-WP-1 has "interim" in its title. Further engagement with data correspondents is required to resolve the data gaps faced by the Commission. The interim report recommend that the WCPFC:

- employ/contract a data capture manager who's priority would be to meet regularly with CCM data correspondents; and

- hold workshops (yearly or twice yearly) that are run and attended by data correspondents.

Discussion

14. The established WCPFC requirement for submitting operational data was reiterated. However, the difficulties of some CCMs in providing comprehensive data were also reiterated, as well as the domestic prohibition many CCMs face regarding disclosure of individual business practices. In relation to the paper's recommendation to hire a data capture manager, it was noted that a similar position exists within the Commission's work plan but is not funded.

15. The SWG recommended that all CCMs complete and submit responses to the data gaps questionnaire, and that an updated analysis be presented at WCPFC5.

Species composition of purse-seine catches

16. A. Fonteneau (Institut de recherché pour le developpement, IRD) presented SC4-ST-WP2 (Species composition of tuna catches taken by purse seiners). Multi-species size sampling has been conducted in the Indian and Atlantic oceans since the early 1980s, and is targeted to estimate the species and size composition of tuna landings by pole-and-line vessels and purse seiners. Similar sampling has been developed by the IATTC since 2000. This sampling is considered to be of key importance in estimating the real catches of small bigeye tunas taken by surface fisheries, as small bigeye tunas tend to be widely underestimated in most logbook and landing statistics. The paper discusses the structural biases that are expected when sampling the complex mixture of sizes and species that are observed on FAD schools by observers. It advocates the sampling of these catches using large-scale port multi-species sampling schemes. The data processing (based the methods developed by EU scientists in the Atlantic and Indian oceans) of these multi-species samples was also discussed. The paper recommends promoting a unified sampling scheme of purse-seine landings in the WCPO and a unified data processing of these size and species samples. The implementation would necessitate the deployment of permanent teams of species and size samplers in selected major ports where tunas are transhipped or landed. The paper also recommends processing all WCPO historical data on species composition using this new method, and promotes the rapid implementation of such an optimized sampling scheme.

17. T. Lawson (SPC-OFP) presented SC4-ST–WP-3 (Factors affecting the use of species composition data collected by observers and port samplers from purse seiners in the western and central Pacific Ocean). The species compositions of catches from associated schools determined from observer data and port sampling data are considerably different: 55.3% skipjack, 35.1% yellowfin and 9.6% bigeye from observer data; and 72.4% skipjack, 19.8% yellowfin and 7.8% bigeye from port sampling data. Several factors that might explain this difference were examined. Port sampling data were found to be subject to set weight bias, grab sample bias and well mixing, all of which result in over-estimation of the proportion of skipjack and under-estimation of the proportion of yellowfin. Observer data are also subject to grab sample bias, while size selection bias has been proposed as an explanation of the relatively low proportion of skipjack and the high proportion of yellowfin in observer data.

18. The paper stated that bias induced by total weight by set in port sampling data occurs because the species composition of associated schools is related to the set weight, with the proportion of skipjack increasing, and the proportion of yellowfin decreasing, with the size of the

school. The criteria used to select wells tend to result in the sampling of wells containing a small number of large sets, rather than a larger number of small sets. Since large sets contain a greater proportion of skipjack, the port sampling data are biased. The sizes of the sets sampled by observers are representative of the sizes of sets fished and so the observer data are unbiased in this regard.

19. The paper stated that grab sample bias occurs because the sampling protocol for both observers and port samplers is to select a certain number of fish, whereas the species composition estimated from data is in terms of weight. The magnitude of the bias depends on the sample size and the distributions of the species and sizes of fish in the set or well.

20. A new sampling protocol was tested by the SPC-OFP in March 2008 in Papua New Guinea. Under the "spill sample" protocol, fish were spilled from every tenth brail directly into a bin. The observer then measured all of the fish in the bin. Since there was no selection of individual fish by the observer, both grab sample bias and size selection bias were eliminated. In contrast to port samples, spill samples taken by observers at sea are neither subject to set weight bias nor well mixing. The conclusion of the study was that spill samples taken by observers is the only sampling protocol that can provide unbiased species composition data.

21. Paper ST-WP3 noted that size separate analyses of observer data and port sampling data, wherein species compositions are estimated separately for small (< 80 cm) and large (≥ 80 cm) fish, were conducted. Given the biases to which the observer data and port sampling data are subject, it was considered that a species composition that is intermediate between those determined from the observer data and port sampling data would be more accurate. The intermediate analysis resulted in a species composition of annual catches during 1997–2006 of 68.0% skipjack, 26.2% yellowfin and 5.8% bigeye. The proportion of bigeye is twice as great as the proportion determined from the aggregated purse-seine data that are currently used for stock assessments.

Discussion

22. The high cost of very comprehensive port sampling and observer programmes, and also the great utility of each, were noted. It was suggested that the EU's practice of measuring two to three samples from each boat unloading might represent over-sampling, and an adequate programme might be achieved with half this effort. The need for port samplers to use information on the sets in each well so that size and species compositions can be determined by set type was also described.

23. Discussion covered the unique ability of observers to measure discards and interactions with turtles and similar species of concern, and to sample before catch is sorted or layered in wells or transhipped. It was noted that well mixing may be of particular concern with certain fleets and that transhipments may also be sampled in port. Prospects for correcting historical biases were addressed as being: i) possible, ii) a high priority, iii) complex, and iv) of unknown reliability until undertaken. It was mentioned that the Commission's commitment to a comprehensive Regional Observer Programme with large coverage makes port sampling an additional cost, not an alternative cost. The practice of stratified sampling of catches by commercial size categories when the data on total landings by those categories is available was described. The effectiveness of this option is limited by the availability of such categorical data. It was suggested that the problems resulting from disproportionate sampling of large sets, when small sets have different compositions, could be addressed by stratified sampling. It was clarified that spill samples are three times larger than grab samples, and that this may be a full-time task

for observers. It was emphasized that the most critical issue is the proportion of bigeye in catches. Assigning a very high priority to these issues was encouraged in next year's work programme. It was noted that these issues require worldwide solutions and a collaborative approach among worldwide tuna RFMOs.

24. One participant proposed to form (as soon as is possible) a technical working group in charge of comparing and analyzing the size and species sampling presently done on purse seiners in the WCPFC, IATTC, ICCAT and IOTC areas.

25. The ST-SWG recommended that catch sampling programmes should be designed to overcome sampling biases and other issues raised by the two working papers. Sampling designs should build on further comparative trials, which should include both observer sampling versus port sampling, and also comparison among different techniques within observer and port sampling.

Purse-seine effort on the high seas and in zones of non-Parties to the Nauru Agreement (PNA) member CCMs

26. D. Wright presented SC4-St-WP-4 (Data relating to purse seining effort on the high seas and in the zones of non-PNA member CCMs) and recalled the request from WCPFC4 to commence a process in early 2008 to support the implementation of compatible measures [*sic.* to the PNA Vessel Day Scheme] to limit purse seine effort on the high seas, consistent with paragraph 9 of CMM 2005-01, and in waters under the national jurisdiction of non-PNA members of the Commission, consistent with paragraph 10(ii) of CMM-2005-01. Utilizing information available to SPC-OFP, and drawing on the relevant provisions of CMM 2005-01 and 2006-01, purse seine effort, in fishing days, was presented to the WG. He noted that, in several instances, data for actual fishing activities during the period 2001-2004 was incomplete or lacking. In such cases best estimates, based on total estimated catch and average catch per fishing day for that period, had been provided.

Discussion

27. Several CCMs articulated the view that implementing effective purse-seine effort limits compatible with the vessel day scheme (VDS) has been identified as a priority issue for the Commission. This is the kind of information that the Commission needs for its work on a bigeye and yellowfin tuna measure. As the paper notes — para 6 of CMM 2005-01 exempts domestic Pacific Island fleets and footnote 1 refers to registered access agreements — these items need to be taken into account in applying the data in Table 1. Some CCMs stated that they have not agreed to the application of a VDS. Some CCMs indicated that they were not able to agree to the data presented in Table 1 and required additional time to review this.

28. The ST-SWG:

- **agreed that the data contained in SC4-ST-WP-4 represented the best assessment of purse-seine fishing effort on the high seas and in the zones of non-PNA members available at this time (August 2008);**
- **recommended that SC4-ST-WP-4 be forwarded to TCC4 and the Commission; and**
- **agreed that any CCM that believes it has additional data that should be included in this paper, provide the proposed changes (along with supporting documentation) to the Secretariat by 15 September 2008.**

Seabird mortality

29. The convenor noted:

- the statement in the WCPFC4 Summary Report that,

  "CCMs shall annually provide to the Commission, in part 1 of their annual reports, all available information on interactions with seabirds, including bycatch and details of species, to enable the Scientific Committee to estimate seabird mortality in all fisheries to which the WCPF Convention applies"; and
- that many of the issues (relating to the collection of data on seabird interactions and mortality) scheduled to be considered by the ST-SWG had already been covered by the Ecosystems and Bycatch Specialist Working Group.

Discussion

30. One CCM indicated the importance of collecting accurate data on seabird mortality and asked whether there were seabird identification guides available for distribution to observers and vessel masters. It was suggested that the SPC-OFP could assist with providing existing longline bycatch identification guides. Regarding the level of observer coverage, it was noted that SC2 recommended an initial coverage rate of 5% as a minimum, to determine possible hot spots or areas that may require enhanced observer coverage rates (for seabirds as well as other bycatch species). It was noted that Birdlife International in its presentations during the Ecosystems and Bycatch Specialist Working Group suggested a 20% coverage rate for areas where interaction rates may be elevated.

It was noted that the collection of data on seabird interactions should be appropriate to the fishing gear being used and areas being fished.

31. The ST-SWG:

- **Recommended that seabird identification guides be made available to observers and vessel masters;**
- **Emphasized the recommendation made in SC2 that the objective of the Regional Observer Programme should initially be to attain a minimum coverage of 5% of fishing effort across all strata; and the distribution of observer effort should be representative of species of interest, fishing areas, seasons, and fishing fleets.**

Shark catches

32. The convenor noted:

- the statement in the SC3 Summary Report that "The SC recommends that observer programmes should collect information on the catch of all shark species, both retained and discarded, to the lowest possible taxonomic level. This information should be provided in the annual reporting to the Commission";
- the statement in the WCPFC4 Summary Report that "The Commission endorsed SC3's recommendation to require data collection and reporting, through the Annual Report to the Commission, of shark catches to the lowest possible taxonomic level"; and
- that many of the issues (relating to the collection of data on shark mortality) scheduled to be considered by the ST-SWG had already been covered in the Ecosystems and Bycatch Specialist Working Group.

Discussion

33. No additional advice, beyond that discussed in the Ecosystems and Bycatch Specialist Working Group, was provided by the ST-SWG.

REGIONAL OBSERVER PROGRAMME

34. D. Wright reported on the second Intersessional Working Group for the Regional Observer Programme, which met in Nadi, Fiji from 7–10 July 2008. He advised that the IWG reviewed the draft minimum data fields for the ROP and that the outcome was presented in SC4-ST-SWG-IP-5.

Discussion

35. It was noted that CMM 2007-01 brings the ROP into force from 31 December 2008, and it is important to ensure that the early stages of the ROP are effectively implemented and that particular importance is placed on recommendations made by SC2 (paras 192 and 197 of the SC2 Summary Report). It was also proposed that the SC draw the attention of the IWG to the existing recommendations that:

- "The objective of the regional observer programme should initially be to attain a minimum coverage of 5% of fishing effort (longline: total hooks deployed; purse seine: days fished and searched) across all strata to allow identification of specific issues. The distribution of observer effort is to be representative of species of interest, fishing areas, seasons, and fishing fleets (types)"; and
- "The data collected from initial levels of coverage should be used to further determine the levels of coverage required to address specific issues of concern to the Commission. For example, coverage rates may need to be higher in certain areas or circumstances to obtain reliable estimates of the catch of some species (e.g. seabirds, sea turtles, marine mammals) or species populations that are particularly vulnerable, for fisheries for which information is currently unavailable, and for other specific issues of concern to the Commission".

36. The ST-SWG agreed that the IWG ROP2 should be thanked for their work in progressing this important element of the data required for the Commission's work. No changes were proposed to the data elements documented in SC4-ST-SWG-IP-5.

INDONESIA AND PHILIPPINES DATA COLLECTION PROJECT

37. D. Wright provided a summary of the fifth meeting of the Steering Committee for the IPDCP, which was held from 12–13 August 2008 in the margins of SC4. He reported that IPDCPSC5 reviewed a financial report for the project for the period up to 31 July 2008, noting that supplemental funding had been secured during the year from the Global Environment Facility (GEF) and the Government of the United States. The financial report was accepted by IPDCPSC5. IPDCPSC5 received status reports from both Indonesia and the Philippines on project activities during the last 12 months and plans for 2009. A work programme and budget for 2009–2011 was also considered as was a schedule of activities and provisional budget (USD100,000) recommended for funding support from the Commission's core budget in 2009. IPDCPSC5 expressed appreciation to the WCPFC Secretariat for its effort in successfully securing funding support for a period of three years under a GEF medium-sized project facility (providing potential of up to USD1 million over three years). The design of that project, which will include activities in Vietnam, is currently underway.

Discussion

38. CCMs thanked the IPDCP steering committee for its work and report. For some CCMs, the work of the IPDCP is a high priority and they appreciate the progress reported. Several positive elements in the IDPCP report were noted with appreciation (including the report from Philippines, the progress on securing GEF funding, the collaboration of SPC, IOTC, and WCPFC in Indonesia; and the recent support from the USA).

39. The ST-SWG recommended that the Commission provide USD100,000 to support the IPDCP to ensure progress in the ensuing year (2009), and to match the requirements established by GEF funding. The ST-SWG also reiterated its request that CCMs provide voluntary contributions to this important project.

OTHER MATTERS

Scientific needs for VMS data

40. The convenor presented SC4-ST-SWG-IP-6 (Scientific issues related to the work of the Ad hoc task group, AHTG [Data]). This paper notes "the immediate task of the AHTG is to develop separate rules and procedures for… the dissemination of VMS data for scientific purposes". The paper puts three questions to the ST-SWG and SC:

(a) What specific kinds of VMS data are needed?
(b) For what particular scientific purposes are these data needed?
(c) At what time scale are data needed?

Discussion

41. Some CCMs noted that this is one of two gaps in the existing rules, and that there needs to be separate rules and procedures for these gaps. These CCMs have existing arrangements that enables VMS data to be accessed by SPC for scientific purposes, which might provide a starting point for consideration of this issue by the Committee.

42. Another CMM stated that the rules for accessing VMS data should be distinguished from access by the Secretariat and their service providers, and access by others. As a general rule, access by the Secretariat and their service providers, should be more open than it is for others. Confidentiality and security aspects should be dealt with under the Commission's Information Security Policy (ISP).

41bis. With regards to time scale, participants noted two separate considerations:

- How recently the VMS data needs to be for various scientific purposes; and
- How frequent (daily, hourly, by minute) VMS time and position data need to be provided for scientific purposes. Near real-time VMS data would be very useful for real-time decision-making on tagging cruises (to improve tag distribution and recovery).

43. The ST-SWG offered the following advice with regard to specific kinds of VMS data that are needed: vessel identification, location, date and time.

44. The ST-SWG noted that participants had not had time to prepare for this agenda item, but offered the following provisional advice - The scientific purposes for which VMS data might be used include:

(a) Estimating fine-scale distribution of fishing effort for use in oceanographic research;
(b) Planning tagging programmes;
(c) Estimating or validating recapture positions of tag returns;
(d) Modeling spatial dynamics of fishing effort for use in operational models associated with any future management strategy evaluation (MSE) work;
(e) Estimating abundance indices using effective effort from fine-scale vessel-specific data;
(f) Validating logbook data.

45. The ST-SWG offered the following advice with regard to the time scale at which data are needed. As an interim arrangement, the standard used by the ICCAT should be adopted by WCPFC.

Request from the WCPFC Secretariat for participants to exercise their right to voluntarily waive the three-vessel rule for public domain data.

46. D. Wright noted:

(a) the restrictions on public domain data contained in the Commission's Rules and Procedures for the Protection, Access to and Dissemination of Data Compiled by the Commission, specifically state that "Data in the public domain shall not reveal the individual activities of any vessel, company or person and shall not contain private information. Catch and effort data in the public domain shall be made up of observations from a minimum of three vessels";
(b) that the three-vessel restriction approximately halves the amount of catch and effort data that the Commission can place in the public domain (e.g. publish on its website);
(c) Most CCMs do not provide the WCPFC with the number of vessels in a particular stratum, and it is not possible (for the Secretariat and its service providers) to determine the number of vessels associated with the aggregated catch and effort data that has been provided, except for those fleets for which operational catch and effort data has been provided.

Discussion

47. Some CCMs expressed the opinion that the Scientific Committee should encourage the Commission to remove the three-vessel restriction on data that is placed in the public domain, so that scientists outside of the Commission process can have greater access to data describing tuna fisheries in the Pacific. Other CCMs expressed the opinion that the appropriate mechanism to achieve the same result was for scientists outside of the Commission process to contact individual CCMs, asking for permission to use the data that were supplied to the Commission. It was noted that IOTC and ICCAT do not have a three-vessel restriction on public domain data. It was also noted that para 34 of the Rules and Procedures for the Protection, Access to and Dissemination of Data Compiled by the Commission allows CCMs to voluntarily authorize (the Commission) to release any data that they have provided to the WCPFC. One CCM remarked that its experience with using something similar to the three-vessel restriction was that much more than half of the Commission's aggregated catch and effort data could be placed in the public domain if the Commission adopted a more flexible approach to data aggregation.

48. **ST-SWG recommended that the Secretariat write to CCMs, encouraging them to use para 34 to voluntarily authorize the Commission to waive the three-vessel restriction for catch and effort data that they have provided.**

Review of the WCPFC transhipment reporting form for collecting data for scientific purposes

47(bis). The Republic of Marshall Islands (RMI) requested an opportunity to make comment on ST-IP4 (Review of the WCPFC transhipment reporting form for collecting data for scientific purposes). RMI thanked the SPC-OFP for the review set out in ST-IP4, which RMI had requested last year. The delegate noted that RMI found the information contained in ST-IP4 very useful for the design of a WCPFC transhipment measure, and recommended that the paper be passed to the Technical and Compliance Committee (TCC). The ST-SWG convenor noted that this was not a scheduled agenda item and asked if any CCM objected to this item being considered. A CCM responded that it had not had notice of this unscheduled agenda item and would not have adequate time to consider this issue. This point was accepted by the convenor and discussion on this issue was halted.

Future work plan

49. ST-SWG recommended that the 2008/2009 work programme include:

(a) Completion of "a study to identify causes of data gaps in the work of the WCPFC", for presentation at WCPFC5;

(b) Continued study into sampling regimes for the size and species compositions of purse-seine catches, specifically:

- **strengths / weaknesses of observer programmes and port sampling; and**
- **optimum sampling methodologies;**

(c) Completion of the WCPFC data gaps website.

Adoption of the report and close of meeting

50. This report was adopted by SC4 on 18h August 2008.

The Commission for the Conservation and Management of

Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

AGENDA FOR THE STATISTICS SPECIALIST WORKING GROUP

1. **Opening of the meeting**
2. **Selection of rapporteurs**
3. **Adoption of agenda**
4. **Issues related to gaps in data**
   - 4.1. Progress in filling gaps.
   - 4.2. Review of "A study to identify causes of data gaps in the work of the WCPFC"
   - 4.3. Species composition of purse-seine catches
   - 4.4. Purse-seine effort on the high seas and in the zones of non-PNA member CCMs
   - 4.5. Seabird mortality
   - 4.6. Shark catches
5. **Regional Observer Programme (ROP)**
6. **Report back from Steering Committee of the Indonesia and Philippines Data Collection Project (IPDCP)**
7. **Other matters**
   - 7.1 Request from the AHTG [Data] for advice on the use of VMS data for scientific purposes
   - 7.2 Request from Secretariat for Participants to exercise their right to voluntarily waive the 3 vessel rule for Public Domain Data
   - 7.3 Future work programme
8. **Adoption of report**
9. **Close of meeting**

Attachment L

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

REPORT OF THE STOCK ASSESSMENT SPECIALIST WORKING GROUP

INTRODUCTION

1. The meeting of the Stock Assessment Specialist Working Group (SA-SWG) took place during from 12–13h August 2008. N. Miyabe (Japan) and K. Bigelow (USA) served as conveners of the meeting, with D. Bromhead, N. Davies, G. DiNardo, S. Harley, D. Kolody and K. Uosaki serving as rapporteurs.

2. A provisional agenda was circulated for review prior to the meeting, and adopted as attached as Appendix 1 to this report. Nine working papers were presented to the SA-SWG, including stock assessments for WCPO bigeye and skipjack tuna, South Pacific albacore and southwest/south-central swordfish. Parallel assessments were conducted for bigeye tuna (MULTIFAN-CL (MFCL) and Stock Synthesis 3 (SS3) and swordfish (MFCL and CASAL). A compendium of fisheries indicators for target tuna species was produced for the first time. Five information papers were provided in support of the assessments. A complete listing of documents presented to the SA-SWG is included in Attachment F of the Summary Report.

3. The SA-SWG discussed responses to the Commission's requests (agenda item 5), discussed the required frequency and prioritization of species' assessments, and identified short- to medium-term research items (see agenda item 9 – Future work programme) to advance stock assessments.

4. On the basis of the presentation of the stock assessment working papers, and the discussions of the SA-SWG, stock status descriptions were formulated for four species: WCPO bigeye and skipjack tuna, South Pacific albacore and south-east/south-central Pacific swordfish. Summaries of each working paper, including relevant status descriptions and SA-SWG discussions, and proposed short- to medium-term research items follow.

BIGEYE TUNA STOCK ASSESSMENT

Summary of SC4-SA-WP-1

5. A. Langley presented SC4-SA-WP-1: Stock assessment of bigeye tuna in the WCPO. The Executive Summary is as follows with several figures regarding stock status.

6. The assessment uses the stock assessment model and computer software known as MULTIFAN-CL (MFCL). The bigeye tuna model is age (40 quarterly age-classes, i.e. 10 years) and spatially (six regions) structured and the catch, effort, size composition and tagging data used in the model are classified by 25 fisheries and quarterly time periods from 1952–2007.

7. The catch, size and tagging data used in the assessment were updated from the 2006 assessment. It should be noted that, at the time the assessment was conducted, 2007 data were not complete for some fisheries, most notably the distant water longline fisheries. The estimation of standardized effort for the main longline fisheries used the GLM approach as per the 2006 assessment. The current assessment included a number of additional fisheries (Japanese coastal pole-and-line and purse-seine and equatorial purse-seine) and reconfigured several main fisheries (Indonesia and Philippines domestic fisheries and the longline fishery within region 3). The revised fisheries structure was equivalent to the 2007 yellowfin assessment.

8. The sensitivity of the assessment model to a wide range of assumptions was examined, including the natural mortality-at-age schedule, steepness of the spawning stock-recruitment relationship, historical and current catch levels from the Philippines and Indonesian domestic fisheries, alternative catch history for the equatorial purse-seine fishery, the assumption of constant (versus increasing) catchability of the Japanese longline fleet, and structural assumptions related to recruitment distribution and movement. Of the sensitivity analyses, it was decided to focus on the results of the analyses which were considered more plausible, while still deviating significantly from the base-case analysis. Four sensitivities were selected for detailed examination.

9. **Lower steepness** (run s11, h=0.75). The base-case model (run 4) estimates a high value of steepness (0.97); however, the model is not very informative about this parameter, which is crucial in the determination of the MSY-based performance measures. Limited information is available to determine steepness for any tuna species or stock. A lower value of steepness is considered plausible and results in more conservative MSY-based reference points.

10. **Increasing longline catchability** (run s7b, LL incr. q). The base-case model assumes that the GLM CPUE model accounts for all significant changes in the longline fishery that might have resulted in an increase in the efficiency (catchability) of the fleet. However, the CPUE model only includes a limited number of variables (location, gear configuration, and proportion of yellowfin in the catch) and does not consider the increase in efficiency of the longline fleet achieved from the adoption of a wide range of technological advances in fishing gear over the history of the fishery (see Ward 2008) or the increase in fisher knowledge and experience. A sensitivity analysis with increasing longline catchability is, therefore, a plausible alternative to the base-case assessment. The sensitivity formulated includes a 0.5% per annum increase prior to 1985 and a 2% per annum increase from 1985 onwards when bigeye was the main species targeted by the longline fleet. These values are considered to represent "best guesses" of the increase in fishing efficiency in the absence of any definitive quantitative study.

11. **Purse-seine revised catch**. Current catches from the equatorial purse-seine fishery may be substantially underestimated (Lawson 2008). The sensitivity incorporates an alternative bigeye tuna catch history, doubling the catch from 1980 onwards.

12. **Low catches from the Indonesian and Philippines domestic fisheries** (run s5, low ID/PH). Historical and recent catches from these two fisheries are highly uncertain, particularly for the Indonesian fishery. A range of alternative catch histories were considered, of which the

run with a 50% reduction in the level of catch from both fisheries represented a substantial improvement in the objective function of the model.

13. The main conclusions of the current assessment are as follows.

14. Recruitment in all analyses is estimated to have been high during 1995–2005 (Fig. BET1). This result was very similar to that of previous assessments, although there are some indications that the high recruitment may be, at least partly, an artefact of the structural assumptions of the model. Recruitment in the most recent years is estimated to have declined to a level approximating the long-term average, although these estimates have high uncertainty.

15. For most analyses, total biomass for the WCPO is estimated to have declined to about half of its initial level by about 1970, and declined gradually over the subsequent period (Fig. BET2). Adult biomass has declined by about 20% over the last decade. Declines in biomass are more pronounced for the model with increasing longline catchability.

16. Biomass trends in the model are strongly driven by the time series of catch and GLM standardized effort from the principal longline fisheries. For some of the main longline fisheries, there is an apparent inconsistency between the trends in the size-frequency data and the trends in longline catch and effort; that is, the two types of data are providing inconsistent information about the relative level of fishing mortality in the region. A number of approaches were applied to investigate the influence of the size data from the key longline fisheries. However, the stock status indicators were relatively insensitive to the treatment of these data.

17. Fishing mortality for adult and juvenile bigeye tuna is estimated to have increased continuously since the beginning of industrial tuna fishing (Fig. BET3). For the models with higher purse-seine catch and increasing longline catchability, estimates of recent juvenile fishing mortality are considerably higher than for the base-case model, while the opposite is the situation for the ID/PH low catch option.

18. The ratios $B_t / B_{t,F=0}$ provide a time series index of population depletion by the fisheries (Fig. BET4). Overall, depletion is estimated to have been rapid, particularly since the mid-1980s. While total biomass has remained relatively stable since 1970, it appears to have been sustained by above average recruitment, particularly since 1995. The assessment indicates that recruitment may have returned to the long-term average level (although recent recruitment estimates have high uncertainty) and, if recruitment remains at that level, biomass would decline rapidly at current exploitation rates. The current level of biomass is 20–26% of the unexploited level ($B_{current} / B_{current,F=0}$ = 0.20–0.28), with higher depletion estimated from the model with increasing longline catchability. Depletion is more extreme for some individual model regions, notably region 1 (recent $B_t / B_{t,F=0}$ ratios around 0.25 in the base-case model) region 3 (0.20) and region 4 (0.25). Other regions are less depleted, with recent $B_t / B_{t,F=0}$ ratios of around 0.4 or greater.

19. The attribution of depletion to various fisheries or groups of fisheries indicates that the longline fishery has the greatest impact throughout the model domain. The purse-seine and Philippines/Indonesian domestic fisheries also have substantial impact in region 3 and to a lesser extent in region 4. The Japanese coastal pole-and-line and purse-seine fisheries are also having a significant impact in their home region (region 1). For the sensitivity analysis with higher purse-

seine catch, the longline and purse-seine fisheries are estimated to have approximately equal impact on total biomass.

20. The reference points that predict the status of the stock under equilibrium conditions are $\widetilde{B}_{F_{current}} / \widetilde{B}_{MSY}$ and $S\widetilde{B}_{F_{current}} / S\widetilde{B}_{MSY}$. For the base-case model, these ratios are 0.68 and 0.55, respectively, indicating that the long-term average biomass would fall below that capable of producing MSY at 2003–2006 average fishing mortality further defined as "current". For most of the analyses, current total biomass exceeds the biomass yielding MSY ($B_{current} / \widetilde{B}_{MSY} > 1.0$), with a high probability in the base-case assessment. On that basis, the bigeye stock in the WCPO is not in an overfished state due to above average recruitment. However, the situation is less optimistic with respect to adult biomass with $S\widetilde{B}_{F_{current}} / S\widetilde{B}_{MSY}$ approaching or being below 1.0 for the principal analyses.

21. The estimate of $F_{current} / \widetilde{F}_{MSY}$ indicates that overfishing of bigeye is occurring in the WCPO with high probability. While the stock is not yet in an overfished state with respect to total biomass ($B_{current} / \widetilde{B}_{MSY} > 1$), the situation is less optimistic with respect to adult biomass and a number of plausible model options indicate that adult biomass has been below the $S\widetilde{B}_{MSY}$ level for a considerable period ($SB_{current} / S\widetilde{B}_{MSY} < 1$). Further, both adult and total biomass are predicted to become overfished at 2003–2006 levels of fishing mortality and long-term average levels of recruitment. The probability of $SB_{current} / S\widetilde{B}_{MSY}$ in the base-case model being less than 1.0 is 10.3%. This is consistent with a recent decline in biomass under increasing levels of fishing mortality resulting in an increase in the probability of the stock becoming overfished over time.

22. For both fishing mortality and biomass based reference points, the stock status is considerably more pessimistic for the scenarios, with increasing longline catchability or steepness of the stock recruitment relationship (SRR) at a moderate level. Both of these scenarios are considered plausible alternative to the base-case assessment and indicate the adult component of the stock is in an overfished state ($SB_{current} / S\widetilde{B}_{MSY} < 1$).

23. Stock projections, using the base-case model, indicate that significant reductions in fishery-specific effort are required to reduce fishing mortality below the F_{MSY} level. The target level of fishing mortality can be achieved via numerous configurations of fishery-specific effort; however, largest changes in the performance measure occur from changes in the multiplier applied to the longline fishing effort. This reflects the relatively high proportion of the total level of current fishing mortality attributable to this method throughout the WCPO. Significant reduction in fishing effort from at least one specific gear type is required to achieve F/F_{MSY} and larger reductions in some fisheries are required for scenarios that model an expansion of one of the other fisheries.

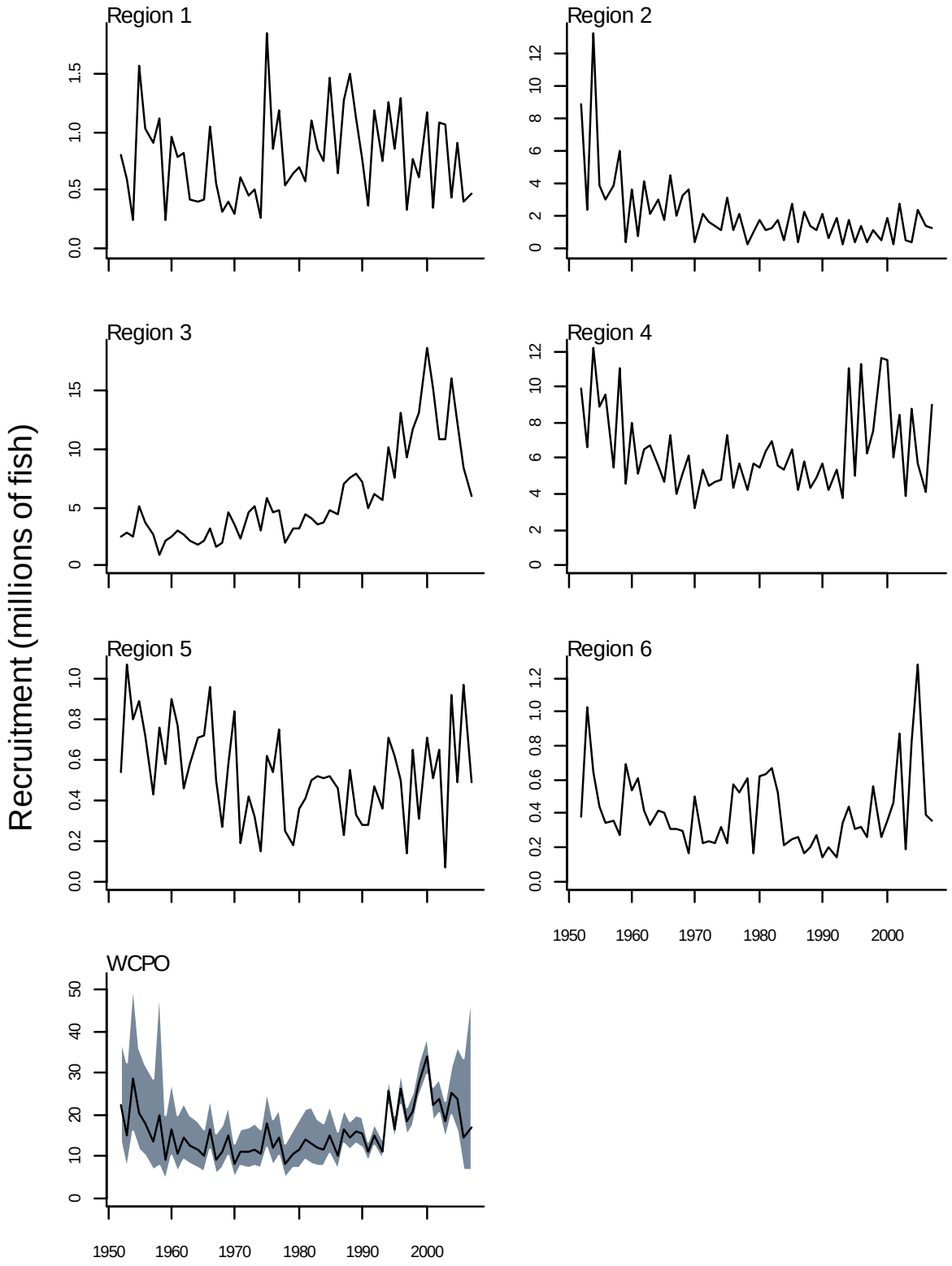

Figure BET1. Estimated annual recruitment (millions) by region and for the WCPO in the base-case model. The shaded area for the WCPO indicates the approximate 95% confidence intervals.

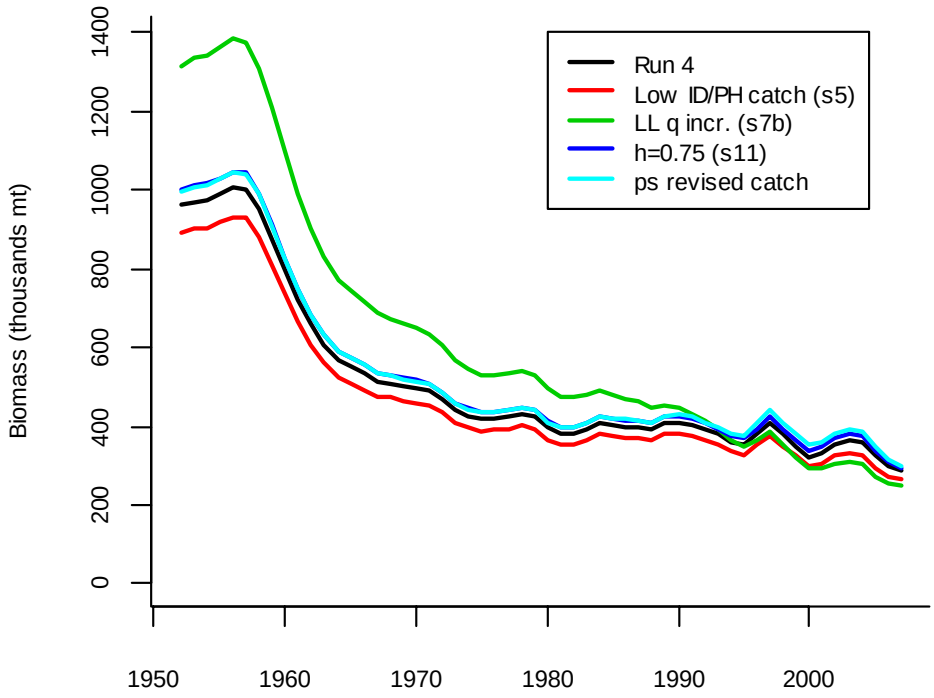

Figure BET2. Estimated annual average total biomass (thousands mt) for the WCPO obtained from the separate analyses. Run 4 is the base-case model.

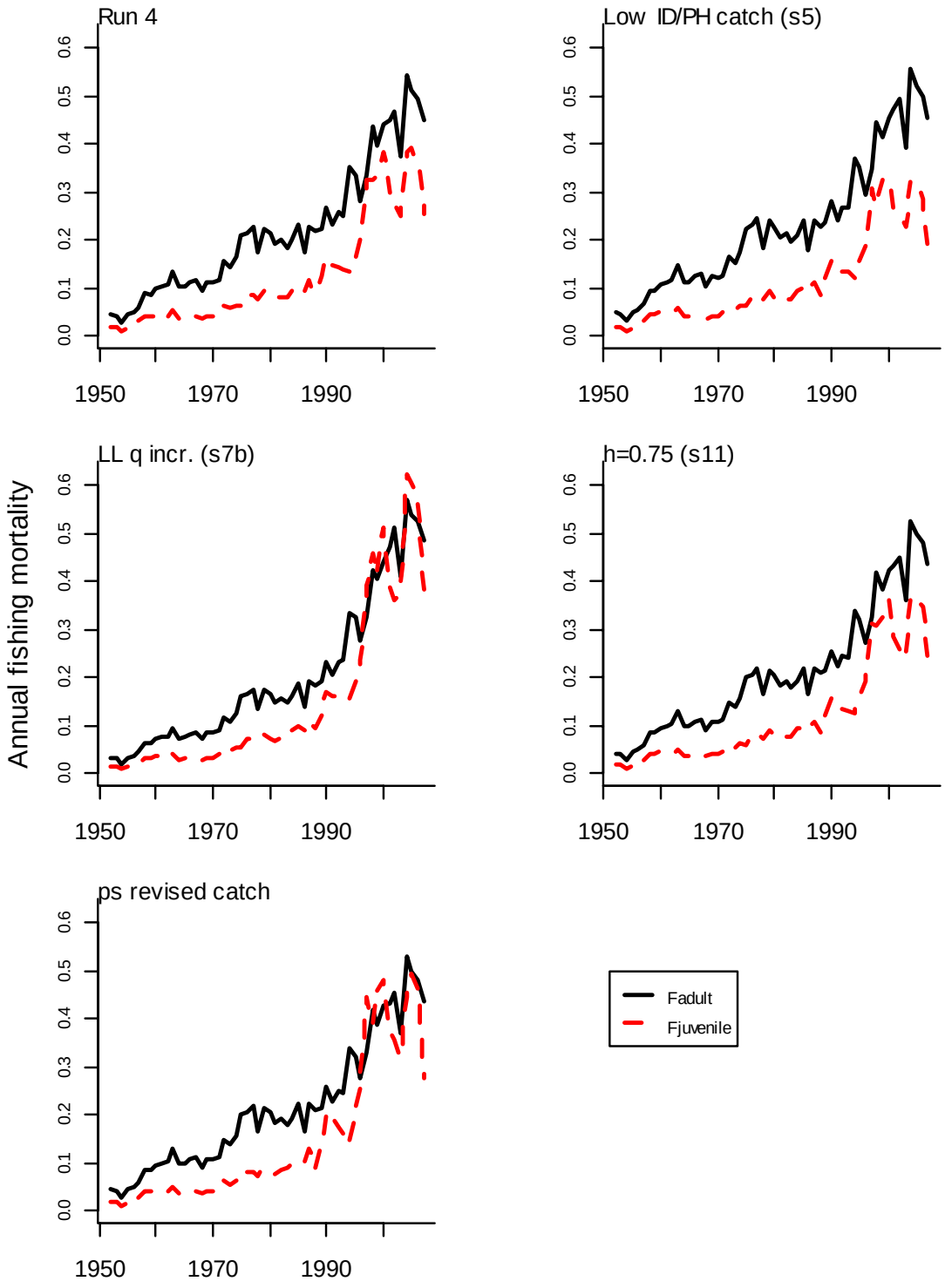

Figure BET3. Estimated annual average juvenile and adult fishing mortality for the WCPO obtained from selected analyses. Run 4 is the base-case model.

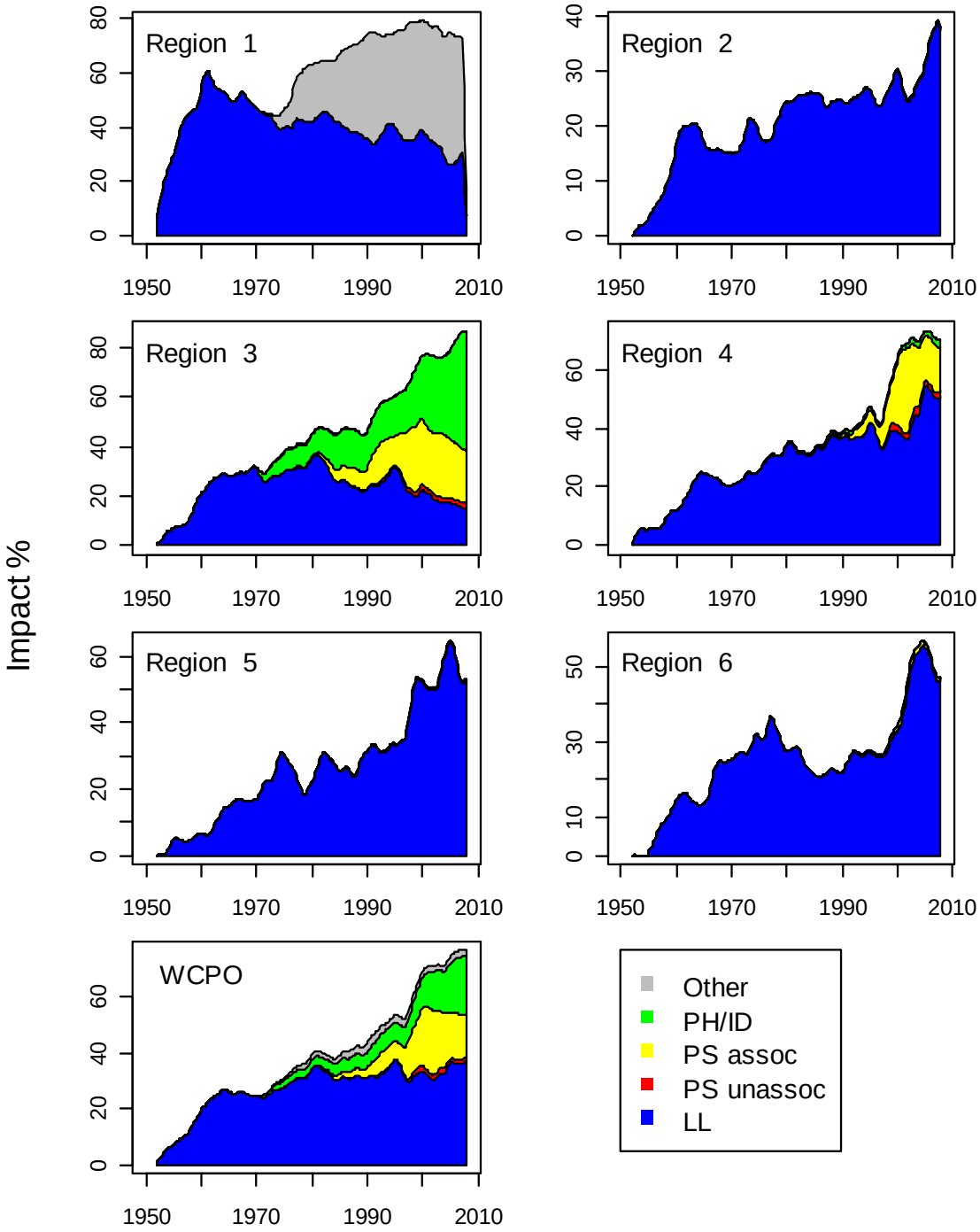

Figure BET4. Estimates of reduction in total biomass due to fishing (fishery impact = $1\text{-}B_t/B_{0,t}$) by region and for the WCPO, attributed to various fishery groups (base-case model). LL = all longline fisheries; PH/ID = Philippines and Indonesian domestic fisheries; PS assoc = purse-seine log and FAD sets; PS unassoc = purse-seine school sets; Other = pole-and-line fisheries and coastal Japan purse-seine fisheries.

Discussion

24. There was general agreement that the bigeye assessment was comprehensive and that the assessment represented the best available scientific information. A suite of recommendations stemming from the previous WCPO bigeye tuna assessment were incorporated into the current assessment, resulting in a more robust assessment. An array of sensitivity analyses were conducted to explore uncertainty and provide recommendations for future research.

25. There was significant discussion on a number of topics that can be categorized into 5 themes, including a) input data, b) model structure and parameterization, c) model output and diagnostics, d) model projections, and e) management advice. Discussion topics within each theme are outlined below.

Discussion — Input data

26. It was noted that new fishery data have been incorporated into the model and that existing composite data sets have been decomposed into specific fisheries. This decomposition was necessary to account for differences in fishing practices, which when combined can increase uncertainty in the model. There was overall agreement that efforts to improve input data are necessary steps in any analysis, and changes in data incorporated into the current assessment are reasonable. However, it was pointed out that the current Chinese Taipei/China series of catch and effort may need to be decomposed into two series to account for changes in targeting from yellowfin tuna to bigeye tuna. It was decided to keep the current series and to investigate the need for decomposing this series prior to the next scheduled assessment.

27. It was pointed out that if catch-at-size data from the Philippines domestic fishery are available, they may assist in the estimation of natural mortality at age of small fish. It was pointed out that these data are scant, and in the absence of other available information natural mortality for the youngest age classes was explored in sensitivity analyses. It was noted that Philippines data are currently being revised and perhaps in the future additional catch-at-size data may be available.

28. The major decline of average sizes of bigeye caught by the WCPFC fisheries was noted. Present average weight caught is in a 5 kg to 15 kg range, when they were above 40 kg until the early 1970s. There is no doubt that the current average weight is below the weight optimizing yield per recruit.

Discussion — Model structure and parameterization

29. It was noted that the assessment model has been modified from the last assessment to be more similar to the 2007 yellowfin tuna assessment as discussed at SC3. It was noted by participants that the goal is not to have a single model structure for both tuna species, but rather to develop a structure and input data criteria that are best for bigeye tuna in the WCPO. However, since most data for yellowfin and bigeye tuna come from the same fisheries, the similarity in structures may be appropriate.

30. From the initial set of model runs, the base-case model option was selected and the sensitivity of this model to several assumptions was investigated. These assumptions include the natural mortality-at-age schedule, steepness of the spawning stock-recruitment relationship, historical and current catch levels from the Philippines and Indonesian domestic fisheries, the assumption of constant (versus increasing) catchability of the Japanese longline fleet, and

structural assumptions related to recruitment distribution and movement. These sensitivities were mostly selected from the items discussed at a preparatory stock assessment meeting held in February 2008. The rationale for the individual sensitivities is described in the report from the meeting (Langley and Hoyle 2008).

31. While there was agreement from all participants that the breadth of sensitivities tested are appropriate, concerns were expressed regarding the assumption of increasing catchability in the Japanese longline fleet. All participants acknowledged that fishing practices in the longline fleet (as well as any fleet) have evolved over time, but there are limited analyses that quantify the impact of these changes on catchability. However, a published study (Ward 2008), which was reviewed by SC3, indicated increases in catchability due to altered operational factors. It was also pointed out that a sensitivity run assuming an increasing level of catchability (5% per year) was a recommendation from the Methods SWG during SC3. The increasing function in catchability adopted as a sensitivity run may be mis-specified, in both magnitude and pattern. It is quite likely that changes in catchability are more variable than assuming constant annual increases for only two individually specified time periods.

32. It should also be noted that regardless of what sensitivity is run, all sensitivity analyzes indicate that $F/F_{MSY}>1.0$.

33. Within the WCPO a six-region spatial stratification was adopted for the assessment. The rationale for this stratification was to separate the tropical area, where both surface and longline fisheries occur year-round, from the higher latitudes, where the longline fisheries occur more seasonally. It should be noted that the stratification is equivalent to the regional structure adopted in the 2006 base-case assessment and tagging data are available to contribute to the estimation of interregional movement. It was pointed out that the estimates of interregional movement are based on scant tagging data and movement of bigeye tuna between the WCPO and EPO, which is likely occurring, is not accounted for in the model. It was noted that the model has the freedom to estimate high or low movement if it is evident in observations, but these movement patterns are assumed to be constant during the entire bigeye longevity (10 years). The very different trends in relative abundance among regions, as inferred from longline CPUE, are evidence of spatial heterogeneity and restricted large-scale movement. Regarding WCPO vs. EPO stock assumptions, previous models have been developed on the Pacific-wide basis, and these assessments were consistent with models applied to the WCPO and EPO separately.

Discussion — Model output and diagnostics

34. Questions were raised regarding the estimated recruitment trajectory and whether or not the recent high levels are an artifact of the model. Particularly given the fact that spawning biomass has been constantly decreasing since the 1960s and fishing mortality has been increasing on all segments of the population since 1952. Explorations of this feature indicated initially that the high recruitment values estimated in recent years are related to the high purse-seine catch. However, the most important factor stems from the observation of very large fish that are being captured by Chinese Taipei and Chinese longline fleets since the early 1990s. The model explains these observations by increasing recruitment during the same period. One MFCL sensitivity downweighted the Chinese Taipei catch-at-size data, resulting in a more stable recruitment trend. However, this change did not materially alter stock status estimates. In a parallel analysis of the same data using the Stock Synthesis software, the use of length-structured selectivity for this fishery was found to largely eliminate the recruitment trend by elevating the pre-1990s recruitment estimates. Further exploration of this issue is a recommendation for future research.

35. A question was raised regarding the difference in the estimation method for recruitment between the 2008 assessment (estimated by phase 11) and the 2006 assessment (2-step estimation). In response to the question, there is little difference in the parameterization and estimation of the overall level of recruitment. The only difference for previous assessments is due to a change in the MFCL code to allow for steepness of the SRR to be fixed (as in the sensitivity analysis).

Discussion — Model projections

36. Stock projections were simulated over a 10 year (2008–2017) time horizon using various assumed combinations of effort levels in the purse seine, longline and Philippines/Indonesian fisheries. It was noted that the projections are likely optimistic, since recent increases in fishing effort on FADs and floating objects are not reflected in the analyses.

37. There was also considerable discussion concerning the methodology used to conduct model projections. There was confusion as to how to interpret the results (SC4 SA-SWG WP1 - Tables 11 and 12), due to an apparent discrepancy between the standard yield analyses (e.g. $F_{current}/\widetilde{F}_{MSY}$) and the projection results (Tables 11 and 12). Although this feature was explained, additional key population parameters spanning the projection period (e.g. B/B_{MSY} and F trajectories) were requested for clarification. The trajectories were developed and presented to the participants. To address the projection methodology concerns, a small working group was convened.

Discussion — Supplemental analyses for bigeye tuna projections

38. A small working group met on 13 August 2008 to clarify assumptions, reach a consensus on projection methodology, and request additional runs required to illustrate management advice. Projection assumptions included: starting the projections in quarter 1 in 2008; specifying total recruitment as per the stock recruitment relationship; specifying the regional distribution of recruitment as the average distribution from 2003–2006; and only using the base-case assessment as the basis of the projections. Three projection runs were considered: a) status quo of continuing the $F_{current\ (2003–2006)}$, b) reducing $F_{current}$ from the status quo by 30% at start of the projection (2008) and c) reducing $F_{current}$ from the status quo by 10% per year over three years.

39. The additional projections were considered by the SA-SWG. After consideration of results, the SA-SWG adopted the results of the projections and yield analyses for the final report. However, the group also noted that all of the projection runs resulted in B/B_{MSY} less than 1.0 (stock overfished), and that the projections were based only on the base-case model, and did not include other sensitivity models considered by the working group, some of which were more pessimistic. The group also recognized that projections contain more uncertainty than the model estimates of past biomass, yields and fishing mortalities.

Discussion — Management advice

40. A number of participants expressed concern with the current status of bigeye in the WCPO and communicated a need for immediate action. Several participants explicitly stated that a reduction of at least 30% in fishing mortality is required. While various measures under consideration may address the concerns outlined in the conclusions of the bigeye assessment, there is an ongoing need for analyses that assess the costs and benefits of various management strategies.

Stock status for bigeye tuna

41. Assessment results from the base-case model closely approximate the results from the 2006 assessment (Table BET1), with inclusion of the additional fisheries and changes in fishery configurations. These changes represent refinements to the model rather than substantive changes to model structure, and resulted in only minor changes to biomass trajectories. The key conclusions of the models presented are similar to the comparative model runs from the 2006 base-case assessment – depletion levels estimated in the base-case (0.26) was slightly lower than the 2006 (LOWSAMP) assessment (0.29), $F_{current}/\widetilde{F}_{MSY}$ was more pessimistic (1.44 (Figs. BET5 & BET6) cf. 1.32 for 2006) and $B_{current}/\widetilde{B}_{MSY}$ was higher (1.37 (Figs. BET5 & BET7) cf. 1.27) while $SB_{current}/S\widetilde{B}_{MSY}$ was comparable (1.19 cf. 1.20). These metrics indicate that recent fishing mortality has continued to increase unless fishing patterns and MSY have changed, although biomass levels have continued to be sustained by higher recruitment. However, the MSY-based reference points are not directly comparable as there has been a shift in the age-specific fishing mortality in recent years due to the recent decline in the longline catch.

42. The estimate of $F_{current}/\widetilde{F}_{MSY}$ indicates that overfishing of bigeye is occurring in the WCPO with a very high probability (100% for the scenario shown in Fig. BET6). While the stock is not yet in an overfished state with respect to total biomass ($B_{current}/\widetilde{B}_{MSY} > 1$), the situation is less optimistic with respect to adult biomass and a number of plausible model options indicate that adult biomass has been below the $S\widetilde{B}_{MSY}$ level for a considerable period ($SB_{current}/S\widetilde{B}_{MSY} < 1$). For the base-case model, there is also a probability of 42.8% that the $SB_{2006}/S\widetilde{B}_{MSY}$ is less than 1.0. Further, both adult and total biomass are predicted to become overfished at 2003–2006 levels of fishing mortality and long-term average levels of recruitment. This is consistent with a recent decline in biomass under increasing levels of fishing mortality resulting in an increase in the probability of the stock becoming overfished over time.

Table BET1. Estimates of reference points from the 2008 and 2006 bigeye tuna stock assessments. Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, ranges shown for each reference point should not be compared across years nor be considered as confidence intervals.

Management Quantity	**2008 Assessment**	**2006 Assessment**
Most recent catch	143,059 mt (2007)	156,768 mt (2004)
MSY	Base case: 64,600 mt Range: 56,800 ~ 65,520 mt	Base case: 72,880 mt Range: 64,600 ~ 91,400 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Base case: 0.94 Range: 0.50 ~ 0.97	Base case: 0.96 Range: 0.94 ~ 0.99
$\mathbf{B_{current}/B_{current,\ F=0}}$	Base case: 0.26 Range: 0.20 ~ 0.28	Base case: 0.29 Range: 0.28 ~ 0.44
$\mathbf{F_{current}/F_{MSY}}$	Base case: 1.44 Range: 1.33 ~ 2.09	Base case: 1.32 Range: 0.87 ~ 1.48
$\mathbf{B_{current}/B_{MSY}}$	Base case: 1.37 Range: 1.02 ~ 1.37	Base case: 1.27 Range: 1.27 ~ 1.59
$\mathbf{SB_{current}/SB_{MSY}}$	Base case: 1.19 Range: 0.76 ~ 1.20	Base case: 1.20 Range: 1.10 ~ 1.74

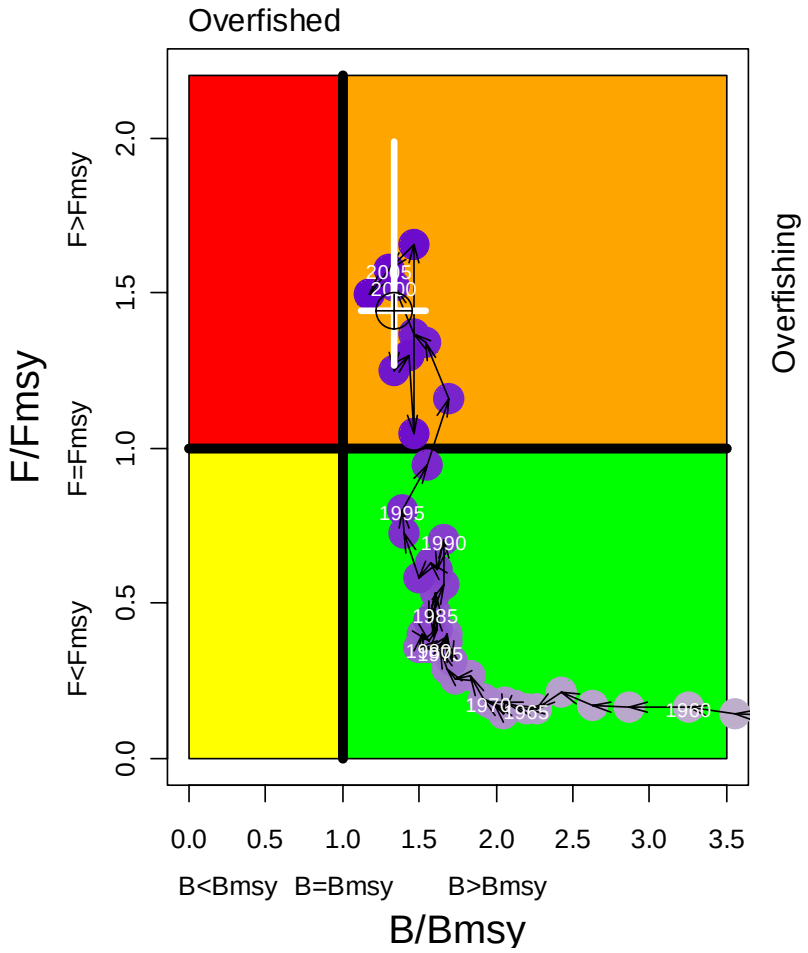

Figure BET5. Temporal trend in annual stock status, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1952–2006) from the base-case model (run 4). The color of the points is graduated from mauve (1952) to dark purple (2006) and the points are labelled at 5-year intervals. The white lines represent the confidence interval of associated with F/F_{MSY} and B/B_{MSY}. The last year of the model (2007) is excluded as it is highly uncertain.

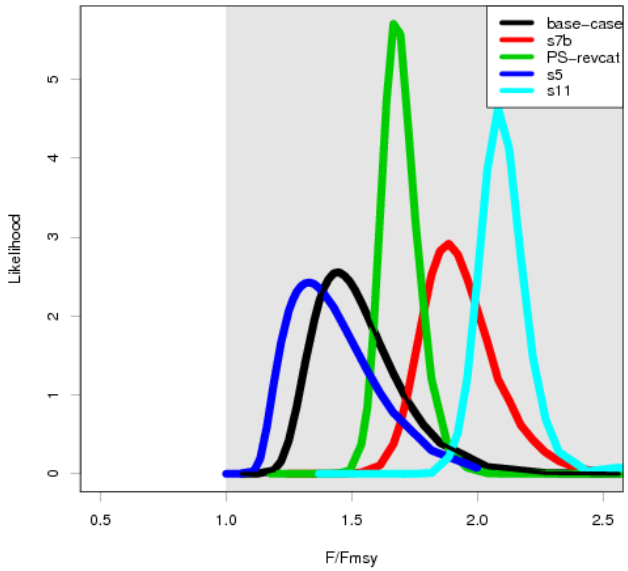

Figure BET6. Probability distributions of $F_{current}/\widetilde{F}_{MSY}$ based on the likelihood profile method for the base-case model and main sensitivity analyses.

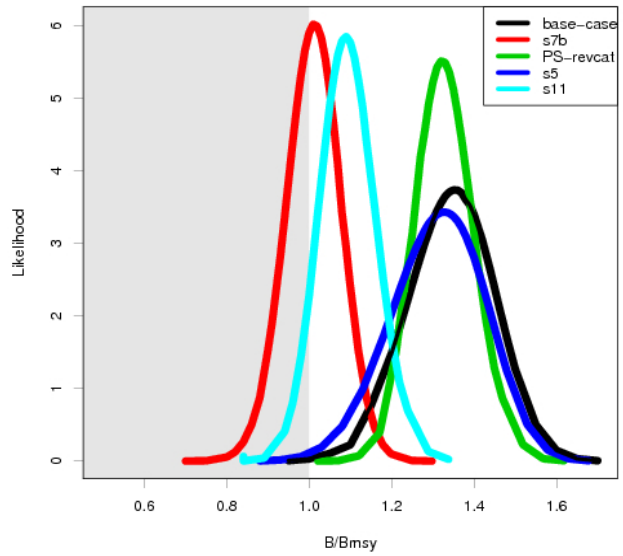

Figure BET7. Probability distributions of $B_{current}/\widetilde{B}_{MSY}$ based on the likelihood profile method for the base-case model and main sensitivity analyses.

43. Three projection runs were considered to illustrate stock status in relation to biomass quantities: a) status quo of continuing the $F_{current}$ (2003–2006), b) reducing $F_{current}$ from the status quo by 30% at start of projection (2008), and c) reducing $F_{current}$ from the status quo by 10% per year over three years. Fig. BET8 illustrates three projections of $F_{current}/\widetilde{F}_{MSY}$.

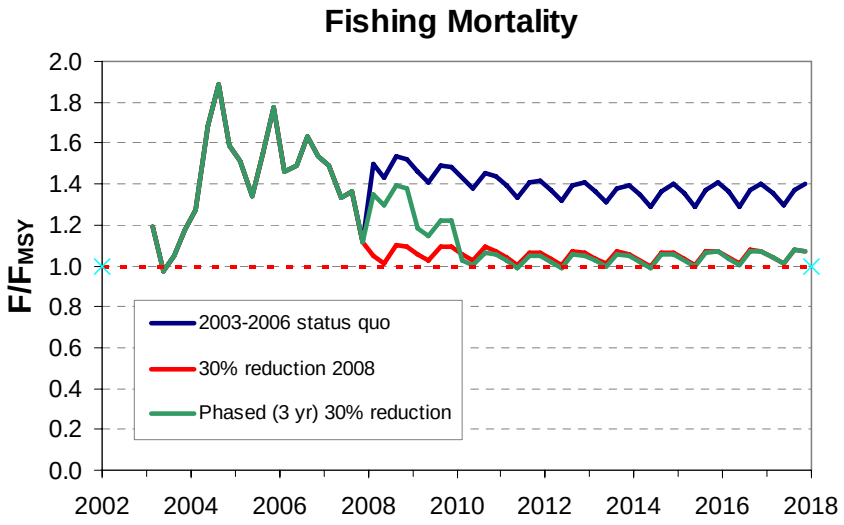

Figure BET8. Estimated (2003–2006) and projected $F_{current}/\widetilde{F}_{MSY}$ based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at start of projection (2008) and reducing $F_{current}$ from the status quo by 10% per year over three years.

44. All projection runs from 2008–2018 indicate that the stock will be overfished after 2013 with regard to both total biomass ($B_{current}/\widetilde{B}_{MSY}$ <1.0, Fig. BET9) and spawning biomass ($SB_{current}/\widetilde{SB}_{MSY}$ <1.0, Fig. BET10), although there is increasing uncertainty in projections through time. As expected, the stock is projected to be overfished sooner if $F_{current}$ (2003–2006) is maintained. Estimates of $F_{current}/\widetilde{F}_{MSY}$ (Table BET2), $B_{current}/\widetilde{B}_{MSY}$ (Table BET3) and $SB_{current}/\widetilde{SB}_{MSY}$ (Table BET4) were computed for three fishery groupings (longline, purse-seine associated, and Indonesian/Philippines), with decreases or increases in fishing effort (60%, 70%, 80%, 90%, 100%, 110% and 120%). Most multiples of reductions in fishing effort still result in overfishing (Table BET2) and a bigeye stock that is overfished with regard to both biomass and spawning biomass (Tables BET3–BET4).

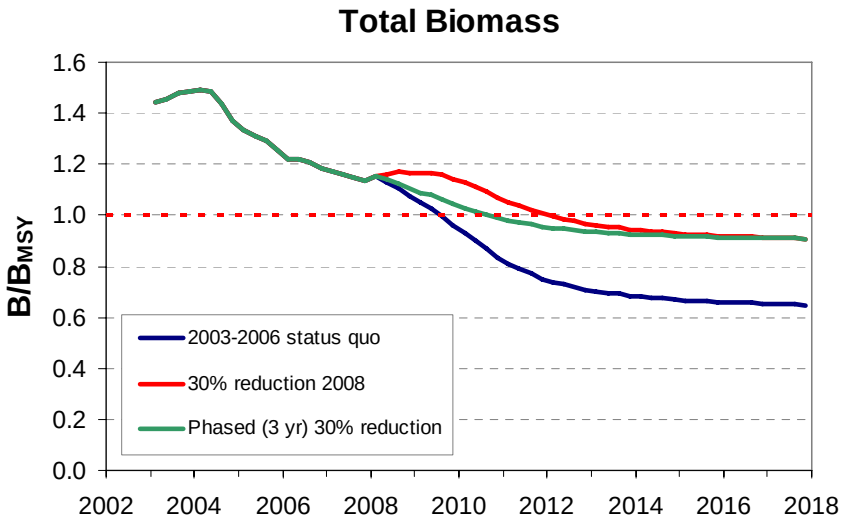

Figure BET9. Estimated (2003–2006) and projected $B_{current}/\widetilde{B}_{MSY}$ based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at start of projection (2008) and reducing $F_{current}$ from the status quo by 10% per year over three years.

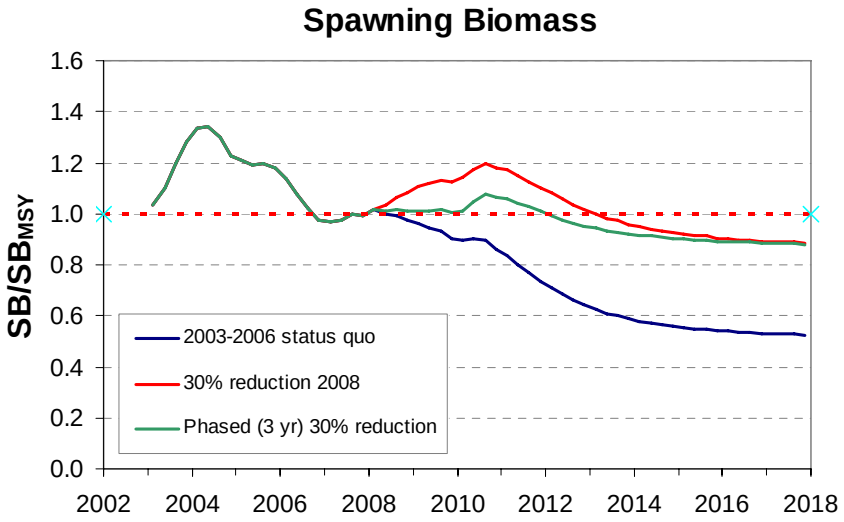

Figure BET10. Estimated (2003–2006) and projected $SB_{current}/\widetilde{SB}_{MSY}$ based on maintaining the status quo of continuing the average (2003–2006) $F_{current}$, reducing $F_{current}$ by 30% at start of projection (2008) and reducing $F_{current}$ from the status quo by 10% per year over three years.

Table BET2. Predicted total fishing mortality relative to fishing mortality at MSY (F/F_{MSY}) for multiples of Indonesian/Philippines (each table), longline (rows), and purse-seine associated set (columns) fishing effort relative to a base-line fishing effort. The shaded area of each table indicates scenarios that result in overfishing (i.e. $F/F_{MSY} > 1$). Boxed values indicate the current situation.

PH/ID 0.6

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.90	0.93	0.96	0.99	1.02	1.05	1.08
0.7	0.95	0.99	1.02	1.05	1.08	1.11	1.14
0.8	1.01	1.04	1.08	1.11	1.14	1.17	1.20
0.9	1.07	1.10	1.13	1.16	1.20	1.23	1.26
1.0	1.12	1.15	1.19	1.22	1.25	1.29	1.32
1.1	1.18	1.21	1.24	1.28	1.31	1.34	1.38
1.2	1.23	1.26	1.30	1.33	1.37	1.40	1.43

PH/ID 0.7

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.94	0.98	1.01	1.04	1.07	1.10	1.13
0.7	1.00	1.03	1.07	1.10	1.13	1.16	1.19
0.8	1.06	1.09	1.12	1.16	1.19	1.22	1.25
0.9	1.11	1.15	1.18	1.21	1.24	1.28	1.31
1.0	1.17	1.20	1.24	1.27	1.30	1.33	1.37
1.1	1.22	1.26	1.29	1.33	1.36	1.39	1.42
1.2	1.28	1.31	1.35	1.38	1.41	1.45	1.48

PH/ID 0.8

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.99	1.02	1.05	1.08	1.11	1.14	1.17
0.7	1.05	1.08	1.11	1.14	1.18	1.21	1.24
0.8	1.11	1.14	1.17	1.20	1.23	1.27	1.30
0.9	1.16	1.20	1.23	1.26	1.29	1.32	1.35
1.0	1.22	1.25	1.28	1.32	1.35	1.38	1.41
1.1	1.27	1.31	1.34	1.37	1.41	1.44	1.47
1.2	1.33	1.36	1.40	1.43	1.46	1.49	1.53

PH/ID 0.9

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.04	1.07	1.10	1.13	1.16	1.19	1.22
0.7	1.10	1.13	1.16	1.19	1.22	1.25	1.28
0.8	1.15	1.19	1.22	1.25	1.28	1.31	1.34
0.9	1.21	1.24	1.28	1.31	1.34	1.37	1.40
1.0	1.27	1.30	1.33	1.37	1.40	1.43	1.46
1.1	1.32	1.35	1.39	1.42	1.45	1.49	1.52
1.2	1.38	1.41	1.44	1.48	1.51	1.54	1.58

PH/ID 1.0

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.09	1.12	1.15	1.18	1.21	1.24	1.27
0.7	1.15	1.18	1.21	1.24	1.27	1.30	1.33
0.8	1.20	1.23	1.27	1.30	1.33	1.36	1.39
0.9	1.26	1.29	1.32	1.36	1.39	1.42	1.45
1.0	1.31	1.35	1.38	1.41	1.44	1.48	1.51
1.1	1.37	1.40	1.44	1.47	1.50	1.53	1.57
1.2	1.42	1.46	1.49	1.53	1.56	1.59	1.62

PH/ID 1.1

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.14	1.17	1.20	1.23	1.26	1.29	1.32
0.7	1.19	1.22	1.26	1.29	1.32	1.35	1.38
0.8	1.25	1.28	1.31	1.35	1.38	1.41	1.44
0.9	1.31	1.34	1.37	1.40	1.44	1.47	1.50
1.0	1.36	1.40	1.43	1.46	1.49	1.52	1.56
1.1	1.42	1.45	1.48	1.52	1.55	1.58	1.61
1.2	1.47	1.51	1.54	1.57	1.61	1.64	1.67

Table BET3. Predicted total biomass relative to total biomass at MSY (B/B_{MSY}) for multiples of Indonesian/Philippines (each table), longline (rows), and purse-seine associated set (columns) fishing effort relative to a base-line fishing effort. The shaded area of each table indicates scenarios that result in an overfished stock (i.e. B/B_{MSY} **< 1)**. Boxed values indicate the current situation.

PH/ID **0.6**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.10	1.07	1.04	1.01	0.98	0.95	0.92
0.7	1.04	1.01	0.98	0.95	0.93	0.90	0.87
0.8	0.99	0.96	0.93	0.90	0.88	0.85	0.83
0.9	0.94	0.91	0.89	0.86	0.83	0.81	0.78
1.0	0.90	0.87	0.85	0.82	0.80	0.77	0.75
1.1	0.86	0.83	0.81	0.78	0.76	0.74	0.71
1.2	0.83	0.80	0.78	0.75	0.73	0.71	0.68

PH/ID **0.7**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.05	1.02	0.99	0.96	0.94	0.91	0.88
0.7	1.00	0.97	0.94	0.91	0.89	0.86	0.83
0.8	0.95	0.92	0.89	0.87	0.84	0.81	0.79
0.9	0.90	0.88	0.85	0.82	0.80	0.77	0.75
1.0	0.86	0.84	0.81	0.79	0.76	0.74	0.72
1.1	0.83	0.80	0.78	0.75	0.73	0.71	0.69
1.2	0.79	0.77	0.74	0.72	0.70	0.68	0.66

PH/ID **0.8**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.01	0.98	0.95	0.92	0.89	0.87	0.84
0.7	0.95	0.93	0.90	0.87	0.85	0.82	0.80
0.8	0.91	0.88	0.85	0.83	0.80	0.78	0.76
0.9	0.87	0.84	0.81	0.79	0.77	0.74	0.72
1.0	0.83	0.80	0.78	0.75	0.73	0.71	0.69
1.1	0.79	0.77	0.75	0.72	0.70	0.68	0.66
1.2	0.76	0.74	0.71	0.69	0.67	0.65	0.63

PH/ID **0.9**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.96	0.93	0.91	0.88	0.85	0.83	0.80
0.7	0.91	0.89	0.86	0.83	0.81	0.79	0.76
0.8	0.87	0.84	0.82	0.79	0.77	0.75	0.72
0.9	0.83	0.81	0.78	0.76	0.73	0.71	0.69
1.0	0.79	0.77	0.75	0.72	0.70	0.68	0.66
1.1	0.76	0.74	0.72	0.69	0.67	0.65	0.63
1.2	0.73	0.71	0.69	0.67	0.64	0.62	0.60

PH/ID **1.0**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.92	0.89	0.87	0.84	0.82	0.79	0.77
0.7	0.88	0.85	0.82	0.80	0.77	0.75	0.73
0.8	0.83	0.81	0.78	0.76	0.74	0.71	0.69
0.9	0.80	0.77	0.75	0.73	0.70	0.68	0.66
1.0	0.76	0.74	0.72	0.69	**0.67**	0.65	0.63
1.1	0.73	0.71	0.69	0.67	0.64	0.62	0.60
1.2	0.70	0.68	0.66	0.64	0.62	0.60	0.58

PH/ID **1.1**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.88	0.86	0.83	0.81	0.78	0.76	0.74
0.7	0.84	0.81	0.79	0.77	0.74	0.72	0.70
0.8	0.80	0.78	0.75	0.73	0.71	0.68	0.66
0.9	0.76	0.74	0.72	0.70	0.67	0.65	0.63
1.0	0.73	0.71	0.69	0.67	0.65	0.63	0.61
1.1	0.70	0.68	0.66	0.64	0.62	0.60	0.58
1.2	0.68	0.65	0.63	0.61	0.59	0.58	0.56

Table BET4. Predicted adult biomass relative to adult biomass at MSY (SB/SB_{MSY}) for multiples of Indonesian/Philippines (each table), longline (rows), and purse-seine associated set (columns) fishing effort relative to a base-line fishing effort. The shaded area of each table indicates scenarios that result in an overfished stock (i.e. $SB/SB_{MSY} < 1$). Boxed values indicate the current situation.

PH/ID **0.6**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.16	1.11	1.06	1.02	0.97	0.93	0.89
0.7	1.07	1.02	0.97	0.93	0.89	0.85	0.82
0.8	0.99	0.94	0.90	0.86	0.82	0.78	0.75
0.9	0.91	0.87	0.83	0.79	0.75	0.72	0.69
1.0	0.84	0.80	0.76	0.73	0.69	0.66	0.63
1.1	0.78	0.74	0.71	0.67	0.64	0.61	0.58
1.2	0.72	0.69	0.65	0.62	0.59	0.57	0.54

PH/ID **0.7**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.08	1.03	0.99	0.95	0.91	0.87	0.83
0.7	1.00	0.95	0.91	0.87	0.83	0.80	0.76
0.8	0.92	0.88	0.84	0.80	0.77	0.73	0.70
0.9	0.85	0.81	0.77	0.74	0.71	0.67	0.64
1.0	0.79	0.75	0.71	0.68	0.65	0.62	0.59
1.1	0.73	0.69	0.66	0.63	0.60	0.57	0.55
1.2	0.67	0.64	0.61	0.58	0.56	0.53	0.51

PH/ID **0.8**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	1.01	0.97	0.93	0.89	0.85	0.81	0.78
0.7	0.93	0.89	0.85	0.81	0.78	0.75	0.72
0.8	0.86	0.82	0.78	0.75	0.72	0.69	0.66
0.9	0.79	0.76	0.72	0.69	0.66	0.63	0.60
1.0	0.73	0.70	0.67	0.64	0.61	0.58	0.56
1.1	0.68	0.65	0.62	0.59	0.56	0.54	0.51
1.2	0.63	0.60	0.57	0.55	0.52	0.50	0.48

PH/ID **0.9**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.95	0.90	0.87	0.83	0.80	0.76	0.73
0.7	0.87	0.83	0.80	0.76	0.73	0.70	0.67
0.8	0.80	0.77	0.74	0.70	0.67	0.64	0.62
0.9	0.74	0.71	0.68	0.65	0.62	0.59	0.57
1.0	0.69	0.66	0.63	0.60	0.57	0.55	0.52
1.1	0.64	0.61	0.58	0.55	0.53	0.51	0.48
1.2	0.59	0.56	0.54	0.51	0.49	0.47	0.45

PH/ID **1.0**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.88	0.85	0.81	0.78	0.75	0.71	0.69
0.7	0.82	0.78	0.75	0.72	0.69	0.66	0.63
0.8	0.75	0.72	0.69	0.66	0.63	0.60	0.58
0.9	0.70	0.67	0.64	0.61	0.58	0.56	0.53
1.0	0.65	0.62	0.59	0.56	**0.54**	0.51	0.49
1.1	0.60	0.57	0.55	0.52	0.50	0.47	0.45
1.2	0.56	0.53	0.51	0.48	0.46	0.44	0.42

PH/ID **1.1**

Longline \ PS associated	0.6	0.7	0.8	0.9	1.0	1.1	1.2
0.6	0.83	0.79	0.76	0.73	0.70	0.67	0.64
0.7	0.77	0.73	0.70	0.67	0.64	0.62	0.59
0.8	0.71	0.68	0.65	0.62	0.59	0.57	0.54
0.9	0.65	0.63	0.60	0.57	0.55	0.52	0.50
1.0	0.61	0.58	0.55	0.53	0.50	0.48	0.46
1.1	0.56	0.54	0.51	0.49	0.47	0.45	0.43
1.2	0.52	0.50	0.47	0.45	0.43	0.41	0.39

Management recommendations

45. The SA-SWG recommended a minimum 30% reduction in fishing mortality from the average levels for 2003–2006 with the goal of returning the fishing mortality rate to F_{MSY}. The point estimate of the $F_{current\ (2003–2006)}/F_{MSY}$ ratio (1.44) in the 2008 assessment was higher than the point estimate (1.32) in the 2006 assessment. A recommendation of a 30% reduction in fishing mortality is consistent with the Scientific Committee recommendation issued in 2006 of a 25% reduction. The SA-SWG acknowledged that projections indicate that the bigeye stock may be overfished (biomass<B_{MSY}, spawning biomass<SB_{MSY}) in the future with regard to both total biomass and spawning biomass even with a 30% reduction in fishing mortality. Therefore, it may be necessary to recommend additional reductions in fishing mortality in the future if assessments indicate that fishing mortality is greater than F_{MSY}.

46. The SA-SWG also provided alternative schemes (as shown in Figs. 8−10, Tables BET2-4) to achieve this reduction in fishing mortality, and suggested that these results be seriously considered when management measures are discussed.

47. The SA-SWG reiterated SC2 advice that exploitation rates differ between regions and that exploitation rates were highest in the western equatorial region; therefore, the SA-SWG recommended a reduction in fishing mortality throughout the WCPO from all major fishing types with priority in the western equatorial region.

Summary of SC4-SA-WP-2

48. A. Langley presented SC4-SA-WP-2: A preliminary stock assessment of bigeye tuna in the western and central Pacific Ocean using stock synthesis 3 (SS3); a comparison with MULTIFAN-CL. A parallel assessment of the current WCPO bigeye assessment, conducted using MULTIFAN-CL (MFCL), was undertaken using Stock Synthesis (SS) software. The two models incorporated the equivalent datasets (catch, effort, size composition, and tag data) and, where possible, the MFCL assumptions were mimicked in the SS model. Differences in the underlying model structure were noted, where relevant. The SS model yielded comparable trends in region-specific recruitment, biomass, and fishing mortality rates to the MFCL assessment. The length-based selectivity formulation, available in SS but not currently available in MFCL, was also applied in a sensitivity analysis to address a potential conflict between key data sets incorporated in the model. It is recommended that SS be applied to other WCPO assessments in parallel with MFCL.

Discussion

49. General support was expressed for the value of undertaking parallel assessments, and despite both models having large parameter numbers and being highly complex, both assessments yielded similar results, in particular for population biomass, despite differences in recruitment estimates. This encourages confidence in the bigeye assessment conclusions. Using a selectivity-at-length formulation for fishing mortality resolved the apparent conflict between the Chinese Taipei/China size-frequency data and the longline CPUE index. This functionality of stock synthesis will be further incorporated in future developments of MFCL.

Summary of SC4-SA-WP-3

50. S. Hoyle presented SC4-SA-WP-3: General structural sensitivity analysis for the bigeye tuna stock assessment. Many sources of uncertainty affect the results of stock assessment models.

It is important to examine their influence, and to consider overall assessment results in the light of this uncertainty. Including structural uncertainty in the assessment, using multiple combinations of structural uncertainties, has advantages over the standard approach of using a base case and sensitivity runs. Integrating across these structural uncertainties can improve understanding of the overall level of uncertainty in the stock assessment. Interactions among sources of uncertainty can also be important. We examined the influence of 15 sources of structural uncertainty, using 2 options for each source (factor), and further examined interactions among 12 of these factors. However, this approach can be difficult to implement, given that each run of the bigeye model takes over 16 hours, and a full factorial design involves 2^12 = 4096 runs of the model. We dealt with this problem using a partially confounded factorial experimental design and a distributed computing system (Condor), which together reduced the expected runtime to six days. Results indicated that uncertainty about the steepness parameter and effort creep contributed most structural uncertainty to the assessment results. Integrating across the chosen components of structural uncertainty, conditional on the equal weighting given to the options, and without including parameter uncertainty, provided conditional probability distributions on $F_{current}/\widetilde{F}_{MSY}$, $B_{current}/\widetilde{B}_{MSY}$, and $SB_{current}/\widetilde{SB}_{MSY}$.

Discussion

51. Participants acknowledged the utility of this research and look forward to further developments. It was pointed out that the distribution of the MSY-based reference points from the 128 model runs were similar to the results of the current WCPO bigeye stock assessment, and provided strong support to the assessment results. Conducting such a large array of sensitivities, while informative, requires significant computing power and time. Both of these constraints are being addressed and their impact will likely be reduced as a result of future developments.

SKIPJACK TUNA STOCK ASSESSMENT

Summary of SC4-SA-WP-4

52. A. Langley presented SC4-SA-WP-4: Stock assessment of skipjack tuna in the western and central Pacific Ocean. The Executive Summary is as follows with several figures regarding stock status.

53. This paper presents the 2008 assessment of skipjack tuna in the WCPO. The assessment uses the stock assessment model and computer software known as MFCL. The skipjack tuna model is age (16 quarterly age-classes, i.e. 4 years) and spatially structured, and the catch, effort, size composition and tagging data used in the model are classified by 24 fisheries and quarterly time periods from 1952–2007.

54. The catch, size and tagging data used in the assessment were updated from the 2005 assessment. A large amount of tagging data was integrated in the assessment model, although the current assessment does not include tag releases and recoveries from the recent PNG and Solomon Islands tagging programmes. For each region, a standardized effort series was calculated from a GLM analysis of catch and effort data from the Japanese distant water pole-and-line fishery. The standardized effort series were scaled among regions by the overall CPUE from the region and the size of the region (regional weighting factors).

55. The assessment was conducted at two spatial scales: the entire WCPO stratified into six regions and a model restricted to the two regions encompassing the equatorial WCPO. A number of sensitivity analyses were conducted using the WCPO model.

56. All WCPO model options estimated a large biomass in the regions north of the equatorial area (regions 1–4), at least relative to the level of catch from these regions. This is most pronounced for regions 3 and 4, which account for 12% and 24% of the total biomass, respectively, while catches from these regions are negligible. This is attributable to the assumption of pole-and-line catchability being equivalent between all regions and the relatively high regional weighting factors associated with these two regions, despite the low catch from these regions, the overall regional pole-and-line CPUE was high and the regions are relatively large. Consequently, these two regions carry significant weight in the overall assessment.

57. For these northern regions (1–4), there are insufficient data included in the model to reliably estimate levels of regional stock abundance. For each region, there is little or no contrast in the time-series of CPUE data, with the possible exception of a decline in CPUE for the Japanese distant water pole-and-line fishery. Further, while there is a considerable number of tag releases and, in some regions, tag recoveries, there is no information available regarding the reporting rates for the corresponding fisheries and, consequently, the tag data are uninformative regarding stock size. In the absence of informative data at the regional level, the assessment model is gaining information on the relative stock size for these northern regions largely from the estimate of (shared) catchability from the equatorial regions, mediated by the regional scaling factors.

58. For the WCPO models, current estimates of total abundance and the corresponding estimates of yield and MSY-related management quantities are extremely uncertain and may be considerably inflated by the high levels of biomass in the northern regions. The equatorial model, which encompasses the domain of the main fisheries within the WCPO, represents a more robust assessment given that it is not sensitive to the assumptions applied to the northern regions of the WCPO model. The large tagging dataset, and associated information on tag reporting rates, is relatively informative regarding stock size in the two constituent regions of the equatorial model. On that basis, the equatorial model was adopted as the principal assessment and, consequently, the scope of the key conclusions is limited to the equatorial region of the WCPO skipjack fishery. These conclusions are essentially unchanged from the last three assessments, as follows.

59. Growth estimates are in general agreement with perceived length-at-age estimates of skipjack from the Pacific and other regions. Moreover, the model seemed to be able to make a consistent interpretation of size data, which is crucial to a length-based approach. Discrepancies between the estimated growth curve and age–length observations for tagged skipjack might be due to the tropical surface fisheries selecting mainly the smaller, slower growing skipjack from the older age-classes.

60. Similar to other tropical tunas, estimates of natural mortality are strongly age-specific, with higher rates estimated for younger skipjack.

61. The equatorial model estimates significant seasonal movements between the western and eastern equatorial regions. The performance of the fishery in the eastern region has been shown to be strongly influenced by the prevailing environmental conditions with higher stock abundance and/or availability associated with El Niño conditions (Lehodey et al. 1997). This is likely to be at least partly attributable to an eastward displacement of the skipjack biomass due to the prevailing

oceanographic conditions, although this dynamic is unlikely to be captured by the parameterisation of movement in the current model.

62. Recruitment showed an upward shift in the mid-1980s and is estimated to have remained at a higher level since that time (Fig. SKJ1). Recruitment in the eastern equatorial region is considerably more variable with recent peaks in recruitment occurring in 1998 and 2004–2005 following strong El Niño events around that time. Conversely, the lower recruitment in 2001–2003 followed a period of sustained La Niña conditions. Recent recruitment is estimated to be at an historically high level, but is poorly determined due to limited observations from the fishery.

63. The biomass trends (Fig. SKJ2) are driven largely by recruitment. The highest biomass estimates for the model period occurred in 1998–2001 and in 2005–2007, immediately following periods of sustained high recruitment within the eastern equatorial region (region 6). The model results suggest that the skipjack population in the equatorial region of the WCPO in recent years has been considerably higher (about 40%) than the overall average level for the model period.

64. The biomass trajectory is influenced by the underlying assumptions regarding the treatment of the various fishery-specific catch and effort data sets within the model. The Japanese pole-and-line fisheries are all assumed to have constant catchability, with any temporal trend in efficiency assumed to have been accounted for by the standardization of the effort series. For all the principal Japanese pole-and-line fisheries, there is a significant increase in standardized CPUE in the late 1980s and early 1990s and the increase is particularly pronounced in the equatorial regions. The increase in CPUE, and the high CPUE for the subsequent period, is influential regarding the general trend in both recruitment and total biomass over the model period. For some regions, most notably region 5, there is a relatively poor fit to the observed CPUE data, particularly during the period when the CPUE series increased rapidly. This indicates a degree of conflict between the CPUE series and the other sources of data, especially the size data, within the assessment model. It remains unclear whether the standardized CPUE indices represent a reliable index of stock abundance.

65. The model also incorporates a considerable amount of tagging data that provides information concerning absolute stock size during the main tag recovery period. For equatorial regions, the most recent data included in the model are from an intensive tagging programme that ceased in the early 1990s, with most tag recoveries occurring over the following 18 months. Consequently, there has been no direct information on the level of absolute biomass from the equatorial component of the stock for at least a decade. Further, the tagging programme occurred prior to the expansion of the fishery in region 6 in the mid–late 1990s and, consequently, given the low exploitation rates, fewer tags were recovered from this region. On this basis, the level of absolute biomass in region 6 is likely to be less well determined than for region 5. The data from recent tagging programmes within PNG and Solomon Islands waters should be integrated into the stock assessment as a matter of urgency.

66. Within the equatorial region, fishing mortality increased throughout the model period and is estimated to be highest in the western region in the most recent years. The impact of fishing is predicted to have reduced recent biomass by about 40% in the western equatorial region and 20% in the eastern region (Fig. SKJ2).

67. The principal conclusions are that skipjack is currently exploited at a moderate level relative to its biological potential. Furthermore, the estimates of $F_{current}/\widetilde{F}_{MSY}$ and

$B_{current}/\widetilde{B}_{MSY}$ reveals that overfishing of skipjack is not occurring in the WCPO, nor is the stock in an overfished state. These conclusions appear relatively robust, at least within the statistical uncertainty of the current assessment. Recruitment variability, influenced by environmental conditions, will continue to be the primary influence on stock size and fishery performance.

68. The range of sensitivity analyses undertaken were restricted to the WCPO wide model and, therefore, are not directly relevant to the equatorial model. Nonetheless, the main conclusions of the assessment appeared relatively insensitive to a number of the model assumptions investigated. However, a crucial assumption is the distribution of recruitment between model regions in the broader WCPO assessment. There are insufficient data to estimate this reliably within the assessment model and many of the key model outputs of the WCPO models are likely to be strongly influenced by the values assumed.

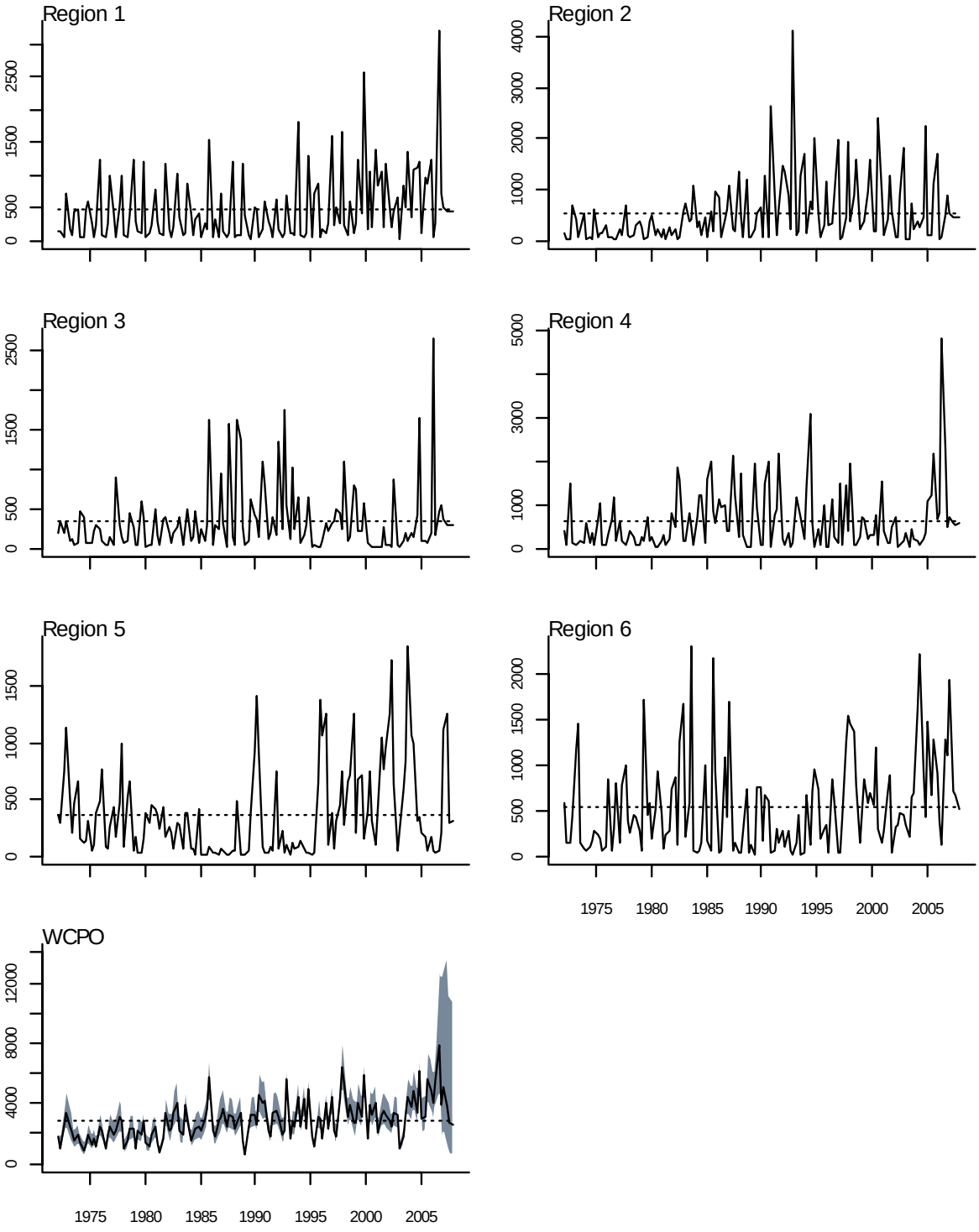

Figure SKJ1. Estimated quarterly recruitment (millions) by region and for the WCPO for the base-case analysis. The dashed line represents the average recruitment for the entire period. The shaded area for the WCPO indicates the approximate 95% confidence intervals.

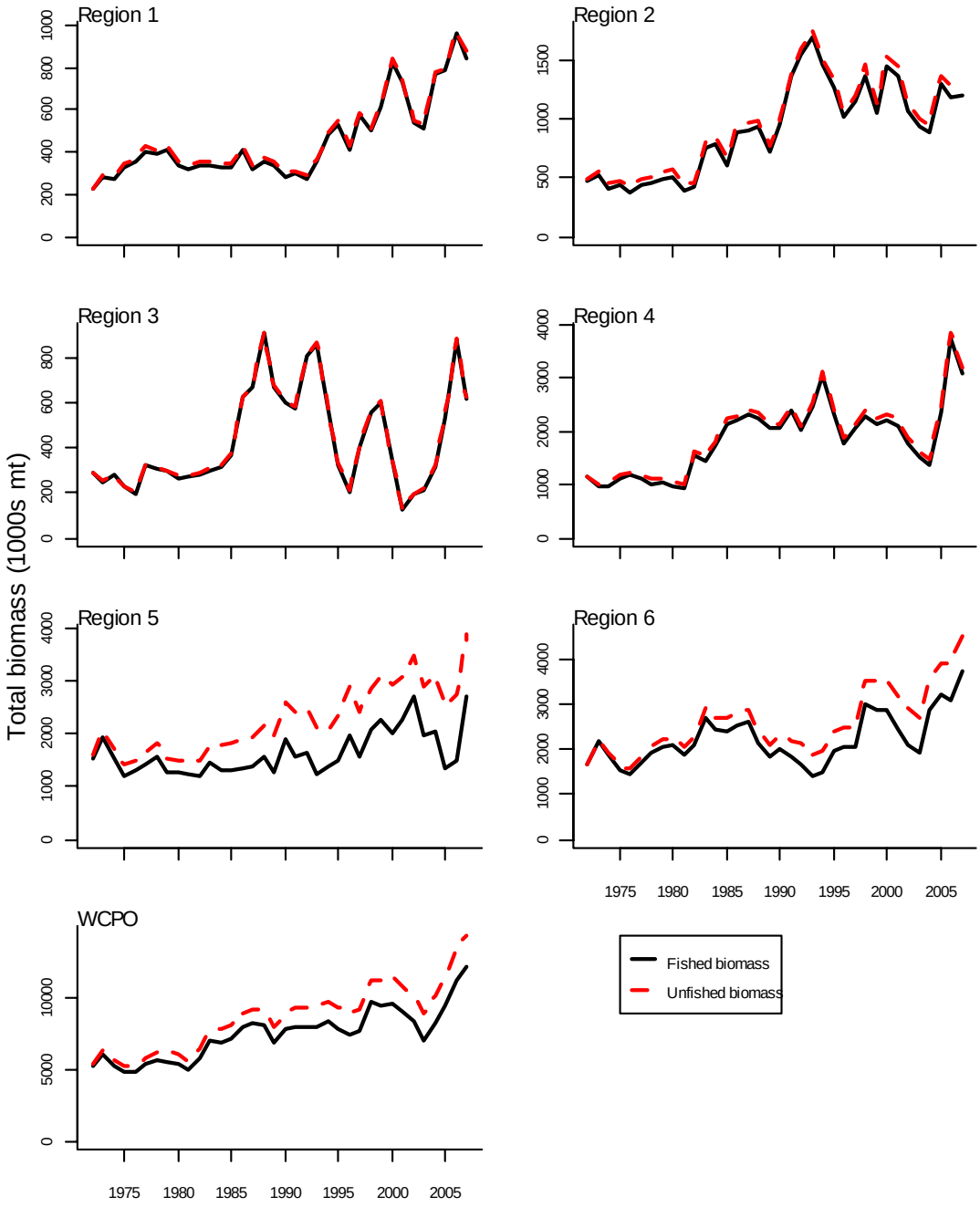

Figure SKJ2. Comparison of the estimated biomass trajectories (lower heavy lines) with biomass trajectories that would have occurred in the absence of fishing (dashed lines) for each region.

Discussion

69. The SA-SWG discussed the implications of changing catchability in the assessment. It was noted that the effort standardization of the pole-and-line fishery included spatial and temporal factors, which the analyst expected to account for changing catchability. However, operational details of the effect of equipment (e.g. bird radar) were not included in the standardization, so it was unclear whether it was appropriate to share catchability among areas in the assessment. Further collaborative work between the assessment scientists and catch rate statisticians was encouraged. It was also noted that the purse-seine catchability would have been expected to increase over time, and this is what the assessment estimated to have occurred.

70. The SA-SWG questioned whether the skipjack tag growth increment data had been analyzed for evidence of differing growth rates among areas and over time. It was noted that these changes might be used to refute or corroborate ecosystem model predictions about the effects of declining interspecific competition. It was recognized that this analysis had not been done and was worth doing. However, it was noted that evidence for changes in growth rate are potentially confounded with changes in gear selectivity, and the two effects would need to be considered jointly. It was further clarified that the tag increment data, as illustrated in the assessment, did not provide evidence for elevated growth rates, only that there was an inconsistency between the model and data.

Stock status for skipjack tuna

71. The major conclusions of the skipjack assessment are essentially unchanged from the last three assessments (2002, 2003 and 2005) and Table SKJ1 compares reference points between the 2008 and 2005 assessments. The key conclusions of the models presented, overfishing is not occurring and the stock is nowhere near to an overfished state are similar to the model runs from the 2005 base-case assessment. Depletion levels estimated in the 2005 WCPO assessment (0.86) were similar to the current equatorial model (0.66), $F_{current}/\widetilde{F}_{MSY}$ was more optimistic (0.17 for 2005 cf. 0.26) and $B_{current}/\widetilde{B}_{MSY}$ was essentially the same (3.01 for 2005 cf. 2.99, Table SKJ1, Fig. SKJ3). There is a zero probability that $B_{current}/\widetilde{B}_{MSY}$ is anywhere close to 1.0 (Fig. SKJ4).

Table SKJ1. Estimates of reference points from the 2008 and 2005 skipjack tuna stock assessments. The spatial domain of the 2008 assessment is limited to the equatorial region of the WCPO. The ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment are not consistent across years, the ranges shown for each reference point should not be compared across years. They should not be considered as confidence intervals.

Management Quantity	2008 Assessment	2005 Assessment
Most recent catch	1,546,436 mt (2007[1]) 1,726,702 mt (2007[2])	1,403,085 mt (2004[2])
MSY	Equatorial: 1,280,000 mt	Base case: 1,996,000 mt Range: 1,304,000 ~ 2,656,000 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Equatorial: 0.70	Base case: 0.46 Range: 0.45 ~ 0.63
$\mathbf{B_{current}/B_{current,\ F=0}}$	Equatorial: 0.66	Base case: 0.86 Range: 0.82 ~ 0.86
$\mathbf{F_{current}/F_{MSY}}$	Equatorial: 0.26	Base case: 0.17 Range: 0.08 ~ 0.34
$\mathbf{B_{current}/B_{MSY}}$	Equatorial: 2.99	Base case: 3.01 Range: 2.91 ~ 3.38
$\mathbf{SB_{current}/SB_{MSY}}$	Equatorial: 3.82	Base case: 3.72 Range: 3.21 ~ 5.00

[1] Equatorial region; [2] WCPFC Convention Area

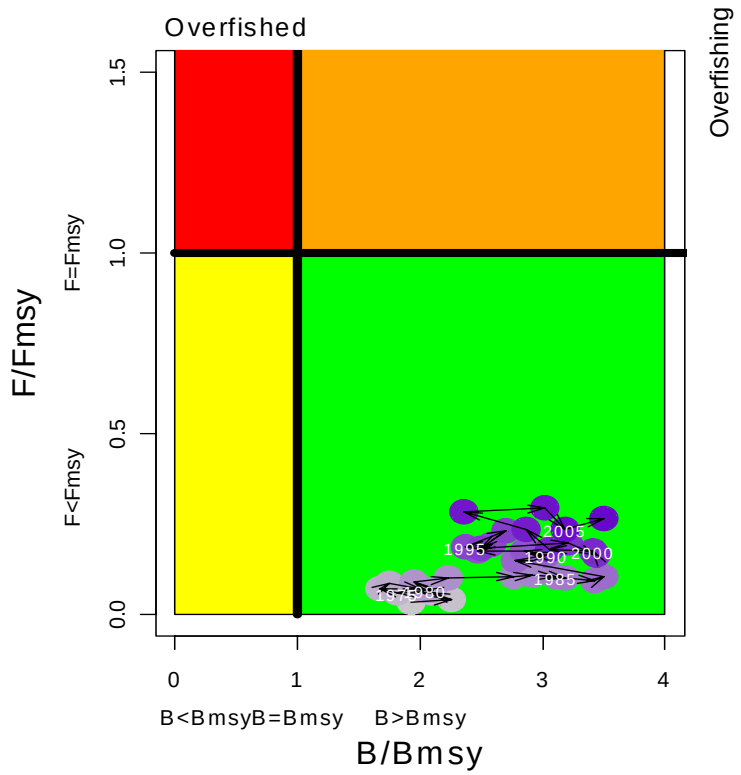

Figure SKJ3. Temporal trend in annual stock status, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1972–2006) from the equatorial model. The color of the points is graduated from mauve (1972) to dark purple (2006) and the points are labeled at 5-year intervals.

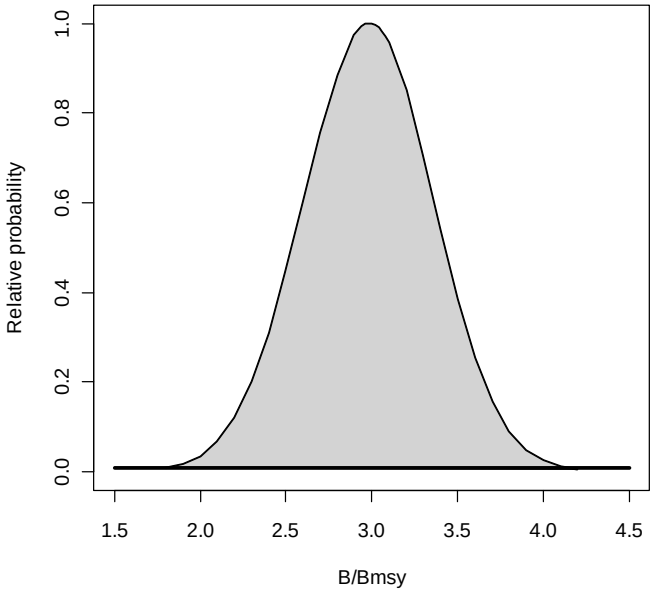

Figure SKJ4. Likelihood profile for B/B_{MSY} from the equatorial model.

Management recommendations

72. Catches in 2007 increased to a historical high of ~1.7 million mt. These high catches are sustainable unless recruitment falls persistently below the long-term average. However, any increases in purse-seine catches of skipjack may result in a corresponding increase in fishing mortality for bigeye and yellowfin tunas.

Summary of SC4-SA-WP-5

73. Francisco Abascal presented SC4-SA-WP-5: Standardized catch rates for the south central and western Pacific swordfish (*Xiphias gladius*) from the Spanish longline fleet for the period 2004–2006. Standardized catch rates in weight were obtained using General Linear Modeling from sets carried out by the Spanish surface longline fleet targeting swordfish in the south-central and southwestern Pacific areas from 2004–2006. Year, quarter, area, ratio between swordfish and blue shark species and gear were used for modeling. The model tested explained 75% of CPUE variability. As in the case of the Atlantic, most of the CPUE variability was attributed to the ratio between the two species and secondly, to the gear factor. Other significant, although less important factors were quarter and area and the interaction between the two, while the year was considered the least important of all the factors examined during this period. The time period covered is too short to be able to lead to any conclusions on the standardized CPUE trend, but the results suggest that activity was stable during the Spanish fleet's initial period of operation in these regions.

Discussion

74. The working group recognized that the ratio of swordfish to blue shark in the catch rate standardization was the most powerful explanatory factor, but noted that there are statistical problems with using this factor. While the ratio is intended to account for targeting effects, it adds swordfish abundance information into the GLM as a predictive factor and simulations have shown that this will tend to mask the real swordfish abundance trend. Furthermore, the ratio factor is confounded with blue shark abundance, which may also be changing. The SA-SWG recognized that it is important to account for targeting effects and suggested that other methods might be employed, including the use of a smaller number of blue shark categorical variables. The presenter stressed that this method is not only used by the authors, but is the one recommended by the Working Group on Stock Assessment Methods of the International Commission for the Conservation of the Atlantic Tunas (ICCAT).

SOUTHWEST SWORDFISH ASSESSMENT

Summary of SC4-SA-WP-6 and 7

75. D. Kolody and N. Davies presented SC4-SA-WP-6: A Multifan-CL stock assessment of southern western-central Pacific swordfish 1952–2007 and SC4-SA-WP-7: CASAL stock assessment for southwest-central Pacific broadbill swordfish 1952–2007. An attempt was made to assess the southern WCPO swordfish population over the domain of 0–50°S and 140°E –130°W, as requested by the Commission in relation to CMM2006-03. An open workshop was held at SPC in April 2008 to review the data and assumptions in the assessment. All of the available fisheries data (catch, effort and size composition), and fisheries independent research (genetics, reproductive studies, pop-up satellite-transmitting archival tagging and conventional tagging, growth rates) was collated for the assessment and analyzed in the context of developing the most

appropriate spatial structure for the model, and to update the biological parameters. A two-tiered approach to the assessment domain was adopted, with a higher priority for the southwest Pacific (SWP 140°E–175°W), which is supported by reasonable quality data and evidence for a semi-independent population; and a lower priority for the south-central Pacific (SCP 175°W–130°W), which has generally lower quality data and possibly stronger links with other Pacific populations to the east and/or north.

76. Declining catch rates and declining trends in size composition in the SWP, coincident with a decade of elevated catches indicate that the fishery has probably had a substantial impact on the population. Recent increases in CPUE in the Australian and New Zealand fleets, combined with substantially decreased catch and effort suggest that the stock may be rebuilding now. However, increasing CPUE trends in the SWP are less evident in the Japanese fleet. Catches in the SCP are increasing, and of a similar magnitude to the SWP. CPUE trends are stable or increasing and the catch size composition data are poor, so it is difficult to make inferences about the fishery effect in the SCP.

77. The assessment involved an extensive exploration of uncertainty including the use of two modeling approaches (CASAL and MFCL), three spatial domains (SWP, SCP, and combined SWP-SCP), and several hundred different combinations of model assumptions. The MFCL models seemed to provide robust and plausible results for the SWP. The CASAL models suffered from numerical convergence problems, but did produce stock status estimates that were reasonably consistent with MFCL. Important changes from the 2006 assessment included a simplified spatial structure, and two to three years of new data, and a recognition of increased uncertainty in growth rates and age-at-maturity. The combined results from 192 SWP MFCL models form the basis of the stock status summary. Based on the mode of posterior distribution (MPD) estimates (minimum and maximum in parentheses):

- Total stock biomass (TSB) 2007/TSB1997 median = 0.69 (0.55 – 0.83)
- TSB2007 / TSB1997 = 0.69 (0.55-0.83)
- SSB2007 / SSB1997 = 0.58 (0.42-0.71)
- TSB2007 / TSBNF(2007) = 0.58 (0.45-0.79) (NF = Not Fished)
- SSB2007 / SSBNF(2007) = 0.43 (0.31- 0.63)
- TSB2007 / TSBMSY = 1.57 (1.22 - 2.06)
- SSB2007 / SSBMSY = 1.98 (1.20 - 3.46)
- TSB2012 / TSB2007 = 1.19 (1.03 - 1.54)
- SSB2012 / SSB2007 = 1.21 (0.91 – 2.07)
- TSB2017 / TSB2007 = 1.24 (1.05 -1.64)
- SSB2017 / SSB2007 = 1.41 (0.94 - 2.30)
- SSB2012 / TSBMSY = 1.89 (1.38 - 2.94)
- TSB2017 / TSBMSY = 1.97 (1.43 - 2.99)
- F2007 / FMSY = 0.44 (0.18 - 0.67)
- MSY (dressed trunked mass tonnes) = 2381 (1722 – 4119)

78. The uncertainty in MSY-related reference points was considerably lower than the 2006 assessment and this is attributed to two causes: a) decreased catch and recent increases in CPUE provide informative contrasts that break the one-way-trip history of the fishery, and b) the simplified spatial structure in the model.

79. None of the assessments for the SCP region, or the combined SWSCP region, were considered to be plausible because the available data were not sufficiently informative to estimate the fishing impacts on the SCP population. Consequently, no stock status estimates were provided

for the SCP. If it is assumed that the SCP CPUE indices provide a true reflection of abundance trends then:

- the SCP population is probably experiencing a gradual long-term increase in recruitment productivity such that the historical data provide little indication of what is going to happen in the future, and
- the SCP swordfish population is not rapidly mixing with the SWP population, as the general CPUE trends in the two areas are in opposite directions despite a similar magnitude of catch removals.

80. It follows that the SWP population should probably be assessed independently of the SCP population (and the SCP population might be more appropriately assessed with the north-central or eastern Pacific populations). However, given the lack of operational level data available for the catch rate standardization in this region, it is also possible that CPUE trends have a very poor relationship with abundance. At present there is no compelling evidence to indicate that the SCP swordfish fishery is overexploiting the stock, but we do not consider the available data to be very convincing.

Discussion

81. The SA-SWG noted the reduced uncertainty for the southwest Pacific model outcomes, and expressed appreciation to the assessment team for its effort to improve the model over the past two years. However, the SA-SWG recognized that there is still uncertainty surrounding stock structure of swordfish in the southern Pacific Ocean that impacts on the interpretation of stock assessment results. The need for further investigation into stock structure was considered a priority. SA-SWG participants noted the useful information coming from electronic and conventional tagging undertaken in New Zealand and Australia and that further tagging research should be encouraged throughout the South Pacific. Notwithstanding this, the available data (CPUE, genetics, etc.) suggest limited mixing between the southwest and the south-central Pacific. The implications are that management responses in each area may be different. The SA-SWG also noted that until this issue is resolved, it is more precautionary to manage on the basis of two separate stocks in the South Pacific.

82. It was also noted that the available data do not indicate evidence of significant fishery impacts in the south-central Pacific, but catches have increased in recent years to levels exceeding that in the southwest Pacific. For target swordfish fisheries it was suggested that some trends in catch rates may be misleading (with respect to biomass/abundance trends) due to operational factors, not included in GLM analyses, which could influence catchability. This is particularly relevant when interpreting CPUE trends in the south-central Pacific. The SA-SWG noted the importance of carefully examining operational factors that may influence catchability and encouraged full data disclosure from all parties and participation in future activities (such as the open workshop) looking to address these issues further. A suggestion was made that, given the lack of a formal assessment in the south-central Pacific, a precautionary approach would be to constrain fishing mortality to recent levels until better understanding of fishing impacts in that region can be determined.

Stock status for southwest and south-central Pacific swordfish

83. Time trends in biomass and fishing mortality (relative to MSY levels) are shown for a subset of models in Figs. SWO1–2 and Table SWO1 compares reference points between the 2008 and 2006 assessments. The subset represents the most extreme (highest and lowest) of the models in terms of the reference points. The 2008 estimates appear to be much more certain than 2006,

and near the center of the distribution of estimates provided in 2006. This reduction in uncertainty is what might have been predicted given that the recent reduction in fishing effort seems to have been sufficient to break the "one-way-trip" nature of the fishery (e.g. Hilborn and Walters 1992) that was observed up to 2003–2004, and hence might have provided informative contrast with which to improve the estimation of stock productivity.

84. The key conclusions of the models presented indicate that overfishing is not occurring and the stock is not in an overfished state (Fig. SWO3). Reference point levels estimated in the 2008 assessment where more optimistic than the 2006 assessment, $F_{current}/\widetilde{F}_{MSY}$ was 0.44 cf. 0.71 in 2006, although $B_{current}/\widetilde{B}_{MSY}$ was 1.57 cf. 1.70 in 2006 (Table SWO1) and the range estimated in the 2006 assessment included more pessimistic estimates

Table SWO1. Estimates of reference points from the 2008 and 2006 southwest Pacific swordfish stock assessments. Values shown in the table correspond to the median of the maximum posterior density (MPD) estimates for the most plausible ensemble of models for each assessment (the minimum and maximum values are indicated below). Note that the swordfish assessment paper reported in trunked mass, however this table reports whole mass assuming that trunked mass = 0.723 (whole mass), and the average catch in mass is derived from numbers assuming 67.2 kg per fish in 2004 and 61.1 kg / fish in 2007 (which may differ from the model estimates).

Management Quantity	2008 Assessment	2006 Assessment
Most recent catch[1] (tonnes)	2580 (final year = 2007[2])	3760 (final year = 2004)
MSY (tonnes)	Median: 3310 Range: 2390–5720	not reported
C_{2007}/MSY	Median: 0.77 Range: 0.45–1.08	n/a
$B_{2007}/B_{2007, F=0}$ (B=total biomass)	Median: 0.58 Range: 0.45–0.79	n/a
$B_{2004}/B_{2004, F=0}$ (B=total biomass)	Median: 0.55 Range: 0.44–0.74	Median: 0.59 Range: 0.31–0.69
F_{2007}/F_{MSY}	Median: 0.44 Range: 0.18–0.67	n/a
F_{2004}/F_{MSY}	Median: 0.71 Range: 0.37–1.13	Median: 0.70 Range: 0.33–2.2
B_{2007}/B_{MSY} (B=total biomass)	Median: 1.57 Range: 1.22–2.06	n/a
B_{2004}/B_{MSY} (B=total biomass)	Median: 1.47 Range: 1.18–1.94	Median: 1.7 Range: 0.87–3.0

[1] Catch in mass for this table was not derived from the model results and may not be entirely compatible with the other reference points.

[2] 2007 catches are provisional, with 2007 catches from some fleets assumed to be equal to 2006.

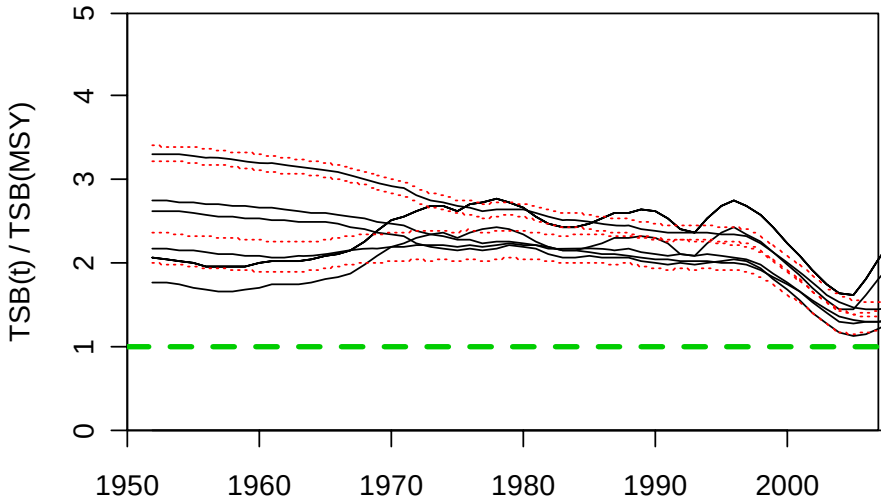

Figure SWO1. Southwest Pacific swordfish total stock biomass (TSB) over time relative to MSY levels for a subset of MFCL models. Black lines indicate the mode of the Bayesian posterior distribution (MPD) estimates for the individual models, while the dotted (red) lines indicate the upper and lower 95% confidence limits for two example models. These model runs are common in Figs. SWO2–SWO3.

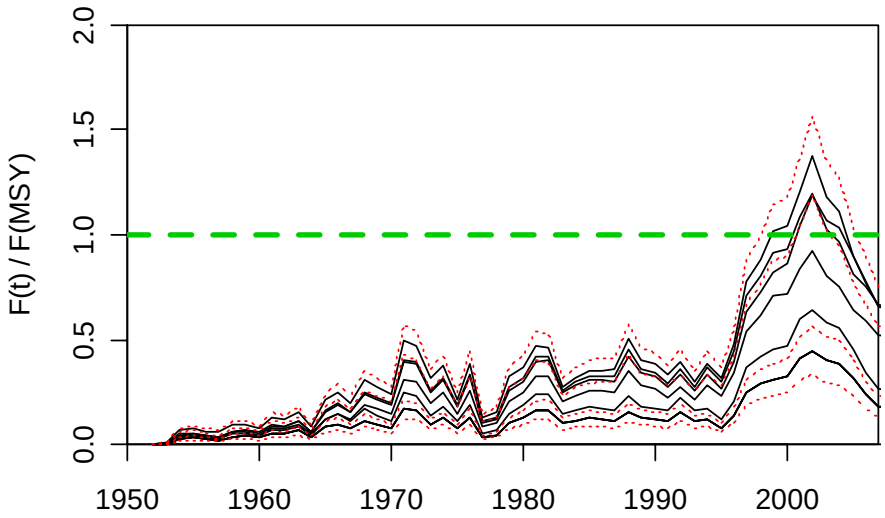

Figure SWO2. Southwest Pacific swordfish fishing mortality over time relative to F(MSY), for a subset of MFCL models. Black lines indicate the mode of the Bayesian posterior distribution (MPD) estimates for the individual models, while the dotted (red) lines indicate the upper and lower 95% confidence limits for two example models.

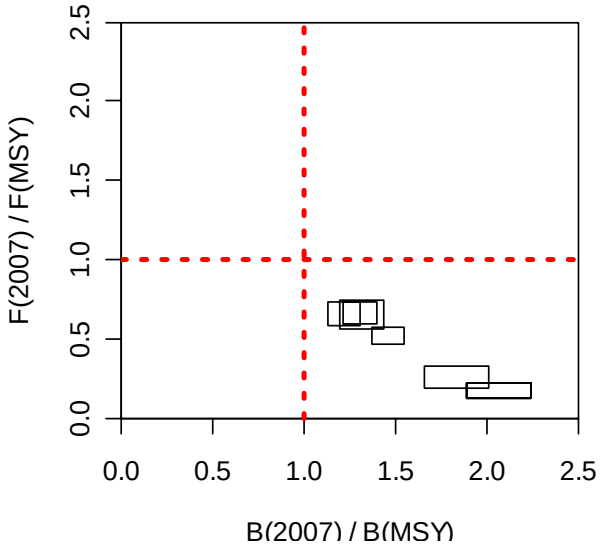

Figure SWO3. Summary plot comparing southwest Pacific fishing mortality, F(2007)/F(MSY), and total stock biomass, TSB(2007)/TSB(MSY), from a subset of plausible MFCL models. Boxes indicate the upper and lower 95% confidence limits (but not the covariance) for each individual model.

Management recommendations

85. The SA-SWG reviewed the second regional assessment undertaken for swordfish in the southwestern Pacific region. This assessment indicated an increase in stock abundance in recent years and the model projections predict further increases at current levels of fishing mortality. Plausible assessment results indicate that overfishing is not occurring and the stock is not in an overfished state. However, due to uncertainty in the assessment, the SA-SWG recommended there be no further increase in catch or effort in order to keep the stock above its associated reference points.

86. The SA-SWG recommended that there be no increases in fishing mortality for south-central Pacific swordfish as a precautionary measure, given the lack of a formal assessment. Constraining fishing mortality to current levels is recommended until there is a better understanding of fishing impacts in the south-central Pacific stock and the relationship between this stock and other South Pacific stocks is more certain.

SOUTH PACIFIC ALBACORE ASSESSMENT

Summary of SC4-SA-WP-8

87. S. Hoyle presented SC4-SA-WP-8: Stock assessment of albacore tuna in the South Pacific Ocean. Since the last MFCL assessment, many of the underlying structural assumptions of the model have been reviewed. Major changes to model structure include: moving the central latitudinal boundary north by 5° to 25°S; separating data from the Japanese and Korean longline fisheries; including standardized CPUE data as relative abundance indices for the Japanese, Korean and Chinese Taipei longline fisheries, and the New Zealand troll fishery; reducing the weight given to length-frequency data; making the selectivity of longline fisheries seasonal; removing length-frequency data collected in Pago Pago before 1971; changing the biological

parameters for natural mortality and reproductive potential; reducing the influence of CPUE from non-standardized fisheries; and permitting declining (i.e. dome-shaped) selectivity to be estimated for most longline fisheries.

88. The cumulative effect of these changes was to reduce the biomass estimates and raise the fishing mortality estimates compared to previous assessments. Model diagnostics indicate that some sources of bias have been removed, but that problems remain.

89. Lower levels of stock size and MSY than in previous assessments appear to be more realistic, since many sources of potential bias have been removed. However, given the evidence of remaining bias, there is considerable uncertainty about current levels of fishing mortality. The stock status indicator F2004-2006/FMSY is strongly affected by structural uncertainty in the model, some of it related to the failure to model the increasing length of fish selected (selectivity) by the fishery through time, and some related to uncertainty about whether the recent large decline in standardized Chinese Taipei CPUE accurately reflects a decline in biomass.

90. Models that permit selectivity to vary through time tend to give lower biomass relative to BMSY, and higher fishing mortality relative to FMSY, throughout the time series. On the other hand, models that give less weight to the recent decline in Chinese Taipei CPUE tend to estimate higher biomass relative to BMSY, and lower fishing mortality relative to FMSY, in recent years.

91. Estimates of F2004-2006/FMSY and SB2004-2006 / SBMSY are highly variable between model configurations. In all credible model configurations, F2004-2006 is estimated to be below FMSY, B2004-2006 is estimated to be above BMSY, and SB2004-2006 is estimated to be above SBMSY. There is no indication that current levels of catch are not sustainable.

92. Given the uncertainty in the results, the evident sources of potential bias, and the less optimistic implications of the results than in previous assessments, further efforts to improve the model should be considered a high priority. A number of potential research directions are suggested.

Discussion

93. The SA-SWG noted the substantial changes in both the model structure and key outputs of the assessment, in particular a large reduction in absolute levels of biomass and sustainable yields (2008 estimated volume being approximately one-third of those estimated in the 2006 assessment), but that the previous conclusions regarding the status of the stock had not changed.

94. There was discussion regarding whether the current model/assessment could be considered an improvement over the 2006 assessment and closer to the true situation. The SA-SWG noted that despite improvements to model fit, and the removal of some biases, significant fitting problems remain, with the conflict between size and CPUE data still apparent. In particular, recent fishing mortality estimates are uncertain, and that F_{CURR}/F_{MSY} is strongly affected by the structural uncertainty. Capturing changes in selectivity, and understanding recent CPUE decline for the Chinese Taipei fleet, are high priorities to reduce uncertainty.

95. It was suggested that a Pacific-wide assessment, which maintains northern and southern stock structure, could be useful for reducing uncertainty in the South Pacific assessment.

96. The question was raised as to whether the lack of fit to the size data in the model might relate to unaccounted for trends in discarding (e.g. high grading) or changes in size of fish caught

due to changes in depth of setting over time. The authors noted that a more detailed data set with appropriate gear related information would be required to investigate such hypotheses.

97. The SA-SWG noted that, while the model attempts to account for targeting through using only catch and effort data from boats unloading albacore to the Pago Pago and Levuka canneries for the formation of standardized CPUE series (as indices of abundance), it is possible that mixed targeting is undertaken by some of those vessels. This requires further investigation, perhaps through examination of species composition on a set by set basis. Future standardization of Chinese Taipei CPUE data might be undertaken in collaboration with Chinese Taipei scientists, who might provide further information regarding changes in fleet fishing methods, and differences in methods between fleets, which can potentially affect both CPUE and the size of fish being caught. Following on from this, the need for better reporting of catch effort data (including information pertaining to discarding/retention levels) in association with relevant information pertaining to gear configuration was identified as a key issue. Chinese Taipei noted that "hooks between floats" data has been collected on logsheets since 1995, with coverage levels estimated between 30–50%. This may be sufficient to inform future CPUE standardizations regarding changes in depth of setting since 1995. In addition, further research into changes in fleet structure and catchability (relating to fishing power and efficiency) over time is needed. More generally, some participants suggested that CCMs might report changes and shifts in gear configurations and selectivity in the Part I Annual Reports.

98. Changes to the growth curve estimated in the model were noted between the 2006 and current assessment. It was also noted that the model estimate is close to recent estimates derived from biological studies in Australia.

99. The lower stock size, low exploitable biomass, and potential for localized depletions were noted as an issue of concern to Pacific Island countries that requires further investigation in the very near future. The urgent need for further research into key biological parameters was also noted, with CCMs urged to support current biological and tagging research efforts being initiated. Appreciation was expressed to the USA delegation for the provision of Pago Pago catch effort data used to improve the assessment.

Stock status for South Pacific albacore

100. The assessment results from the base-case model differ substantially from results from the 2006 assessment (Table ALB1), due to the aforementioned changes in relative abundance indices, selectivity and biological parameters for natural mortality and reproductive potential. These changes represent both refinements to the model and substantive changes to model structure which reduced the biomass estimates and raised fishing mortality.

101. Time trends in estimated recruitment, biomass, fishing mortality and depletion are shown in Figs. ALB1–4 and Table ALB1 compares reference points between the 2008 and 2006 assessments. The key conclusions of the models presented indicate that overfishing is not occurring and the stock is not in an overfished state (Fig. ALB4). Reference point levels estimated in the 2008 assessment where more pessimistic than the 2006 assessment, depletion levels estimated in 2008 were 0.70 compared to 0.90 in 2006, $F_{current}/\widetilde{F}_{MSY}$ was 0.44 cf. 0.04 in 2006, $B_{current}/\widetilde{B}_{MSY}$ was 1.26 cf. 1.34 in 2006 and $SB_{current}/\widetilde{SB}_{MSY}$ was 2.21 cf. 4.10 in 2006 (Table ALB1).

Table ALB1. Estimates of reference points from the 2008 and 2006 South Pacific albacore tuna stock assessments (WCPFC and IATTC RFMO regions). Ranges shown in the table provide the minimum and maximum values of each reference point across the range of sensitivity scenarios considered within each assessment. However, as the range of scenarios considered within each assessment is not consistent across years, the ranges shown for each reference point should not be compared across years. They should not be considered as confidence intervals.

Management Quantity	**2008 Assessment**	**2006 Assessment**
Most recent catch	59,495 mt (2007[1])	60,440 mt (2005[1])
MSY	Base case: 64,000 mt Range: 64,000 ~ 75,000 mt	Base case: 180,800 mt Range: 90,080 ~ 201,800 mt
$\mathbf{Y_{Fcurrent}/MSY}$	Base case: 0.86 Range: 0.72 ~ 0.86	Base case: 0.33 Range: 0.28 ~ 0.59
$\mathbf{B_{current}/B_{current,\ F=0}}$	Base case: 0.70 Range: 0.70 ~ 0.77	Base case: 0.91 Range: 0.79 ~ 0.93
$\mathbf{F_{current}/F_{MSY}}$	Base case: 0.44 Range: 0.25 ~ 0.44	Base case: 0.04 Range: 0.03 ~ 0.11
$\mathbf{B_{current}/B_{MSY}}$	Base case: 1.26 Range: 1.26 ~ 1.50	Base case: 1.34 Range: 1.13 ~ 1.48
$\mathbf{SB_{current}/SB_{MSY}}$	Base case: 2.21 Range: 2.21 ~ 2.90	Base case: 4.10 Range: 2.86 ~ 6.11

[1] entire South Pacific Ocean

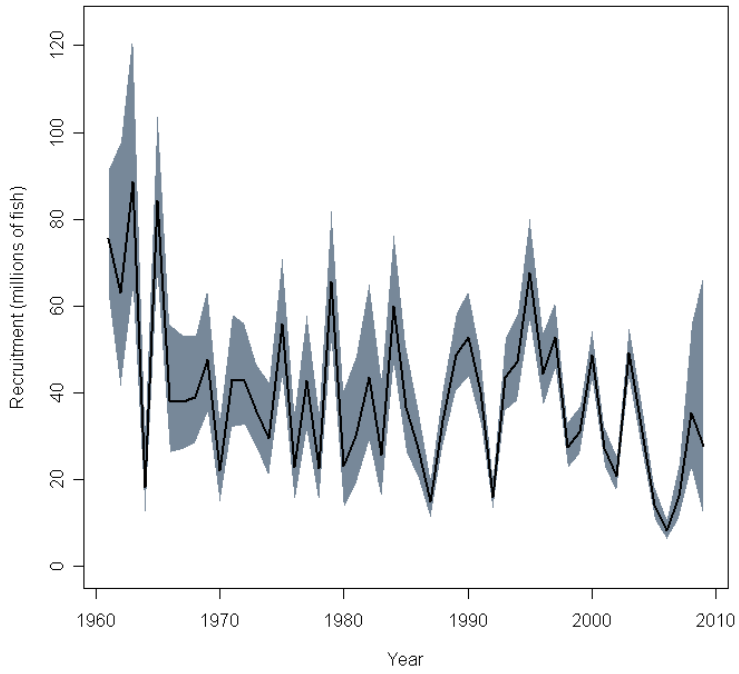

Figure ALB1. Annual recruitment (number of fish) estimates from the one-region model. The shaded area indicates the approximate 95% confidence intervals.

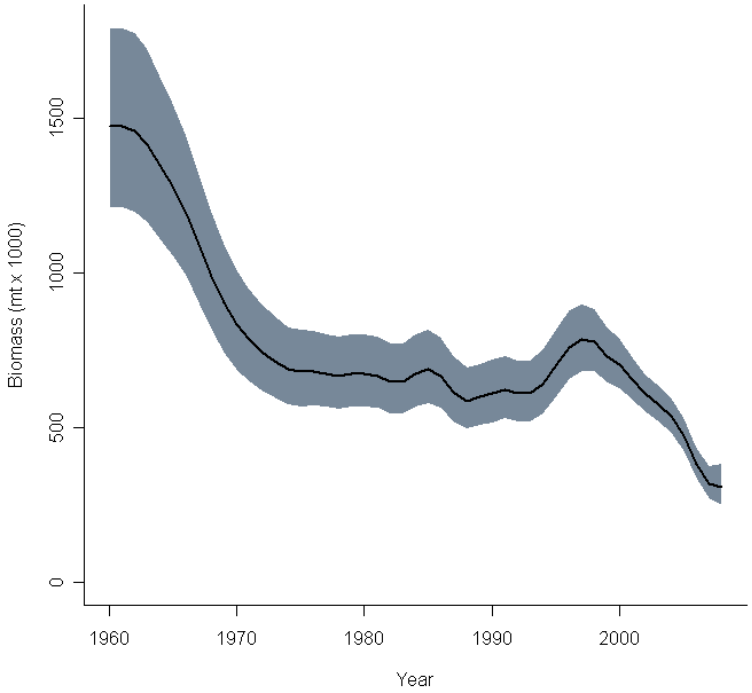

Figure ALB2: Annual estimates of total biomass (thousands of metric tonnes) from the one-region model. The shaded area indicates the approximate 95% confidence intervals.

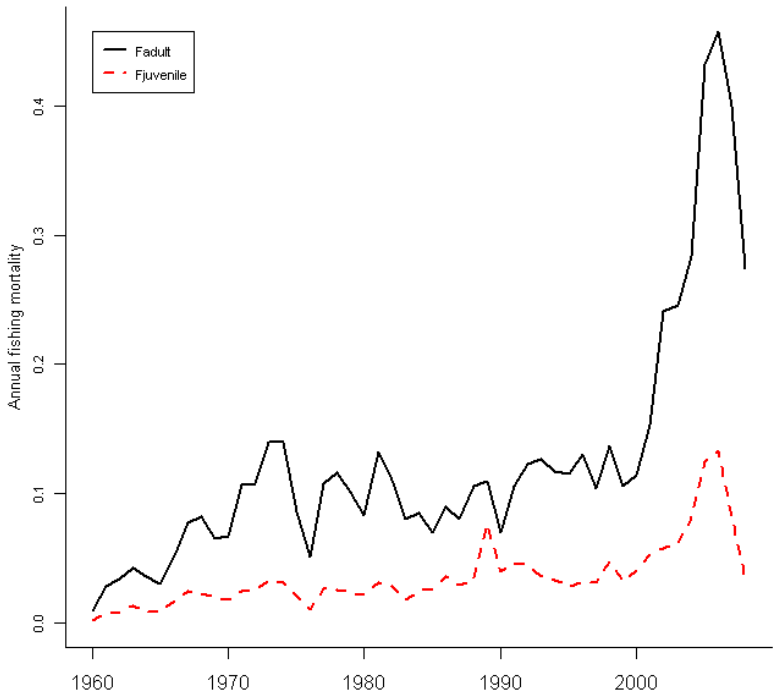

Figure ALB3. Annual estimates of fishing mortality for juvenile and adult South Pacific albacore.

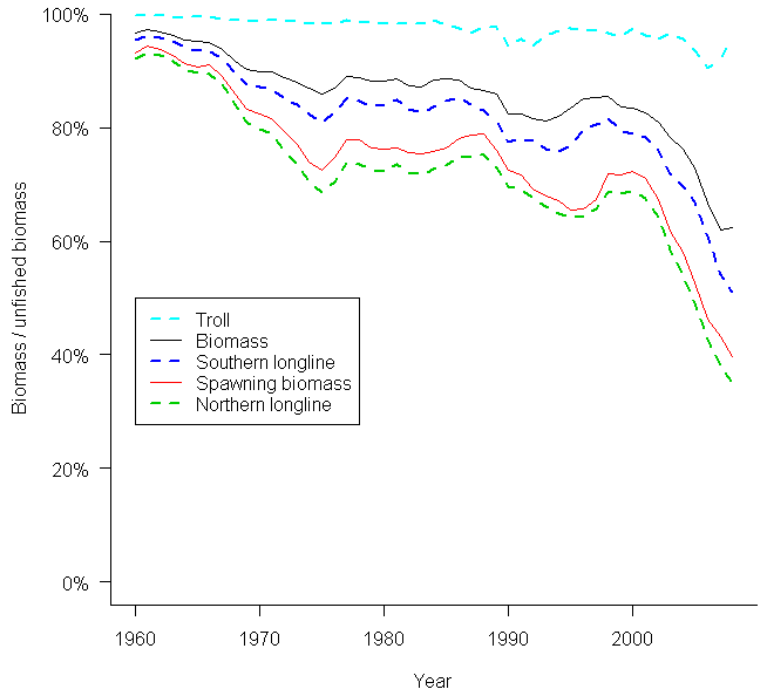

Figure ALB4. Decline in biomass due to the impact of fishing mortality, for exploitable biomass in the troll, southern longline, and northern longline fisheries, for total biomass and for spawning biomass.

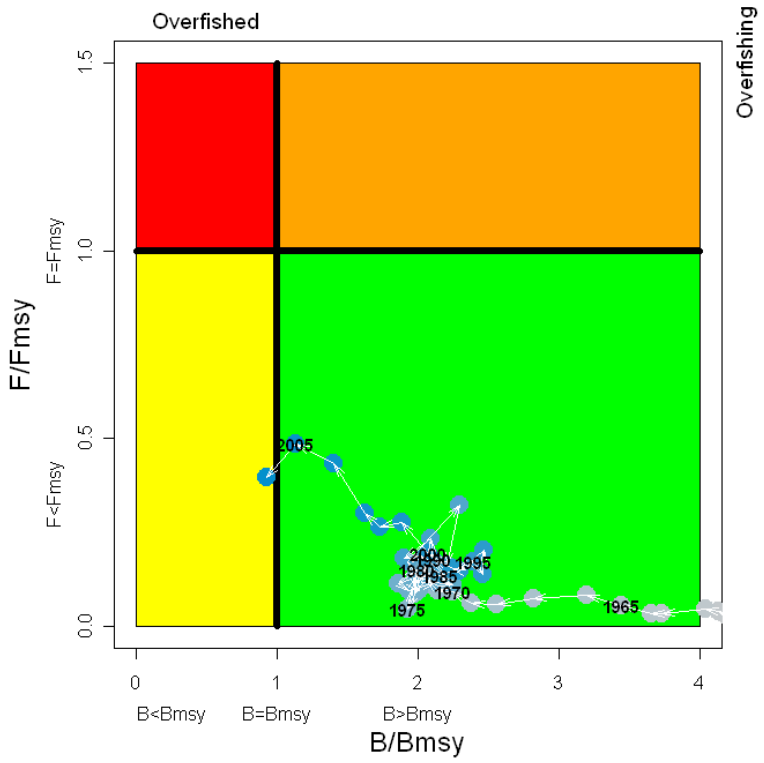

Figure ALB5. Temporal trend in annual stock status, relative to B_{MSY} (x-axis) and F_{MSY} (y-axis) reference points, for the model period (1960–2006) for the four main alternative models. The colour of the points is graduated from pale blue (1960) to blue (2006) and the points are labelled at 5-year intervals. The last year of the model (2007) is excluded as it is highly uncertain.

Management recommendations

102. The current assessment indicates lower levels of stock size and maximum sustainable yield which appear to be more realistic than previous assessments. There is uncertainty regarding the sustainability of the south Pacific albacore stock and the SA-SWG recommended that catches of South Pacific albacore remain at current levels considering the current rates of fishing mortality on adult albacore.

Summary of SC4-SA-WP-9

103. John Hampton presented SC4-SA-WP-9: Compendium of fishery indicators for target tuna species. The SA-SWG found that the data-based indicators paper provided a very useful summary of general fisheries and stock status trends that was complementary to the model-based assessments, and encouraged this to be a regular annual submission. It was suggested that some indices based on assessment model results should be omitted, and only data summaries should be included. It was noted that the indicators chosen should be compatible with other RFMOs to facilitate comparisons among oceans. It was suggested that the best estimates of average sizes caught entered in the model should be illustrated.

SOUTHWESTERN PACIFIC STRIPED MARLIN STOCK ASSESSMENT

104. There was no stock assessment undertaken for striped marlin in the southwestern Pacific Ocean in 2008. The latest stock assessment for striped marlin is presented in SC2-SA-WP-6.

RESPONSES TO COMMISSION REQUESTS

105. Provide analysis on management options related to FAD closure.

106. Provide advice and recommendations that will support the development of the CMM, *inter alia*, consideration of the status of stocks, and the potential for technological solutions to minimize the impact of fishing gear for juvenile yellowfin and bigeye tuna while minimizing the loss of catch on skipjack.

107. There were no working papers presented to SC4 on these requests. The SA-SWG indicated that the following papers were reported in the past.

Summary of working paper SC2-SA-WP-5

108. John Hampton presented SC2-SA-WP-5, which examined the utility of temporal closures of the WCPO purse-seine fishery in the previously adopted WCPFC conservation and management measure for bigeye and yellowfin tuna. This research was conducted in response to a directive of the second meeting of the Commission as detailed in Attachment D of the Summary Record of the second regular session of the Commission (para 11), that is:

> In order to achieve the overall reduction in catch and effort required for bigeye and yellowfin tuna, in accordance with advice and recommendations received from the Scientific Committee, the Executive Director shall work with CCMs during 2006 to develop a proposal for consideration at the Third Session of the Commission that is consistent with the IATTC arrangements that allow for a system of temporary purse seine closures.

109. The paper examined purse-seine data for 1996–2005 to determine on an empirical basis whether closures in certain months would be more effective than others. Effectiveness is judged by how well a closure in a particular month would satisfy two objectives: a) to maximize the percentage reduction in yellowfin and bigeye catch; and b) to minimize the reduction in skipjack catch.

110. The results of the analysis are summarized in Table S1. The percentage reductions in skipjack and yellowfin + bigeye catches that would have been achieved by closures in each month are shown in the first two substantive columns of the table. In the next two columns, the reductions are ranked, with the month resulting in the smallest skipjack catch reduction having the highest rank (1) for the skipjack objective, and the month resulting in the largest yellowfin + bigeye catch reduction having the highest rank for that objective. For skipjack, January, December and August have the highest ranks (smallest catch reductions) while for yellowfin + bigeye, September, November and October have the highest ranks (largest catch reductions). The skipjack and yellowfin + bigeye ranks were integrated by combining the two outcomes using several example weighting schemes. These are only examples, but the idea is that the outcomes should be weighted in such a way to reflect our relative priorities for the two objectives (see caption to Table S1). For example, if we weight both objectives equally, the months of September to December (composite ranks 1–4) would have performed best for purse-seine closures based on the historical data. On the other hand, the months of March to May would have performed worst

in terms of simultaneously satisfying both objectives (and this is also true for the other weighting schemes in Table S1).

111. While there is no guarantee that future variation in catch by month would follow the past, the approach outlined above might nevertheless be useful for assisting in the design of purse-seine closures. A more detailed analysis would examine the inter-annual variation in catch composition and potentially consider the effect of set type, if appropriate to any particular management proposal.

112. Note that the data were aggregated over the entire area of the fishery for this analysis. It would be relatively straightforward to stratify the analysis spatially in order to assess the efficacy of closures in particular sub-areas of the fishery. There are apparent temporal and spatial differences in the catch composition that may enable a more directed management action that achieves a better outcome for the overall fishery.

Table S1. Percentage catch reductions assuming that various monthly closures had been applied over the period 1996–2005. Rankings for skipjack (SKJ) are numbered 1–12 from the lowest to highest percentage reductions. Rankings for yellowfin plus bigeye (YFT+BET) are numbered 1–12 from the highest to lowest percentage reductions. Composite catch reduction indices, *CRI*, are derived by subtracting SKJ from YFT+BET weighted catch reductions.

Closure month	% Catch reductions		Rank		Composite rank					
	SKJ	YFT+ BET	SKJ	YFT + BET	$w_{y+b} = 50$ $w_s = 50$		$w_{y+b} = 25$ $w_s = 75$		$w_{y+b} = 75$ $w_s = 25$	
					CRI	Rank	*CRI*	Rank	CRI	Rank
1	7.7	8.5	1	7	0.83	5	-3.64	3	4.46	6
2	8.0	7.7	6	8	-0.30	8	-4.06	8	3.76	8
3	9.4	6.4	11	12	-2.95	12	-5.43	11	2.48	12
4	9.1	6.7	10	11	-2.39	10	-5.16	10	2.76	11
5	9.6	7.0	12	10	-2.62	11	-5.44	12	2.82	10
6	7.9	7.3	4	9	-0.62	9	-4.10	9	3.48	9
7	7.9	8.7	5	5	0.82	6	-3.74	4	4.56	5
8	7.9	8.6	3	6	0.70	7	-3.76	5	4.46	6
9	8.0	10.4	7	1	2.34	1	-3.44	1	5.77	1
10	8.5	9.5	9	3	0.99	4	-3.99	7	4.98	4
11	8.4	9.9	8	2	1.51	3	-3.80	6	5.31	2
12	7.8	9.4	2	4	1.69	2	-3.46	2	5.14	3

Discussion

113. The need for additional analysis using different spatial and temporal specification was noted by the Federated States of Micronesia with closures on high seas areas being one suggested analyses that should be undertaken. Dr Hampton agreed that other analyses could be undertaken, although the need for clear guidance from the Commission to the science provider in terms of exactly what analyses should be conducted was required.

114. The provision of additional information, for example, total catch reductions as opposed to percentage reductions was requested by Chinese Taipei. Dr Hampton noted that this could be derived based on the figures provided in the table and catch data.

115. The likelihood that the higher composition of yellowfin and bigeye tuna in the catch in

the period September to December was a result of a greater proportion of sets on unassociated yellowfin tuna schools being made at this time of year was noted by the USA and New Zealand. The inclusion of school sets on yellowfin could lead to incorrect conclusions regarding closures given that larger yellowfin are taken in school sets. Dr Hampton noted the importance of the implementation of the observer programme in assessing catch from different set types.

116. It was noted that this particular application did not separate juvenile and adult yellowfin tuna taken in purse seine fisheries and that the paper was not meant to provide support for any particular closure regime; rather it was an example of the types of analysis with regard to closures that could be done using historical data. The convenors noted their support for this observation.

117. Some CCMs felt that analysis of closures on high seas areas might also be worth pursuing as purse-seine effort in waters under national jurisdictions are already limited by Commission measures, but there is no limit on purse-seine effort in the high seas.

A similar request was made at SC3 and SC3 responded as given below

Commission's request at SC3

118. Mitigate the catches of small bigeye and yellowfin tunas caught by purse seine: "Review spatio-temporal aspects of such catches and refine analyses of potential management options that the Commission might adopt in order to reduce such catches."

Discussion summary at SC3

119. Adam Langley presented the results of an analysis of recent catch and effort data from the industrial purse seiners operating in the equatorial WCPO (SC3-SA-WP-4). The objective of the analysis was to identify areas that have yielded a high catches of bigeye tuna, both in absolute terms and as a ratio of the catch of skipjack tuna and yellowfin tuna from unassociated sets. The analysis identified that high catches of bigeye tuna (in absolute and relative terms) were consistently taken within Papua New Guinea and Solomon Islands archipelagic waters — areas where purse-seine fishing effort is concentrated on anchored FADs. In addition, high catches of bigeye tuna have also been taken in the far eastern area of the equatorial WCPO in the last two quarters of the year. These catches have largely been taken from purse-seine fishing associated with drifting FADs, largely by vessels based in the eastern Pacific Ocean.

Discussion

120. Subsequent discussion noted a number of relevant issues. First, estimates of bigeye in purse-seine catches are generated from observer data, which are currently limited. It was suggested that more extensive port sampling could assist in increasing the information available for similar analyses in the future for some fleets. Concern was raised regarding the inability of such analyses (such as presented by SC3-SA-WP-4) to investigate and account for catches of small bigeye tuna that are being taken in the Indonesian and Philippine fisheries, possibly limiting the utility of such analyses. It was also noted that while area closures should be investigated as management measures, their effectiveness has been mixed. In some cases they have been effective, while in other situations their effectiveness has been shown to be limited due to effort transfer, changes in oceanographic conditions and shifts in the distribution of the stock. Concern was raised regarding the transfer of effort (by vessels not registered in the Commission) from the EPO into the eastern area of the WCPO, most likely as a result of IATTC area closures in the

EPO in the third and fourth quarters.

121. It was also noted that if FAD-based controls aimed at reducing the catch of small bigeye and yellowfin tuna were to be attempted, the Commission would first require a better understanding of the type, structural and technological characteristics, location and frequency of FAD use across the Convention Area. Management options regarding gear characteristics (such as net depths and dimensions) should also be considered. It was also noted that phase 1 of the recent regional tagging programme focused on anchored FADs in the Bismarck Sea to allow investigation of the impacts of FADs on tuna stocks in PNG EEZ. The proposed phase 2 tagging project would be focused more on drifting FADs and their impacts on tuna stocks generally in the WCPO.

RESEARCH PLANNING

Short- and medium-term research plan

122. Following consideration of the stock assessment papers presented to the SA-SWG, a number of suggestions were made in relation to future research priorities. The following areas of further research were suggested for incorporation in the research plan:

- Give a higher prioritization to standardization of longline and purse seine CPUE to remove aspects of catchability influences.
- Consider parameterization of size-structured selectivity in developing assessment software.
- Give a higher priority to developing methods to deal with changes in selectivity through time.
- Assess the potential impact upon reductions in fishing mortality on the bigeye tuna stock utilizing the current bigeye tuna stock assessment model with the recommended measures adopted in the PNA Third Implementing Arrangement.
- Conduct stock structure research for South Pacific swordfish.

Work programme for 2009–2011

123. K. Bigelow provided a brief overview of the Scientific Committee's draft work programme for monitoring and assessment of stocks, noting progress on projects since SC2 and listed projects that are ongoing.

124. The SWG discussed prioritization and frequency of species to be assessed. Target species with current high rates of fishing mortality such as WCPO bigeye and yellowfin should be assessed every two years. South Pacific albacore should be assessed in 2009 given that the 2008 assessment result differed substantially from results from the 2006 assessment, due to changes in relative abundance indices, selectivity and biological parameters. Assessments of bycatch species were encouraged and the ongoing Commission funded ecological risk assessment could be used to prioritize bycatch species for assessments, such as sharks. While there are cost implications in the number of assessments that can be conducted by the scientific provider, it was encouraged to continue with "Full" assessments as required, along with more "Streamlined" assessments for species frequently assessed.

ADMINISRATIVE MATTERS

Terms of reference

125. No amendments to the existing terms of reference for the SA-SWG were suggested.

Other matters

126. No other matters were raised by the SA-SWG.

Adoption of report

127. The SA-SWG report was adopted by the SC4 on 18 August 2008.

Close of meeting

128. In closing the meeting, the co-conveners thanked SWG participants, presenters and rapporteurs for their contributions.

Attachment L, Appendix 1

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

AGENDA FOR THE STOCK ASSESSMENT SPECIALIST WORKING GROUP

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1. Opening of the meeting

2. Selection of rapporteurs

3. Adoption of agenda

4. Stock Assessments
   - 4.1. Bigeye Assessment
     - SA WP–1: Langley, A. [1], J. Hampton [1], P. Kleiber [2] and S. Hoyle [1]. *Stock assessment of bigeye tuna in the western and central Pacific Ocean, including an analysis of management options.* [1] SPC, Noumea, New Caledonia, [2] PIFSC, NOAA, Honolulu.
     - SA WP–2: Langley, A. [1] and R. Methot [2]. *A preliminary stock assessment of bigeye tuna in the western and central Pacific Ocean using stock synthesis 3 (SS3); a comparison with MULTIFAN-CL.* [1] SPC, Noumea, New Caledonia, [2] NOAA Fisheries, NWFSC, Seattle
     - SA WP–3: Hoyle, S., A. Langley, and J. Hampton. *General structural sensitivity analysis for the bigeye tuna stock assessment*. SPC, Noumea, New Caledonia.
   - 4.2. Skipjack tuna assessment
     - SA WP–4: Langley, A. and J. Hampton. *Stock assessment of skipjack tuna in the western and central Pacific Ocean.* SPC, Noumea, New Caledonia.
   - 4.3. South central and western swordfish assessment
     - SA WP–5: Mejuto, J., B. García-Cortés, and A. Ramos-Cartelle. *Standardized catch rates in biomass for the south central and western Pacific swordfish (Xiphias gladius) from the Spanish longline fleet for the period 2004-2006.* Instituto Español de Oceanografía. Spain.
     - SA WP–6: Kolody, D. [1] R. Campbell [1] and N. Davies [2]. *A Multifan-CL Stock Assessment of Southern Western-Central Pacific Swordfish 1952-2007.* [1]CSIRO, Australia, [2] SPC, Noumea, New Caledonia.
     - SA WP–7: Davies, N.[1], R. Bian, [2], D. Kolody [3], and R. Campbell.[4]. *CASAL Stock Assessment for South-West-Central Pacific Broadbill Swordfish 1952-2007.* [1] National Institute of Water and Atmospheric Research Ltd, Auckland, New Zealand, currently at the Secretariat of the Pacific Community, Noumea, New Caledonia, [2] National Institute of Water and Atmospheric Research Ltd, Auckland, New Zealand, [3]CSIRO Marine and Atmospheric Research, Hobart, Australia, [4]CSIRO Marine and Atmospheric Research, Aspendale, Australia.
   - 4.4. South Pacific albacore assessment

SA WP–8: Hoyle, S., A. Langley, and J. Hampton. *Stock assessment of Albacore tuna in the south Pacific Ocean.* SPC, Noumea, New Caledonia.

4.5. Fisheries indicators

SA WP–9: Hampton, J. and P. Williams. *Compendium of fishery indicators for target tuna species.* SPC, Noumea, New Caledonia.

Discussion and Conclusions

Information Papers

SA IP–1: Anon. *Report of the Southern WCPO Swordfish Assessment Workshop.*

SA IP–2: Kolody, D [1] and Davis, N.[2]. *Spatial structure in South Pacific Swordfish Stocks and Assessment Models.* [1] CSIRO, Australia, [2] SPC, Noumea, New Caledonia.

SA IP–3: Campbell, R. *Data summary pertaining to the catch of swordfish by longline fleets operating in the southern WCPO.* CSIRO, Australia.

SA IP–4: Campbell, R. [1], M. Unwin [1], N. Davis [2] and N. Miyabe [3]. *Swordfish CPUE trends across the southern WCPO.* [1] CSIRO, Australia, [2] SPC, Noumea, New Caledonia, [3] NRIFSF, Japan.

SA IP–5: Langley, A. and S. Hoyle. *Report from the stock assessment preparatory workshop, Noumea, February 2008.* SPC, Noumea, New Caledonia.

5. Responses to the Commission's requests

5.1. Provide analysis on management options related with FAD closure.

5.2. Provide advice and recommendations that will support the development of the CMM, inter alia, consideration of the status of stocks, and the potential for technological solutions to minimize the impact of fishing gear for juvenile yellowfin and bigeye tuna while minimizing the loss of catch on skipjack.

6. Research planning

6.1 Short- and Medium-term research plan

6.2 Detailed operational research plan for 2007/2008 with budget

6.3 Work programme for 2009–2010 with indicative budget

7. Administrative matters

7.1 Terms of reference

7.2 Other matters

8. Adoption of report (including a one-page summary)

9. Close of meeting

Attachment M

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

GUIDELINES OUTLINING THE PROCESS FOR FORMULATING THE WORK PROGRAMME AND BUDGET OF THE SCIENTIFIC COMMITTEE

An informal small group (ISG) met during afternoon tea on Monday, 18 August to discuss working paper GN-WP-3. This working paper outlined two options for supporting the process of updating the SC work programme and science budget, and identifying projects to be supported by the WCPFC science budget.

Based on this discussion, the process identified in Table 1 below (closely based on Option B in GN-WP-3) was agreed upon and recommended to the SC.

Table 1. Schedule outlining the process for updating the SC work programme and science budget and identifying projects to be supported by the WCPFC science budget

Month	Task/Activity	Responsibility
August	1. Update SC work programme 2. Prioritize projects (i.e. High, Medium, Low) 3. Scoping of High priority projects 4. Science budget	ISG makes recommendations to SC for discussion and adoption
December	Commission reviews and endorses SC recommendations	Commission
December	Call for expressions of interest for priority projects posted on WCPFC website[1]	Secretariat
31 January	Deadline for receipt of proposals by Secretariat	Proposer
February	Review and appraisal (and modification, if required) of proposals and identification of projects for funding support (using agreed proposal assessment criteria)[2]	Secretariat (coordinator)/ SWG Convenors/ Expert Advisors
March	Signing project contracts	Secretariat
August	1. Update SC work programme 2. Prioritize projects (High, Medium, Low) 3. Science budget	ISG makes recommendations to SC for discussion and adoption
December	Commission reviews and endorses SC recommendations	Commission

[1] There is the option of posting the recommended prioritised SC Work Programme on the website after completion of the SC in order to provide more time for consideration by scientists/organizations who may submit a proposal. The approved budget for supporting proposals would not be known until after the Commission meets in December.
[2] Example selection criteria are given in Table 2.

Table 2. Example research proposal assessment criteria

Assessment Criteria	**Score (1,2,3)**	**Justification for score**
Attractiveness		
Is proposal aligned with WCPFC research priorities?		
Is the need and are the planned outputs/benefits well-defined and relevant?		
Adoption and uptake. What is the level of impact and likelihood that the project outputs will be adopted? Is the pathway for uptake described?		
Cost effectiveness: Is the project cost effective? Is it using other sources to lever additional funds?		
Is there an appropriate level of collaboration between the applicant and other relevant researchers, fisheries managers and the fishing industry?		
Feasibility		
Are the objectives clearly specified and are they consistent with the planned project outputs/benefits?		
Sound methodology: Is the project design/method well described and is it consistent with the projects objectives?		
Likelihood of success: Are the project objectives likely to be achieved?		
Is there a strategy for managing data arising from the project so that it will be easily accessible by others in the future?		
Applicant's expertise/experience. Does the research team have the ability, capacity and track record to deliver the outputs?		
Total score (out of 30)		

Scores for assessing proposals: 1 = Low; 2 = Medium; 3 = High

Attachment N

The Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean

Scientific Committee
Fourth Regular Session

Port Moresby, Papua New Guinea
11–22 August 2008

ANNUAL REPORT TO THE COMMISSION
PART 1: INFORMATION ON FISHERIES, RESEARCH AND STATISTICS

Purpose: To provide relevant information to the Commission on fishing activities of CCMs and cooperating non-CCMs, including management and compliance issues. The report should include all fishing activities for highly migratory species being undertaken within the Convention Area as required by the Convention and decisions by the Commission.

PART 1. INFORMATION ON FISHERIES, RESEARCH AND STATISTICS

(Summary information for the previous year, complementary to data submitted[1])

Part 1 of the Annual Report is due one-month prior to the annual regular session of the Scientific Committee.

Part 1 of the Annual Report shall include the following, completed box at the front of the report.

Scientific data was provided to the Commission in accordance with the decision relating to the provision of scientific data to the Commission by 30 April 2xxx	[answer YES or NO]
If no, please indicate the reason(s) and intended actions:	

ANNUAL FISHERIES INFORMATION

Essential information

I	Annual catch and effort by primary species and gear in the WCPFC Convention Area	Previous calendar year (x-1) and previous 4 years (x-2 to x-5)
II	Number of vessels by gear type and size (fleet structure)	Previous calendar year (x-1) and previous 4 years (x-2 to x-5)
III	Fishing patterns (catch by time/area)	Previous year; comparisons with earlier years
IV	Estimated total catches of non-target, associated and dependent species (if available)	Previous calendar year; other years if available

Useful information

V	Developments/trends in the fishery (changes in fishing patterns, fleet operations, target species, level of transhipment, etc.)
VI	Associated socioeconomic factors (which may influence or explain the above trends)
VII	Disposal of catch (fresh/frozen/other)/market destination (export/domestic)
VIII	Onshore developments (processing plants, support facilities, etc.)
IX	Future prospects of the fishery (long term viability, expansion/contraction, etc.)

RESEARCH AND STATISTICS

X	Summary of observer and port sampling programmes (scientific data)
XI	Research activities (tunas, other species, species of special interest, oceanographic influences, etc.)
XII	Statistical data collection systems in use (describe)
XIII	Data coverage of catch, effort and size data for all species

[1] Catch/effort and scientific data in un-aggregated form supplied separately to the Commission in accordance with Scientific Data to be provided to the Commission.

Annex 1. Suggested layout for PART 1 of the Annual Report to the Commission

Section	Sections in Annual Report
1*	**ABSTRACT/SUMMARY** … for inclusion in the SC summary report
2*	**Tabular Annual Fisheries Information** (see below)
3	**Background** …for example, a brief historical description of national fisheries in the WCPFC Convention Area
4*	**Flag State Reporting** …describe recent activities by national fleets (by gear type) in the Convention Area, including development/trends in each fishery (e.g. changes in fishing patterns, fleet operations, target species, trends in size composition, etc.)
5	**Coastal State Reporting** …describe recent activities by foreign and domestic fleets in the waters of national jurisdiction, including development/trends in each fishery (e.g. changes in fishing patterns, fleet operations, target species, trends in size composition, etc.)
6	**Socio-economic factors** Associated socioeconomic factors (which may influence or explain the above trends)
7	**Disposal of catch** Disposal of catch (fresh/frozen/other)/market destination (export/domestic)
8	**Onshore developments** Onshore developments (processing plants, support facilities etc)
9	**Future Prospects of the fishery** Future prospects of the fishery (long-term viability, expansion/contraction, etc.)
10	**Status of tuna fishery data collection systems** a. Logsheet data collection and verification b. Observer programme c. Port sampling programme d. Unloading/Transhipment e. Other
11	**Research activities covering target and non-target species** …for example, biological studies supporting stock assessments; composition of the catch according to length, weight and sex; research on environmental factors, abundance/biomass surveys, oceanographic and ecological studies, etc.

* Essential information

Tabular Annual Fisheries Information - [national fleet], for years [x-5] to [x-1]

The following table shows the suggested captions for the tables and figures required in Annual Report Part 1 covering Annual Fisheries Information.

Suggested Table / Figure caption	
Table 1.	Annual catch and effort estimates for the **[National fleet],** by gear and primary species, for the WCPFC Convention Area and [other broad ocean area], for years [x-5] to [x-1].
Figure 1	Historical annual catch for the **[National fleet],** by gear and primary species, for the WCPFC Convention Area presented as a line graph.
Figure 2	Historical annual vessel numbers for the **[National fleet],** by gear for the WCPFC Convention Area presented as a line graph
Table 2.	Number of **[National fleet]** vessels, by gear and size category, active in the WCPFC Convention Area, for years [x-5] to [x-1].
Figure 3	Annual distribution of target species catch and effort by the **[National fleet]** active in the WCPFC Convention Area, for years [x-5] to [x-1].
Table 3.	Observed annual estimated catches of species of special interest (seabird, turtle and marine mammals) by gear for the **[National fleet]**, in the WCPFC Convention Area, for years [x-5] to [x-1] to the extent available.
Table 4.	Annual estimated catches of non-target, associated and dependent species, including sharks, by the **[National fleet]**, by gear and species, in the WCPFC Convention Area, for years [x-5] to [x-1] to the extent available.
Table 5.	Estimated annual coverage of operational catch/ effort, port sampling and observer data for the **[National fleet**], by gear, active in the WCPFC Convention Area, by gear, for years [x-5] to [x-1].

Notes

1. The **[national fleet]** data must be broken down by gear. Gear includes, but is not limited to, longline, purse seine, pole-and-line, troll, handline, ringnet and driftnet, where relevant. Tables and Figures can be labelled with (a), (b), (c), etc. for each gear.

2. The "primary species" catch covered in Table 1 should include, but not limited to, the following species, by gear type:

longline	albacore, yellowfin, bigeye, pacific bluefin and skipjack tuna. black, blue and striped marlin. swordfish
purse seine	skipjack, yellowfin, bigeye, albacore and pacific bluefin tuna
pole-and-line	skipjack, yellowfin, bigeye, albacore and pacific bluefin tuna
troll	albacore, skipjack, yellowfin, bigeye and pacific bluefin tuna
handline	yellowfin, bigeye, skipjack and albacore tuna
[others]	albacore, skipjack, yellowfin and bigeye tuna

3. The catch estimates in Table 1 should be broken down by WCPFC Convention Area, depending on species, according to the section on "Annual Catch Estimates" contained in the document "Scientific Data to be provided to the Commission".

4. The vessel size classes by gear to be reported in Table 2 are defined in the section on "Number of vessels active" contained in the document "Scientific Data to be provided to the Commission".

5. Table 4 should cover all species not included in Tables 1 and 3.