ANNEX 7

REPORT OF THE SIXTH MEETING OF THE INTERNATIONAL SCIENTIFIC COMMITTEE FOR TUNA AND TUNA-LIKE SPECIES IN THE NORTH PACIFIC OCEAN

Plenary Session, March 23-27, 2006
La Jolla, California U.S.A.

Report of the Bluefin Tuna Working Group meeting (January 16-20, 2006, Shimizu, Japan)

1.0 INTRODUCTION

The ISC Pacific Bluefin Tuna Working Group meeting was held in Shimizu, Shizuoka, Japan during 16-20 January 2006. This was the fourth meeting of this Working Group since its inception in 2000.

Dr. Yoshio Ishizuka, the Director of the National Research Institute of Far Seas Fisheries, welcomed all the participants and wished for a fruitful outcome to the meeting.

Dr. Ziro Suzuki (Japan) chaired the meeting. Al Coan, Kevin Piner, Simon Hoyle, Mio Takahashi, Koji Uosaki, Naozumi Miyabe and Yukio Takeuchi were appointed as rapporteurs. Scientists from Chinese-Taipei, Japan, U.S.A., and IATTC as well as officers from the Fishery Agency of Japan participated in the meeting (Appendix 1). Nineteen working documents and three working papers were provided at the meeting (Appendix 2). The draft agenda was reviewed and adopted with minor modification (Appendix 3).

2.0 REVIEW OF RECENT FISHERIES (DESCRIPTION OF RECENT DEVELOPMENTS AND ISSUES OF FISHERIES.)

2.1 Fisheries report by members

Japan, presented by Mio Takahashi (ISC/06/PBFWG/02)

Japanese catch estimates in recent years for Pacific bluefin tuna (PBF) were revised using the catch and size data from a large-scale research program, Research on Japanese Bluefin tuna (RJB), conducted by NRIFSF. Estimates of catch in 1952-2004 were based on official statistics (Norin-tokei), RJB, and other supplementary data. According to the estimates, annual total catch of PBF has fluctuated between about 6,300 and 32,000 tons, and ranged from 8,900 to 24,000 tons during the last decade. About 60 percent of the annual catch is taken by purse-seine vessels in the Pacific and from the Sea of Japan. The total purse seine PBF catch has ranged between 2,000-23,000 tons and has been highly variable. The annual catches of longline, troll and set net have been around

3,000-9,000 tons respectively, and the catches of the pole-and-line, drift-net and handline fisheries have been relatively minor in recent years.

Discussion: Bluefin tuna catches in coastal fisheries included in the species-aggregated categories in Norin-tokei which were estimated by applying the annual ratio of PBF catch to other tuna catches in the dis-aggregated catches at species level. A question arose on the adequacy of this assumption. The aggregated catches are known to be composed of small fishes so that this assumption is considered reasonable. It was clarified that catch is available in number of fish and weight of fish for longline fisheries and that either measurement could be used in assessments.

Chinese-Taipei, presented by Chien-Chung Hsu (ISC/06/PBFWG/03)

Pacific bluefin tuna are traditionally exploited by Chinese-Taipei's small scale tuna longline vessels (<100 GRT) from late April to June, when PBF typically aggregate for spawning in the waters off eastern Luzon and Chinese-Taipei. The catch is chilled, eviscerated and unloaded at three domestic ports, Tungkang (>70%), Suao and Hsinkang. The annual production was relatively low before 1996, and has varied between 1,400 mt and 3,000 mt since then. Before 1999, about 40-50% of the catch was exported to Japan and the rest was kept for local consumption. Recently, however, the percentage kept for local consumption has increased to over 80-90% of the catch. Since 1993 size data have been collected, with coverage over 80%, and fishing effort has been compiled from fishing vessels' logbook, with coverage over 70% per year. The Chinese-Taipei Pacific bluefin tuna fishery is characterized by (1) a seasonal fishery operating from late April to June, (2) a local fishery operating in waters off eastern Luzon and Chinese-Taipei, (3) a fishery exploiting adults larger than 180 cm fork length, and (4) a fishery where almost the entire catch is consumed domestically. Research on biological studies and stock assessment is in progress by national scientists.

Discussion: Considerable discussion ensued on fishing effort estimates for Chinese-Taipei's longline fisheries. It was assumed that each vessel used two sets per day. This practice was thought to be caused by crew sizes that worked in 12 hour shifts. Therefore, it is thought that setting takes place at 1300-1400 hours and again at 0200-0300 hours each day. It is assumed that 700 hooks are deployed for each set and there appears to be no difference in catchability between sets. Scientist from Chinese-Taipei will clarify this practice (2 sets per day) for the working group and verify that the 700 hooks per set practice. This can be done by interviewing longline vessel captains. Additional information on longline operations should also be sought such as hooks per basket, length of branch lines, etc.

The working group noted that catches back to 1980 were missing from the report but should be kept in Table 1. Catches from 1980 to 1993 were monitored by National Taiwan University, and 1994 to the present are from the Overseas Fisheries Development Council (OFDC). Coverage rates are over 80% for data from 1994-2005.

Korea (No Document)

Bluefin tuna catch data were received at the meeting for 2005. The data were given by month and totaled 594 t. The Korean catches were compared to Japanese import data for the first six months of 2005 that totaled 950 t. Since the Japanese import data were higher than that reported by Korea, the higher value was adopted for Table 1 of this report. Import data for 2003 and 2004 were also used.

Mexico (No Document)

Data were adopted from the last 5th ISC meeting. Data are from the purse seine fishery that operates off Baja California. The bluefin tuna catch is mostly transported to fish farms. Data for this meeting were submitted by the IATTC.

U.S.A., presented by Al Coan (ISC/06/PBFWG/01)

Pacific bluefin tuna catch estimates from U.S. fisheries were summarized from various sources and made available to the working group for stock assessments. Annual and quarterly estimates were provided for the period 1918 to 2004. Fishing gear identifiers were by commercial and sport gear only for the period 1918 to 1980. A finer division of commercial catch estimates by gear (pole and line, gillnet, purse seine, troll/handline, was provided for 1981-2004. During the period 1918 to 2004 the bluefin tuna commercial catch peaked in 1966 at 15,920 t and has decreased to a low of 11 t in 2004. Some of the commercial purse seine catch was sold to Mexico for pen rearing in 1995 to 2003. Recreational catches have increased during the period 1999 to 2003, before reaching its lowest level in 2004 of only 34 t. Logbook and length frequency data for U.S. purse seine gear are provided to the working group by the IATTC.

Discussion: It was noted that the Mexican purse seine Pacific Bluefin tuna catch in 2004 was almost 9,000 t whereas the U.S. catch was 0 t. It appears that this was caused by low availability of fish in waters off the U.S. in 2004.

IATTC, presented by Simon Hoyle (No Document)

Catch data were provided for purse seine catches by flag. Appropriate values have been incorporated in Table 1.

3.0 FISHERY STATISTICS

The working group revised the Pacific bluefin tuna catch table until 2005 (Table 1). The following concerns and assumptions were identified while compiling catches for Table 1.

1. Catches reported by Korea (Koh, Pers. comm.) are less than reported Japan imports of Korean catches (Yamada Wp1). The group recommends that the higher

of the two estimates be used. Also, Korean scientists should be contacted to identify the source of these differences.

2. Concern was expressed about the accuracy of the Table 1 catches for Chinese-Taipei's purse seine in 2001-2003. The working group agreed to verify these values with Eric Chang, Fishery Agency.
3. Countries should strive to verify estimates in Table 1.

4.0 REVIEW OF BIOLOGICAL STUDIES

Biological Parameters Used for the Pacific Bluefin Tuna Stock Assessment in the ISC PBFWG, presented by Harumi Yamada (ISC/06/PBFWG/04).

Biological parameters of PBF used in the 2004 assessments were reviewed.

Stock structure: single Pacific-wide stock
Growth curve: Yukinawa and Yabuta (1967)

$$Lt = 320.5\left(1 - e^{-0.135t - 0.07828}\right)$$

Maturity: Bayliff (1994), Yorita (1981) and Ishihara (1994)
Length-weight relationship: Shingu et al. (1974) $W(kg) = 0.2977 \cdot 10^{-4} \cdot L(cm)^{2.9103}$
Natural mortality: Bayliff et al. (1991) and Takeuchi and Takahashi (2002)
Weight at age, maturity at age and natural mortality at age were as follows.

Age	0	1	2	3	4	5	6	7	8	9	10+
Wt(kg)	1.0	5.7	15.5	25.6	42.2	62.2	84.9	109.6	135.7	162.5	218.0
Mat	0.0	0.0	0.0	0.0	0.2	1.0	1.0	1.0	1.0	1.0	1.0
M	1.6	0.8	0.4	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25

The working group did not discuss the paper because it was a review of biological parameters used in previous assessments. Discussion was delayed until after presentation of the biological papers.

Reconstructing von Bertalanffy Growth Equation of Pacific Bluefin Tuna (*Thunnus orientalis*) with Additional Spawners Scale Samples from the Southwestern North Pacific Ocean, presented by Chien-Chung Hsu (ISC/06/PBFWG/05).

Several growth equations have been developed for Pacific bluefin tuna, but the only hard parts used to estimate growth parameters have been scales. We used the scale based ages from the 1967 study and introduced newly collect scales from large spawners to estimate the von Bertalanffy growth equation. The Ford-Walford plot and the nonlinear least square method are used to estimate the growth parameters. The result is successful for animals older than 7 years, and the growth curve estimated by Ford-Walford plot seems to fit the observed length range better than the nonlinear least square algorithm. Consequently, the von Bertalanffy growth equation can be expressed as follows for the bluefin tuna in the North Pacific Ocean.

$$L_t = 325 \cdot \left[1 - e^{-0.1098(t+0.3993)}\right]$$

Discussion: The working group discussed the lack of noticeable numbers of fish >250 cm in the available fisheries samples. Three hypotheses were discussed that could explain this result: 1) largest fish not available to the gear, 2) largest fish are dead due to high mortality rates, and 3) the L_{inf} is an overestimate due to under-ageing of oldest samples. Furthermore, the working group discussed the tendency of scales to underestimate age in older fishes of other species. More work on ageing and age validation is needed. The working group recommends further research using otoliths.

An Investigation of Length-Weight Relationship for Pacific Bluefin Tuna, presented by Kyuji Watanabe (ISC/06/PBFWG/06).

The length-weight (L-W) relationships for the Pacific bluefin tuna by quarter and year from 1993 to 2004 were investigated. The L-W relationships differ significantly by quarter (quarter 1 and 2 ($p < 0.03$), quarter 2 and 3 ($p < 0.006$)). The condition factors in quarter 2 were higher than those in all the quarters. The average condition factors over all quarters showed an increasing trend from 2001 to 2004. The equations estimated in our study used a wider length range than the length range (171–219 cm) used in Shingu et al (1974). Thus, our equations are more appropriate for estimating weight over a wide age range. A conversion factor is needed to estimate total weight from the gilled and gutted weight. Consequently, further study is needed before using the L-W equations to estimate weight-at-age.

Discussion: The working group discussed the importance of seasonal changes in weight at length to converting catch in biomass to catch in numbers. Some discussion occurred regarding the temporal scale that should be considered and that perhaps a fine scale may be needed. Results presented in the study were influenced by the size range used, and there were questions of how applicable the results were to the small fish excluded from the study. The working group encouraged further research to more formally confirm the increasing trend in condition factor during the recent years. The working group emphasized the need for a conversion factor for gilled and gutted to whole weight before the study could be used in the assessment.

Estimation of Natural Mortality of Age 0 Pacific Bluefin Tuna from Conventional Tagging Data, presented by Yukio Takeuchi (ISC/06/PBFWG/07).

Natural mortality of Pacific bluefin tuna, specific to age 0 was estimated from conventional tag-release-recapture data. In contrast to previous work, which covered a wide age range, data corresponding to tagging at an age of about 3 months were selected. This enables us to compares the effects of tagging experiments done in the early 1980s, late 1980s and from mid 1990s. The results suggests natural mortality of age 0 Pacific bluefin tuna currently used (1.6) is reasonable with respect to the average M for age 0 in fishing year (this is corresponding to the age of 3 months to age 1 and 3 months, if we can assume April 1 is birth date).

Discussion: The working group discussed the how M on age-0 was determined based upon scaling down the estimate from two quarters of tagging data. Although this was deemed reasonable, it was emphasized this was based largely upon subjective reasoning. The working group discussed the importance of emigration, and tag shedding on the estimates of M. For example high rates of emigration out of the study are would lead to overestimates of M in the study. However, trans-Pacific migration is thought to occur primarily in the winter which would reduce the effect on the results. The working group encouraged further research on incorporating the emigration effect into subsequent work. It was suggested that using growth rates and selectivity patterns in different fisheries may help define the emigration pattern. The working group also recommended investigating modeling M as a function of length to incorporate the decrease in M with increasing size, although the group recognized this is a more complicated analysis that may not be feasible at this time. The working group also suggested modeling mortality that declined within the tag-mortality model as a function of age. Finally, the working group suggested using priors rather than point estimates on some assumed parameters such as reporting and shedding rates, in order to better estimate uncertainty.

Habitat SST of Young Pacific Bluefin Tuna, Based on Archival Tag Data, presented by Mio Takahashi (ISC/06/PBFWG/08).

To determine better area stratification in the analysis of CPUE of the surface fisheries (purse seine and troll), SST habitat of PBF was analyzed from archival tag data by spatial stratification based on movement pattern of tagged PBF. Daily location and SST of the tag data of 12 individuals with times at liberty of more than 500 days were used in the analysis. The SST frequency of occurrence in "purse seine fishing ground", "WPO", and "EPO" showed similar distributions, peaking at 18-19°C, and distributed from 13-20°C. The frequency of observations was very low at temperatures above 20°C in quarters 2 and 3, which correspond to the main fishing seasons of purse seiners.

In contrast, the SST frequencies in the coastal areas around Japan showed different distributions to the former three. They showed clear seasonal change, and were mostly above 18°C in quarter 3. The fish in coastal areas may be influenced by other environmental factors, such as prey and topography.

Discussion: The working group encouraged the incorporation of environmental factors such as oceanic frontal structure into future studies to potentially help explain movement patterns. A recommendation was made that size of fish be reported in future papers. The working group also discussed the difference in preferred temperatures in this study versus previous IATTC work. Fish appeared to prefer slightly cooler temperatures than previously thought. Further research with IATTC researchers should be conducted in this area because it may impact the habitat analyses conducted by the IATTC.

Maturation of Bluefin Tuna in the Sea of Japan, presented by Sho Tanaka (ISC/06/PBFWG/09).

Histological observations of northern bluefin tuna ovaries were made to determine size and age of maturity. Ovary samples were collected from fish caught by the purse seine fishery in the Sea of Japan, with 458 samples from the summer of 2003, and 859 from 2004. Results showed that in 2003, 20% of bluefin tuna below 130 cm FL were immature or maturing, as were 30% between 131 cm and 150 cm FL. In 2004, 20% of tuna below 105 cm FL were immature, 10-20% from 106 cm to 125 cm FL were maturing, and less than 10% of tuna from 126 cm to 150 cm FL were maturing. These results indicate that 80 % of bluefin tuna at age 3 in the Sea of Japan become mature and 90 % of tuna at age 4 are mature. However, the rate of maturity in 2003 was less than that in 2004. This indicates that maturation of bluefin tuna may be influenced by environmental factors.

Discussion: The working considered the results of this study which indicated bluefin tuna matures at smaller sizes than previous thought. The working group discussed the need to produce a maturity ogive by length and age. Discussion of the reliability of the results was centered on the lack of small fish in the study and the limited spatial coverage of the samples. The working group encourages more samples from smaller fish and other areas beyond the Sea of Japan.

5.0 REVIEW OF STOCK ASSESSMENT STUDIES

5.1 CPUE indices

Habitat-Based Index and Standardized Index of Catch per Unit Effort Derived from Captain's Logbooks and Observer Records for Purse-seine Vessels Fishing between 1960 and 2005, presented by Simon Hoyle (ISC/06/PBFWG/11).

The commercial fishery in the EPO harvests one part of what is believed to be a single bluefin tuna stock. Bayliff's habitat index, one of several previously developed for this subpopulation, was updated for 1960-2005, by including additional years of data and changing the method for calculating effort. The data were also standardized to develop a new index of abundance. The standardization used a delta-lognormal model which took into account the zeroes in the catch. Significant factors in the analysis included vessel ID, month, temperature, temperature^2, latitude, and longitude. The standardized index was less variable than the unstandardized version, with a lower rate of increase in recent years. The result was relatively unchanged by the removal of each of the significant effects, apart from vessel ID, which accounted for the majority of the variation explained by the model.

Discussion: Discussion of this paper focused on what had caused the temporal shift in the catch from younger fish to older fish. One suggestion was a change in purse seine fleets. Another explanation forwarded was that targeting of large fish for Mexican pen farms may have affected selectivity patterns in recent years. More sampling of the size of fish taken to the fish farms will be needed to explore this hypothesis.

Standardization of CPUE of age-0 Pacific Bluefin Tuna by Japanese troll fishery, presented by Harumi Yamada (ISC/06/PBFWG/10).

In the previous PBFWG meeting, the authors presented a standardized CPUE series derived from the Japanese troll fishery in the East China Sea (Figure 1). Several problems were encountered with restricting the analysis of CPUE to only the area of the East China Sea. The main spawning ground of PBF is to the south of Japan, from where larvae and juveniles may be transported by the Kuroshio Current to the troll fishing grounds. Therefore, the abundance of PBF in the East China Sea may be affected by oceanographic conditions. This study includes data collected in the Pacific Ocean. Large yearly fluctuations of CPUE were observed in both the Pacific Ocean and East China Sea. Both historical trends of standardized CPUE during 1989 to 1997 look similar, although before and after that period there were some differences between the trends. Some of this discrepancy may be the effects of oceanographic conditions on juvenile transportation to the East China Sea and the Pacific Ocean. The 2001 cohort, which seemed to produce substantial PBF catch in the EPO, was not as clear in the East China Sea, but was shown clearly in the CPUE trend in the Pacific Ocean. The standardized CPUE from the trolling data in the Pacific Ocean as well as the East China Sea should be taken into account, even though the catch in the Pacific Ocean is relatively small compared with the East China Sea.

Discussion: The working group discussed the effects of the year*quarter interaction on the LSMEANS estimate of the year affect. One suggestion was removing the interaction term if the interaction was not of practical importance. One test of practicality suggested was plotting the CPUE time series by quarter to determine if there is a real divergence between series. The working group also discussed that the large 1994 year class in the index appears to be confirmed by length information from the fisheries. This may strengthen the argument that the index does detected higher than average recruitment years. The working group also discussed the possibility of hyperstability of the index due to market saturation. However, the market quality of the animals in this fishery is quite good and it was thought that this factor along with bluefin tuna constituting the major fishery during this time of year reduces the probability of market saturation.

Bluefin Tuna CPUE Index Derived from Commercial Passenger Fishing Vessel (CPFV) Logbooks 1936-2004, presented by Kevin Piner (ISC/06/PBFWG/12).

An index of the relative abundance of bluefin tuna was prepared from the logbooks of a recreational fleet operating off Southern California (U.S.A.) and Baja California (Mexico). The index spans 1936-2004 (Figure 1) and was created using a delta-GLM approach. Catch rates increased dramatically over the last decade, but it is not clear that this is indicative of an increase in juvenile bluefin tuna. Other hypotheses that explain the increase include availability and increased reporting of bluefin tuna because of changes in logbook structure.

Discussion: The working group discussed the problems with working with aggregated data. Individual trip records would be preferable. Information was introduced into the discussion that the index is primarily composed of ages 1-3. However the work was considered preliminary, and considering the potential biases discussed in the paper, it was considered premature to use the index in the assessment.

An Updated Standardization of a Bluefin Tuna CPUE by Japanese Purse Seine Fishery in Pacific Side of Japanese Coastal Water, presented by Yukio Takeuchi (ISC/06/PBFWG/13).

Standardized CPUE for the Japanese purse seine fishery operating in the northwestern Pacific Ocean was updated through 2004 (Figure 1). Major changes since the last workshop involved truncation of the time series and area definition. Because purse seine effort moved offshore around 1980, standardization was applied to the catch and effort data after this effort shift. Introduction of finer spatial resolution enable us to find significance of an area effect in the GLM. The results, however, indicate a very similar trend to the previous analysis. The quarterly abundance index for use with Multifan-CL was also updated.

Discussion: The working group discussed the issue of the index being derived from only positive catch observations. Discussion included the possibility that positive catch records may not be sufficient to capture potential changes in bluefin tuna abundance. A recommendation was made to include more SST data into the analysis to help in identifying fishing opportunities with zero bluefin tuna catch. The working group also encouraged investigations using vessel identification to potentially capture targeting effects. The group also suggested that two purse seine components should be differentiated in order to distinguish coastal from larger tropical purse seine boats. More biological sampling of the catch may be needed to estimate age/size – specific indices.

New Abundance Index for the Small-Scale Longline Fishery Targeting Spawning Bluefin Tuna (*Thunnus orientalis*) in the Southwestern North Pacific Ocean, presented by Chien-Chung Hsu (ISC/06/PBFWG/14).

This paper reports standardization of catch rate to produce an annual index of abundance using a general linear model on data from 1999 to 2004. The fixed effects of year, month, and vessel categories, and a two-way interaction effect of month and vessel-categories were considered. Only the fixed factors were significant and used in the final model. Monthly length frequency distributions were separated into age groups by assuming normally distributed length-at-age, with mean lengths-at-age following a von Bertalanffy growth model. The abundance index time series dramatically declined from 1999 to 2002, slightly increased in 2003, and remained at the same level in 2004 (Figure 1).

Discussion: The working group discussed that some catch records were excluded because of a lack of effort associated with the catch. The proportion of those records was small. The group also discussed that differences between the northern and southern ends of the spawning area may be important in the estimation. The working group also discussed the assumption that the same number of hooks per day are set across vessel size classes. The relationship found between CPUE and vessel size may be related. The author clarified to the working group that vessels operating in the fishing ground are detected even if they did not catch bluefin tuna because they did catch other species.

Standardization of CPUE in the Pacific Bluefin Tuna Caught by Japanese Offshore and Coastal Longliners, presented by Momoko Ichinokawa (ISC/06/PBFWG/15).

The CPUE of Pacific bluefin tuna caught by Japanese longliners was updated for use in tuning the stock assessment of PBF. Two different logbook databases for the Japanese longline fishery were used in the standardization. The first provided data from offshore longliners since 1952. The second was from Japanese coastal longliners, a fleet composed of relatively small vessels operating since 1994. The coastal fleet has not previously been used to produce an abundance index for use in the stock assessment of Pacific bluefin tuna. Using the two different databases, standardized CPUE (Figure 1) was estimated by general linear modeling, assuming quasi-likelihood. The estimated CV of the yearly abundance index suggested that reliability of the estimates in quarters other than the spawning season was very low, because of small number of bluefin caught in those quarters. During the spawning season, the estimated CV of the standardized CPUE from offshore longliners was higher than those from coastal longliners, especially in recent years. The temporal trends of CPUE from the two longliners were similar, although the two fisheries were different in total amount of data, main fishing area, and average weights of fish. Therefore, CPUE of coastal longliners in the second quarter would better represent abundance of the spawning population in recent years, because large number of records of the coastal longliners can provide more reliable estimation of standardized CPUE than that of offshore longliners.

Discussion: The working group discussed comparisons of the Japanese longline nominal CPUE with comparable data from the Chinese-Taipei longline fishery. Because of area differences this may not be a straightforward analysis. The working group discussed the decrease in hooks per basket in the offshore longline fishery in recent years, concluding that this may be related to targeting changes. This is an area of further investigation. The working group suggested including environmental data, such as SST, throughout the series to help explain changes in CPUE.

General Discussion: The general discussion of the working group, in regards to CPUE indices, focused on which series were likely to best represent changes in population abundance (Figure 1). The group focused primarily on subjective criteria that could be used to weigh the merits of series against other series for use in assessment. Table 2 shows the result after discussion. The following seven criteria were identified as important:

1. Positive only- Indices that do not consider observation with zero catch may be less reliable if population change is best reflected in encounter rates and not catch rates of positive encounters.

2. Spatial extent- In general, indices derived from sampling a larger fraction of the stock distribution may be more reliable than those that sample a small fraction.

3. Size Category defined- Indices that define the size/age component that is indexed will be more useful than indices that do not.

4. Targeting- Indices with fleets that show trends in targeting will not be as reliable as those with constant targeting (or non-targeting) due to potential changes in catchability and selectivity patterns.

5. Temporal coverage- Longer time series are more useful than shorter series.

6. Data quality- Data records that are free from potential biases, non-reporting and aggregation will produce more reliable and precise estimates of CPUE.

7. Diagnostics available- The availability of diagnostics of the performance of statistical models is preferable.

5.2 Catch-at-Age/Size

Sampling the Catch of Bluefin Tuna (*Thunnus orientalis*) for Length Composition, presented by S. Hoyle (ISC/06/PBFWG/16).

The methods used by the IATTC to calculate length frequencies and age structure from commercial and sport fishery length sample data were described. Length distributions were estimated monthly, with each sample catch weighted. The method is largely described by Bayliff 1993. The main change from Bayliff 1993 is that age composition was not estimated using cohort slicing, but by fitting normally distributed length-at-age distributions to the data. Unlike the equivalent process in MULTIFAN, this fitting procedure assumes independence between length-at-age distributions of the same cohort in different time periods. The implication is that variation in length-at-age represents sampling variation between different schools, rather than growth rate variation between different cohorts. In estimating age structure, missing values in the length sampling were accommodated by substituting samples either from adjacent months, or from the same month in a year with a similar length frequency distribution in months that were present in both years. Results of the analysis showed increasing average length, and hence average age, through time

Discussion: There was some discussion of the quality of sampling in recent years, which has become more difficult as a higher proportion of the catch is delivered to farming operations in Mexico. The IATTC has not obtained length measurements of fish delivered to farms. The meeting recommended increased sampling of commercial bluefin tuna length frequencies in the EPO, particularly of farmed fish. Mean lengths at age from the age estimation program were requested.

Estimation of Pacific bluefin tuna catch-at-age/size by fishery in the North Pacific, presented by Mio Takahashi (ISC/06/PBFWG/17).

Catch-at-age (CAA) of Pacific bluefin tuna in the North Pacific was estimated. The process of catch-at-age estimation was explained, including accounting of all the substitutions. Catches were aggregated by fishery and fishing year (from 3rd quarter to next 2nd quarter) in order to correspond to the correct year class. Age compositions were decomposed to each age by age slicing points, which were estimated visually from monthly length frequency data. For Japanese purse-seine fisheries in the Pacific and for set net, CAA were estimated by size category to reduce the influence of sampling bias. The coverage of size frequency data in recent years is improving, as a result of RJB and port sampling by NRIFSF, Chinese-Taipei, and IATTC.

Discussion: There was a lengthy discussion seeking clarification of the methods used. Seasonal growth was considered in estimating age at length. Monthly catches were not available, and nor was catch in the set or the trip from which the sample was taken. It was assumed sampling was proportional to the monthly catch. It was recommended that historical monthly catch should be estimated if possible; there are no monthly data from before 1971 from the purse-seine fishery. Catch for the whole fishery may be inferred from the monthly ratios in part of the fishery. Quarterly estimates may be easier to estimate than monthly estimates, and would be an improvement over the current annual data. It may be best to focus on the last 10 years initially. It was suggested that for the coastal longline landings by month may be informative about monthly catch, because trips are around 10-14 days. Clear summaries of sampling design and analysis methods were also requested. A conflict was noted between the size categorization in the logbooks (Maguro and Meji categories) and the size distribution in the sampling data. This appears to be because most length sampling has been of the large fish. The meeting recommended that sampling should be undertaken by size category. Better documentation of the methods used to resolve this was requested.

Catch-at-age estimation from the Southwestern North Pacific Ocean, presented by Chien-Chung Hsu (ISC/06/PBFWG/14).

MULTIFAN was used to separate monthly length-frequency distributions into age distributions with two growth equations, for which the estimated mean lengths are presented. The age distributions were dominated by fish with estimated ages from 9 to 11; dominant age classes changed from year to year. The major age classes (over 75% annual catch) changed from age 9 and age 10 in 1999-2000 to age 10 and age 11 in 2001-2002, then shifted back to age 9 and age 10 in 2003, and moved to age 10 and age 11 in 2004.

Discussion: The parameterization of MULTIFAN was discussed, including the appropriateness of the month used in the growth curve. The total number caught in a year was estimated by individual count, and also data from auctions, which record individual fish. In addition, total weight estimates are given by the fishermen's association. It was observed that it may be appropriate to use slicing rather than MULTIFAN to estimate ages when there are no modes apparent in the fishery. Interest was expressed in seeing the sex ratio at length data.

5.3 Condition of Stock

Updated stock assessment of Pacific bluefin tuna using a tuned VPA, presented by Harumi Yamada (ISC/06/PBFWG/18).

The analysis was conducted using the ADAPT framework, and six CPUE indices were used to tune the estimates of terminal year F (fishing mortality) for ages 1, 3, 6 and 9. The un-standardized CPUE for the EPO was used, rather than the standardized CPUE improved in the meeting. The program used in the study was also developed to handle the discontinuous CPUE series and to give confidence intervals on the point estimates through bootstrap simulation. The VPA was conducted with data from the period 1952-2004.

The VPA analysis showed that the total biomass shows decadal changes from the level of 60 thousand MT to the level of 160 thousand MT. Recent total biomass recovered from the historical low level in late 1980's, and seems to be stable at or above the level of around 100 thousand MT. The SSB trend was roughly similar with that of total biomass. Historical lower levels appeared in 1970 and 1985. The SSB recovered around 40 - 50 thousand MT in 1995 from lower levels in mid 1980s, then decreased to the level of 30 thousand MT in 2002, which is about the middle level of SSB through the period analyzed.

The fishing mortalities of ages 0 and 1 in 1990s were higher than those in 1980s. The current fishing mortalities of fish older than age 5 were estimated to increase to the level of early 1980s from the lower level of early 1990s. The strong year cohort observed in 1994 did not substantially contribute to prevent SSB from declining from a peak at that time to the current level because of the recent high fishing mortality of juvenile.

The yield per recruitment analysis showed that the magnitude of fishing mortality in each decade has been two times higher than Fmax during the analysis period since 1952. However, recruitment overfishing does not seem to have occurred. Although the highest historical recruitment in 2001 would maintain biomass above the level of the current biomass by 2010 based on the future projection run, continuous careful monitoring of the stock is necessary to keep the stock sustainable, considering the lower reliability of the most recent years in the VPA estimates.

Discussion: The residual patterns in the CPUE indices were noted, which indicate that the model did not fit well to the Japanese longline or the early EPO purse seine indices. Possible changes in targeting in the longline fishery were discussed. Clarification of Korean purse seine fishery age distribution was sought, given that different age compositions appeared to have been applied to the Korean data and the Japanese data. The model failed to fit the CPUE indices before 1980 because it is constrained by the catch-at-age data, and to a lesser extent the assumption that the plus group has the same fishing mortality as the oldest age class. This approach leads to convergence of the estimate without estimating terminal mortality. The influence of the catch-at-age data, which is assumed to be known without error, in defining population dynamics is indicated by the lack of variance in the bootstraps before about 1997. The sensitivity analysis indicated that the results of the VPA except for recent years were not driven by any of CPUE indices.

The residual patterns indicate that the Japanese longline CPUE and the IATTC purse seine CPUE data conflict with the catch-at-age data. However, some information is missing from the early period. It was suggested that the conflict might be reduced if the CPUE time series was separated into two parts. One option is to focus on the current time period, during which the data are better, and dispense with the early data. The fishing mortality-at-age used in the forward projections was derived by resampling F-at-age estimates from 1997 to 2001. The group discussed a number of concerns on parameter estimates. One further analysis was carried out during the meeting (see ISC/06/PBFWG/Info-04).

Evaluation of the Use of the Fully Integrated Length-Structured Stock Assessment Model Stock Synthesis II for Use in Modeling Northern Bluefin Tuna, presented by Kevin Piner (ISC/06/PBFWG/19).

A preliminary integrated length-structured assessment was conducted on data taken from the 2002 and 2004 assessments of northern bluefin tuna. The goal was to investigate the potential usefulness of Stock Synthesis II (SS2) in modeling bluefin dynamics. Important model structure included seasonal selectivity for each fishery through separation into seasonal fisheries. Proportion-at-length and CPUE were included as likelihood components, and the model appeared to reasonably fit both series. Some issues remain with selectivity estimation for the age-0 fisheries. Estimated spawning biomass was influenced by the long line CPUE and showed a population that declined from the 1950's to present. Despite some unresolved problems, the model appeared to be flexible enough to reproduce the relevant processes without sacrificing model efficiency. Integration across parameter space using MCMC appears to be possible given the current model structure.

Discussion: Conflict was noted between recent CPUE & length frequency data, similar to those seen in the 2004 MULTIFAN-CL analysis. The selectivity parameterization of the smallest size classes may be causing the problem, but should be resolved relatively easily. It was suggested that the Japanese purse-seine fishery in the Pacific has probably changed its selectivity dramatically from large to small fish, indicating that it may be useful to split the purse seine fishery into different blocks to account for this change. However, the change appears to be gradual, which will make it difficult to decide where to break the series. Iterative re-weighting was used to ensure internal consistency among the emphases given to the different data sources. Re-weighting in this way adds process error, and should be viewed differently from the observation error implied by the statistical uncertainty in the CPUE and length frequency data series. It may be useful to estimate trends in catchability through a random walk of catchability deviates, although this is difficult unless there is something else in the model with which to find a contrast. Alternatively, large CV on the effort deviates in MULTIFAN-CL permitted the model to ignore the Japanese longline CPUE. Given the influence of the Japanese longline time series on the results, the meeting recommended that it should be investigated thoroughly, in order to determine how much confidence can be placed on it. Substantial conflict was not apparent in the SS2 analysis between the Japanese longline CPUE and other data.

An application of MULTIFAN-CL to Pacific bluefin tuna,
presented by Yukio Takeuchi (No document).

The Multifan-CL application to Pacific bluefin tuna was updated. The main changes since the last workshop were the addition of two years of data (from 2003Q3 to 2005Q2), removal of the set net effort data, the addition of standardized effort for the Chinese-Taipei longline fishery, and separation of Japanese longline fishery into four fisheries (one in each quarter). The Multifan-CL executable program itself was also updated to the latest version. Given the limited time given to the analysis, the reliability of the results must be regarded as very limited. In particular the recent biomass trend is very doubtful. Small changes to some options made remarkable changes to the results. Since Multifan-CL has a great deal of flexibility, in particular in the link between effort and fishing mortality, assumptions about this link, along with the other assumptions, should be carefully chosen for future modeling.

Discussion: There was a discussion of the need for the MULTIFAN-CL and other length based analyses, in order to provide contrast with the VPA, and in future to perhaps provide a better analysis than the VPA. These methods may be less affected by the missing size data from early years and may be preferable.

5.4 General Discussion of Stock Assessment

After discussion of the need for examination of the VPA results, and the need to begin examining the effects of uncertainty in catch-at-age, the following sensitivity runs were suggested:

1) Japanese longline data divided into 2 periods
2) Catch-at-age matrix transformed to reflect possible ageing error. Transform from one growth curve to another.
3) VPA run using only the data after 1992 or 1993.

Besides the uncertainty in the model runs, it was suggested that the fundamental issue is the contrast between two sources of information – the implications of the catch-at-age matrix used in the VPA, versus the implications of the longline, EPO and Japanese purse seine CPUE series. Compared to the importance of this issue, sensitivity analysis is less significant.

The meeting emphasized the high degree of uncertainty in the results of the analysis. Quality of catch-at-age and size data is poor in the early part of the time series, and there is uncertainty about targeting in the Japanese longline fishery. Given the very different implications of CPUE indicators of abundance, such as that derived from the Japanese longline data and the EPO purse seine fishery on the one hand, and the results of the catch-at-age analysis on the other, it is difficult to draw conclusions without resolving this incompatibility. Better data are available from the more recent period, so population dynamics of past twenty years are likely to be better represented by the models than are the population dynamics of 50 years ago. We can therefore have more confidence in the recent trend than in stock status indicators, such as spawning biomass ratio, which depend upon early data.

It was suggested that future stock condition will be driven by annual recruitment fluctuation. The high recruitment estimated for 2001 is likely to contribute substantially to spawning stock biomass in the short term.

There were several uncertainties about biological parameters, such as natural mortality, catch at age, and the maturity ogive. During the meeting, not all of uncertainties were dealt with using sensitivity analyses. The group tried a single sensitivity analysis during the meeting, using an alternative catch-at-age matrix, based on the alternative growth curve estimated by Stock Synthesis II (Doc. 19). The results (ISC/06/PBFWG/Info-04) are summarized as follows.

Catch-at-age data were adjusted by *ad hoc* transformation to simulate the slower growth rate estimated in the SS2 analysis, which is similar to the growth rate estimated in MULTIFAN-CL. A potential problem was noted with the data used in the sensitivity run, in the calculation of numbers at age, but was not regarded as serious for an *ad hoc* sensitivity run.

The sensitivity run gave quite different results from the base case (see Appendix 4). Early biomass estimates were more than two times higher than the base case, but current biomass was similar to the base case. Thus the estimated biomass trend is very different. Fishing mortality in early years is estimated to be lower than in the base case analysis. The CPUE series fits do not appear to have improved. The substantial changes that are evident demonstrate the great sensitivity of the VPA analysis to the growth rate assumption, but cannot be used to draw conclusions about stock status because of the *ad hoc* nature of the data preparation. It was noted that the higher early biomass predicted by this version of model may reflect the lower productivity implied by a slower growth rate.

6.0 SUMMARY OF STOCK CONDITION

Despite the efforts of this working group, the stock assessment still involves large uncertainties, including lack of precise information on numbers at length, catch, and reliable abundance indices in earlier time periods, and uncertainty about age and growth of larger fish. Therefore the stock condition from the 1950s to the 1980s is uncertain. Nevertheless, results from the multiple models converged to some common conclusions: biomass has local peaks in the late 1970s and late 1990s, with decline after the second peak. Recruitment in recent decades has largely fluctuated, and the 2001 year class appears to be strong. We have no evidence of recruitment failure in recent years.

Outlook for the stock in the short term depends upon the contribution to the total biomass of the 2001 year class, which might be poorly estimated. Despite this, if fishing mortality remains at the current level, the strong 2001 year class may maintain spawning biomass above the current level by 2010. However, if the fishing mortality increases by 20%, the spawning biomass can drop below the current biomass, even with the strong 2001year cohort. Therefore the working group recommends not increasing the fishing mortality any more. There remain other uncertainties such as age and growth, which can affect the outlook of the stock. Careful and continuous monitoring of the fisheries, and directed research, are necessary to obtain more precise assessments of the outlook of the stock and appropriate reference points.

7.0 RESEARCH RECOMMENDATIONS AND UPDATED WORK PLAN

7.1 Fisheries Statistics

1. Catches reported by Korea are less than the reported Japanese imports of Korean catches. The group recommends that the higher of the two estimates be used. Also, Korean scientists should be contacted to identify the source of these differences.
2. Concern was expressed over the accuracy of the catches for Chinese-Taipei purse seine in 2001-2003 (Table 1). The working group agreed to verify these values with Eric Chang, Fishery Agency.
3. Add metadata to Table 1 to explain sources of data, data collection methods, conversion factors used and any assumptions made.

7.2 Biological Studies

1. The working group reiterated that larger spatial scale studies for maturity should be conducted and ogives produced. This could be done in conjunction with research from other working groups, as all working groups appear to face similar data issues.
2. The working group also recommended that more research be conducted on natural mortality rates. Although there has been some good work on juvenile mortality rates, little or no research has focused on the mortality rates of older fishes. Perhaps if age data could be produced for the Chinese-Taipei fishery on large bluefin tuna, general estimates of natural mortality could be inferred from these large old fish.

3. Working group emphasized the need for more research on ageing, age validation, and the growth curve. This research should be a priority.
4. More work on confirming the increasing trend in condition factor of bluefin tuna was also encouraged.

7.3 Estimating Catch-at-Age table

1. Catch-at-age estimates do not equal Table 1 catches. A separate table should be created for catch at age estimates and differences between catch at age estimates and Table 1 estimates identified. The table would be useful to explain differences in Table 1 and data used in assessment (e.g. In some cases minor catches have been omitted).
2. The meeting recommended increased sampling of commercial bluefin tuna length frequencies in the EPO, particularly of fish destined for farms.
3. Historical monthly catch should be estimated for the Japanese and Korean purse seine fisheries if possible, or if not monthly, then quarterly.
4. In future, length frequency sampling of the WPO purse-seine fishery catches should be undertaken by size category.
5. Interest was expressed in seeing the sex ratio at length data.

7.4 CPUE Standardization

1. The working group recommends that model diagnostics be included in future papers and that seasonal/monthly effects be considered.
2. A recommendation was made to include more sea surface temperature data into the Japanese purse seine CPUE analysis to help in identifying fishing opportunities with zero bluefin tuna catch.
3. The group also recommended that the Japanese purse seine CPUE analysis should include recent searching day's information.
4. The working group further recommended investigations using vessel identification to potentially capture targeting effects in the Japanese purse seine fishery in the Pacific.
5. It was recommended that attempts should be made to explore creating a CPUE index of juvenile bluefin tuna for the purse seine fishery in the Sea of Japan.
6. Chinese-Taipei will clarify the practice of making 2 sets per day for the working group, and verify that the assumed 700 hooks per set is reasonable. This can be done by interviewing longline vessel captains. Additional information on longline operations should also be sought such as hooks per basket, length of branch lines, etc.
7. The group recommended that Table 2 be considered a significant basis for deciding which CPUE series should be included in the assessment.

7.5 General Recommendations

The following recommendations were suggested during stock assessment discussions. They may need to be prioritized and assigned to individuals. They may also need to be identified as short-term or long-term research items. Therefore the group felt it necessary to hold a meeting dealing these subjects.

1. There is a need for commonly agreed biological parameters such as length-weight relationships and conversion factors (K. Watanabe).
2. A high priority should be given to validating age estimation, particularly for the oldest ages, given the importance of growth and longevity (C.C. Hsu). A working group on age and growth should be set up.
3. Further work should be carried out to improve estimates of natural mortality rate, the maturity ogive (S. Tanaka), and seasonal length-weight relationships, perhaps by area as well (K. Watanabe).
4. Encourage further development, improvement of integrated modeling (S. Hoyle, K. Piner, M. Ichinokawa, and Y. Takeuchi).
5. A desktop exercise should be undertaken to investigate available biological parameters in past literature for Pacific bluefin tuna and related species, as was done for striped marlin (PIFSC).

7.6 Others

1. The meeting recommended that in future each member country should send a representative.
2. Scientists familiar with fisheries data collection procedures from countries should attend species working group meetings.
3. Category II and III data should be supplied directly to the Statistics Working Group (STATWG) central database. The data would then be made available to the various species working groups for their review. Species working groups would then evaluate the data and recommend any changes to the STATWG. The STATWG would then compile recommended changes from all species working groups and obtain changes from the data correspondents.

8.0 ADMINISTRATIVE MATTERS

It is believed that an inter-sessional meeting will be required to work with data, to work on the longline time series, and to decide on future assessment methods. A proposal was made for one or perhaps two inter-sessional meetings in 2007. One meeting would concentrate on data preparation, and the other on development of stock assessment methods. Timing of the working group meeting to prepare the official assessment was discussed. Attaching the meeting to the ISC plenary would ensure better attendance at the working group meeting, but would cause difficulty for delegation leaders, who need time to digest the assessment documents.

9.0 ADJOURNMENT

The report was adopted after the careful review of the draft report. The Chair thanked all participants and the rapporteurs for their contribution in making this a successful meeting. The meeting was adjourned at 14:30 on 20 January 2006.

Table 1. Catch of Pacific bluefin tuna by country and gear.

revised Jan 19 2006

unit: metric tones

Year	Western Pacific states: Japan ※1 Purse Seine	Japan Longline	Japan Troll	Japan Pole and Line	Japan Set Net	Japan Drift Net	Japan Handline	Japan Others	Japan total	Korean ※2 Purse seine	Korean Trawl	Taiwan Longline	Taiwan Purse Seine	WPO Total	Eastern Pacific states: United States ※3 Pole and Line	US Purse Seine	US Longline	US Troll	US Gillnet	US Other	US Sport	US total	Mexico Purse Seine	Mexico Pole and Line	Mexico Longline	Mexico Unidentified	EPO Total	Grand Total
1952	3,690	2,581	439	4,852	2,145	286	37	34	14,064					14,064		2,076					2	2,078					2,078	16,142
1953	4,189	1,998	1,465	3,049	2,335	9	50	74	13,169					13,169		4,433					48	4,481					4,481	17,650
1954	4,043	1,588	1,656	3,041	5,579	48	188	31	16,173					16,173		9,537					11	9,548					9,548	25,721
1955	10,561	2,099	1,507	2,839	3,256	15	146	103	20,526					20,526		6,173					93	6,266					6,266	26,792
1956	15,810	1,242	1,765	4,058	4,170	24	572	107	27,748					27,748		5,727					388	6,115					6,115	33,863
1957	15,971	1,490	2,395	1,795	2,822	14	161	33	24,680					24,680		9,215					73	9,288					9,288	33,968
1958	7,860	1,429	1,509	2,337	1,187	7	148	35	14,512					14,512		13,934					10	13,944					13,944	28,456
1959	9,108	3,667	1,011	586	1,575	1	102	51	16,100					16,100		6,914					15	6,929					6,929	23,029
1960	9,268	5,784	1,846	600	2,032	67	218	78	19,893					19,893		5,422					1	5,423	0	0			5,423	25,316
1961	8,120	6,175	3,116	662	2,710	19	511	68	21,380					21,380		8,136					26	8,162	130	0			8,292	29,672
1962	9,501	2,238	978	747	2,545	6	233	50	16,298					16,298		11,268					28	11,296	294				11,590	27,888
1963	8,677	2,104	2,403	1,256	2,797	18	203	59	17,517					17,517		12,271					8	12,279	412				12,691	30,208
1964	7,950	2,379	2,739	1,037	1,475	9	256	100	15,945					15,945		9,218					8	9,226	131				9,357	25,302
1965	10,173	2,062	1,429	831	2,121	52	173	130	16,972			54		17,026		6,887					1	6,888	289				7,177	24,203
1966	8,790	3,388	1,502	613	1,261	42	54	18	15,667			0		15,667		15,897					23	15,920	435	0			16,355	32,022
1967	5,750	2,099	3,115	1,210	2,603	39	113	130	15,060			53		15,113		5,889					36	5,925	371				6,296	21,409
1968	8,341	2,278	1,407	983	3,058	6	196	1	16,271			33		16,304		5,976					1	5,977	195				6,172	22,476
1969	2,876	1,366	1,836	721	2,187	32	149	3	9,170			23		9,193		6,926					17	6,943	260				7,203	16,396
1970	2,644	1,123	1,181	723	1,779	62	151	2	7,666			0		7,666		3,966					21	3,987	92	0			4,079	11,745
1971	3,559	757	2,189	938	1,555	35	188	3	9,223			1		9,224		8,360					8	8,368	555	0			8,923	18,147
1972	3,827	724	2,385	944	1,107	39	112	3	9,140			14		9,154		13,348					17	13,365	1,646	0			15,011	24,165
1973	2,001	1,158	3,519	526	2,351	309	249	19	10,132			33		10,165		10,746					61	10,807	1,084	0			11,891	22,056
1974	3,679	1,220	2,994	1,192	6,019	335	316	28	15,784			47		15,831		5,617					65	5,682	344	0			6,026	21,857
1975	4,308	1,558	941	1,401	2,433	676	104	1	11,422			61		11,483		9,583					38	9,621	2,145	0			11,766	23,249
1976	1,964	520	920	1,082	2,996	1,085	136	5	8,709			17		8,726		10,646					23	10,669	1,968	0			12,637	21,363
1977	3,960	712	2,230	2,256	2,257	884	142	5	12,446			131		12,577		5,473					21	5,494	2,186				7,680	20,257
1978	8,878	1,049	4,757	1,154	2,546	2,030	113	40	20,567			66		20,633		5,396					5	5,401	545				5,946	26,579
1979	12,266	1,223	2,659	1,250	4,558	1,541	265	394	24,157			58		24,215		6,118					12	6,130	213	0			6,343	30,558
1980	10,414	1,170	1,494	1,392	2,521	1,479	142	310	18,922			114		19,036		2,938					8	2,946	582	0			3,528	22,563
1981	23,219	796	1,758	754	2,129	2,130	139	272	31,197			179		31,376	0	867	0	10	4	1	6	888	218	0			1,106	32,482
1982	16,180	880	872	1,777	1,667	1,577	37	9	22,998	31		207		23,236	1	2,639	0	0	1	2	7	2,650	506	0			3,156	26,392
1983	14,105	707	2,020	356	972	807	32	53	19,051	13		175		19,239	6	629	0	0	3	125	21	784	214	0			998	20,237
1984	4,016	360	1,905	587	2,234	532	108	17	9,761	4		477		10,242	4	673	1	0	4	25	31	738	166	0			904	11,146
1985	4,239	496	1,920	1,817	2,562	728	232	32	12,026	1		210		12,237	3	3,320	0	0	6	146	55	3,530	676	0			4,206	16,443
1986	7,466	249	1,562	1,086	2,914	316	143	9	13,745	344		70		14,159	1	4,851	0	0	15	323	7	5,197	189	0			5,386	19,545
1987	7,771	346	1,030	1,565	2,198	258	50	0	13,218	89		365		13,672	0	861	0	0	2	112	21	996	119	0			1,115	14,787
1988	2,931	241	1,190	907	843	371	32	0	6,515	32		108	197	6,852	4	923	0	0	4	73	4	1,008	447	0	1		1,456	8,308
1989	5,624	440	1,025	754	748	173	30	1	8,795	71		205	259	9,330	8	1,046	0	0	3	54	70	1,181	57	0			1,238	10,568
1990	2,960	396	1,291	536	716	256	57	38	6,251	132		189	149	6,721	61	1,380	0	0	10	94	40	1,585	50	0			1,635	8,356
1991	8,217	285	2,168	286	1,485	236	68	36	12,782	265		342	-	13,389	0	410	2	0	4	5	57	478	9	0			487	13,876
1992	6,147	573	908	166	1,208	888	97	1	9,988	288		464	73	10,813	1	1,928	38	0	8	81	93	2,149	0	0			2,149	12,962
1993	5,675	857	534	129	848	159	102	2	8,305	40		471	4	8,820	5	580	42	0	31	25	114	797	0	0			797	9,617
1994	6,919	1,138	3,427	206	1,158	126	74	101	13,149	50		559	-	13,758	1	906	30	0	28	101	24	1,090	63	0		2	1,155	14,913
1995	15,978	769	4,631	307	1,859	110	77	38	23,770	821		335	2	24,928	1	689	29	0	19	0	166	904	10	0			914	25,842
1996	6,641	978	3,296	256	1,149	67	203	6	12,597	102		956	-	13,655	0	4,523	25	2	43	0	30	4,623	3,700	0			8,323	21,978
1997	11,123	1,383	2,676	71	803	109	264	6	16,436	1,054		1,814	-	19,304	1	2,240	26	1	57	0	90	2,415	367	0			2,782	22,086
1998	4,371	1,260	2,701	120	874	91	139	8	9,564	188		1,910	-	11,662	4	1,771	54	172	40	1	213	2,255	1	0			2,256	13,918
1999	13,440	1,155	3,236	124	1,097	59	78	13	19,202	256		3,089	-	22,547	2	184	54	8	19	2	397	666	2,369	5	30		3,070	25,617
2000	14,021	1,005	4,503	256	1,125	51	198	23	21,181	794	0	2,780	2	24,757	12	693	19	1	29	0	220	974	3,025	61	42		4,102	28,859
2001	6,727	1,004	3,266	332	1,366	100	334	23	13,152	995	10	1,839	104	16,100	1	149	6	6	34	0	226	422	863	0			1,285	17,385
2002	8,009	889	2,448	187	1,011	212	361	17	13,133	674	1	1,523	4	15,335	2	50	2	1	7	0	348	410	1,708	1	5		2,124	17,459
2003	5,680	1,230	801	59	439	43	465	202	8,920	1,591	0	1,863	21	12,395	2	22	1	0	14	0	229	268	3,211	0	46		3,525	15,920
2004	6,340	1,311	922	237	520	81	863	147	10,421	636	0	1,714		12,771	0	0	1	0	10	0	34	45	8,880	0	11		8,936	21,707
2005	3,090	870	1,046	604	632	87	-	104	6,433	950		1,366		8,749	0	165	0	0	0	0	56	221					221	8,970

*1: until June for 2005
*2: Catch statistics of Korea derived from Japanese Import statistics for 1982-1999, and from the Statistical Document Program for 2005 (minimum estimates).
*3: preliminary for 2005

Table 2. Subjective criteria for evaluating CPUE indices from different data sources.

Index (*paper #*)	Positive only	Spatial extent	Size category defined	targeting	Temporal coverage	Data quality	Diagnostics available
Age-0 Japan troll (*ISC PBFWG 10*)	yes	good?	yes	yes	1980-present	good aggregated month representative of area	No
Habitat-based EPO *(ISC PBFWG 11)*	no	Limited to EPO	yes	yes	1960-present	good	Fairly good
CPVF recreational (*ISC PBFWG12)*	no	Limited to small part EPO	yes	no- composite of pelagic and groundfish trips	Extensive 1936-present	poor - Aggregated Small sample size Some bias possible	Fairly good
Japanese PS (*ISC PBFWG 13)*	yes	limited to WPO	no	sometimes	1981-present	good	No
Chinese-Taipei LL (*ISC PBFWG 14)*	yes	limited spawning area	yes	yes	1999-present	good catch poor effort	Fairly good
Japanese LL offshore Quarter 1,3,4 (*ISC PBFWG15)*	no	WPO	yes	no	1952-present	good	No
Japanese LL offshore Quarter 2 (*ISC PBFWG 15)*	no	coastal Japan	yes	sometimes	1952-present	good	No
Japanese Coastal LL Quarter 2 (*ISC PBFWG 15)*	no	coastal Japan	yes	yes	1994-present	good	No
Japanese Coastal LL Quarter 1,3,4 (*ISC PBFWG 15)*	no	coastal Japan	yes	no	1994-present	good	No

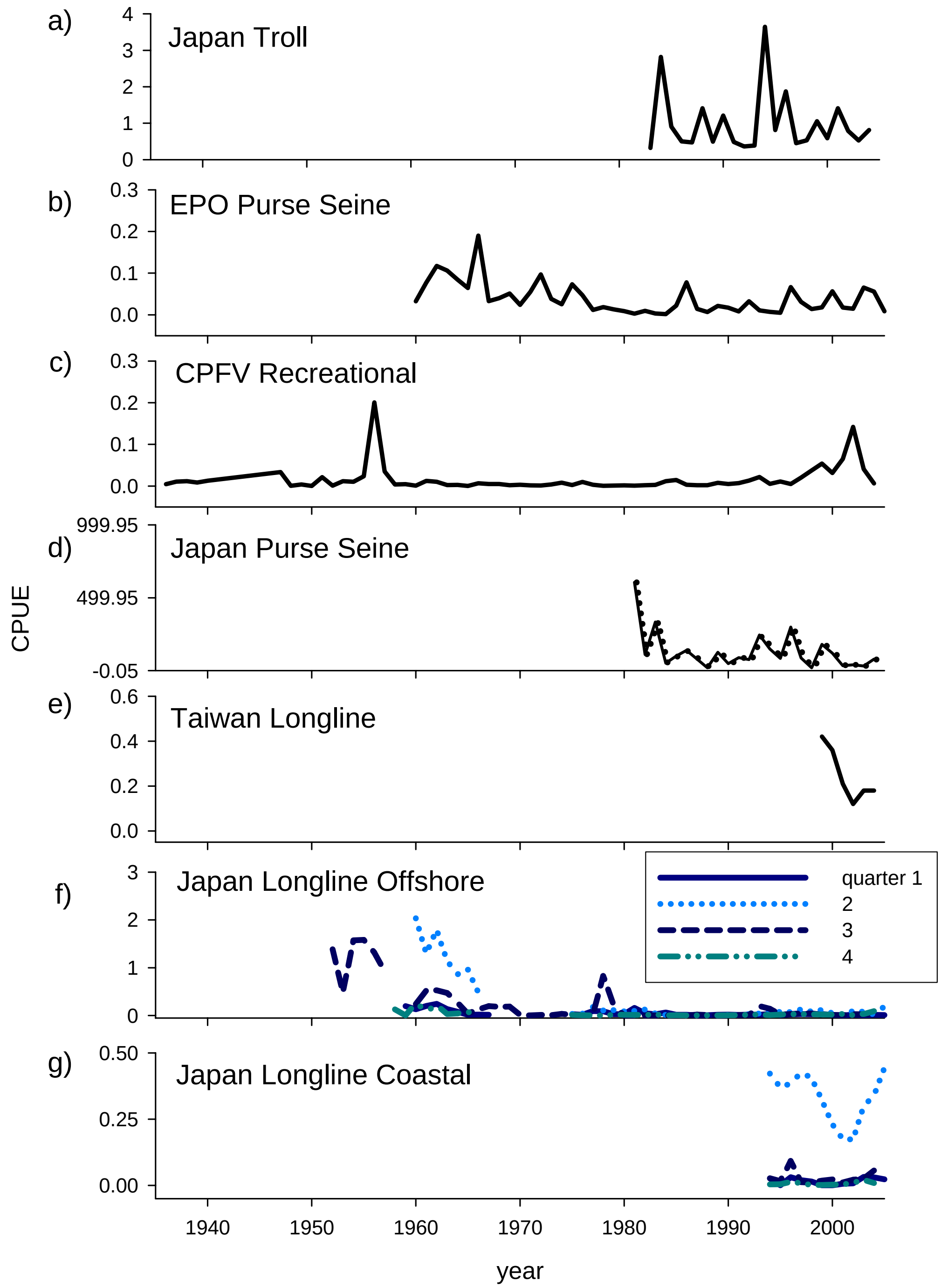

Figure 1. Time series of estimated CPUE from different data sources. In d) the solid line depicts the annual index and the dotted line the quarterly index. In f) and g) quarterly indices are shown.

Appendix 1

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Appendix 2

List of Documents

ISC/06/PBFWG/01	United States Catch Time Series for Pacific Bluefin Tuna in the North Pacific Ocean. Atilio L. Coan Jr.
ISC/06/PBFWG/02	Reviews of Japanese Fisheries and Catch Estimation on the Pacific Bluefin Tuna. Mio Takahashi
ISC/06/PBFWG/03	Pacific Bluefin Tuna Fishery in Chinese-Taipei. Chien-Chung Hsu
ISC/06/PBFWG/04	Biological Parameters Used for the Pacific Bluefin Tuna Stock Assessment in the ISC PBFWG. Harumi Yamada
ISC/06/PBFWG/05	Reconstructing von Bertalanffy Growth Equation of Pacific Bluefin Tuna (*Thunnus orientalis*) with Additional Spawners Scale Samples from the Southwestern North Pacific Ocean. Chien-Chung Hsu and Kuo-Shu Chen
ISC/06/PBFWG/06	An Investigation of Length-Weight Relationship for Pacific Bluefin Tuna. Kyuji Watanabe, Harumi Yamada and Mio Takahashi
ISC/06/PBFWG/07	Estimation of Natural Mortality of Age 0 Pacific Bluefin Tuna from Conventional Tagging Data. Yukio Takeuchi and Mio Takahashi
ISC/06/PBFWG/08	Habitat SST of Young Pacific Bluefin Tuna, Based on Archival Tag Data. Mio Takahashi, Yukio Takeuchi and Harumi Yamada
ISC/06/PBFWG/09	Maturation of Bluefin Tuna in the Sea of Japan. Sho. Tanaka
ISC/06/PBFWG/10	Standardization of CPUE of age-0 Pacific Bluefin Tuna by Japanese troll fishery. Harumi Yamada and Yukio Takeuchi
ISC/06/PBFWG/11	Habitat-Based Index and Standardized Index of Catch per Unit Effort Derived from Captain's Logbooks and Observer Records for Purse-seine Vessels Fishing between 1960 and 2005. Simon Hoyle and Kevin Piner
ISC/06/PBFWG/12	Bluefin Tuna CPUE Index Derived from Commercial Passenger Fishing Vessel Logbooks 1936-2004. Kevin Piner, Ray Conser and Simon Hoyle
ISC/06/PBFWG/13	An Updated Standardization of a Bluefin Tuna CPUE by Japanese Purse Seine Fishery in Pacific Side of Japanese Coastal Water. Yukio Takeuchi and Harumi Yamada
ISC/06/PBFWG/14	New Abundance Index for the Small-Scale Longline Fishery Targeting Spawning Bluefin Tuna (*Thunnus orientalis*) in the Southwestern North Pacific Ocean. Hui-Hua Lee and Chien-Chung Hsu
ISC/06/PBFWG/15	Standardization of CPUE in the Pacific Bluefin Tuna Caught by Japanese Offshore and Coastal Longliners. Momoko Ichinokawa and Yukio Takeuchi
ISC/06/PBFWG/16	Sampling the Catch of Bluefin Tuna (*Thunnus orientalis)* for Length Composition. S. Hoyle

ISC/06/PBFWG/17	Estimation of Pacific Bluefin Tuna Catch-At-Age by Fishery in the North Pacific. Mio Takahashi and Harumi Yamada
ISC/06/PBFWG/18	Updated Stock Assessment of Pacific Bluefin Tuna, Using a Tuned VPA. Harumi Yamada
ISC/06/PBFWG/19	Evaluation of the Use of the Fully Integrated Length-Structured Stock Assessment Model Stock Synthesis II for Use in Modeling Northern Bluefin Tuna. Kevin Piner, Ray Conser, Hui-Hua Lee and Simon Hoyle
ISC/06/PBFWG/Info-01	Behavior of Bluefin Tuna Schools in the Eastern North Pacific Ocean as Inferred from Fishermen's Logbooks, 1960-67. J. Michael Scott and Glenn A. Flittner
ISC/06/PBFWG/Info-02	Amount of Pacific Bluefin Tuna Imported to Japan by Country Based on the Statistical Document Program. Harumi Yamada
ISC/06/PBFWG/Info-03	Catch Table by Country and Fishery. Mio Takahashi
ISC/06/PBFWG/Info-04	Sensitivity Test for Growth Curve on the VPA Results. Yukio Takeuchi, Mio Takahashi, Harumi Yamada and Momoko Ichinokawa

Appendix 3

Meeting Agenda

1. Opening

2. Fisheries Statistics for Pacific Bluefin Tuna
   2.1 Fisheries report by members
   2.2 Import of PBF to Japan

3. Biological Studies

4. Stock Assessment Studies
   4.1 CPUE indices
   4.2 Catch-at-Age/Size
   4.3 Condition of Stock
   4.4 Summary of Findings on Stock Condition

5. Research Recommendations
   5.1 Fisheries Statistics
   5.2 Biological Studies
   5.3 Stock Assessment Studies
   5.4 Others

6. Future Arrangement

7. Adoption of Report

8. Adjournment

Appendix 4

Results of Exploratory Analyses Using Different Stock Assessment Models and Available Data

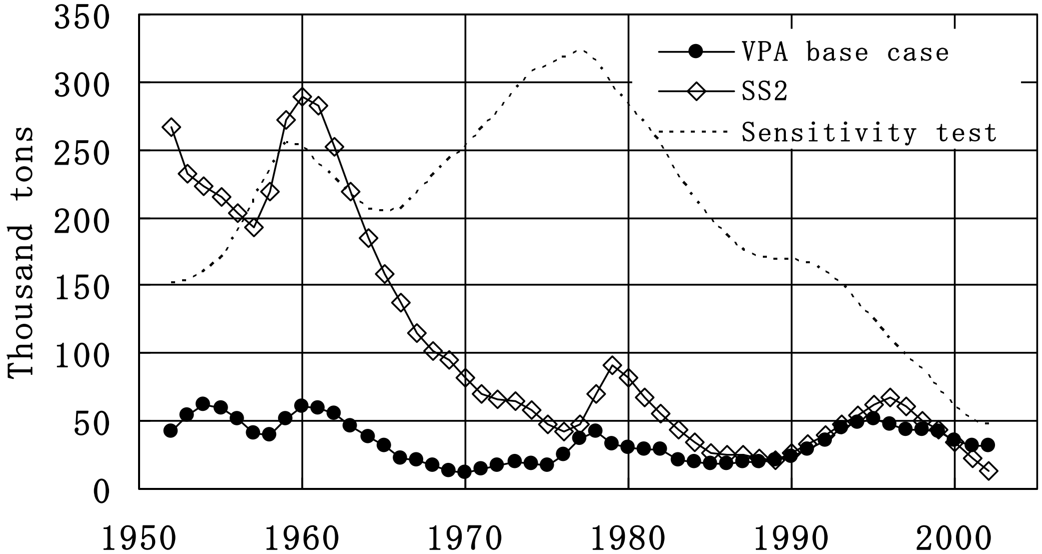

Figure 1. Comparison of estimated spawning stock biomass for Pacific bluefin tuna from analyses reviewed by the PBFWG.

The comparison above was constructed for exploratory purposes only because the data and assumptions used by the different analyses were not the same. Sources for the above comparison are "VPA base case" from ISC/06/PBFWG/18 and "SS2" from ISC/06/PBFWG/19. "Sensitivity test" is based on the VPA base case model using an ad hoc catch-at-age matrix with an alternative slower growth curve, which was estimated by the SS2 model. The time of year for the spawning stock biomass estimates (SSB) is also different for the different analyses. SS2 estimates SSB for the first quarter of each year. VPA base case and Sensitivity test estimate SSB for the end of the second quarter of each year.