# ANNEX 6

*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 Albacore Working Group Meeting (November 28 – December 2, 2005, La Jolla, CA, U.S.A.)

## 1.0 INTRODUCTION

The meeting of the ISC Albacore Working Group was held in La Jolla, California, U.S.A. during November 28 – December 2, 2005. This was the first meeting of the Working Group since the induction of the North Pacific Albacore Workshop into the International Scientific Committee (ISC) as the sixth Working Group. Roger Hewitt, on behalf of the Southwest Fisheries Science Center Director opened the meeting and welcomed all participants. Max Stocker (Canada) chaired the meeting. Gerard DiNardo, Jerry Wetherall, Paul Crone, Simon Hoyle, Kevin Piner, Yukio Takeuchi, Suzy Kohin, Mark Maunder and Ray Conser were appointed rapporteurs. Scientists from Canada, Chinese-Taipei, Japan, U.S.A., and IATTC participated (Appendix 1). Fourteen working documents were tabled (Appendix 2). The draft agenda was reviewed and adopted with minor modification (Appendix 3).

The primary focus of this meeting was to outline preparations for conducting the next North Pacific albacore assessment in 2006. The meeting also considered appropriate reference points for North Pacific albacore, both with respect to fishing mortality and stock abundance; choice of modeling platforms for the 2006 assessment; research studies needed to improve knowledge of albacore biology; the process to update fisheries data and other information; and to update North Pacific albacore catches to 2004.

## 2.0 REVIEW OF RECENT FISHERIES

### 2.1. Canada

Max Stocker presented a summary of catch, effort, and catch per unit of effort (CPUE) data for the Canadian North Pacific albacore tuna fishery in 2004 (ISC/05/ALBWG/12). The Canadian fishery for albacore in the North Pacific is a troll fishery using tuna jigs. All Canadian vessels must carry logbooks while fishing for highly migratory species in any waters. Detailed analysis of a combination of sales slips, logbooks, phone-in and transshipment records are undertaken to report fisheries statistics for the Canadian albacore fishery.

In 2004, 218 Canadian vessels operated in the North Pacific and caught 7,796 tonnes (t) of albacore (Table 1) in 9,728 vessel days of fishing for a CPUE of 0.8 t/vessel-day. Estimates for

2004 are considered preliminary. Both catch and CPUE have followed an increasing trend over the period 1995-2004. As in previous years, most of the 2004 catch was taken within 200-miles of the North American coast. Access by Canadian albacore vessels to waters in the U.S. EEZ is governed by a U.S.-Canada albacore treaty.

2.1.1. Discussion

Questions were raised by workshop participants as to whether the number of fishing vessels will change in future. While future vessel participation is difficult to predict, it was suggested that the number of fishing vessels may decrease due to treaty arrangements for access of Canadian boats to U.S. waters to fish for albacore and raising fuel costs.

2.2. Chinese-Taipei

C.-C. Hsu presented a summary of catch and effort trends in the Chinese-Taipei longline fisheries (presentation; no written report). Two Chinese-Taipei tuna fisheries currently operate in the North Pacific Ocean, namely the distant-water longline fishery (DWLL) and offshore longline fishery (OSLL). The DWLL fleet operates between 20° N and 20° S latitude fishing for tropical tunas and billfishes with deep-set gear and in temperate waters of the North Pacific and South Pacific targeting albacore with conventional longline gear. In the North Pacific, DWLL vessels operate in the winter and spring north of 25° N and east of 150° E catching albacore, then move south of 15° N to fish for bigeye tuna. In 2004, 25 DWLL vessels caught an estimated 4,061 t of albacore in the North Pacific compared with 23 vessels catching 6,454 t in 2003.

The OSLL fleet operates between 10° N and 25° N latitude and 115° E and 150° E longitude, e.g., in coastal waters east of Chinese-Taipei, around Luzon Island, and in the Bashi Channel. OSLL vessels deploy only 1/3 to 1/2 the number of hooks used on DWLL vessels and catch primarily yellowfin tuna, with smaller catches of bigeye tuna, billfishes, and other species. They also fish for Pacific bluefin tuna from April to June. Preliminary data for 2004 show that 333 OSLL vessels landed 927 t of albacore in Chinese-Taipei ports compared with 348 vessels catching 712 t of albacore in 2003.

A distant-water drift gill net fishery, once an important fishery in the North Pacific Ocean targeting flying squid and albacore, was discontinued after 1992 due to the United Nations resolution prohibiting large-scale high-seas drift net fishing.

2.2.1. Discussion

Meeting participants noted that the submitted longline catch and effort statistics differed from those archived in the database. For example, catch in recent years has almost doubled compared to previously submitted data. A similar pattern was observed with fishing effort. Changes in reported longline catch and effort are thought to be due to corrected fishing locations, which moved fishing catch and effort from the South Pacific to the North Pacific. After much discussion it was agreed that Eric Chang (Chinese-Taipei Data Correspondent) should be contacted to clear up the discrepancies. In the meantime the updated statistics from 1989 to 2004 will be adopted and included in Table 1. At this time updated statistics prior to 1989 will not be

adopted until discussions with Eric Chang have concluded and a favorable consensus reached.

2.3. Japan

K. Uosaki reported that Japan has two major fisheries that catch albacore in the North Pacific, namely pole-and-line and longline (presentation; no written report). Other miscellaneous fisheries include troll, and drift-net fisheries. Total catches by the Japanese fisheries were 58,817 t in 2003, and 55,109 t in 2004. All 2004 figures are preliminary estimates. The albacore catch by the two major fisheries account for more than 87% of the total catch in recent years.

Pole-and-line catches were 36,121 t in 2003, and 32,361 t in 2004. The pole-and-line fishery catches albacore during summer and autumn from off Honshu-island through the Emperor Sea Mountain area, while this fishery primarily catches skipjack tuna out of season for albacore.

The catches by the longline were 20,915 t in 2003, and 15,593 t in 2004. The catch shows a declining trend since 1996 when the catch peaked at 38,000 t. The longline fishery can be classified into two categories, the distant water and offshore longline fishery (by larger than 20 GRT vessels) and the coastal longline fishery (by smaller than 20 GRT vessels). The catches by both fisheries show a declining trend in recent years.

2.3.1. Discussion

There was some discussion by meeting participants as to whether longline effort and pole and line effort had been decreasing since 2000. While no conclusion was reached, it was noted that the number of vessels in the longline and pole and line fisheries have been decreasing.

2.4. Mexico

Mexico was unable to participate in the meeting, but L. Fleischer provided an update of albacore catch statistics for Mexican tuna fisheries. This information has been incorporated in Table 1. Effort by the fleet purse seine fleet is directed primarily toward catching yellowfin tuna in the Eastern Tropical Pacific (ETP). Albacore are caught incidentally by purse seine vessels involved part time in targeting bluefin tuna to supply bluefin ranching (rearing) activities that developed in recent years along the northwest coast of Mexico. The few boats involved in bluefin tuna searching will occasionally set on albacore, mainly when they are not able to find bluefin.

Mexico's National Tuna-Dolphin Program (PNAAPD) reported that the purse seine vessels caught 29 t of albacore in 2003 and 107 t in 2004 (Table 1).

2.4.1. Discussion

Meeting participants noted that catch statistics provided in the update differed from those previously reported. Because no representative from Mexico attended the meeting, it was agreed that A. Coan would contact L. Fleischer to clear up the observed discrepancies and finalize reported catch.

2.5. United States

J. Childers presented an update of trends in catch and effort by the U.S. albacore troll fishery (ISC/05/ALBWG/02). Distant-water troll vessels begin fishing albacore in the central Pacific Ocean (around the International Date Line) in April and May. As the fish become available off the North American coast in June and early July, coastal vessels enter the fishery. The troll fishery is most successful between August and November off the coasts of Washington and Oregon. The total albacore catch for U.S. North Pacific troll fishery was 13,432 t in 2004 (preliminary estimate).

Data sources used to develop catch time series represent 100% coverage, and are from the Pacific Fisheries Information Network (PacFIN) data base (landing receipt information), fishing industry catch reports (Western Fishboat Owners Association), catch reports from the Pacific Islands Fisheries Science Center in Honolulu (NMFS), and catch reports from U.S. canneries in American Samoa. In recent years the major purchasers of troll caught albacore by the U.S. fleet have changed from U.S. canneries to markets in Europe and Canada. In 2004, voluntary logbook data represented 40% of the fleet's catch. Starting in 2005, submission of logbooks by U.S. troll vessels was mandated as a requirement of the Highly Migratory Species Fishery Management Plan.

Biological data are collected through a port sampling program conducted in collaboration with state (and 'territory') fishery agencies in California, Oregon, Washington, Hawaii, and American Samoa. Sampling coverage for length measurements usually represents approximately 1% of the catch. U.S. fishermen and NMFS observers also collect length samples to augment port sampling. In 2004, a total of 30,453 albacore were measured via the port sampling program. Length distributions from the U.S. troll fishery have been very consistent over the last 10 years, with average size varying only a few centimeters over the years. In 2004, albacore ranged from 47-98 cm in length, with an average of 68 cm.

J. Wetherall reported on the U.S. longline fleets based in Hawaii and California (ISC/05/ALBWG/13). A total of 125 U.S. longline vessels were active in 2004. Of these, 17 also landed catches in California. In 2004, the fleet deployed 32.0 million hooks and landed a total of 362 t of albacore. (Table 1).

U.S. longline vessels do not target albacore, but catch them incidentally while using shallow-set gear aimed at harvesting swordfish or gear set deeper in the water column directed at catching bigeye tuna or yellowfin tuna. Longline vessels based in Hawaii fish primarily in central Pacific waters from about latitude 40°N to the equator and between the international dateline and about 140°W. Prior to 2001, a significant portion of the fleet fished for swordfish in the Subtropical Frontal Zone north of Hawaii, where interactions with sea turtles were more frequent than in tuna fishing grounds in lower latitudes. In late 2000, Hawaii-based longline vessels were temporarily prohibited from targeting swordfish in the North Pacific, a measure intended to protect sea turtles. The fleet's operations then focused on catching primarily bigeye tuna in waters south of 25°N. The prohibition ended on April 2, 2004, and vessels based in Hawaii were allowed to resume shallow-set operations targeting swordfish, subject to strictly enforced limits on the number of sets, use of circle hooks, use of mackerel or mackerel-like bait only, limits on the

number of interactions with leatherback and loggerhead turtles, and other restrictions. California-based vessels operate primarily in waters of the North Pacific Transition Zone between about longitude 120°W and the dateline. Longline fishing is not permitted within California's 200-mile EEZ, and since May 2004, California-based longliners have been prohibited from targeting swordfish.

NMFS monitors the catch of U.S. longline vessels through mandatory logbooks submitted by longline vessel captains. In addition, observers deployed by NMFS to monitor interactions with sea turtles and other protected species opportunistically collect biological data on albacore and other fish species. Observers measured fork lengths of 4,358 albacore onboard Hawaii-based longline vessels in 2004. Observers on California-based vessels measured 83 albacore in 2004.

## 3.0 FISHERY STATISTICS

### 3.1. International Scientific Committee Albacore Working Group Data Base Catalog

A. Coan reported on the current status of the ISC Albacore Working Group Data Base Catalog (ISC/05/ALBWG/01), including additions and updates made since the November 25 - December 2, 2004, Nineteenth North Pacific Albacore Workshop. The Data Base Catalog provides tables of fleet and gear specific data on annual catches of North Pacific albacore and the number of active vessels in each fishery (Category I), summarized logbook catch and effort data by five-degree or one-degree square and month strata (Category II), and size composition data by five-degree or one-degree square and month strata (Category III).

A call for data was placed to data correspondents in August, 2005, for updates to the data base. Updates were received from Chinese-Taipei, Japan, U.S.A. and Canada. The majority of the updates were for 2003 and 2004 data for Category I, II and III data. However, Chinese-Taipei revised the complete series of data for 1964 to 2004 for Category I and II data. Further Category I updates for 2003 and 2004 were received at the current meeting for Chinese-Taipei and Mexico and these were incorporated into Table 1.

The data are still being maintained by the Southwest Fisheries Science Center (SWFSC) in La Jolla, CA, U.S.A, in data bases on a secure FTP server at the Alaska Fisheries Science Center. The SWFSC oversees the distribution of data to ISC Albacore Working Group members and other scientists using the FTP site. The FTP site is accessible at ftp.afsc.noaa.gov. Access requires a user account and password. In addition to Category I, II and III data bases and metadata, the site also archives the data base catalog, Working Group meeting/workshop reports, working papers from previous workshops, and derived analysis data sets (e.g., estimated catch-by-age matrices) used in albacore stock assessments.

#### 3.1.1. Discussion

Meeting participants discussed the utility of category III data (size data) from the Chinese-Taipei DWLL, and it was again agreed that size frequency data from 1981-2003 would not be used in subsequent assessments. Participants also discussed the future of the Albacore Working Group FTP and Web sites. In the future, the ISC Statistics Working Group will be responsible for

maintaining the official ISC web site. However, it is unclear whether adequate resources are available to facilitate development and maintenance of this site. Participants agreed that A. Coan should discuss this at the January 2006 meeting of the ISC Statistics Working Group.

## 4.0 REVIEW OF BIOLOGICAL STUDIES

The Working Group reviewed various research studies that generally addressed the biology of albacore, including: migration (archival tagging projects); reproduction (fecundity/maturity-related research); and growth (length-weight relationship).

### 4.1. Archival Tagging Study

S. Kohin presented an update of the Southwest Fisheries Science Center's ongoing North Pacific albacore archival tagging program (ISC/05/ALBWG/04). The project is now in its fifth year. As of Nov. 2005, 384 archival tags have been deployed in juvenile albacore. Tagging efforts have concentrated in two areas: off the coast of southern California and Baja California Mexico where a large sport fishing fleet operates; and off the coast of Oregon and Washington where the U.S. and Canada troll fleets operate. A total of 15 archival tags have been returned by fishers. The data demonstrate quite a variation in individual fish movements with some fish making extensive migrations over the course of one year, to areas offshore and as far west as 145-170° W during winter months, whereas others remained more coastal throughout the year utilizing areas off the coast of Baja California, Mexico. Data from more fish are necessary to determine whether any consistent migratory patterns exist. All fish demonstrated diurnal diving behavior with repetitive diving to depths below the thermocline during the day and remaining closer to the surface at night. The results are preliminary, and are currently being analyzed to refine location estimates. In 2006, if funding is secured, two tagging trips will be conducted to deploy another 120 tags.

### 4.2. Sampling Design for Maturity Study

P. Crone presented an adaptive sampling framework for collecting maturity-related data regarding albacore of the North and South Pacific Oceans (ISC/05/ALBWG/03). Population models for North and South Pacific albacore are based on maturity-related data accumulated in the mid-1950s and ultimately, a step-function maturity schedule is defined by 50% mature-at-age 5 and fully-mature for age 6 and older. In general, maturity schedules of fish populations represent critical (and influential) time series in typical stock assessments conducted by fishery researchers world-wide. Ultimately, these reproductive-based stock parameters are used to estimate levels of spawning stock biomass (SSB), both spatially and temporally, which provides the basis for assessing the overall status (health) of an exploited fish population. Since 2000, the Albacore Working Group of the International Scientific Committee has strongly recommended that a population-wide reproductive biology study be revisited and further, if possible, to develop such a study collaboratively with nations within the ISC. In general, the overriding objective of the research proposed here is to rigorously (in statistical and practical terms) compare female maturity schedules between the North and South Pacific albacore populations and subsequently, to provide researchers the most appropriate reproductive time series to use in stock assessments presently conducted. Secondary objectives of the study include: detailed evaluations of stages of gonad maturation via histological examinations of gamete subsamples; developing indices of

well-being, such as the Gonadosomatic Index, GSI; examining sex ratio statistics, and providing ecological-related information concerning extent of spawning distributions and seasonality. The proposed sampling design will allow spatial/temporal partitioning within the overall statistical analysis, which is necessary to account for potential biases associated with determining representative (accurate) maturity schedules for highly migratory species that are typically characterized by both broad timing (seasonality) and distribution (range) of spawning. Design-related discussion generally addressed field, laboratory, and analysis methods, as well as anticipated costs. Finally, the proposed study would necessarily rely on support (funds, field/laboratory/analysis staff, etc.) from particular countries/institutions associated with both the ISC ALBWG and Western and Central Pacific Fisheries Commission (WCPFC).

4.3. Reproductive Biology Study

C.-C. Hsu presented an update to a reproductive biology study of North Pacific albacore, *Thunnus alalunga*, (ISC/05/ALBWG/09). Histological investigations of gonads were conducted on 105 females and 115 males during 2001-2005 from the central and western North Pacific Ocean. Only samples from the western North Pacific Ocean included females with reproductively-active ovaries and thus, based on this sample study area, spawning occurred from March to September, with a peak in March and April. The estimated length-at-50% maturity (86 cm fork length, FL) was similar for both females and males. Estimated logistic-based maturity schedules follow: for females, $p = \frac{1}{1+e^{-0.9318(L-86.07)}}$; and for males, $p = \frac{1}{1+e^{-0.7488(L-86.48)}}$. All large (>101 cm) albacore in the sample were males. The estimate of spawning frequency, based on the postovulatory follicle method, was 1.7-3 days during the peak spawning months of March and April. The estimate of batch fecundity, determined by counting migratory-nucleus-stage and hydrated oocytes of 21 females (89-99 cm FL), ranged from 0.17 to 1.66 million eggs, with a mean (±1SD) of 0.94 (±0.43).

4.4. Growth Study

K. Watanabe presented results from a weight-length relationship study on North Pacific albacore (ISC/05/ALBWG/07). Length-weight (L-W) relationships for the North Pacific albacore by sex, area, season, and year from 1990 to 2004 were investigated. The results were as follows: (1) the L-W relationship for males and females in the length range 43-97 cm were significantly ($p < 0.05$) different; (2) in each quarter, differences existed in the L-W relationships among the areas; (3) in almost all of the quarters, condition factors in areas 1 (25-45°N, 130-180°E) and 2 (0-25°N, 130-180°E) were higher than in areas 3 (25-45°N, 125-180°W) and 4 (0-25°N, 125-180°W), albeit the estimates were variable; (4) the L-W relationship in area 1 fluctuated yearly; (5) a significant ($R^2 = 0.41$, $p < 0.05$) negative relationship was indicated between the condition factors and estimates of stock biomass. Consequently, estimation of total and spawning stock biomass necessarily was influenced by which L-W relationship was relied upon.

4.5. Discussion

As in past meetings/Workshops, participants emphasized the need to continue research efforts that address biological issues surrounding North Pacific albacore, given the importance of this information to assessing the status of the population. It was suggested that collecting sex ratio at length/age information is of utmost importance in a maturity study, given the importance of this information for stock assessment Recommendations from the Working Group are summarized as follows—issues are presented in descending order of importance:

(1) A primary goal common to all biological studies is collection of sample information that allows population-based inferences. That is, sampling plans need to consider the broad spatial and temporal dynamics exhibited by the stock, otherwise, conclusions are subject to substantial bias and misinterpretation. In this context, high priority should be given to further development of a North Pacific Ocean-wide sampling design, whereby representative data are collected regarding reproductive parameters of albacore. The proposed study will necessarily rely on support (funds, field/laboratory/analysis staff, etc.) from particular countries/institutions associated with both the ALBWG and WCPFC, and further, will likely require formal coordination through the Working Group forum. Finally, other ISC Working Group Chairs should discuss the potential for developing this broad reproductive-related sampling design around multi-species objectives (i.e., given much of the biological information of concern is common to other highly migratory species as well, including striped marlin, bluefin tuna, etc.).
(2) Archival tagging programs provide useful information for formalizing stock structure assumptions in stock assessment models and thus, should be continued in the future. Further, researchers should consider the merits/drawbacks associated with conventional (dart) tagging projects in concert with the archival tagging studies.
(3) Recent growth-related research presented at this meeting indicated the need (potentially) to employ multiple length-weight relationships when conducting an overall stock assessment. That is, one applicable to converting catches in weight to numbers and another for purposes of deriving spawning stock biomass and spawning potential ratio. However, a further examination of specific details of this overall research should be conducted in early 2006, before formally adopting a different length-weight relationship(s) than used in past assessment-related work. Finally, it is intended that decisions regarding growth parameters to use in upcoming assessments will be finalized at the Task Group meeting scheduled for July 2006 (see section 8.3).

## 5.0 REVIEW OF STOCK ASSESSMENT STUDIES

5.1. Abundance Indices

H. Lee presented a paper on some updated analyses of the indices of abundance for albacore targeted by the Chinese-Taipei longline fishery (ISC/05/ALBWG/14). The paper is based on suggestions from the Nineteenth North Pacific Albacore Workshop (Stocker 2005) that the indices of abundance for North Pacific albacore targeted by Chinese-Taipei longline fishery should be reviewed. The primary objective of the present study is to generate representative abundance indices included in assessments of the North Pacific albacore stock. The broad stages

of the filtering techniques for the catch and effort data were presented and the uncertainties around the filtering approaches and models were considered. The logbook data were examined using four stages of filtering. Time series of nominal CPUE based on all of the data from the original logbooks and the various subsets based on different stages of filtering all showed similar trends. The choice of the additive constant was fairly robust, given the trends were similar for 10% of the mean CPUE (a value of 0.1), as well as when a value of 1 was applied. Furthermore, the trends of the standardized CPUE were also similar regardless of the assumed error distribution (e.g., normal, Poisson, and negative-binomial error distributions). In general, the standardized series increased from 1995 to the highest level in 1996, sharply dropped in 1998, remained stable until 2000, slightly decreased to the lowest level in 2002, and finally, increased slightly in 2003. Although this research showed that the influence of the filtering methods did not substantially influence resulting time series of CPUE, we argue that it is critical to conduct this type of analysis in all situations when typical catch-effort data collected in the field are potentially biased (to some degree), which ultimately, could produce misleading conclusions concerning relative stock abundance.

5.1.1. Discussion

The Working Group was very pleased to see the improvements made in standardizing the Chinese-Taipei longline index and appreciated the transparency of the process. It was recommended that this type of initial investigation be carried out for all CPUE and length-frequency data. All the filtering processes were well described. A concern was raised about being able to reliably remove sets from which fishing did not target albacore. Number of hooks/basket has been used to standardize other longline indices, however, it was communicated that the Chinese-Taipei logbook data did not include that level of detail in the earlier part of the time series and it is not available for all logbooks for the later time period. It was noted that using catch composition levels effectively removed those sets with zero albacore catch, and that could alternatively be accomplished by further subsetting the areas used in the analysis since the zero catch seems to be concentrated in the eastern part of area four (the southeast area). A question arose concerning the logbook coverage rate, and it appears that the estimate of 60-65% may not be accurate given the reported total catch and the small number of sets in the analysis. The Working Group made the following recommendations on how to proceed with the Chinese-Taipei longline index before it could be considered for use in the population modeling: try to standardize using hooks/basket instead of catch composition; examine subsetting the 4 areas into smaller ones; include an interaction term of area and season in the GLM; use either the negative binomial, Poisson, and delta-lognormal distributions to avoid the problem of adding a constant to the data for the lognormal transformation; and try standardizing by vessel, to avoid including transient vessels that may have different intrinsic rates of capture. As a more general point, the Working Group noted that the level 1 and 2 filters (removing partial day sets and clearly inaccurate data) should be part of a preliminary data screening process for all information coming into the ISC databases, and recommended that the ISC STATWG discuss this issue. Finally, the Working Group also recommended that more information on the distance between floats and how this is modified during a trip should be obtained.

## 5.2. Stock Assessment Models

### 5.2.1. Overview

M. Maunder presented a table summarizing characteristics of several potential alternative models to use, in comparison to the VPA-2Box model, and then provided an introduction to statistical stock assessment modeling and Stock Synthesis 2 (SS2). Integrated analysis, which is the statistical framework of including all data simultaneously in model parameterization, and the use of prior information were described. The differences between backward-simulation (e.g., VPA-2Box model) and forward-simulation (e.g., SS2 model) catch-at-age methods were described. Integrated, forward-simulation catch-at-age analysis is preferable when catch-at-age data are poor (e.g., low sample size, aging error), catch-at-age data are missing for some years/fisheries, and/or catch-at-age data are calculated from catch-at-length data based on relatively subjective approaches (e.g., age-slicing methods). The SS2 model is a statistical stock assessment model based on AD Model Builder software, which generally speaking, allows for considerable more spatial/temporal evaluation of the available sample data than possible using VPA-like methods. Further, the SS2 model allows a broad suite of parameter estimation to be conducted, including consideration of confidence bounds, initial or fixed values, phase of estimation, priors, environmental variables, temporal deviates, and time blocks. One major advantage of using the SS2 model is in terms of selectivity parameterization, i.e., many functional forms of statistical distributions can be critically evaluated within the overall assessment. The SS2 model utilizes typical sources of input data, including *environmental*, *control*, *data*, and miscellaneous *ancillary* files. There also exists a helpful MS Excel file that can be used to summarize (and view in displays) the results. Finally, a more comprehensive Graphics User Interface is under development, with a beta-version scheduled for release in early 2006.

S. Kohin presented a paper which also described characteristics of the potential models to use for the 2006 assessments (ISC/05/ALBWG/10). In particular, the paper focused on the types of "sensitivity analyses" which will need to be conducted for the VPA analysis. In addition, the Group was encouraged to consult the ICCAT Report on the 2002 Atlantic bluefin assessment for guidance when conducting the VPA-2BOX assessment and projections for 2006.

### 5.2.2. Stock Synthesis 2

S. Hoyle presented a guide for using Stock Synthesis 2 (SS2) for modeling North Pacific albacore, including a CD of sample input and output files from an early modeling effort (i.e., see ISC/05/ALBWG/08). All files needed to develop a baseline assessment model were described briefly.

P. Crone and S. Hoyle presented an alternative population analysis of the North Pacific albacore stock using the length-based/age-structured SS2 model (see ISC/05/ALBWG/05). Ultimately, the stock assessment will be used to evaluate more fully the relationship between this species' population dynamics and associated fishery operations (i.e., areas of uncertainty in an overall stock assessment) than is possible using a backward-simulation approach, such as a virtual population analysis (VPA) or other age-structured fishery analyses, in which age distributions are determined 'outside' the model. That is, currently, the ISC Albacore Working Group

(ALBWG) relies mainly on a VPA to develop consensus on the status of this fish population, which largely serves as the scientific information for guiding potential management. The goals of the overall assessment presented were:

- to briefly present methods and results from a 'baseline' SS2 model, i.e., a model scenario that is developed primarily to demonstrate broad parameterization issues associated with the SS2 platform. This particularly applies to the species' biology and associated fishery-related dynamics. Results are not intended as final assessment conclusions, since substantial changes to input data and model configuration are expected during preparation of a formal assessment that will be reviewed at the next meeting of the ALBWG in late 2006.
- to gain a better understanding of critical areas of uncertainty associated with the general SS2 modeling approach. Subsequently the baseline model will be refined as sensitivity analysis proceeds in 2006, i.e., the SS2 model for North Pacific albacore presented here reflects initial efforts of sensitivity analysis.
- to begin formal efforts to 'transition' to a length-based, age-structured modeling approach as a basis for management-related decisions within the ISC forum.

5.2.2.1. Discussion

Input data and parameterization issues associated with the SS2 baseline model were generally discussed, with emphasis on comparisons to other length-based/age-structured platforms (e.g., MULTIFAN-CL), as well as VPAs. In general, the preliminary baseline model generated similar results for management-related stock parameters as past MULTIFAN-CL and VPA model scenarios (e.g., estimated time series of biomass, spawning stock biomass, recruitment, etc.). It was noted that investigation of the CPUE and length-frequency data on a fine spatial scale is needed to determine the temporal and spatial divisions used to define fisheries. Finally, recommendations were proposed that serve as a prioritized outline for conducting work that will need to be supported (and conducted) by the ALBWG to accomplish the goals described above.

5.2.3. MULTIFAN-CL

S. Hoyle described work on an assessment using MULTIFAN-CL that is currently being developed by John Hampton and Adam Langley of SPC (presentation; no written report). The focus was on changes in the methods since the last MFCL assessment presented to the Albacore Working Group. The main points of interest were the inclusion of catch data since 1952, modeling longevity to age 15, and sensitivity analysis surrounding time of recruitment.

5.2.4. Discussion

As in past meetings, the Working Group recommended that as the transition to using an alternative forward-simulation assessment model proceeds, the current VPA be continued in at least the short term. However, there was much concern about the limited resources available to fully develop both the VPA and alternative assessments. Both SS2 and MULTIFAN-CL are good candidate models to work from, with the Working Group agreeing that the SS2 model receive a high priority in 2006 assessment research. Further concerns centered on the

partitioning of fishery-related data into quarterly time periods. For example, currently, the catch from some of the Japanese and Chinese-Taipei fisheries is only available on an annual basis and for the preliminary analysis, those data were simply equally-distributed across each quarter within a year. For an assessment to be considered more seriously as a consensus assessment (using any of the modeling platforms), these data will need further scrutiny to determine whether they can be appropriately used in a model using quarterly time periods. It was also noted that subdividing fisheries (i.e., developing the initial spatial structure in the modeling process) within MFCL (or SS2) needs to be further evaluated to ensure statistical violations in analyses do not preclude appropriate parameterization within the overall (multiple likelihood components) model. These types of concerns should be addressed when developing an assessment with one of these alternative models.

In response to all of the presentations concerning alternative models, the Working Group felt it was time to commit fully to conducting an assessment using a forward-simulation model for the 2006 assessment. Conducting the additional VPA assessment was considered necessary in order to have continuity with previous consensus-based assessments, before an alternative model is selected for future assessments. In addition, there is not yet a clear reason to adopt a forward-simulation assessment method in place of the current VPA. The Working Group agreed that assessments for the 2006 meeting will be conducted using SS2 and VPA-2BOX. There was some discussion about how the Working Group would determine which model is better once the assessments are completed and/or how to explain potential differences in results between the two models. However, the Working Group felt that these concerns would likely be addressed as the modeling progresses through parallel decisions regarding how best to treat various parameters within the models. The ALBWG appointed a Task Group to work together over the next year to conduct the analyses, including the data preparation work, making decisions about the model parameterizations, conducting preliminary assessments and projections, and providing sufficient model diagnostics for review at the 2006 assessment-related meeting. Members of the Task Group include R. Conser, P. Crone, G. DiNardo, S. Hoyle, H. Lee, M. Stocker (chair), Y. Takeuchi, and K. Uosaki. A. Coan, and J. Wetherall will work closely with the Task Group to make sure that the necessary data are available.

5.3. Biological Reference Points

5.3.1. Remarks on the Precautionary Approach

M. Stocker gave a brief overview of the legal framework for the precautionary approach (PA), emphasizing that the approach is embodied in various international agreements:

- UN Convention on the Law of the Sea (1982)
- Rio Declaration (1992)
- FAO Code of Conduct for Responsible Fisheries (1995)
- UN Straddling Stocks Agreement UNFA (1995)
- Convention on the conservation and management of highly migratory fish stocks in the western and central Pacific Ocean (2000)

The language of the various PA agreements is taken as the context within which the ALBWG

must operate. Article 6 of the Convention of conservation and management of highly migratory fish stocks in the western and central Pacific Ocean (Application of the precautionary approach) provides direction. In relation to resource conservation objectives, the PA requires both biomass and exploitation rate reference points. A PA for North Pacific albacore involves management procedures that avoid resource collapse and maintain high productivity and sustainable harvests of albacore. Furthermore, the PA prescribes the use of a pre-defined decision process, which implies the implementation of a harvest control rule. It is important to note that the PA cannot be implemented by scientists' activities alone; there are important roles that Commissions play in the process.

5.3.1.1. Discussion

Subsequent to the presentation, the Working Group discussed how fisheries reference points (both target and limit) have been used by other management bodies. A number of different references points (MSY, F-based Spawning Potential Ratios, etc.) are used based upon the experience of the scientific members and management objectives. The Working Group agreed that it may be beneficial to follow a format similar to that of NAFO in the development of reference points. However, an array of potential reference points should be discussed with the WCPFC and narrowed to meet its management needs.

5.3.2. Preliminary Biological Reference Points Research

R. Conser gave a presentation on the analysis of a specific biological reference point for North Pacific albacore (ISC/05/ALBWG/06). Recognizing that productive, large-scale albacore fisheries have been conducted in the North Pacific for more than 50 years, it would seem prudent to maintain the albacore spawning stock biomass (SSB) at levels that have historically produced these catches. The paper introduced a straightforward, fishing mortality-based, reference point designed to ensure that SSB in future years remains within the range of the historically 'observed' SSB. Potential utilization of this new reference point ($F_{SSB}$) for albacore requires full accounting for the uncertainty in the stock assessment results and the likely uncertainty regarding future condition of the stock. The approach can be used by fishery managers to associate a probability of success to any selected $F_{SSB}$ level – allowing full use of the precautionary principle in the face of uncertainty.

Results indicated that future SSB can be maintained at or above the minimum 'observed' SSB (43,000 t in 1977) with F's slightly higher than the current F range. However, the lowest 'observed' SSB estimates all occurred in the late 1970's and may be the least reliable estimates of SSB. A more robust SSB threshold could be based on the lower 10th or 25th percentile of 'observed' SSB. If so done, current F should maintain SSB at or above the 10th percentile threshold. A modest reduction in current F may be needed to maintain SSB at or above the 25th percentile threshold.

The table below summarizes the fishing mortality rates that will maintain the spawning stock biomass (SSB) above the respective threshold level with the given probability. Four distinct SSB threshold levels and two probability levels are provided, but other levels may be desired by fishery managers. For example, if managers desire to maintain the SSB above the 25th

percentile of observed SSB with a 95% probability of success, then the fishing mortality rate should not exceed F=0.55 in a low productivity regime and not exceed F=0.57 in a high productivity regime. In general, a higher desired probability of success requires a more precautionary fishing mortality rate.

| | Low Productivity | | High Productivity | |
|---|---|---|---|---|
| | Probability Level Desired | | Probability Level Desired | |
| SSB Threshold Desired | 50% | 95% | 50% | 95% |
| Minimum Observed SSB | 0.89 | 0.72 | 1.05 | 0.78 |
| 10th Percentile | 0.82 | 0.66 | 0.98 | 0.71 |
| 25th Percentile | 0.72 | 0.55 | 0.86 | 0.57 |
| Median | 0.54 | 0.33 | 0.67 | 0.33 |

5.3.2.1. Discussion

Subsequent to the presentation, the Working Group discussed the use of a minimum SSB as a limit reference point. While choice of which SSB level to use will remain somewhat subjective, the best choice may not be the minimum estimated because of uncertainty in those estimates. The work presented by R. Conser on minimum SSB (as possible limit reference point) is an improvement over past information and should be considered in the suite of potential candidates. The Working Group also discussed the needs to further investigate the rationale of maintaining the SSB above a certain level, and the appropriate level of minimum SSB acceptable with respect to meeting management objectives.

5.3.3. IATTC Workshop on Reference Points

M. Maunder presented a summary of the report from the Workshop on Reference Points for Tunas and Billfishes held at the Inter-American Tropical Tuna Commission, La Jolla, U.S.A., 27-29 October 2003 (ISC/05/ALBWG/11). The report summarizes the management objectives and use of reference points of the Inter-American Tropical Tuna Commission, International Commission for the Conservation of Atlantic Tunas, Secretariat of the Pacific Community, and the National Marine Fisheries Service. The report also contains information about research on reference points presented by the participants. General recommendations from the Workshop included further investigation of several limit and target reference points, reference points that are regime-specific or robust to regime changes, and a general framework based on an F reference line. Other IATTC specific recommendations were also reported.

5.3.4. Discussion

Following the presentations on reference points, the discussion of the Working Group focused on creating a framework for the development of appropriate reference points for North Pacific albacore. The proposed framework could, for example, follow the framework devised by NAFO and presented by Stocker (see section 5.3.1). That framework would describe the role of the scientific Working Group by itemizing scientific products the Working Group would need to produce. The framework would also describe the role of the fisheries Commissions in establishing biological reference points. The steps in this framework (as modified for albacore) are described below, and the first four steps have already been completed by the ALBWG (indicated by √).

**Role of the ALBWG**[1]

1. √ Establish international data bases suitable for stock assessment.
2. √ Establish an internationally-agreed process for conducting periodic stock assessments and reaching consensus on the assessment results that are needed for management.
3. √ Provide a suite of candidate biological reference points suitable for albacore management. The suite should include both target and limit reference points (see Table 3)
4. √ Describe and fully characterize the uncertainty associated with current and projected stock dynamics (e.g. B, SSB, and F) relative to the suite of candidate reference points.
5. Using the management objectives provided by the Fisheries Commissions (see below), conduct simulations and risk analysis to evaluate the relative risk associated with albacore management using each of the candidate reference points and concomitant control rules.
6. Provide results of risk analysis to the Fisheries Commissions and actively interact with commissions in the process of establishing desired reference points and control rules for albacore management.

**Role of the Fisheries Commissions**[2]

1. Specify general management objectives, e.g., maximize total catch, maximize total value of catch, minimize year-to-year variation in catch, etc.
2. Specify general management strategies (i.e. courses of action), e.g. if $F_{current} > F_{ref}$, how many years should be allowed to reduce F to the $F_{ref}$; if $SSB_{current} < SSB_{ref}$, how many years should be allowed to rebuild SSB to the $SSB_{ref}$ level; etc.
3. Provide inputs needed for the ALBWG risk analysis, e.g., what situations should be avoided at all costs?; what degree of risk-averse management is desired?; and what level of certainty (probability) is desired for the outcome of management actions?

[1] The "Working Group" items were discussed by the ALBWG in November 2005 and relate, in particular to North Pacific albacore. However, the process described is quite general and may be appropriate for other ISC species working groups as well.

[2] IATTC and WCPFC-Northern Committee

4. Make final decision on target and limit reference points and control rules for North Pacific albacore.

It is anticipated that this framework will facilitate the development of biological reference points by highlighting the role of the Commission in the process. Specifically, the Commission will need to define management objectives, management strategies, and degree of precaution (Steps 1-3 above) before the Working Group can proceed with the next step (step 5) in the process.

The Working Group produced a list of candidate target and limit reference points (Table 3) that were taken from previous albacore workshop reports, ISC/05/ALBWG/06, and other management bodies (e.g., ICCAT and IATTC). For example, MSY-related reference points have been used for tunas and billfishes in ICCAT and IATTC. No specific recommendations regarding reference points will be forwarded at this time. The Working Group will need to consult with the Commission before narrowing down the list of reference points.

After adopting biological reference points, control rules will need to be developed that specify action once the stock status and the level of exploitation is determined. Figure 1 demonstrates how biological reference points can be used to designate the status of the stocks and the level of current exploitation. The reference points in Figure 1 ($F_{MSY}$ and Minimum SSB) are only examples. In the case of $F_{MSY}$, its estimation is often quite difficult and therefore proxies are sometimes substituted.

## 6.0 CURRENT STOCK STATUS

At this meeting no stock assessment was conducted for North Pacific albacore. The most recent stock status information can be found in the Report from the Nineteenth North Pacific Albacore Workshop (Stocker 2005). The next North Pacific albacore assessment will be conducted in November/December 2006.

## 7.0 RESEARCH RECOMMENDATIONS AND UPDATED WORK PLAN

### 7.1. Fisheries Statistics

Annual submission of fishery data (Category I, II, and III) by Data Correspondents to the Working Group Data Manager (A. Coan) for inclusion in the data base is a requirement of Working Group members. Correspondents must pay special attention to submitting up-to-date fishery data on a timely basis and well in advance of planned Working Group meetings.

The new submission of Category II data from Chinese-Taipei should be reviewed by the ISC Statistics Working Group to verify and document changes with the Chinese-Taipei data correspondent. Participants agreed that A. Coan should discuss this at the January 2006 meeting of the ISC Statistics Working Group.

In the future, the ISC Statistics Working Group will be responsible for maintaining the official ISC web site. However, it is unclear whether adequate resources are available to facilitate development and maintenance of this site. It is also unclear if working papers and plots of the

data will be available. Participants agreed that A. Coan should discuss this at the January 2006 meeting of the ISC Statistics Working Group.

7.2. Biological Studies

Recommendations from the Working Group regarding biological-related studies that should be considered in the future are listed above (see section 4.5). In this context, (1) a biology-related Task Group (consisting of P. Crone, K. Uosaki, C.-C. Hsu, and G. DiNardo) was appointed to further evaluate the merits/drawbacks of a Pacific Ocean-wide sampling design for collecting data in the field necessary to update parameters of interest, such as maturity (see section 4.2), age/growth, etc.; (2) archival tagging research should continue; and (3) length-weight estimation research should continue, with results being available for review at the upcoming 'intersessional' meeting in July 2006.

7.3. Stock Assessment Studies

7.3.1. Chinese-Taipei Longline Index

Recommendations from the Working Group regarding the Chinese-Taipei CPUE longline index are summarized above (see section 5.1.1).

7.3.2. 2006 Stock Assessment

Recommendations from the Working Group regarding future stock assessment activities are summarized above (see sections 5.2.4). Of highest concern was carrying out an assessment using a forward-simulation model to be considered at the 2006 ISC ALBWG assessment meeting, in addition to a VPA assessment. That is, the Working Group agreed that assessments for the 2006 meeting will be conducted using SS2 and VPA-2Box.

A Task Group (consisting R. Conser, P. Crone, G. DiNardo, S. Hoyle, H. Lee, M. Stocker (chair), Y. Takeuchi, and K. Uosaki) was appointed to work together over the next year to conduct data preparation, make decisions about critical model parameterizations, conduct preliminary analysis, and provide sufficient model diagnostics for review at the 2006 ISC ALBWG assessment meeting.

## 8.0 ADMINISTRATIVE MATTERS

8.1. ISC Related Matters

8.1.1. Archiving Documents

The Working Group recommended that the ISC website be modified to accommodate Working Group documents in a secure environment.

8.1.2. Meetings

Participants suggested that formal stock assessment meetings do not necessarily have to be held each year. The Working Group felt strongly that higher quality assessments would come to fruition if they were not undertaken each year, e.g., such a schedule would allow more time for critical review of input data and time series included in the population models. That is, the Working Group recommended that meetings need to be held during the intervening years to allow improvement in the overall work necessary to conduct a thorough stock assessment.

8.2. Procedure for Clearing the Report

The report follows the outline provided in the ISC rules and procedures. A handout compiling available authors' paper summaries and rapporteurs' report was provided at the meeting for comments. A "complete" draft document will be distributed by the chair for review, comment, and approval by participants by the end of January 2006. The chair will evaluate and incorporate all appropriate comments in a final text to be submitted to the ISC chair by mid-February 2006. The final report will also be archived on the ALBWG FTP site.

8.3. Next Meeting

The next meeting of the ALBWG will be held November 28 – December 5, 2006. The Japanese delegation offered to host the meeting in Shimizu, Japan. The stock assessment Task Group will meet July 13-17 in Nanaimo, B.C.

8.4. Acknowledgement

Participants collectively thanked the hosts (NOAA Fisheries, Southwest Fisheries Science Center) for their hospitality and overall meeting arrangements. The arrangements served as the foundation for participants to engage in meaningful scientific discussion and a successful meeting.

## 9.0 ADJOURNMENT

The meeting was adjourned at 11:45 AM on December 2, 2005. The chairperson (Max Stocker) thanked all participants for their attendance and contributions.

## 10.0 REFERENCES

Stocker, M. (Ed.). 2005. Report of the Nineteenth North Pacific Albacore Workshop. Nineteenth North Pacific Albacore Workshop, Nanaimo, B.C. Canada, Pacific Biological Station, Nanaimo, B.C. 127 p. http://www.dfo-mpo.gc.ca/Library/315833.pdf

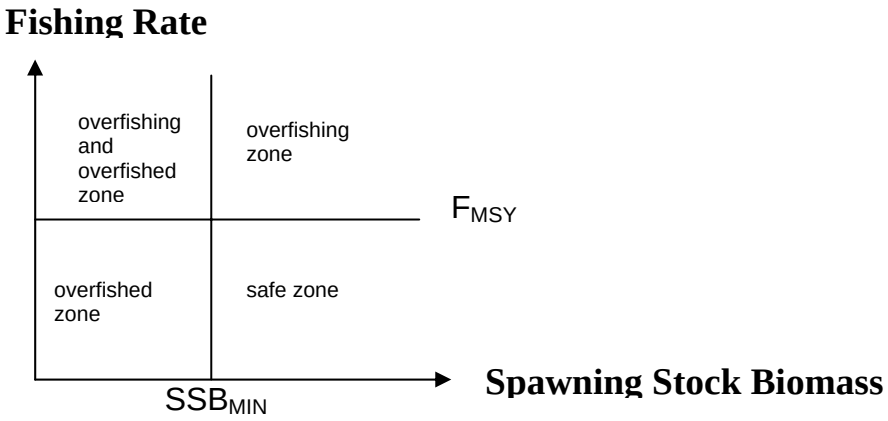


Figure 1. Four zones describing stock status and level of exploitation. Harvest above the harvest reference point ($F_{MSY}$) indicates overfishing. Spawning stock biomass (SSB) below the reference point (minimum SSB) indicates a stock that is overfished.

**Table 1.** North Pacific albacore catches (in metric tons) by fisheries, 1952-2004[1]. Blank indicates no effort. -- indicates data not available. 0 indicates less than 1 metric ton. Provisional estimates in ().

| YEAR | CANADA | | JAPAN | | | | | | KOREA | | MEXICO |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | TROLL | PURSE SEINE | GILL NET | LONG LINE | POLE & LINE | PURSE SEINE | TROLL | UNSP. GEAR | GILL NET | LONG LINE | UNSP. GEAR |
| 1952 | 71 | | | 26,687 | 41,787 | 154 | | 237 | | | |
| 1953 | 5 | | | 27,777 | 32,921 | 38 | | 132 | | | |
| 1954 | | | | 20,958 | 28,069 | 23 | | 38 | | | |
| 1955 | | | | 16,277 | 24,236 | 8 | | 136 | | | |
| 1956 | 17 | | | 14,341 | 42,810 | | | 57 | | | |
| 1957 | 8 | | | 21,053 | 49,500 | 83 | | 151 | | | |
| 1958 | 74 | | | 18,432 | 22,175 | 8 | | 124 | | | |
| 1959 | 212 | | | 15,802 | 14,252 | | | 67 | | | |
| 1960 | 5 | 136 | | 17,369 | 25,156 | | | 76 | | | |
| 1961 | 4 | | | 17,437 | 18,639 | 7 | | 268 | | | 0 |
| 1962 | 1 | | | 15,764 | 8,729 | 53 | | 191 | | | 0 |
| 1963 | 5 | | | 13,464 | 26,420 | 59 | | 218 | | | 0 |
| 1964 | 3 | | | 15,458 | 23,858 | 128 | | 319 | | | 0 |
| 1965 | 15 | | | 13,701 | 41,491 | 11 | | 121 | | | 0 |
| 1966 | 44 | | | 25,050 | 22,830 | 111 | | 585 | | | 0 |
| 1967 | 161 | | | 28,869 | 30,481 | 89 | | 520 | | | |
| 1968 | 1,028 | | | 23,961 | 16,597 | 267 | | 1,109 | | | |
| 1969 | 1,365 | | | 18,006 | 31,912 | 521 | | 935 | | | 0 |
| 1970 | 390 | | | 16,283 | 24,263 | 317 | | 456 | | | 0 |
| 1971 | 1,746 | | | 11,524 | 52,957 | 902 | | 308 | | | 0 |
| 1972 | 3,921 | | 1 | 13,043 | 60,569 | 277 | | 623 | | | 100 |
| 1973 | 1,400 | | 39 | 16,795 | 68,767 | 1,353 | | 495 | | | 0 |
| 1974 | 1,331 | | 224 | 13,409 | 73,564 | 161 | | 879 | | | 1 |
| 1975 | 111 | | 166 | 10,318 | 52,152 | 159 | | 228 | | 2,463 | 1 |
| 1976 | 278 | | 1,070 | 15,825 | 85,336 | 1,109 | | 272 | | 859 | 36 |
| 1977 | 53 | | 688 | 15,696 | 31,934 | 669 | | 355 | | 792 | 0 |
| 1978 | 23 | | 4,029 | 13,023 | 59,877 | 1,115 | | 2,078 | | 228 | 1 |
| 1979 | 521 | | 2,856 | 14,215 | 44,662 | 125 | | 1,126 | 0 | 259 | 1 |
| 1980 | 212 | | 2,986 | 14,689 | 46,742 | 329 | | 1,179 | 6 | 597 | 31 |
| 1981 | 200 | | 10,348 | 17,922 | 27,426 | 252 | | 663 | 16 | 459 | 8 |
| 1982 | 104 | | 12,511 | 16,767 | 29,614 | 561 | | 440 | 113 | 387 | 7 |
| 1983 | 225 | | 6,852 | 15,097 | 21,098 | 350 | | 118 | 233 | 454 | 33 |
| 1984 | 50 | | 8,988 | 15,060 | 26,013 | 3,380 | | 511 | 516 | 136 | 113 |
| 1985 | 56 | | 11,204 | 14,351 | 20,714 | 1,533 | | 305 | 576 | 291 | 49 |
| 1986 | 30 | | 7,813 | 12,928 | 16,096 | 1,542 | | 626 | 726 | 241 | 3 |
| 1987 | 104 | | 6,698 | 14,702 | 19,082 | 1,205 | | 155 | 817 | 549 | 7 |
| 1988 | 155 | | 9,074 | 14,731 | 6,216 | 1,208 | | 134 | 1,016 | 409 | 15 |
| 1989 | 140 | | 7,437 | 13,104 | 8,629 | 2,521 | | 393 | 1,023 | 150 | 2 |
| 1990 | 302 | | 6,064 | 15,789 | 8,532 | 1,995 | | 249 | 1,016 | 6 | 2 |
| 1991 | 139 | | 3,401 | 17,046 | 7,103 | 2,652 | | 392 | 852 | 3 | 2 |
| 1992 | 363 | | 2,721 | 19,049 | 13,888 | 4,104 | | 1,527 | 271 | (15) | 10 |
| 1993 | 494 | | 287 | 29,966 | 12,797 | 2,889 | | 867 | | (32) | 11 |
| 1994 | 1,998 | | 263 | 29,600 | 26,389 | 2,026 | | 799 | | (45) | 6 |
| 1995 | 1,720 | | 282 | 29,075 | 20,981 | 1,177 | 856 | 81 | | 440 | 5 |
| 1996 | 3,591 | | 116 | 32,493 | 20,272 | 581 | 815 | 117 | | 333 | 21 |
| 1997 | 2,433 | | 359 | 38,950 | 32,238 | 1,068 | 1,585 | 123 | | 319 | 53 |
| 1998 | 4,188 | | 206 | 35,813 | 22,926 | 1,554 | 1,190 | 88 | | (288) | 8 |
| 1999 | 2,641 | | 289 | 33,365 | 50,369 | 6,872 | 891 | 127 | | 107 | 23 |
| 2000 | 4,465 | | 67 | 30,046 | 21,549 | 2,408 | 645 | 171 | | 414 | 428 |
| 2001 | 4,985 | | 117 | 28,819 | 29,430 | 974 | 416 | 96 | | 82 | 18 |
| 2002 | 5,022 | | 332 | 23,640 | 48,454 | 3,303 | 787 | 135 | | (146) | (0) |
| 2003 | 6,735 | | 126 | 20,915 | 36,121 | 627 | 922 | 106 | (0) | (146) | (29) |
| 2004 | (7,796) | | (126) | (15,593) | (32,316) | (6,046) | (922) | (106) | (0) | (146) | (107) |

[1] Data are from the 1st ISC Albacore Working Group, November 28 - December 2, 2005 except as noted.

**Table 1.** Continued

| YEAR | TAIWAN | | U.S. | | | | | | | OTHERS | | GRAND TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | GILL NET | LONG LINE[2] | POLE & LINE | GILL NET | LONG LINE | PURSE SEINE | SPORT | TROLL | UNSP. GEAR | LONG LINE[3] | TROLL | |
| 1952 | | | | | 46 | | 1,373 | 23,843 | | | | 94,198 |
| 1953 | | | | | 23 | | 171 | 15,740 | | | | 76,807 |
| 1954 | | | | | 13 | | 147 | 12,246 | | | | 61,494 |
| 1955 | | | | | 9 | | 577 | 13,264 | | | | 54,507 |
| 1956 | | | | | 6 | | 482 | 18,751 | | | | 76,464 |
| 1957 | | | | | 4 | | 304 | 21,165 | | | | 92,268 |
| 1958 | | | | | 7 | | 48 | 14,855 | | | | 55,723 |
| 1959 | | | | | 5 | | 0 | 20,990 | 0 | | | 51,328 |
| 1960 | | | | | 4 | | 557 | 20,100 | 0 | | | 63,403 |
| 1961 | | | 2,837 | | 5 | | 1,355 | 12,055 | 1 | | | 52,608 |
| 1962 | | | 1,085 | | 7 | | 1,681 | 19,752 | 1 | | | 47,264 |
| 1963 | | | 2,432 | | 7 | | 1,161 | 25,140 | 0 | | | 68,906 |
| 1964 | | | 3,411 | | 4 | | 824 | 18,388 | 0 | | | 62,393 |
| 1965 | | | 417 | | 3 | | 731 | 16,542 | 0 | | | 73,032 |
| 1966 | | | 1,600 | | 8 | | 588 | 15,333 | 1 | | | 66,150 |
| 1967 | | 330 | 4,113 | | 12 | | 707 | 17,814 | 0 | | | 83,096 |
| 1968 | | 216 | 4,906 | | 11 | | 951 | 20,434 | 0 | | | 69,480 |
| 1969 | | 65 | 2,996 | | 14 | | 358 | 18,827 | 0 | | | 74,999 |
| 1970 | | 34 | 4,416 | | 9 | | 822 | 21,032 | 0 | | | 68,022 |
| 1971 | | 20 | 2,071 | | 11 | | 1,175 | 20,526 | 0 | | | 91,240 |
| 1972 | | 187 | 3,750 | | 8 | | 637 | 23,600 | 0 | | | 106,717 |
| 1973 | | -- | 2,236 | | 14 | | 84 | 15,653 | 0 | | | 106,836 |
| 1974 | | 486 | 4,777 | | 9 | | 94 | 20,178 | 0 | | | 115,113 |
| 1975 | | 1,240 | 3,243 | | 33 | | 640 | 18,932 | 10 | | | 89,696 |
| 1976 | | 686 | 2,700 | | 23 | | 713 | 15,905 | 4 | | | 124,816 |
| 1977 | | 572 | 1,497 | | 37 | | 537 | 9,969 | 0 | | | 62,799 |
| 1978 | | 6 | 950 | | 54 | | 810 | 16,613 | 15 | | | 98,822 |
| 1979 | | 81 | 303 | | -- | | 74 | 6,781 | 0 | | | 71,004 |
| 1980 | -- | 249 | 382 | | -- | | 168 | 7,556 | 0 | | | 75,126 |
| 1981 | -- | 143 | 748 | | 25 | | 195 | 12,637 | 0 | | | 71,042 |
| 1982 | -- | 38 | 425 | | 105 | | 257 | 6,609 | 21 | | | 67,960 |
| 1983 | -- | 8 | 607 | | 6 | | 87 | 9,359 | 0 | | | 54,527 |
| 1984 | -- | -- | 1,030 | | 2 | 3,728 | 1,427 | 9,304 | 0 | | | 70,258 |
| 1985 | -- | -- | 1,498 | 2 | 0 | | 1,176 | 6,415 | 0 | | | 58,170 |
| 1986 | -- | -- | 432 | 3 | | | 196 | 4,708 | 0 | | | 45,344 |
| 1987 | 2,514 | -- | 158 | 5 | 150 | | 74 | 2,766 | 0 | | | 48,986 |
| 1988 | 7,389 | -- | 598 | 15 | 308 | | 64 | 4,212 | 10 | | | 45,554 |
| 1989 | 8,350 | 40 | 54 | 4 | 249 | | 160 | 1,860 | 23 | | | 44,140 |
| 1990 | 16,701 | 4 | 115 | 29 | 177 | 71 | 24 | 2,603 | 4 | | | 53,683 |
| 1991 | 3,398 | 12 | 0 | 17 | 313 | 0 | 6 | 1,845 | 71 | | | 37,253 |
| 1992 | 7,866 | -- | 0 | 0 | 337 | 0 | 2 | 4,572 | 72 | | | (54,796) |
| 1993 | | 5 | | 0 | 440 | | 25 | 6,254 | 0 | | | (54,067) |
| 1994 | | 83 | 0 | 38 | 546 | | 106 | 10,978 | 213 | | 158 | (73,248) |
| 1995 | | 4,280 | 80 | 52 | 883 | | 102 | 8,045 | 1 | | 137 | 68,197 |
| 1996 | | 7,596 | 24 | 83 | 1,187 | 11 | 88 | 16,938 | 0 | 1,735 | 505 | 86,506 |
| 1997 | | 9,119 | 73 | 60 | 1,652 | 2 | 1,018 | 14,252 | 1 | 2,824 | 404 | 106,533 |
| 1998 | | 8,617 | 79 | 80 | 1,120 | 33 | 1,208 | 14,410 | 2 | 5,871 | 286 | (97,967) |
| 1999 | | 8,186 | 60 | 149 | 1,540 | 48 | 3,621 | 10,060 | 1 | 6,307 | 261 | 124,917 |
| 2000 | | 8,842 | 69 | 55 | 940 | 4 | 1,798 | 9,645 | 3 | 3,654 | 490 | 85,692 |
| 2001 | | 8,684 | 139 | 94 | 1,295 | 51 | 1,635 | 11,210 | 0 | 1,471 | 127 | 89,644 |
| 2002 | | 7,965 | 378 | 30 | 525 | 3 | 2,357 | 10,387 | | 700 | (127) | (104,292) |
| 2003 | | (7,166) | 59 | 15 | 524 | 44 | 2,214 | 14,102 | (2) | (2,400) | (127) | (92,381) |
| 2004 | | (4,988) | (125) | (9) | (362) | (1) | (1,506) | (13,432) | (0) | (2,400) | (127) | (86,109) |

[2] Catches for 2000-2004 contain estimates of offshore longline catches from vessels landing at domestic ports

[3] Other longline catches from vessels flying flags of convenience being called back to Taiwan. The catches may be duplicated in Taiwan longline catches (November 2005).

Table 2. Number of vessels fishing for albacore in the North Pacific Ocean

| | Canada | Japan | | | | | | | | | | Taiwan | | | | USA | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Troll | Longline | | | | Pole-and-line | | | Purse seine | | | Distant-water Longline | | | | Troll | Longline |
| | | Small 10-19 GRT | Offshore2 0-119 GRT | Distant water 120- GRT | Total | Offshore 20-119 GRT | Distant water 120- GRT | Total | 50-199 GRT | 200- GRT | Total | 100-200 GRT | 200-500 GRT | 500-1000 GRT | Total | | |
| 1970 | | | | | | | | | | | | | | | | | |
| 1971 | | | | | | | | | 33 | 4 | 37 | | | | | | |
| 1972 | | | | | | 161 | 209 | 370 | 12 | - | 12 | | | | | | |
| 1973 | | | | | | 187 | 248 | 435 | 18 | - | 18 | | | | | | |
| 1974 | | | | | | 182 | 240 | 422 | 11 | - | 11 | | | | | | |
| 1975 | | | | | | 174 | 238 | 412 | 17 | - | 17 | | | | | | |
| 1976 | | | | | | 233 | 255 | 488 | 49 | - | 49 | | | | | | |
| 1977 | | | | | | 192 | 258 | 450 | 27 | - | 27 | | | | | | |
| 1978 | | | | | | 236 | 256 | 492 | 27 | - | 27 | | | | | | |
| 1979 | | | | | | 238 | 236 | 474 | 25 | - | 25 | | | | | | |
| 1980 | | | | | | 258 | 205 | 463 | 23 | - | 23 | | | | | | |
| 1981 | | | | | | 248 | 182 | 430 | 9 | - | 9 | | | | | 1,817 | |
| 1982 | | | | | | 261 | 142 | 403 | 26 | - | 26 | | | | | 752 | |
| 1983 | | | | | | 168 | 128 | 296 | 26 | 1 | 27 | | | | | 1,648 | |
| 1984 | | | | | | 163 | 118 | 281 | 41 | - | 41 | | | | | 1,151 | |
| 1985 | | | | | | 163 | 110 | 273 | 32 | - | 32 | | | | | 824 | |
| 1986 | | | | | | 152 | 99 | 251 | 43 | - | 43 | | | | | 462 | 39 |
| 1987 | | | | | | 114 | 106 | 220 | 42 | - | 42 | | | | | 518 | 37 |
| 1988 | | | | | | 103 | 64 | 167 | 35 | - | 35 | | | | | 547 | 50 |
| 1989 | | | | | | 108 | 78 | 186 | 40 | - | 40 | | | | | 346 | 88 |
| 1990 | | | | | | 107 | 75 | 182 | 32 | 1 | 33 | | | | | 371 | 138 |
| 1991 | | | | | | 78 | 50 | 128 | 32 | 1 | 33 | | | | | 179 | 144 |
| 1992 | | | | | | 94 | 50 | 144 | 25 | - | 25 | | | | | 603 | 125 |
| 1993 | | | | | | 75 | 47 | 122 | 24 | 2 | 26 | | | | | 518 | 129 |
| 1994 | | 272 | 163 | 243 | 678 | 83 | 51 | 134 | 19 | 2 | 21 | | | | | 686 | 156 |
| 1995 | 284 | 270 | 150 | 229 | 649 | 53 | 45 | 98 | 19 | 1 | 20 | | | | | 464 | 132 |
| 1996 | 295 | 264 | 119 | 223 | 606 | 80 | 51 | 131 | 12 | 3 | 15 | | 12 | 4 | 16 | 640 | 118 |
| 1997 | 200 | 250 | 116 | 193 | 559 | 80 | 54 | 134 | 21 | 4 | 25 | | 12 | 4 | 16 | 1,121 | 130 |
| 1998 | 216 | 269 | 126 | 182 | 577 | 84 | 52 | 136 | 16 | 1 | 17 | | 12 | 4 | 16 | 755 | 147 |
| 1999 | 238 | 262 | 161 | 174 | 597 | 82 | 56 | 138 | 22 | 10 | 32 | | 12 | 4 | 16 | 705 | 130 |
| 2000 | 243 | 271 | 107 | 171 | 549 | 52 | 55 | 107 | 23 | 8 | 31 | | 15 | 5 | 20 | 649 | 129 |
| 2001 | 244 | 275 | 99 | 160 | 534 | 66 | 54 | 120 | 22 | 7 | 29 | | 12 | 4 | 16 | 870 | 125 |
| 2002 | 230 | 280 | 109 | 155 | 544 | 69 | 55 | 124 | 18 | 8 | 26 | | 16 | 8 | 24 | 641 | 123 |
| 2003 | 193 | 263 | 118 | 133 | 514 | 61 | 53 | 114 | 9 | 2 | 11 | | 13 | 10 | 23 | 834 | 129 |
| 2004 | 218 | 238 | 89 | 110 | 437 | 61 | 53 | 114 | 12 | 8 | 20 | 1 | 15 | 9 | 25 | 731 | 125 |

Table 3. Candidate biological reference points for North Pacific albacore.

**Target Reference Points**

| | |
|---|---|
| $F_{MSY}$ | fishing mortality rate associated with maximum sustainable yield |
| $B_{MSY}$ | stock biomass associated with maximum sustainable yield |
| $SSB_{MSY}$ | spawning stock biomass associated with maximum sustainable yield |
| $F_{0.1}$ | fishing mortality rate that yields near maximum yield per recruit (Y/R) with significantly less effort than that needed to achieve maximum (Y/R) |
| $B_{0.1}$ | associated stock biomass |
| $SSB_{0.1}$ | associated spawning stock biomass |
| $F_{30\%}$ | fishing mortality rate that reduces SSB/R to 30% of the level expected in the unfished state |
| $B_{30\%}$ | associated stock biomass |
| $SSB_{30\%}$ | associated spawning stock biomass |
| $F_{40\%}$ | fishing mortality rate that reduces SSB/R to 40% of the level expected in the unfished state |
| $B_{40\%}$ | associated stock biomass |
| $SSB_{40\%}$ | associated spawning stock biomass |

**Limit Reference Points**

| | |
|---|---|
| $F_{20\%}$ | fishing mortality rate that reduces SSB/R to 20% of the level expected in the unfished state |
| $SSB_{20\%}$ | associated spawning stock biomass |
| $F_{MAX}$ | fishing mortality rate that yields maximum yield per recruit |
| $SSB_{MAX}$ | associated spawning stock biomass |
| $F_{SSB\text{-}Min}$ | fishing mortality rate that prevents the SSB from declining below the minimum observed SSB |
| $SSB_{Min}$ | associated spawning stock biomass |
| $F_{SSB\text{-}10th}$ | fishing mortality rate that prevents the SSB from declining below the $10^{th}$ percentile of observed SSB |
| $SSB_{10th}$ | associated spawning stock biomass |
| $F_{SSB\text{-}25th}$ | fishing mortality rate that prevents the SSB from declining below the $25^{th}$ percentile of observed SSB |
| $SSB_{25th}$ | associated spawning stock biomass |

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## Appendix 2. List of Documents

**ISC/05/ALBWG/01** *International Scientific Committee Albacore Working Group Data Base Catalog* – A. L. Coan Jr.

**ISC/05/ALBWG/02** *Summary of the 2004 U.S. North and South Pacific Albacore Troll Fisheries* – J. Childers

**ISC/05/ALBWG/03** *Maturity Study for Albacore of the Pacific Ocean*: A Proposal -- P. R. Crone and J. D. McDaniel

**ISC/05/ALBWG/04** *Update on the U.S. Albacore Archival Tagging Program: 2001-2005* -- S. Kohin and J. Childers

**ISC/05/ALBWG/05** *Population Analysis of North Pacific Albacore Using a Length-based, Age-structured Model: Stock Synthesis 2* -- P. R. Crone, S. D. Hoyle, S. Kohin, and R. J. Conser

**ISC/05/ALBWG/06** *Preliminary Research Concerning Biological Reference Points Associated With North Pacific Albacore Population Dynamics and Fisheries* -- R. J. Conser, P. R. Crone, S. Kohin, K. Uosaki, M. Ogura, and Y. Takeuchi

**ISC/05/ALBWG/07** *Preliminary Examination of Length-Weight Relationship for the North Pacific Albacore* – K. Watanabe, K. Uosaki and T. Kokubo

**ISC/05/ALBWG/08** *A Guide to Setting up a Stock Assessment for North Pacific Albacore in Stock Synthesis 2* – S. D. Hoyle, M.N. Maunder and P.R. Crone

**ISC/05/ALBWG/09** *Reproductive Biology of Albacore (Thunnus alalunga) from Central and Western Pacific Ocean* – C.-C. Hsu and K.S. Chen

**ISC/05/ALBWG/10** *VPA and Beyond: Plans forNorth Pacific Albacore Assessments in 2006* - S. Kohin, P. Crone and R. Conser

**ISC/05/ALBWG/11** *IATTC Workshop on Reference Points for Tunas and Billfishes* – M. Maunder

**ISC/05/ALBWG/12** *The 2004 Canadian North Pacific Albacore Troll Fishery* – M. Stocker and W. Shaw

**ISC/05/ALBWG/13** *North Pacific Albacore Catch in the U.S. Longline Fishery* – J. Wetherall and A. Coan

**ISC/05/ALBWG/14** *Critical Evaluation of Abundance Index for North Pacific Albacore Caught by the Taiwanese Longline Fishery, 1995-2003* – H.-H. Lee

## Appendix 3. Agenda

**Report of the Albacore Working Group Meeting**
**(November 28 – December 2, 2005, La Jolla, CA, U.S.A.)**

# Agenda

**November 28 *(Monday)***, **0930-1630**

1. Registration and distribution of documents, **0930-1000**

2. Meeting Opening, **1000-1030**
    a. Welcome remarks by Dr William (Bill) Fox, Science Director, Southwest Region, National Marine Fisheries Service
    b. Work program and logistics

3. Agenda
    a. Adoption of agenda
    b. Appointment of rapporteurs

4. Review of fisheries
    a. Canada – Stocker (ISC/05/ALBWG/12)
    b. Japan – (presentation)
    c. Korea
    d. Mexico – (handout)
    e. Chinese-Taipei – (presentation)
    f. U. S. – Childers (ISC/05/ALBWG/02); Wetherall (ISC/05/ALBWG/13)
    g. IATTC

5. Review of fishery statistics

Fisheries Statistics (Al Coan and National Data Correspondents) update of Table 1 of the Data Base Catalog (2004 and preliminary 2005 data).

    a. Status of NPALBW Data Catalog – Coan (ISC/05/ALBWG/01)
    b. Review and update of catch data (Category I)
    c. Conclusions and work assignments

**November 29 *(Tuesday)***, **0900-1700**

6. Workgroup session on biological studies

Biological studies include research that addresses age, growth, maturity, etc. For all of these studies, emphasis should be on developing stock parameter estimates that are applicable at

the population level and thus, able to be included in population (stock) assessment models. The research needs should be addressed at two levels. The first is a review of existing information in published documents with the objective of identifying and validating the information currently used in stock assessments. The objective would be to ensure that the best available information is being used in the assessments. This task is assigned to NOAA Fisheries (NMFS), NRIFSF, and IO/NTU. The second level is to use information gained from the review to design studies to estimate biological parameters at the population level.

a. Update on U.S. albacore archival tagging program 2001-2005 – Kohin and Childers (ISC/05/ALBWG/04)
b. Maturity study for albacore of the Pacific Ocean – Crone and McDaniel (ISC/05/ALBWG/03)
c. Reproductive studies – Hsu (ISC/05/ALBWG/09)
d. Age and growth – Kohin
e. Length-Weight relationship – Watanabe (ISC/05/ALBWG/07)
f. Conclusions and work assignments

**1800-2200:** Welcoming Reception
Scripps Institute of Oceanography, Martin Johnson House
Beverages and light meal provided

**November 30** ***(Wednesday)***, **0900-1700**

7. Workgroup session on biological reference points

Currently, alternative proxies for particular biological reference points of interest (e.g., MSY-related) are computed for the albacore stock. The proxies, however, span a wide range and thus, further research is needed to better define appropriate biological reference points for this fish population, including both MSY- and overfishing-related target levels. Such research should include determining robustness of the proxies through simulation studies, using both equilibrium and non-equilibrium (stochastic) assumptions. Also, analysis of appropriate reference points for species with similar life histories to albacore could provide a basis for selecting the appropriate proxies for albacore.

a. Background information – Stocker (presentation)
b. Preliminary research concerning biological reference points associated with North Pacific albacore population dynamics and fisheries – Conser, Crone, Kohin, Uosaki, Ogura, and Takeuchi (ISC/05/ALBWG/06)
c. IATTC Workshop on reference points – Maunder (ISC/05/ALBWG/11)
d. Conclusion and work assignments

8. Workgroup session on stock assessment improvement

A priority identified at the Nineteenth NPALBW was to continue investigations with the Virtual Population Analysis-2BOX Model. The coordinating research team from the SWFSC and NRIFSF was tasked with continuing their critical examinations of this modeling

effort, particularly, evaluations that address developing a better understanding of stock parameter uncertainties (e.g., sensitivity analysis), diagnostics, biological reference points, and projections. In addition, the workgroup was tasked with continuing population analysis efforts based on 'alternative' stock assessment models. Finally, the workgroup was tasked to begin research that addresses comparing/contrasting the alternative assessment models. That is, currently, stock assessment models that are emerging as choices for formally assessing the status of the North Pacific albacore population are highly parameterized and thus, inherently sensitive to various combinations of input data, assumptions, and parameter estimation decisions, which ultimately influences results and subsequent management advice.

a. Chinese-Taipei Longline Abundance Indices - Lee (ISC/05/ALBWG/14)
b. VPA vs Statistical Length-based Modelling Methods - Maunder
c. Stock Synthesis 2 Guide – Hoyle (ISC/05/ALBWG/08)
d. Population analysis of North Pacific albacore using length-based, age-structured model: Stock Synthesis 2 – Crone, Hoyle, Kohin, and Conser (ISC/05/ALBWG/05)
e. Albacore MULTIFAN-CL analysis by SPC (presentation Hoyle)
f. VPA and beyond: plans for 2006 – Kohin (ISC/05/ALBWG/10)
g. Conclusion and work assignments

**December 1** ***(Thursday)***, **0900-1700**

9. Future Research

10. Administrative matters
    a. ISC related matters
    b. Procedures for clearing the report
    c. Time and place for next meeting
    d. Acknowledgements

**1400-1700: Report preparation - rapporteurs and others**

**December 2** ***(Friday)***, **0900-1200**

11. Meeting conclusions

12. Clearing of Meeting Report

13. Adjournment