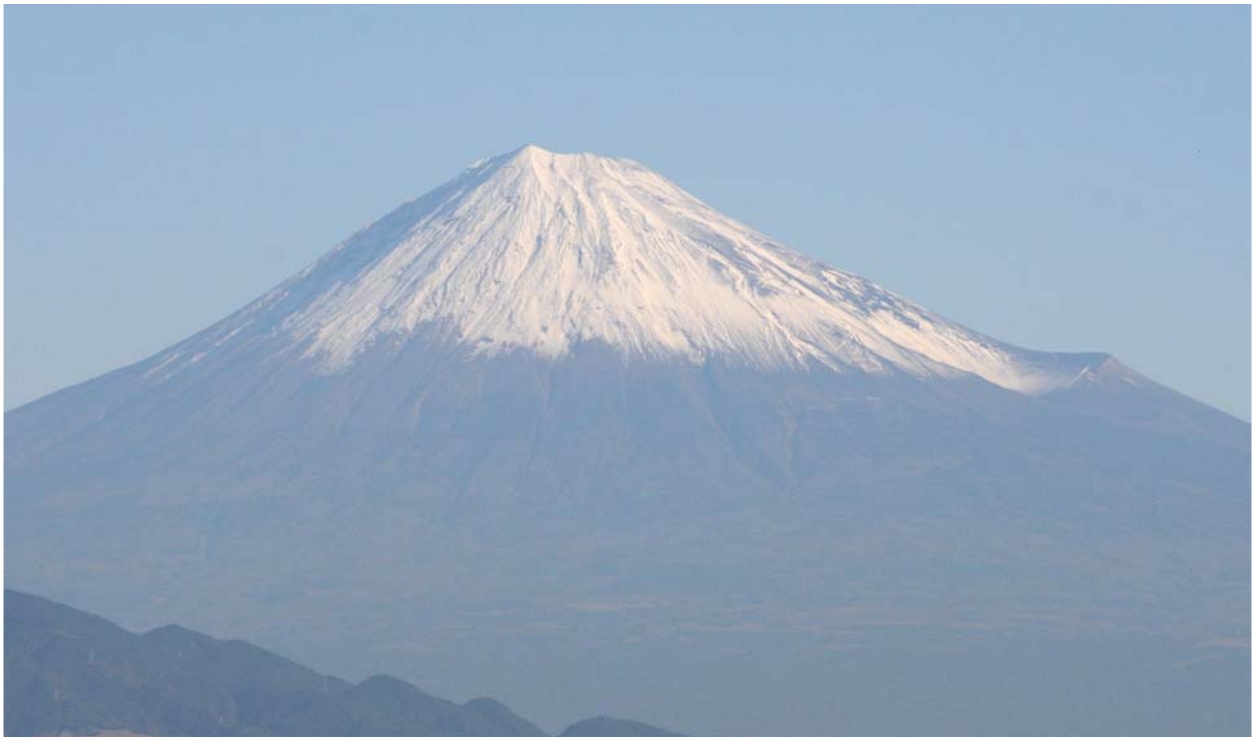
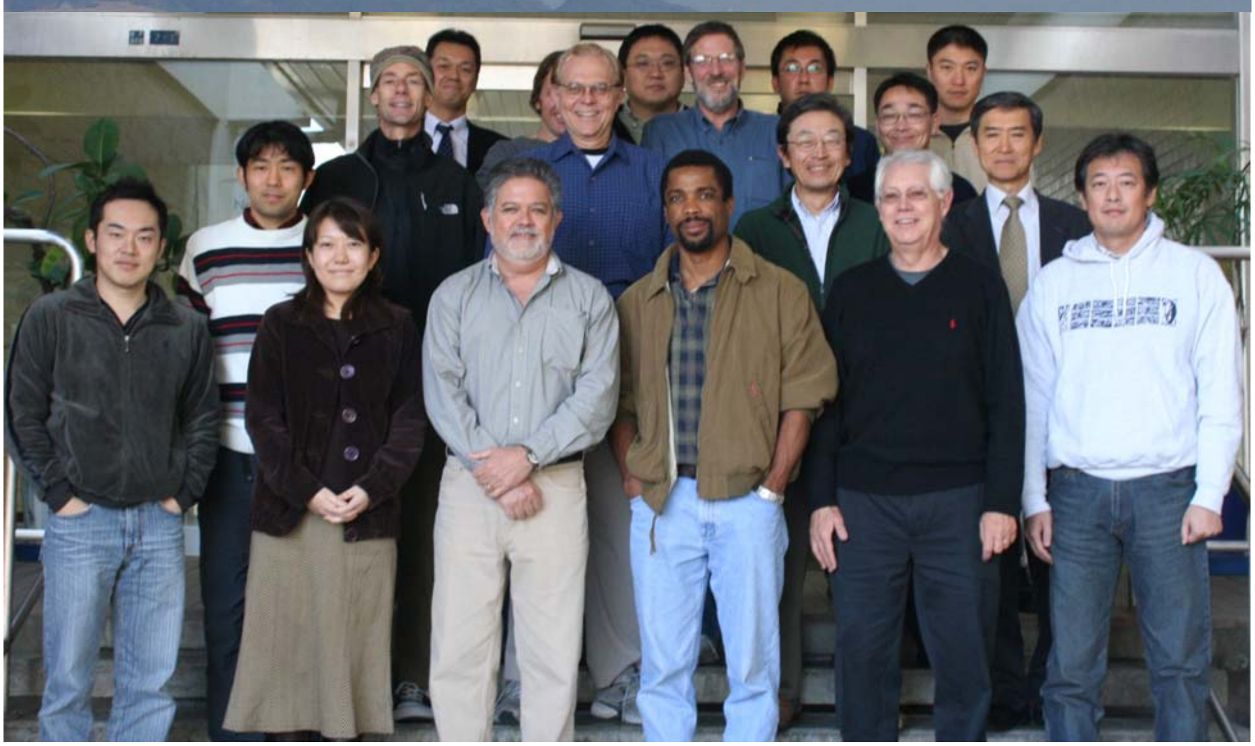
Report of the ISC - Albacore Working Group Stock Assessment Workshop

NATIONAL RESEARCH INSTITUTE OF
FAR SEAS FISERIES (NRIFSF)
5-7-1 ORIDO
SHIMIZU-KU, SHIZUOKA-SHI
424-8633 JAPAN

NOVEMBER 28-DECEMBER 5, 2006





Group Photo (left to right):

Hirokazu Saito, Mikihiko Kai, Momoko Ichinokawa, Paul Crone, Hiroyasu Hasegawa, Al Coan, Kevin Piner (partial view), Ray Conser, Yukio Takeuchi, Emmanis Dorval Vidar Wespestad, Kyuji Watanabe, Yuji Uozumi,, Hitoshi Honda, Max Stocker, Minoru Kanaiwa, Tokimasa Kobayashi, Koji Uosaki

Contents

Contents (continued)

Figures

Figures (continued)

Figures (continued)

Figures (continued)

TABLES

APPENDICES

1. INTRODUCTION

The ISC Albacore Working Group (ISC-ALBWG) stock assessment workshop was held at the National Research Institute of Far Seas Fisheries (NRIFS) in Shimizu, Shizuoka, Japan from November 28 to December 5, 2006. Dr. Kobayashi, NRIFS Director, welcomed the participants. In his address to the participants, Dr. Kobayashi reflected on the long history of scientific cooperation on north Pacific albacore and he observed that the ISC Albacore Working Group serves as an effective forum for exchanging data, presenting research, and conducting stock assessments on albacore. He stressed that Japan recognizes the important scientific contributions the Working Group is making to the development of an understanding of the North Pacific albacore population. In closing, Dr. Kobayashi wished for participants to have a successful meeting.

A total of 15 participants from Canada, Japan, and the United States (U.S.) attended the Workshop (Appendix 1). Dr. Max Stocker chaired the stock assessment workshop. A provisional agenda that was circulated prior to the workshop received minor revisions and was then adopted (Appendix 2). A total of nineteen working documents were presented (Appendix 3). Paul Crone, Ray Conser, Al Coan, and Koji Uosaki served as section rapporteurs.

The charge for the meeting was to complete a full assessment of the North Pacific albacore stock with data u to 2005, and to develop scientific advice on biological reference points for consideration of management action and for recommending action.

2. REVIEW OF RECENT FISHERIES

North Pacific albacore are a valuable species with a long history of exploitation in the North Pacific Ocean. During the past five years, fisheries based in Japan accounted for 70.6% of the total harvest, followed by fisheries in the United States (U.S.,15.5%), Taiwan (5.6%) and Canada (4.8%). Other countries targeting North Pacific albacore contributed 3.6% and included Korea, Mexico, Tonga, Belize, Cook Islands, Ecuador and longline catches from vessels flying flags of convenience (Table 1). The total catch of North Pacific albacore for all nations combined peaked at a record high of 125,400 metric tons (mt) in 1976, then declined to a low of 37,600 mt in 1991 (Figure 1). In the early 1990s, catches increased again, peaking in 1999 at 121,500 mt, and averaging 92,600 mt between 2000-05.

While various fishing gears have been employed over the years to harvest albacore in the North Pacific Ocean, the main gears used over the last five years were longline (38.5%), pole-and-line (37.8%), and troll (17.7%) (Figure 2). Other gears used since the mid-1990s included purse seine, gill net, unspecified and recreational fishing gears and accounted for roughly 6.0% of the total catch of albacore from the North Pacific Ocean.

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 2005 (**ISC/06/ALBWG/05**). 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 2005, 208 Canadian vessels operated in the North Pacific and caught 4,810 mt of albacore in 8,525 vessel days of fishing for a CPUE of 0.56 mt/vessel-day. Estimates for 2005 are considered preliminary. Both catch and CPUE have followed an increasing trend over the period 1995-2004 and then dropped in 2005. As in previous years, most of the 2005 catch was taken within 200-miles of the North American coast. Access by Canadian albacore vessels to waters in the US EEZ is governed by a US-Canada albacore treaty.

In terms of research activities, a project to document the existing relational database for the Canadian Pacific albacore catch and effort data is underway. A technical report is being prepared that describes the design of the entire database (including triplog, saleslip and hail components) based on a venn diagram concept, and include the relationship diagram that documents the structure of the relationships between these components.

2.1.1. Discussion

The group questioned the decrease in effort in offshore areas in 2005. The decrease was thought to be caused by increased fuel prices and depressed market conditions.

2.2. Japan

Koji Uosaki summarized recent trends in the Japanese fisheries (**ISC/06/ALBWG/04**). Japan has two major fisheries that catch albacore in the North Pacific, namely pole-and-line and longline. Other miscellaneous fisheries include purse seine, troll, and drift gillnet fisheries (Table 1). Total catches by the Japanese fisheries were 57,900 t in 2004 and decreased to 38,255 t in 2005. All 2005 figures are preliminary estimates. The albacore catch by the two major fisheries account for more than 90% of the total catch in recent years.

Pole-and-line catches were 32,255 t in 2004, and decreased to 16,883 t in 2005, the lowest reported catch during the last decade. The catch fluctuated ranging between 17,000-50,000 mt in the last decade. The pole-and-line fishery catches albacore during summer and autumn in areas from off Honshu-Island to the Emperor Sea Mount. This fishery targets primarily skipjack tuna and switches to albacore at the end of the skipjack season.

Longline albacore catches were 17,547 t in 2004 and 19,615 t in 2005. The catch shows a declining trend since 1996 when the catch peaked at 39,000 t. The longline fishery can be classified into two categories, the distant water and offshore longline fishery (vessels >20 GRT) and the coastal longline fishery (vessels < 20 GRT). The catches by both fisheries show a declining trend in recent years.

In 2004-2005, the coastal longline fleet operated principally off the eastern and southern coast of Japan, in an area between the Equator to 10°N, and 140°E to 150°E. The fleet caught albacore mainly during January-April, with catches distributed primarily off the south coast of Japan. In contrast, the 2004-2005 Japanese offshore and distant-water longline fleet (>20 GRT vessels) operated throughout the high-seas. High concentrations of effort were in areas between the Equator and 15°N, the east coast of Japan and 175°E, and in waters northeast of Hawaii. This longline fleet targeted mainly bigeye tuna in 2004-2005. Albacore were taken incidentally throughout the year and primarily from areas between 15°N to 40°N, and 150°E to 180°. Fishing effort and albacore catches in areas N-E of Hawaii drastically decreased from those in the 2002-2003 season.

Size (fork length, cm) measurements were taken from nearly 90,000 and 87,000 albacore landed by the longline fisheries in 2004 and 2005, respectively. Harvested albacore ranged between 50 cm and 120 cm. Size distributions showed two modes, namely at 75, 100 cm in 2004, 77, 102 cm in 2005. About 7,800 and 8,900 albacore were measured for length from pole-and-line landings in 2004 and 2005, respectively. Sizes of albacore caught ranged between 39 and 109 cm. The size distributions showed three modes, at approximately 52, 64 and 75 cm in 2004, and 54, 64, 78cm in 2005.

2.2.1. Discussion

The group discussed the decrease in albacore catches especially in the Japan pole and line fisheries. Koji indicated that this was caused by low availability of fish especially late in the year.

The group also noticed that the number of offshore and distant water longline vessels fishing in 2005 has decreased while the number of hooks fished has increased. Koji explained that this could be caused by the different areas represented in the two tables (north of the equator and north of 10 degrees N latitude). He also noted that coverage rates were low at the end of the year (Nov-Dec) and could also influence CPUE particularly of large vessels.

The group noticed the decrease in the number of hooks set by small longliners and the number of vessels fishing in 2005. Koji explained that this was probably due to the low logbook reporting rate and raising problems. Raising problems did not influence catch rate as raised data were not used.

2.3. South Korea

No information applicable to recent fisheries discussion was provided at this time. Korea has submitted catch data to the ISC data base for 2002-2005. However, albacore catches seem to be combined and reported in the other species and miscellaneous gear category.

2.4. Mexico

Luis Fleisher, representing the National Institute of Fisheries of Mexico (INP-Mexico), was unable to attend this meeting. He did email the chair that he would supply an updated catch table for Mexico sometime before the end of the meeting.

2.5. Chinese Taipei

No information applicable to recent fisheries discussion was provided at this time.

2.6. United States

In the U.S., North Pacific albacore are harvested by various types of fishing gear (Table 1). Troll gear has dominated since the early 1950s. During the last five years, troll fishing accounted for 81% of the total U.S. North Pacific albacore landings, with recreational fishing, and longline fishing generating roughly 13% and 4% respectively. Other gears included purse seine, pole-and-line, unspecified and gill net, which collectively accounted for only 2% of the total landings.

Al Coan reported on the U.S. albacore troll fishery that operated in the North Pacific Ocean in 2005 (**ISC/06/ALBWG/02**). During April-May, distant-water troll vessels begin fishing albacore in the central Pacific Ocean (around the International Date Line). As the fish become available off the North American coast in June and early July, the distant-water fleet moves closer to the coast and coastal vessels enter the fishery. The distributions of effort for the troll fishery in 2005 show this fishery operates from Mexico to Canada and from the west coast of North America to roughly 150°E. The majority of the 2005 albacore troll catch was concentrated mainly along the North American coast. The fleet continued a trend of decreased albacore catch and fishing in the mid Pacific Ocean and east of the International Date Line that started in 2004. Total albacore catch for U.S. North Pacific troll fishery was 13,346 mt in 2004, and declined to 9,122 mt in 2005 (Table 1). The number of vessels operating in the fishery decreased from 734 in 2004 to 652 in 2005. In 2005, 21,362 albacore were measured for fork length by port samplers. Fish ranged in size from 50-92 cm in length, with an average of 70 cm.

Al Coan reported on the U.S. longline fleets based in Hawaii and California (**ISC/06/ALBWG/03**). In 2005, U.S. longline vessels caught 277 metric tons (t) of albacore in the North Pacific Ocean, a reduction from the 560 t landed in 2004 and well below the peak catch of 1,652 t in 1997. Some of the catch was taken by the single vessel based in California, but most was recorded by the 124 active longline vessels based in Hawaii using shallow-set gear directed at swordfish or gear deployed deeper in the water column for bigeye tuna. The total fleet size has remained fairly stable over the past several years. The nominal effort by the U.S. fleet was about 35.1 million hooks in 2005, exceeding the 32.4 million hooks deployed in 2004.

During 2005, observers were deployed on 106 shallow-set trips (100% coverage) and 1,377 tuna trips (26% coverage) by Hawaii-based vessels. Observers were placed on one of the two tuna trips by the California-based vessel (shallow-set operations are not permitted by the California-based fleet). Observers on Hawaii-based longline vessels took fork length measurements on 3,577 of the 13,637 albacore they reported being caught. The observer on the California-based vessel also measured albacore.

Logbook data collected by Hawaii-based longline vessels in 2005 indicated that 3.6% of the albacore caught were discarded at sea. However, observer data suggest that discarding of albacore by these vessels may be more prevalent than indicated by logbook data, especially on trips targeting swordfish; this question is under investigation. All albacore caught by the California-based vessel were reported retained.

U.S. longline data for 2006 are being compiled and processed and will be disseminated as soon as they are validated and approved for release. The Hawaii-based shallow-set fishery for swordfish was closed on March 20 for the rest of 2006 because the swordfish fleet had already reached its annual incidental take limit for loggerhead sea turtles. The shallow-set fishery will resume in 2007. One of the new developments in the U.S. fishery for 2006 is the reported activity of a longline vessel based in Guam. Logbook data from this vessel are being collected by NMFS.

2.6.1. Discussion

The appropriateness of using a CPUE index for the U.S. longline fishery in the stock assessment was discussed. Two concerns were identified 1) Regulations may have effected the index, and 2) Use of an index for a fishery that does not target albacore. The group agreed that this discussion should be addressed in the CPUE section. Al was asked to capture the effect of U.S. longline regulations on albacore catches and develop quarterly plots of albacore catch and effort for the U.S. longline fishery for 2003 to 2005.

2.7. IATTC

No information applicable to recent fisheries discussion was provided at this time.

3. FISHERY STATISTICS

Al Coan reported on the current status of the North Pacific Albacore Working Group Data Catalog (**ISC/06/ALBWG/01**), including additions and updates made since the November-December 2005 Albacore Working Group meeting in La Jolla, California. The Data Catalog provides tables of fleet-specific data on annual catches of North Pacific albacore, the number of active vessels in each fishery (Category I), summarized logbook catch and effort (Category II), size composition (Category III) and the metadata for databases used for stock assessments, and other investigations. The Southwest Fisheries Science Center (SWFSC) in La Jolla, CA, U.S.A, maintains the Data Catalog and associated database files. It provides a secure FTP server at the Alaska Fisheries Science Center, and oversees the distribution of data to Workshop 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 data and metadata, the site archives workshop reports, working papers from previous workshops, and derived analysis data sets (e.g., estimated catch-by-age matrices) used in albacore stock assessments.

The Data Catalog tables in ISC/06/ALBWG/01 reflect updates based on recent data submissions. Most of the data sets have been updated through 2005. In some instances uncertainty remains about table entries for recent catches because data updates have not yet been received (e.g., Category I data for the Korean longline fishery). Final catches received for this meeting are reflected in Table 1 of this report.

3.2. Discussion

Al asked that the group consider three items:

1) Historical Category II and III data (Korea and Taiwan) submitted from the ALBWG ftp site to the ISC in October of 2005 have not been transferred to the new ISC ftp site. A decision has to be made if the ALBWG data manager will resubmit the data again or the ISC will copy the data to the respective ISC ftp site country folders. The working group will address this in other administrative matters later in the agenda.
2) Data are currently being submitted to the ISC and to the Albacore working group data bases. This policy will eventually lead to discrepancies in each data base. In order to alleviate this difference the group should decide whether to have data submitted to the ISC through the working group rather than directly to the ISC. The Working Group would rather keep their data base and will engage the Statistics Working Group to set up the necessary protocols.
3) The entire Chinese Taipei longline Category II data have been revised for the period 1964 to 2003. Since the changes are substantial, the ALBWG Data Base Administrator needs some guidance from the ALBWG in approving the data set for addition to the data base. The Working Group will check with Chinese Taipei to clarify whether these new data were used to develop the standardized CPUE data used in the assessment models. If so, they will then recommend that the data be added.

The group agreed on the need for getting better information on Category I catch data for vessels presumed to have conducted illegal, unreported, and unregulated (IUU) fishing operations. Catches of North Pacific albacore may be taken but unreported by IUU vessels using longline or drift gill net gear. At the 19th Albacore Workshop, Adam Langley provided information from the OFP database on catches of albacore taken by IUU longline vessels in waters north of Hawaii but landed in the South Pacific. These data represented a partial reporting of the activity by these vessels. Adam Langley and Chien-Chung Hsu used these data to update entries in Table 1 for the “other longline” country category for 1996-2003. Workshop participants agreed to seek further information on activities of IUU vessels and work towards a comprehensive accounting of the North Pacific albacore catch, especially in 2004 and 2005 and for gillnet vessels..

4. BIOLOGICAL STUDIES

4.1. Age/Growth and Reproductive Biology Studies

Kyuji Watanabe presented a paper on length-weight (L-W) relationships for the North Pacific albacore (**ISC/06/ALBWG/14**). The length-weight (L-W) relationships at sex, area, season and year from 1990-04 were investigated. The results were as follows: (1) The differences of the L-W relationships among the areas were found at each quarter; (2) in quarters 1, 2 and 4, condition factors *CF*s in area 4 tended to obviously decline in a range of approximately 90-140 cm as the length becomes bigger. (3) In quarters 1-3, condition factors in areas 1, 2 and 3 were higher than an average. While, in area 4, condition factors were below the average. Consequently, the utilization of the L-W equations for reliable estimations of the stock biomass and the SSB was recommended.

4.1.1. Discussion

4.2. Tagging Studies

4.2.1. Archival Tagging Studies

Koji Uosaki presented a summary of Japan's albacore archival tagging program (**ISC/06/ALBWG/10**). Two archival tagging to albacore were made during 2005-2006 by NRIFSF. In August 2005, a total of 50 tags (40 archrivals, 2 dummies and 8 conventional tags) were released at 43˚ – 44˚ N, 155˚ – 157˚ E. Size of tagged fish ranged from 51 to 58 cm in folk length, corresponding to age 2. In March 2006, a total of 13 tags (12 archrivals, 1 dummy) were released at 18˚ – 20˚ N, 135˚ – 137˚ E from Research Vessel Shoyo-Maru. Size of tagged fish ranged from 94 to 103 cm in folk length, corresponding to adult albacore. This was the first case in Japan that archival tagging was made for adult albacore. No archival tag was recovered from those tagging up to date.

4.2.2. Discussion

4.3. National Institute of Far Seas Fisheries - Japan

A scientific research cruise by the Japanese research vessel *Shoyo-maru* was conducted to investigate biology, ecology and stock dynamics of albacore (**ISC/06/ALBWG/12**). Ten longline operations were conducted around Okinotori-island (20-25ºN, 136-05ºW) during February 21 to March 7, 2006. Gps buoys, TDRs, small current meters and hook timers were attached to longline gear to monitor spatial and temporal movement of longline gear and to estimate hooking time and depth of the catch.

A total of 317 individuals consisting of 15 species were caught, which include four tuna and three billfish species. Albacore (118 individuals, 80-115cm FL) was the most frequently caught, and the mode was different between male (100-105cm FL) and female (95-100cm FL). A total of 41 individuals were caught by branch lines that were attached TDR or hook timer. Six of seven hook timers were successfully recorded hooking time that ranged between 6:36 and 18:07 (local time).

Thirteen tags (12 archival tags and one dummy tag) were implanted during first to fifth longline operations (February 23-26, 2006). Pingers were attached to two adult albacore (97 and 96 cm FL) on February 27 and March 3, 2006. As a result of pinger tracking, both individuals died within a day after release although the second fish pingered seemed to be best condition. This result might be due to a damage of hauling-up from deep depth to surface even an adult individual. The authors recommended that it might be better to hauling-up slowly if the method of catching tunas using deep longline, or using other gears, such as pole-and-line to reduce mortality of tracking.

4.3.1. Discussion

5. STOCK ASSESSMENT STUDIES

5.1. VPA-2BOX Model Analysis

5.1.1. North Pacific Ocean Fisheries

5.1.1.1. Catch-at-age Matrices

Catch-at-age matrices derived from fishery sample information are integral sources of data used in age-structured assessment models, such as VPA-2BOX (Porch 2003). Two papers were presented that generally addressed this subject: one paper from the U.S. contingent that addressed the eastern North Pacific Ocean fisheries (**ISC/06/ALBWG/09**) and a paper from Japan researchers that focused on Japan's fisheries of the western North Pacific Ocean (**ISC/06/ALBWG/06**).

5.1.1.1.1. Eastern North Pacific Ocean Fisheries

Paul Crone presented research (**ISC/06/ALBWG/09**) that addressed constructing catch-at-age matrices for the albacore fisheries in the 'eastern' North Pacific Ocean, i.e., based on sample data collected from vessels associated with the nations of North America (U.S., Canada, and Mexico). The estimation methods were based generally on the assumption that all 'surface' fisheries typically target juvenile albacore. Thus, size distributions derived from the U.S. troll fishery were applied to the catches of other 'surface' fisheries, including the pole-and-line, gill net, purse seine, and recreational fisheries of the U.S., as well as the Canada troll fishery, Mexico 'unspecified' fisheries, and 'Others' troll fisheries (Table 1).

For the single 'sub-surface' fishery that operated in the eastern North Pacific Ocean (i.e., the U.S. longline fishery), catch-at-age estimation was derived from biological (length and weight) data collected from an ongoing observer sampling program (1994-05).

The two catch-at-age matrices for the surface and longline fisheries were simply summed together to produce a complete catch-at-age matrix that represented all fisheries (i.e., vessels from nations of North America) that operated in the eastern North Pacific Ocean (1975-05). In summary, the complete catch-at-age matrix indicated that the vast majority of the albacore landed by the fisheries above were primarily juvenile fish (i.e., ages ≤ 5), which typically composed over 95% of the total (eastern North Pacific Ocean) landings in any given year (1975-05).

5.1.1.1.2. Western North Pacific Ocean Fisheries

Kyuji Watanabe presented methods used to develop catch-at-age matrices for Japan's surface and longline fisheries (**ISC/06/ALBWG/06**). The catches-at-age of albacore by the Japanese fisheries in the North Pacific for 1966-2005 were updated. In the case of the Japanese large and small long line fisheries, the length-weight equations by quarter and area by Watanabe *et al*. (2006) instead to the length-weight equation by Suda and Warashina (1961). The estimated total catches slightly increased 4 to 6 millions during the 1960s-1970s, they reached 13 millions, but they began to decrease in the late 1970s, and dropped from about 5 to 2 millions during the early 1980s. Then, they gradually rose during the 1990s, reached to 10 million in 2002. To evaluate effects of the changes of the L-W equation on the catch number, the differences between the estimates induced from this change and those submitted in ISC ABWG subgroup meeting in Nanaimo. However, both the fluctuations proved to be good fit with one another.

5.1.1.1.3. Discussion

It was noted that the changes in Japan catch-at-age data (CAA) – from the CAA used for the 2004 assessment – are appreciable and tend to move the CAA to older ages. The effect of these changes on the assessment results will be fully explored and documented by the WG during this meeting.

5.1.1.1.3. North Pacific Ocean Fisheries

A single catch-at-age matrix (1966-05) applicable to all (inclusive) fisheries was developed by simply summing the complete catch-at-age matrices independently derived above. Ultimately, this combined catch-at-age matrix served as the foundation for stock assessments based on the VPA-2BOX model analysis (Table 2).

5.1.1.1.4. Discussion

In summary, discussion on catch-at-age matrices addressed those developed from Eastern (Section 5.1.1.1.1.) and Western (Section 5.1.1.1.2.) North Pacific Ocean fisheries. The following summary provides an overview of this discussion:

(1) Meeting participants

(2) The topic of

(3) It

(4) When

(5) When

5.1.1.2. Indices of Abundance

Indices of abundance (i.e., catch-per-unit-effort or CPUE) represent an important source of auxiliary data commonly used for 'tuning' purposes in VPA-based methods, such as the VPA-2BOX model. Several papers were presented that generally addressed this subject, including papers from the U.S. (**ISC/06/ALBWG/09**), Japan (**ISC/06/ALBWG/07**, **ISC/06/ALBWG/08**, **ISC/06/ALBWG/11** and **ISC/06?ALBWG/13**).

5.1.1.2.1. Eastern North Pacific Ocean Fisheries

Paul Crone presented research results regarding 'standardized' indices of abundance for both the U.S. troll and longline fisheries (**ISC/06/ALBWG/09**). Generalized Linear Model (GLM) estimation methods were used for purposes of standardizing catch and effort data collected from ongoing logbook sampling programs for the U.S. troll (1961-05) and longline fleets (1991-05).

The CPUE index applicable to the U.S. troll fishery indicated the stock size has fluctuated markedly since the 1960s, with generally declining catch rates from the 1960s to the late 1980s and increasing rates, albeit variable estimates, since the late 1980s (Figure 15). Since the early 1990s, catch rates for the U.S. longline fishery have been variable, ranging from 0.14 to 0.54 fish/set since 2000 (Figure 15).

5.1.1.2.2. Discussion

There is a mismatch between USA LL size composition data and the reported catch. The size data include discarded small fish but the recorded catch does not include these discards, i.e. only landings – not catch – data are available for USA LL fishery. Landings of this fleet are quite small relative to the annual stock-wide landings. The impact of this mismatch on the overall assessment should be minimal. However, if the USA LL CPUE continues to be used as an index of abundance (for VPA-2Box and/or SS2), care should be taken in considering the appropriate selectivity of this index. Further, there have been significant regulation changes during 2002-2005 that may impact albacore catchability and selectivity. The WG compiled to (1) to compile a history of regulations affecting the USA LL fishery (2002-2005) with particular emphasis on aspects of the regulations likely to affect albacore catchability and/or selectivity; and (2) to compare Japanese LL CPUE indices from time-area strata similar to those covered by USA LL fishery. A decision on the use of this index in the stock assessment will be based on these analyses.

5.1.1.2.2. Western North Pacific Ocean Fisheries

Kyuji Watanabe presented a paper on age-specific abundance indices of the Japanese longline fisheries (**ISC/06/ALBWG/07**). The standardization of age-specific abundance index of albacore from Japanese large and small longline fisheries (L-LL and S-LL) in the North Pacific for 1966-2005 were improved. To used the indices throughout 1966-2005, the effects of area classification, fishery (the L-LL = 1, S-LL =2) and excluded gear configuration were compared throughout the several models (Table 2). The results ware as: (1) the effects of area classification can provide the decrease of AIC; (2) the effect of fishery removed difference between the models included it and that not included it; (3) the model excluded gear configuration during 1966-2005 was coincident with that included the effect of gear configuration. Consequently, we recommended the use of the model excluded gear configuration during 1966-2005. In addition, the indices of age 3 should not be used for VPA-2BOX age-structured model because they were significantly low than those of other ages.

Discussion

The "M-2006" Japanese longline (JLL) index of abundance is quite useful for the stock assessment because it begins in 1966, whereas the previously-used JLL index began in 1975. However, some concern was raised that the gear configuration factor – hooks per basket (HPB) – typically used in GLM analyses of longline CPUE was not incorporated into the M-2006 index. HPB was not used since the hooks per basket data are missing for several years of the early time series (1967-74).

From the various GLMs presented in ISC/06/ALBWG/07 (some of which included the hooks per basket effect), there did not appear to be major differences in the standardized indices with and without the HPB effect. Based on these comparisons, the WG recommended that the M-2006 index be used for the 2006 assessment. For future assessments, however, the WG recommends developing a JLL index with the HPB effect beginning in 1966. This may be accomplished by simply assuming 5-9 HPB for all sets during 1967-74, since

Koji Uosaki presented age-specific abundance indices applicable to the pole-and-line fishery (**ISC/06/ALBWG/08**). These indices were relatively low during the 1970s and through the mid 1980s, with higher estimates observed from the late 1980s through recent years. The age-specific abundance indices by fishing year indicated that 1999 and 2002 were associated with very high estimates, which represented 1995-99 year classes.

Kyuji Watanabe presented a paper on investigating declining abundance indices (**ISC/06/ALBWG/11**). The causes of the extreme decline of abundance indices for North Pacific albacore from the Japanese large longline (L-LL) fisheries from 2001-04 were investigated as follows: (1) Comparing the standardized CPUEs for North Pacific albacore by middle area *m* (Fig. 1 upper); (2) evaluating effectiveness of fishing effort as ratio for the estimated effective fishing effort to the aggregated fishing effort at *m* in year *y*; (3) investigating annual catch number, hook number by grid 5°x5°. The results were as; (a) In almost the all *m*, the CPUEs largely dropped, slightly declined or remained a constant during 2000-04, but, these proved to increase a little bit in 2005; (b) in almost all the *m*, effectiveness of fishing effort remained below 1 over the period. This is, little the L-LL harvests albacore as main target species; (c) At middle areas 1, 3, 5 and 8, where the standardized CPUEs were relatively high, the decrease rates of the catches were relative higher than those of the hook number, this is, the decline of the standardized CPUEs from 2001 to 2004 implies a decrease of an actual stock size. Consequently, the causes of the extreme decline of the CPUEs were low stock size and, in *m* 5, they were also the decrease of hook number.

Discussion

Several clarifications on the presentation were made during the discussion. However, no additional points were raised.

Kyuji Watanabe presented a paper on classification of horizontal habitats for albacore (**ISC/06/ALBWG/13**). To establish the estimations of the correct abundance index for North Pacific albacore, the classification of horizontal habitats of the stock considering similarities among variation patterns of the CPUEs and the fishing effort at area and their horizontal distributions were performed as: (1) Conducting a principal component analysis (PCA) to examine similarities among annual fluctuations in CPUE and *x* (hook number) by area (*a* = 1, 70) (Fig. 1 upper), which were caught by the L-LL during period studied; (2) calculating averages of the CPUE and the hook number at area over the period studied; (3) testing a cluster analysis for results of the PCA and the averages of the CPUE and fishing effort. The results were as; (a) In large area 1, the trajectory of CPUE in the 2000s slightly increased at the range for 10°-35°N to 140°-180°E (Fig .3 (pc1)). While, they declined at the range for 30°-40°N to 140°-180°E (Fig .3 (pc 2)); (b) the time series of hook number in the 2000s decreased bit by bit over large area 1(Fig. 3 (hook pc1)), particularly, the hook number at the range for 10°-40°N to 160°-180°E decreased (Fig. 3 (hook pc2)); (c) in large area 2, the trajectory of CPUE from 2003 largely dropped (Fig. 5 (cpue pc 1)); (d) since 2003, the Hook number extremely declined over large area 2, but they slightly increased in the right side of large area 2. (e) in large area 3, the CPUEs fell gradually since 2001, particularly, in Northeast Pacific. They declined than those in Northwest Pacific (Fig. 7 (cpue pc1 and 2)); (f) in large area 3, the hook number showed a decreasing trend (Fig. 7 (hook pc1 and 2)). However, in a range from 10°-23°N to 120°-150°E, they rose gradually since 2002. Consequently, the cluster analysis generated from area classification in consideration of the mixed-information on the variation of the CPUE and the hook number and on their horizontal distributions.

Discussion

Several clarifications on the presentation were made during the discussion. However, no additional points were raised.

5.1.2. Results

The VPA team conducted VPA-2BOX model analysis for this year's Workshop using 'primary' sources of input data, i.e., the single, combined catch-at-age matrix (see Section 5.1.1.1.3. and Table 2) was used and the suite of candidate indices of abundance (see Section 5.1.1.2) was also used. Emmanis Dorval presented the results of a preliminary VPA analysis of the 1966-2005 data using the VPA-2BOX model (**ISC/06/ALBWG/19**). Fifteen different model runs were performed based on the following specifications:

<u>Model Scenario A</u>
This model scenario included the same catch-at-age (CAA), weight-at-age (WAA), index data (**1975-2003**), and parameterization as the 2004 VPA-2Box assessment model. The purpose of this scenario was to perform a validation run to show that we can accurately reproduce the results obtained in the 2004 model assessment.

<u>Model Scenario B1</u>
This model scenario included the same parameterization as in model A, but with a new set of 1975-2003 CAA. The catch-age matrix was updated due to the application of new weight – length relationship (Watanabe et al. 2006) to derive number-at-age from landing data; and also due to the use of a calendar year instead of a biological calendar to distribute fish among age classes in the Japanese fisheries (Watanabe and Uosaki, 2006b).

Model Scenario B2

This model scenario included the same parameterization as in model A, but with a new set of 1975-2003 indices of abundances. Age-specific and age-aggregated indices were updated because of the application of a "new method" by the Japanese researchers (**Watanabe and Uosaki 2006, Uosaki 2006**) to derive these relative estimates of abundance. Additionally, the vulnerability indices that are associated to the age-aggregated indices were updated due to the new changes in the derivation of catch-at-age data (see above).

Model Scenario B3

This model scenario included the same parameterization as in model *A*, but with a new set of 1975-2003 WAA matrix. In this scenario we used Watanabe et al. (2006) equation, *all area combined/Quarter 1*, to compute January 1 biomass; and Watanabe et al. (2006) equation, *Area 2/Quarter 2*, to estimate mid-year (Month-6) biomass.

Model Scenario B4

This model scenario included the same parameterization as in model *A*, but with new set of 1975-2003 CAA and index data. The CAA matrix and indices used in this model were similar to Model *B2*, the WAA matrix from the 2004 assessment model was used.

Model Scenario B5

This model scenario included the same parameterization as in model A, but with new set of 1975-2003 CAA and WAA. CAA matrix in this model was similar to model B1, whereas WAA matrix was similar to model B3. The 2004 estimates for all indices were used.

Model Scenario B6

This model scenario included the same parameterization as in model *A*, but with new set of 1975-2003 index and WAA data. All index data were similar to model *B2*, but the WAA matrix was similar to model *B3*. The 2004 CAA matrix was used.

Model Scenario B7

This model scenario included the same parameterization as in model A, but with new set of 1975-2003 CAA, WAA, and index data. The CAA matrix in this model was similar to model *B1*, the WAA matrix to model *B3*, and the indices of abundance to model *B2*.

Model Scenario B8

This model scenario included the same parameterization as in model A, but with new set of 1975-2003 CAA, WAA, and index data along with the new Taiwan age-aggregated index. The CAA, WAA, and index data for the US and Japanese fisheries were similar to model *B7*.

Model Scenario C1

This model scenario included the same parameterization as model *B8*, but with the time period for all input data extended forward to 2005. Newly available data for all fisheries in 2004 and 2005 were added to 1975-2003 data in model *B8*.

Model Scenario C2

This model scenario included the same parameterization as model *B8*, but with the time period for all input data extended back to 1966. Historical input data from 1966-1974 for the different fisheries were incorporated to the model in addition to the new set of 1975-2003 used in model *B8*.

Model Scenario D1

This model scenario included the same parameterization as model *C1*, with time period for all input data extended back to 1966. This model contains only new data spanning from 1966 to 2005, but the model parameterization is similar to the 2004 VPA2-Box assessment model.

Model Scenario D2

This model scenario included the same parameterization as model *D1*, but with only new 1975-2005 index data. The purpose of this run was to investigate the effect of deriving estimates for age-aggregated and age-specific indices on relatively few "biological" and fishery data during the period of 1966-1974. Both US and Japanese researchers had to perform more data substitution when deriving indices for 1966-1974 relative to the 1975-2005's period.

Model Scenario D3

This model scenario included the same parameterization as model *D1*, but with only the 1966-2005 age-aggregated index data. This model run was performed to determine the effects of removing all age-specific indices from model *D1*.

Model Scenario D4

This model scenario included the same parameterization as model *D1*, but with only 1966-2005 age-specific index data. The purpose of this model run was to determine the impact of removing all age-aggregated indices from the modeling process.

5.1.2.1. Discussion

First, Workshop

5.2. Alternative Stock Assessment Models

5.2.1. Stock Synthesis 2 (SS2)

P. R. Crone presented preliminary research (**ISC/06/ALBWG/18**) that addressed an alternative population analysis of the North Pacific albacore stock using a length-based/age-structured, forward-simulation model (Stock Synthesis 2, SS2). It is important to note that currently the International Scientific Committee's North Pacific Albacore Working Group (ISC-ALBWG) relies strictly on a VPA to develop consensus on the status of this fish population, which largely serves as the scientific information for guiding potential management. General methods of the SS2 modeling approach were presented, particularly, in respect to the ongoing assessment efforts applicable to the albacore population. Input data and parameterization files associated with a 'baseline' model scenario were generally discussed, as well as current difficulties associated with the development of this alternative assessment model. That is, currently, all input data (say time series) are not yet complete and further, some parameterization issues are currently unresolved.

It is important to note that the SS2 baseline model was developed in the context of the general VPA model, i.e., the baseline model reflects efforts to develop a configuration that generally mimics (mirrors) the parameterization of the VPA model. Thus, the SS2 baseline configuration should be viewed as the first 'phase' of an ongoing development of an alternative, more flexible modeling platform that can be used to assess the status of this fish population over the long-term, i.e., the overriding objective was to review model structure and not results from this baseline configuration. Finally, the alternative model is expected to receive substantial attention following this year's focused assessment-related exercises applicable to the VPA and ultimately, gain increasing support as the ALBWG's assessment model for purposes of providing management-related advice within the ISC forum.

5.2.2. Discussion

The WG discussed the progress towards the development of an integrated statistical catch-at-age assessment model of NPO albacore using Stock Synthesis II (SS2). The WG reiterated its continuing supports of the development of an alternative model that is in addition to the VPA which is currently used to assess stock status. The WG acknowledges that additional work will be needed after the current WG to resolve or explain potential differences in results from the two assessment approaches.

The working group discussed the appropriate format of data for an SS2 assessment model of NPO albacore. It was noted that SS2 could use age-specific indices of relative abundance, but the working group concluded that age-aggregated indices were preferable. The working group also concluded that CPUE indices in SS2 should be fishery specific. It was also decided that the SS2 model should be started in 1966 with an initial catch of the same magnitude as the earliest recorded catches and that the initial age-structure should be estimated. Inputted values of natural mortality (*M*) and growth will be the same as used in the VPA.

6. STOCK ASSESSMENT CONCLUSIONS

6.1. Introduction

Following review of the preliminary VPA-2BOX (Porch 2003) runs presented by the VPA team, Workshop participants recommended that Model Scenario D1 be further evaluated. Maturity schedules (Ueyanagi 1957), length-weight relationship (Watanabe et al. 2006); growth curve (Suda 1966), and rates of natural mortality (*M* of 0.3 for all ages and years) were used. Model Scenario D1 was based on the following 17 indices: age-specific indices for ages 2-5 (U.S./Canada troll fishery); age-aggregated (assumed to represent ≥ 6-yr old fish) abundance index (U.S. longline fishery); age-specific indices for ages 2-5 (Japan pole-and-line fishery); age-specific indices for ages 3 to ≥ 9 (Japan longline fishery), and age-aggregated abundance index (Chinese Taipei longline fishery).

For the purposes of assessing current stock status and projecting future stock conditions, Model Scenario D1 was chosen as the preferred model, given: (1) statistical fits and diagnostics were deemed generally satisfactory; and (2) Model Scenario D1 utilized all of the available sample information. The Workshop members concluded that Model Scenario D1 represented a reasonable current understanding of the population dynamics of North Pacific albacore.

6.2. Input Data and Output Results From Model Scenario D1

The catch-at-age matrix used for the Workshop-based Model Scenario D1 run is presented in Table 2. Indices of abundance data and assumptions have been described generally in Section 5 above. The Model Scenario D1 estimates of numbers-at-age, and fishing mortality-at-age are presented in Tables 3 and 4, respectively. Also, given VPA-based methods commonly produce highly uncertain (imprecise) estimates of young fish for recent years, the following calculations were conducted: (1) numbers of age-1 fish in 2003-04 reflected the mean estimate over the period 1966-98; and number of age-2 fish in 2006 reflected the exponential decline of age-1 fish in 2005 (i.e., e^{-Z} applied to the mean number of age-1 fish in 2005). Finally, extensive output associated with Model Scenario D1 can also be found in the Workshop Data Base Catalog, i.e., this output is archived in 'pdf' format and can be found at the site 'ftp.afsc.noaa.gov.' This output-related file includes all of the input data, statistical results (including diagnostics), and the complete suite of management-based results.

6.3. Results

6.3.1. Exploitable Biomass and Spawning Stock Biomass Trends

Estimated 'exploitable' stock biomass (*B*, ages ≥ 1 or 1+) fluctuated around 150,000 mt from 1966 to 1994. The biomass peaked in 1996 at 221,000 mt (Figure 17). From 1997 to the present the biomass fluctuated around 175,000 and is estimated at about 194,000 mt in 2006 (January 1).

Spawning stock biomass has experienced slight fluctuations since the 1960s, but generally, it has remained relatively stable at roughly 90,000 mt over the last two decades (Figure 18). The historically high estimate observed in 1996 (approximately 140,000) was largely the outcome of a very successful year class in 1994 (i.e., age-1 fish in 1995). The stock assessment indicates that *SSB* is increasing from 2002-05. The estimated spawning stock size in 2005 (May 1) is about 94,000 mt. However, the estimate of spawning stock biomass in recent years is imprecise and thus, should be interpreted accordingly. For example, the 80% confidence limits (*CI* derived from a bootstrap method, based on 500 replications) of the 2005 spawning stock biomass estimate ranges from roughly 70,000 to 120,000 mt (Figure 20).

For the purpose of comparison, *B* and *SSB* time series generated from the VPA-2BOX model in 2004 are also shown (Figures 17 and 18). For the most part, the 2004 and 2006 biomass trends were similar; however, some discrepancies exist, given the 2006 analysis incorporated changes to the catch-at-age matrix and abundance indices.

6.3.2. Biological Reference Points

The Working Group reviewed two documents relative to biological reference points (**ISC/06/ALBWG/16** and **ISC/06/ALBWG/17**). Paper **ISC/06/ALBWG/16** relates to computational methods to calculating the plus age group statistics relative to stock forecasting and reference point estimation in the VPA2Box model. The working group reviewed and accepted the methodology. Paper **ISC/06/ALBWG/15** reviewed potential reference points that could be utilized for Pacific albacore.

In the previous assessment (Stocker 2005) the determination of 'biological reference points' involved uncertainty analysis based on four model configurations that expressed uncertainty in terms of productivity and level of fishing mortality (high and low F). The previous analyses had suggested that there were two distinct productivity periods; a low productivity period 1975-89 and a high period 1990-00. However, the current analysis does not indicate any distinct productivity regimes. Therefore, computation of biological reference points was limited to examination of current levels of fishing relative to the various biological reference points presented in Paper **ISC/06/ALBWG/15**.

Crone has fig for this – UPDATE Figure 22
The estimate of *F* at age are not adjusted for partial recruitment at age, but partial recruitment at age is applied to *F* in the forward projections (see Section 6.3.3.).

Equilibrium yield-per-recruit (*Y/R*) and spawning stock biomass-per-recruit (*SSB/R*) calculations were conducted using the same vital rates (growth, maturity, and natural mortality) used in Model Scenario D1 (Figure 21). The partial recruitment (*PR*) schedule (i.e., selectivity ogive) was taken from Model Scenario D1 results, i.e. *PR* used in the *Y/R* and *SSB/R* analyses was calculated as an arithmetic mean (normalized to maximum value) over the period 1995-03 (Figure 21). Results from *Y/R* and *SSB/R* analyses are presented in Figure 22.

6.3.2.1. Discussion

A range of potential reference points were examined relative to albacore management, but the working group could not establish that any particular approach was appropriate for albacore. Perhaps with the collection and analysis of additional biological data important for evaluating the reproductive potential of the stock it may be possible to establish meaningful biological reference points.

6.3.3. Stochastic Stock Projections

The initial conditions for the projections were taken from Model Scenario D1 ……..

6.3.4. Stock Condition in Relation to Biological Reference Points

In addition to estimating stock sizes in the past (i.e., see Section 6.3.1.), it is desirable to assess 'current' conditions of both fishing mortality and stock biomass in relation to biological reference points of interest. Although inclusion of such reference points is becoming a standard feature of stock status determinations, there is no agreement yet as to which reference points are appropriate for tuna stocks, including North Pacific albacore. Accordingly, participants continued to take the approach adopted at the *Eighteenth North Pacific Albacore Workshop* and simply compare current levels of fishing mortality and biomass with a familiar suite of reference points. Evaluation and selection of preferred reference points is a task for the future and should be done by consensus among scientists, fishery managers, and stakeholders.

The biological reference points considered here fall into two categories:

(1) reference points that are potential candidates as *F*-based MSY proxies, namely $F_{40\%}$, $F_{30\%}$, and $F_{0.1}$;

and

(2) candidates to serve as *F*-based 'limit' proxies, namely $F_{20\%}$ and F_{Max}.

While it is recognized that this list of reference points does not encompass all possible reference points for North Pacific albacore, it does include the most commonly used reference points for contemporary fisheries management.

In this assessment the length-weight parameters were recalculated, and the time of spawning changed from month 6 to month 4 (Table XX). These changes resulted in different values than previously used. In Table XX the current estimated F and the corresponding F values for the various biological reference points considered are shown for the 2004 NPALB Assessment (Stocker 2005), the 2004 NPALB Assessment with the new length-weight data and time of spawning, and the estimates from the 2006 NPALB Assessment (this workshop).

Comparison of 2004 results to the 2004 results using the new length-weight and time of spawning estimates show the new estimates only slightly increased the F values associated with the different BRPs The previously estimates of F current ranged from 0.43 to 0.68. This placed the level of fishing near the high end of acceptable levels of fishing relative to the BPRs examined.

The most recent assessment estimates the current level of fishing $F_{2006} = 0.72$, slightly higher than the F current estimated for the high F – low production estimated of the previous stock assessment (Table XX),. Again, as in the prior assessment the estimated current level of fishing relative to the BRPs suggests that the level of fishing may be higher than desired.

An alternate method of examining the current level of fishing relative to BRPs is to compute F in relative terms. In this manner the current level of fishing is F=1 and the BPR F levels are ratio value of current F. A table entry greater than 1.0 implies that recent F is below the BRP and a value less than 1.0 implies that the fishing level is great than the desired BRP level.
Table XXX shows the fishing mortality rates (F) relative to recent F estimated in the 2004 and 2006. The 2004 BRP presentation was complex in that two scenarios regarding recent F were coupled with two scenarios regarding recent productivity. The BRPs associated with the 2006 assessment are more straightforward, i.e. recent F (1.0) appears to be greater than the F

associated with $F_{20\%}$ but less than the F associated with F_{max}. For most of the comparisons of current effort to BRPs the relative values suggest that current effort could be about double that of the recommended level of fishing.

The Working Group is concern that the current level of fishing may be greater than desired under standard accepted BRPs, but these have primarily been developed for groundfish species. It is not clear if these BRPs are appropriate of tunas. Also, the Working Group notes that there is a high degree of uncertainty in the estimates of current stock abundance, so the current level of fishing can be below the BRPs; however, the Precautionary Approach advises that conservative values should be considered in a range of alternative current states.

This conclusion regarding the spawning potential ratio reference point (i.e., $F_{\%}$) is based on Model Scenario D1 (and assumptions regarding current F), coupled with the per-recruit analyses. In this context, important management-based statistics presented in Table 5 are summarized below:

For the F_{MSY} proxies considered, B_{MSY} ranges from
Approximately ,000 to ,000 mt (49% to 57% of B_0). The estimate of stock biomass in 2004 (B_{2004}) is 22% below this range. Similarly, SSB_{MSY} ranges from roughly 220,000 to 290,000 mt (30% to 40% of SSB_0), with SSB_{2004} 25% below this range. Again, note that the high level of *SSB* in 2004 is largely driven by a historically high 1999 yearclass (see the age-1 data point in 2000, Figure 19), with estimates of *R* since that time declining markedly (see Table 3); also see Figures 25A-B for projected (2005-10) estimates of *SSB*. Current catch (C_{2004}) is captured within the MSY range.
\
The estimate of stock biomass in 2004
(B_{2004}) is near the middle of the MSY range. Similarly, SSB_{MSY} ranges from roughly 160,000 to 210,000 mt (30% to 40% of SSB_0), with SSB_{2004} at the lower-end of the MSY range. Again, note that the high level of *SSB* in 2004 is largely driven by a historically high 1999 year-class (see the age-1 data point in 2000, Figure 19), with estimates of *R* since that time declining markedly (see Table 3); also see Figures 26A-B for projected (2005-10) estimates of *SSB*. Current catch (C_{2004}) is approximately 34% above the MSY range and in excess of the catch 'limits' associated with $F_{20\%}$ and F_{Max}.

In summary, as noted above, the current level of spawning stock biomass (i.e., SSB_{2006} = XXX mt) is largely reflective of a very strong 1999 year-class that eventually became a major contributor in 2004 as part of 'mature' (spawning) biomass. However, subsequent recruitment (*R*) declined to levels more typical of the extended historical time series, which translated to reduced levels of forecasted *SSB*, particularly, assuming 'high *F*' scenarios (Figures 25B and 26B) within the overall uncertainty analysis. This coupled with a current fishing mortality rate (F_{2003}) that is high relative to commonly used reference points, may be cause for concern regarding the current stock status of North Pacific albacore. Future conditions are less well known, but if rates of *F* continue at assumed levels, the SSB will decrease to the range from approximately 100,000 to 150,000 mt in 2010; the only potential exception to this point is the 'low productivity/'low F' scenario. Thus, participants of the North Pacific Albacore Workshop noted the critical need to closely monitor the population over the coming years, particularly, to validate SSB abundance in relation to MSY levels. In this context, it was recommended that another assessment be conducted in 2006.

Further, Workshop discussions reflected a growing concern about current and future stock condition and the uncertainties in stock assessments. It is particularly noteworthy that key biological parameters used in the overall stock status analysis, particularly growth and maturity rates, were based on studies conducted in the 1950-60s. While these remain the best available studies on which to base the analysis, it is not known to what extent vital rates of this species may have changed from those measures obtained over 40 years ago.

These biological studies should be brought up-to-date as soon as possible. Concern was also expressed about the current lack of understanding of factors affecting recruitment and more generally, the processes affecting productivity (i.e., recruitment levels). Also, it is important to note that retrospective analysis revealed a noticeable trend of under-estimation of *F* in the ongoing Workshop-based assessments, which necessarily warrants consideration of precautionary management advice associated with the results generated from year-to-year.

Finally, there is a general expectation that biological reference points will be needed to guide future fishery management discussions about North Pacific albacore. Accordingly, along with research to improve the accuracy and reliability of stock assessments, a high priority should be given to scientific studies of appropriate reference points for the stock, both with respect to fishing mortality and stock abundance.

Participants agreed that further studies of candidate reference points should be undertaken during the intersessional period and presented at the next Workshop.

Further, ALBWG discussions reflected a growing concern about current and future stock condition and the uncertainties in stock assessments.

7. RESEARCH RECOMMENDATIONS AND UPATED WORKPLAN

The recommendations are grouped into three broad categories: (1) Fishery statistics, (2) Biological studies and (3) Stock assessment studies.

7.1. Fisheries Statistics

Annual submission of fishery data by Data Correspondents to the Workshop Data Manager (Al Coan) for inclusion in the data base is a requirement of participants. Correspondents must pay special attention to submitting up-to-date fishery data on timely basis and well in advance of planned meetings.

7.1.1. Maintain Data Base Catalog

The data base catalog is to be maintained by the Workshop Data Manager as a record of available data, contributors and timeliness of submissions by Data Correspondents. The catalog also serves as a record of progress with special data requested of participants, such as detailed information on length-frequency samples: (1) sample size (i.e., number of fish measured) by year; (2) notes on measurement units, accuracy, etc. and sampling procedures used, particularly when procedures differ from the protocol; and (3) full description of steps employed and assumptions made in processing the samples to represent entire catches, particularly when different from Workshop standard procedures. The catalog is to be made available annually to participants.

7.1.2. IUU

The working group has insufficient data to analyze IUU impacts at this time. If the ISC wishes, the ALBWG can develop simulations to evaluate differing patterns and levels of IUU fishing to evaluate the impact of simulated IUU removals on stock abundance and trends.

7.2. Biological Studies

Biological information is a critical building block for stock assessments. It should be reviewed and updated regularly in order to capture changes in population parameters if they occur.

7.2.1. Conduct Age and Growth Studies

There is a need for a wide range of related studies that the participants classified as age and growth. These include studies on weight-length relations, ageing techniques and growth curves. For all of these studies emphasis should be on developing parameter estimates that are applicable at the population level.

7.2.2. Conduct Studies on Behavior and Movement with Archival Tagging

Archival tags are being deployed off the U.S. West Coast by NMFS and off Japan by the NRIFSF to study albacore behavior and movement. So far, the results have not shown trans-Pacific movement, but movement solely within the respective eastern and western North Pacific where fish had been tagged. Both parties have plans for further deployment of tags and plan to report progress to the ISC ALBWG on a regular basis.

7.3. Stock Assessment Studies

Recent stock assessment results as well as fishery developments suggest that the North Pacific albacore stock is at or fast approaching full exploitation by the fisheries. Demand for more frequent and more precise information on status of the stock and the sustainability of the fisheries, thus, is likely to increase. With this in mind, the ALBWG identified priority research needs to be executed in the near-term to improve analyses from current stock assessment models and to better understand the models' behavior to changes in parameter estimates and assumptions.

7.3.1. Conduct Research on Alternative Assessment Models

Exploratory work with the Stock Synthesis 2 model was conducted in 2006. Further research of this model as a stock assessment tool for albacore is recommended. Results of this research should be made available at the next ALBWG meeting.

7.3.2. Conduct Studies on Reference Points

Further development of appropriate biological reference points (MSY and limit-based) for North Pacific albacore is recommended. Currently, proxies for commonly used biological reference points are computed for the albacore stock. The proxies, however, span a wide range and research to narrow the range to appropriate ones needs to be undertaken. Such research should include determining robustness of the proxies through simulation studies and with both equilibrium and dynamic states.

7.3.8. Conduct Studies to Develop Abundance Indices

The accuracy of current stock assessments for albacore is largely constrained by the abundance indices used in the assessment models and obtained from fishery statistics. A thorough examination of abundance indices needs to be conducted in 2007.

8. ADMINISTRATIVE MATTERS

8.1. ISC-related Matters

The working group was directed to evaluate the effect of IUU fishing on the North Pacific albacore resource. Reportedly illegal fishing is occurring within the range of albacore. The characteristics and magnitude of this IUU fishing is unknown, but has the potential to increase total fishing mortality to unsustainable levels. The working group has insufficient data to analyze IUU impacts at this time. If the ISC wishes, the ALBWG can develop simulations to evaluate differing patterns and levels of IUU fishing to evaluate the impact of simulated IUU removals on stock abundance and trends.

8.2. Procedures for Clearing the Report

A handout compiling available authors' paper summaries, rapporteurs' reports, and most figures was provided at the meeting for comments. A "complete" draft document will be distributed by the Chairman for review, comment and approval by participants by mid-March 2007. The Chairman will evaluate and incorporate all appropriate comments in a final text. Completion of this process and publication of a final Workshop report is planned for no later than ed of May 2007.

8.3. National Coordinators and Data Correspondents

As noted in Section 8.1., the Workshop will continue to maintain its data submission, management and exchange procedures and research coordination until these responsibilities are transferred to the ISC. Designated national coordinators and data correspondents, therefore, will continue in their roles. The coordinators and correspondents are as follows:

Sector	National Coordinator	Data Correspondent
Canada	Max Stocker	Max Stocker
Japan	Koji Uosaki	Koji Uosaki
Mexico	Luis Fleischer	Luis Fleisher
Taiwan	Chien-Chung Hsu	Shui-Kai Chang
United States	Paul Crone	Al Coan
IATTC	??????	Michael Hinton
SPC	Adam Langley	Peter Williams

8.4. Time and Place

The time and place for the next ISC Albacore Working Group meeting is planned for November 6-13, 2007 in Honolulu, Hawaii. The objective of the meeting will be to: 1) update the catch (Table 1) to 2006, 2) conduct a thorough evaluation of the abundance indices, and 3) conduct further research to develop the SS2 stock assessment model for potential operational implementation in 2008 (i.e., input data are correct, assumptions are verified, and diagnostics are specified).

8.5. Acknowledgments

Workshop participants collectively thanked the hosts (National Research Institute of Far Seas Fisheries and staff) for their hospitality and overall meeting arrangements that served as the foundation for meaningful scientific discussion and a successful meeting.

8.6. Adjournment

The Workshop was adjourned at xx PM on December 5, 2006. The chairperson (Max Stocker) thanked all of the participants for their attendance and contributions and finally, stressed to National Coordinators the need to maintain ongoing communication concerning scientific data exchange and research applicable to North Pacific albacore, as well as scheduling future ALBW meetings, such as the proposed November 2007 meetings discussed here.

9. REFERENCES

Bartoo, N., and T.J. Foreman. 1994. A review of the biology and fisheries for North Pacific albacore (*Thunnus alalunga*). Pages 173-187 *in* Interactions of Pacific tuna fisheries, Volume 2: papers on biology and fisheries, R.S. Shomura, J. Majkowski, and S. Langi (editors). FAO Fisheries Technical Paper No. 336/2. Rome, FAO.

Clemens, H. B. 1961. The migration, age, and growth of Pacific albacore (Thunnus germo) 1951-58. California Department of Fish and Game Fishery Bulletin 115:1-128

Crone, P.R. and R.J. Conser (eds.). 2004. *Report of the Eighteenth North Pacific Albacore Workshop*. Eighteenth North Pacific Albacore Workshop, La Jolla, California, United States, December 4-11, 2002. National Marine Fisheries Service, Southwest Fisheries Center, La Jolla, CA. 92 p.

Labelle, M. 2005. Testing the MULTIFAN-CL assessment model using simulated tuna fisheries data. Fisheries Research 71: 311-334.

Porch, C. E. 2003. VPA-2BOX: User's guide (Version 3.01). Sustainable Fisheries Division Contribution SFD-01/02-151, Southeast Fisheries Science Center, 75 Virginia Beach Dr., Miami, FL 33149, USA. 69 p.

Stocker, M. 2005 (editor). *Report of the Nineteenth North Pacific Albacore Workshop*. Nineteenth North Pacific Albacore Workshop, Nanaimo, B.C., Canada, November 25-December 2, 2004. Fisheries and Oceans Canada, Pacific Biological Station, Nanaimo, B.C., Canada. 127 p.

Suda, A. 1966. Catch variations in the North Pacific albacore VI. The speculation about influence of fisheries on the catch and abundance of the albacore in the north-west Pacific by use of some simplified mathematical models (continued paper - I). Rep. Nankai Reg. Fish. Res. Lab. 24:1-14.

Suda, A and Y. Warashina. 1961. Some consideration on factor of albacore in the North West Pacific, especially on differences between albacore caught by longline and pole and line methods. Rep. Nankai Reg. Fish. Res. Lab. 13:21-34.

Ueyanagi, S. 1957. Spawning of the albacore in the Western Pacific. Rep. Nankai Reg. Fish. Res. Lab. 6:113-124.

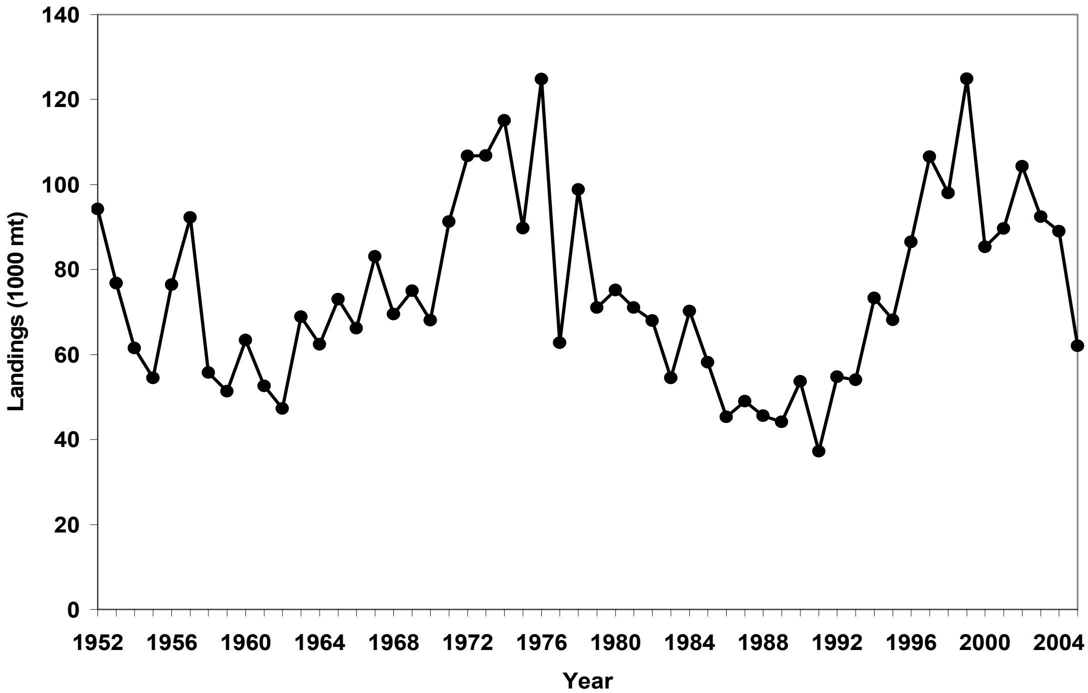


Figure 1. North Pacific Ocean albacore landings for all gears and nations combined (1952-05).

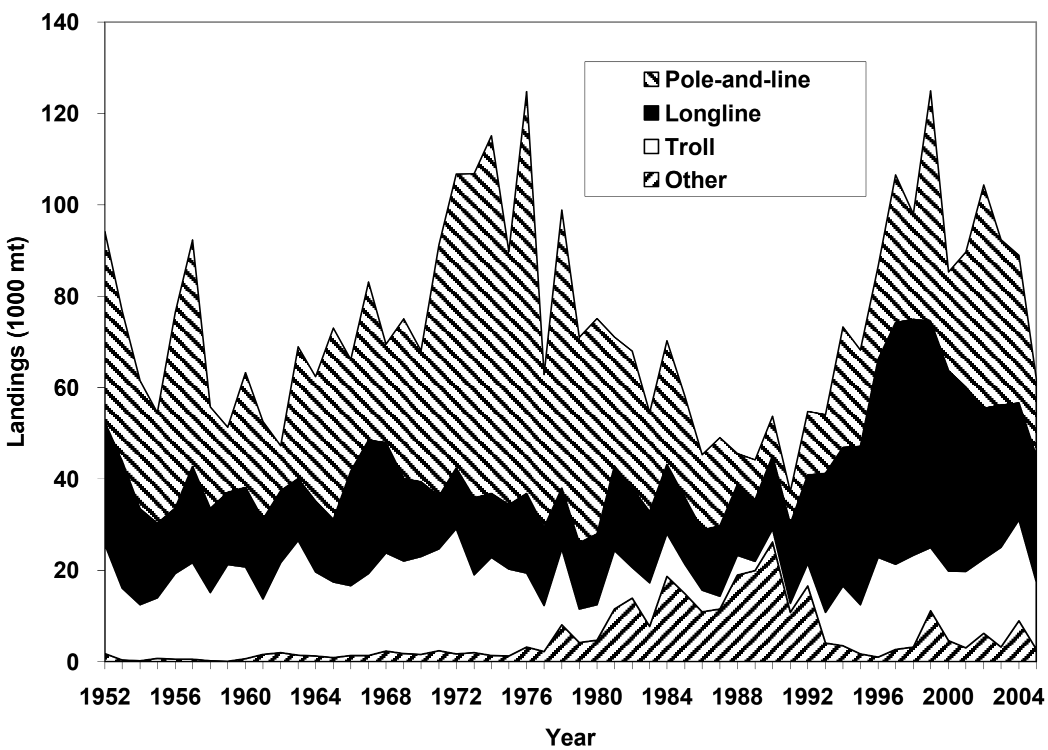


Figure 2. North Pacific Ocean albacore landings by gear, all nations combined (1952-05).

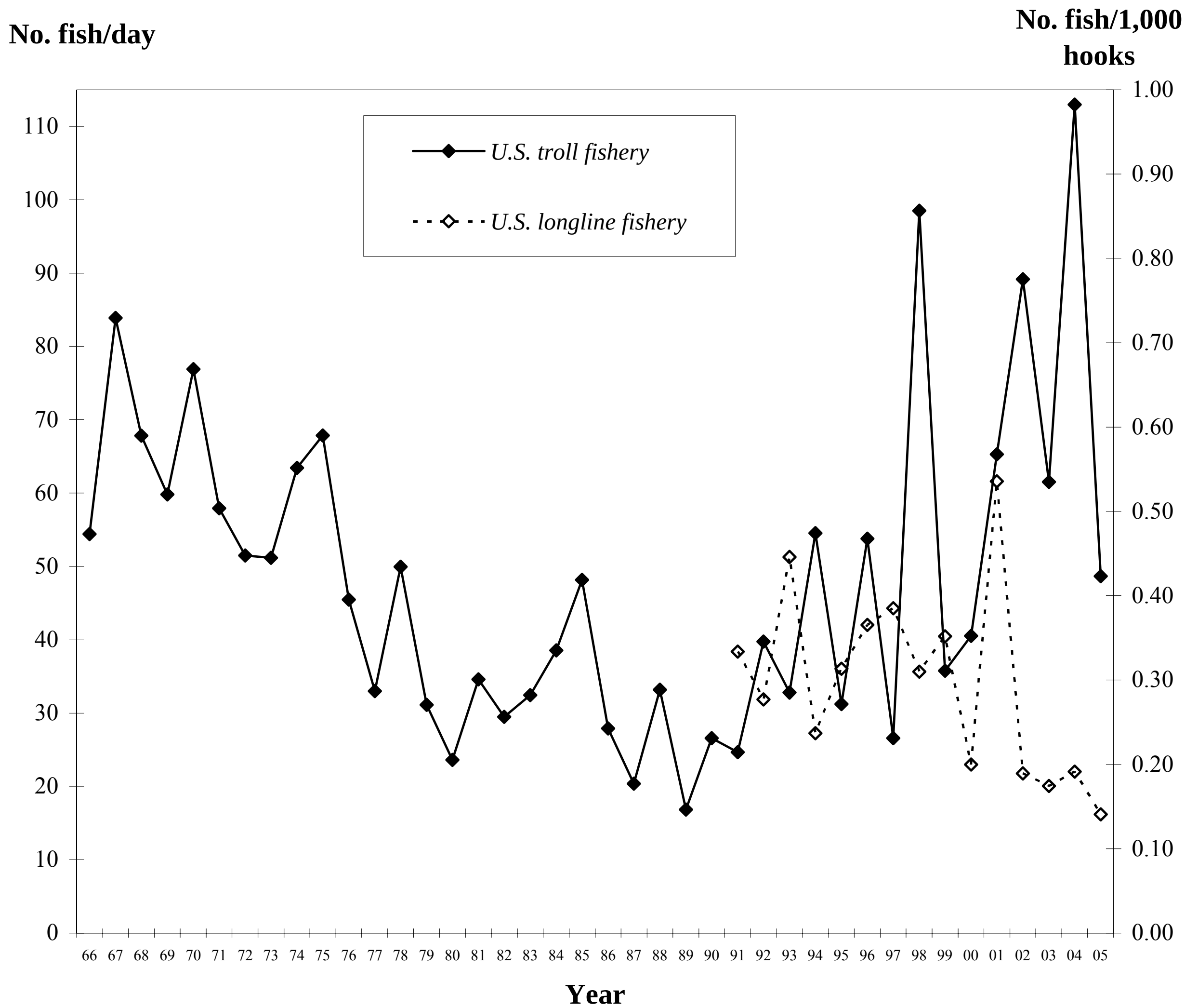


Figure 15. North Pacific albacore 'standardized' CPUE relative indices of abundance for the U.S. troll (1966-05) and longline (1991-05) fisheries.

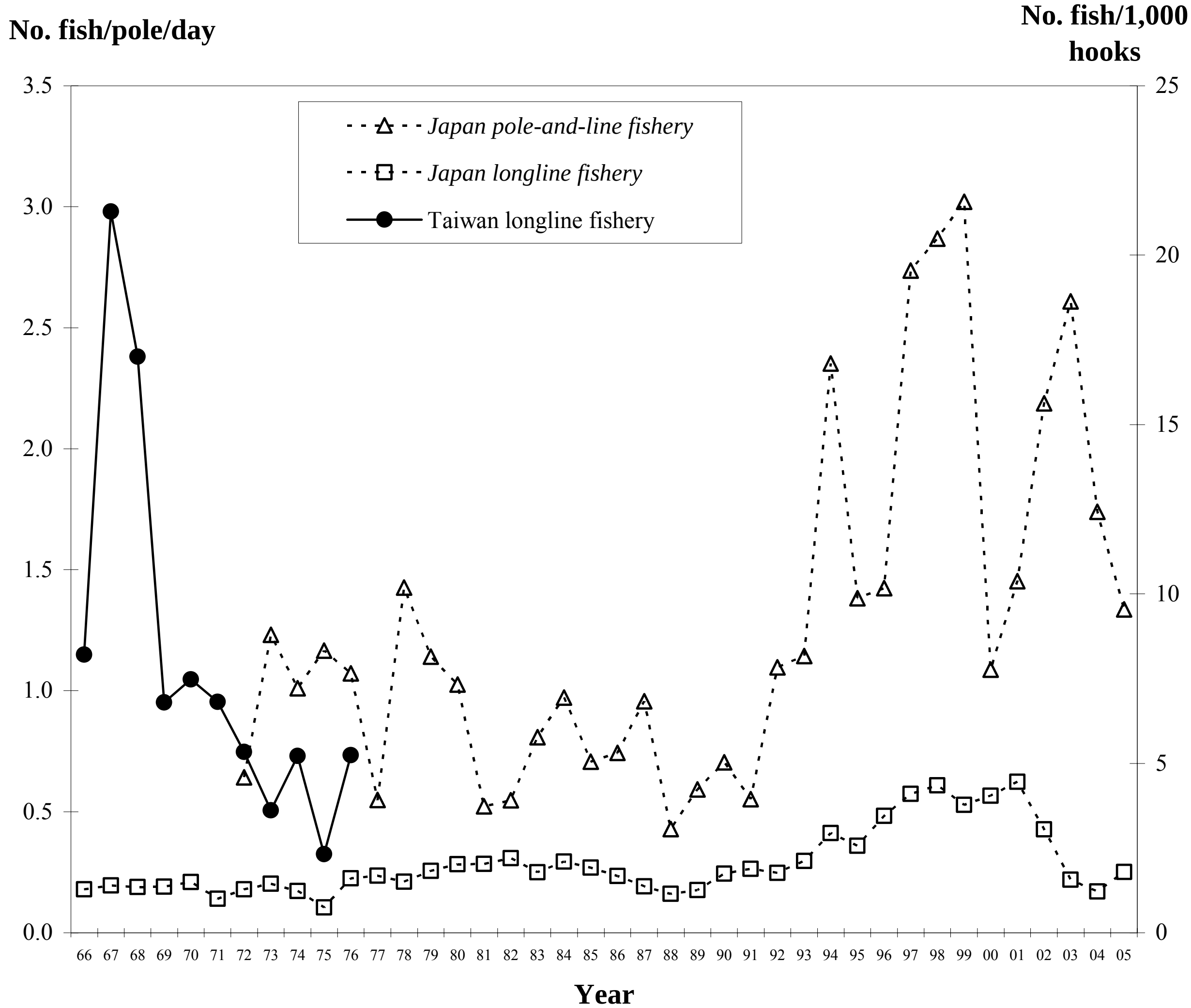


Figure 16. North Pacific albacore 'standardized' CPUE relative indices of abundance for western Pacific Ocean fisheries: Japan pole-and-line (1972-05); Japan longline (offshore/distant-water, 1966-05); and Taiwan longline (1995-05).

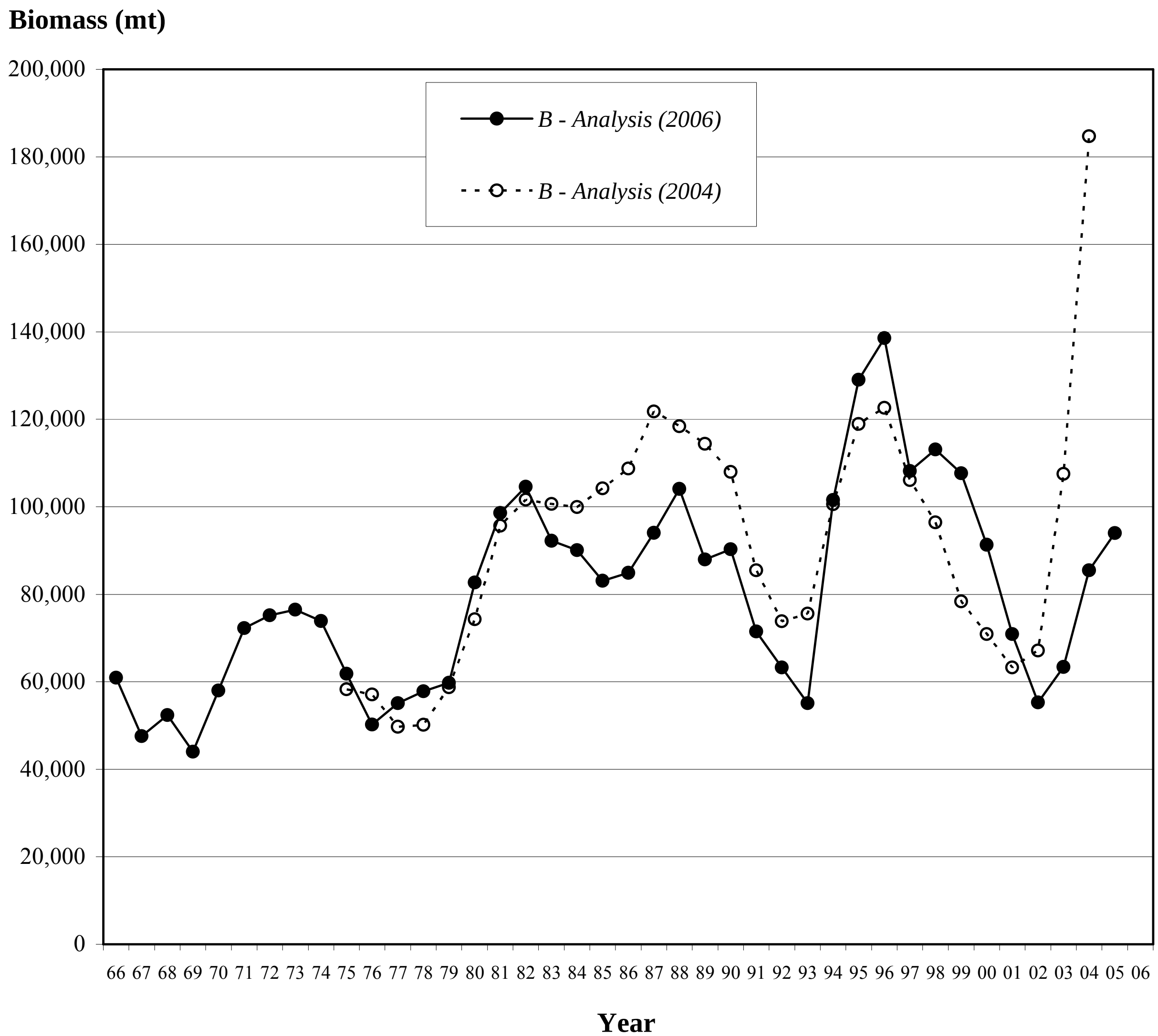


Figure 17. Total 'exploitable' stock biomass (*B* , mt) time series (1966-06) for North Pacific albacore generated from Model D1 (Analysis 2006). Final estimated time series from the previous North Pacific Albacore Workshop (2004) are also presented. Time series for *B* are based on 'January 1' estimates.

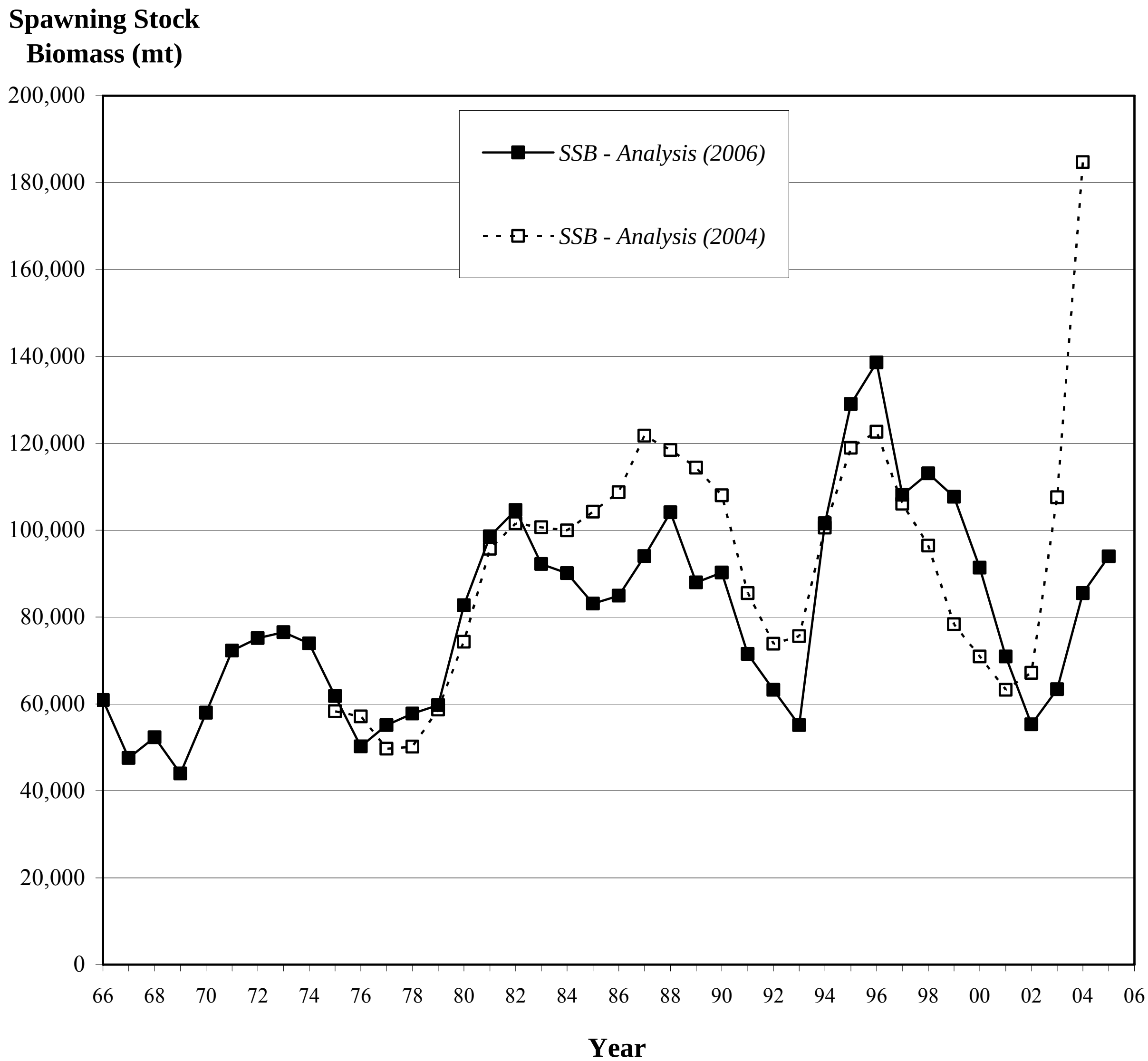


Figure 18. Spawning stock biomass (*SSB* , mt) time series (1966-06) for North Pacific albacore generated from Model D1 (Analysis 2006). Final estimated time series from the previous North Pacific Albacore Workshop (2004) are also presented. Time series for *SSB* are based on 'May 1' estimates.

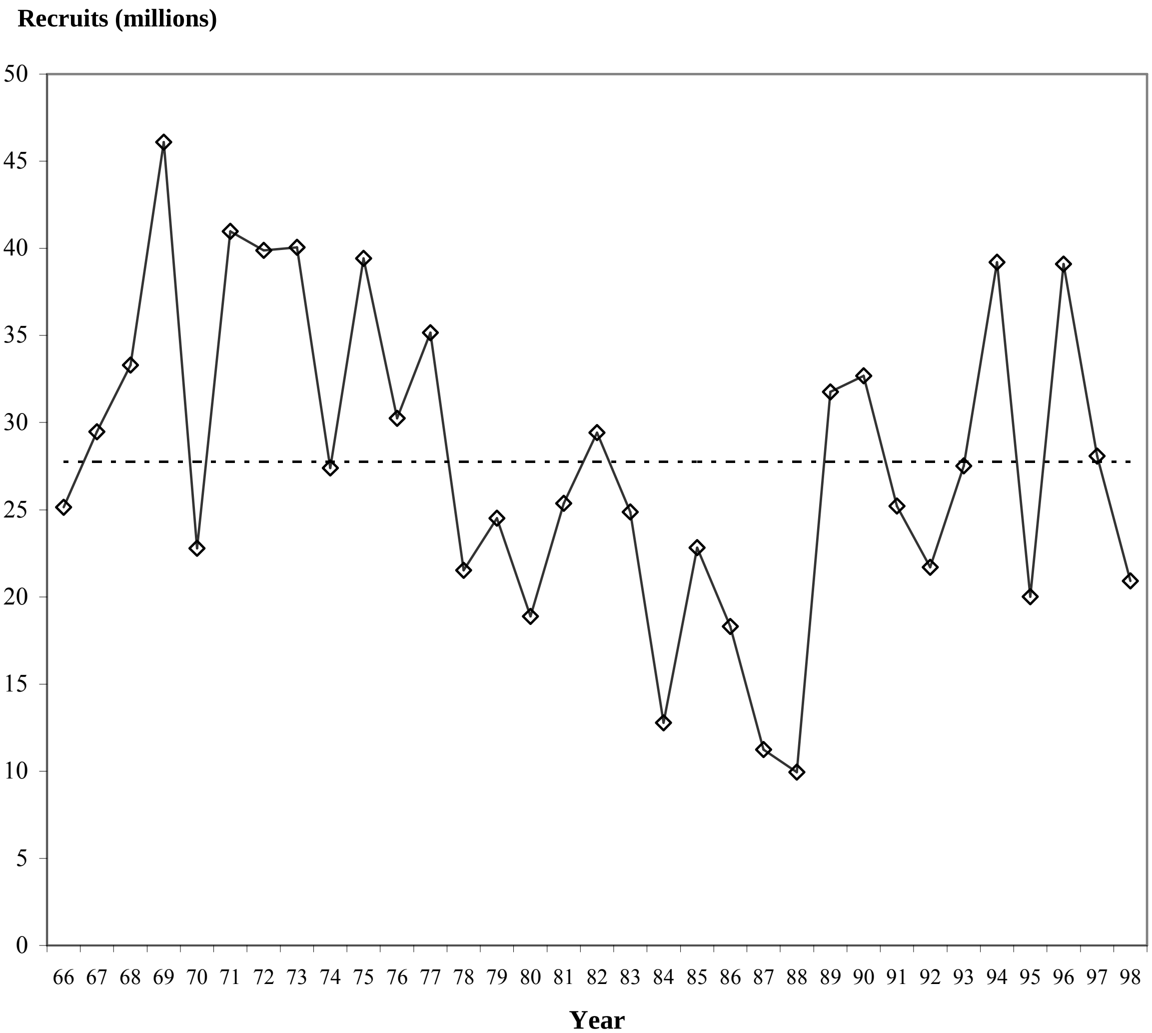
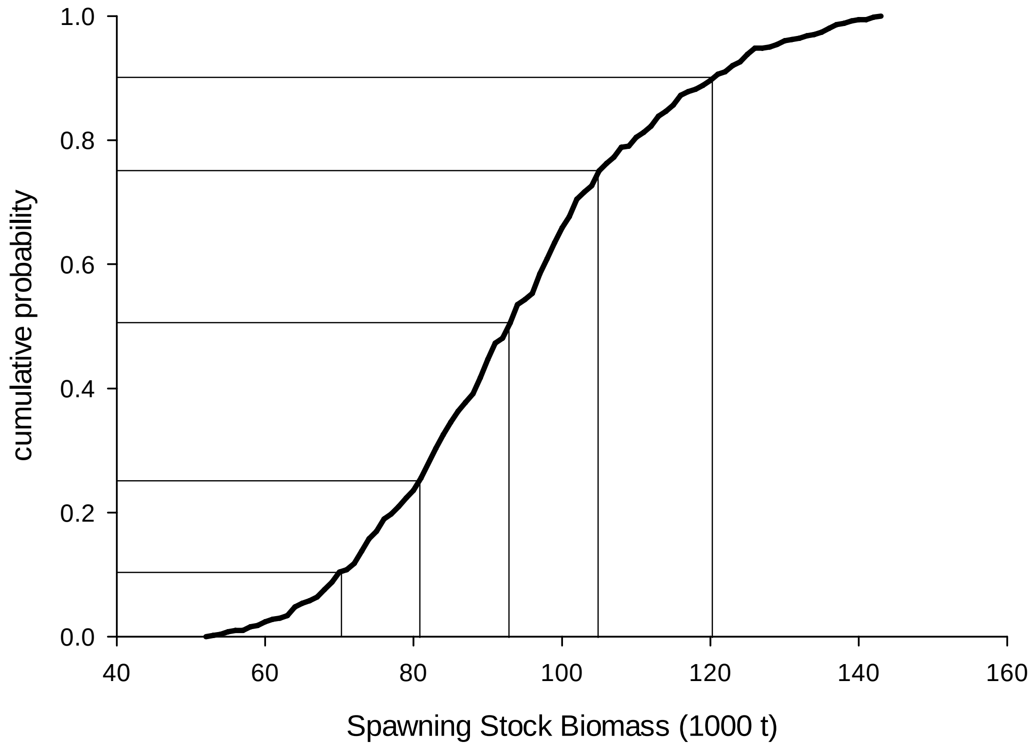


Figure 19. Recruitment (age-1 fish in millions) time series of North Pacific albacore generated from Model D1 (1966-98). Mean (1966-98) recruitment is presented as horizontal dashed line.


1.0
0.8
0.6
0.4
0.2
0.0
cumulative probability
40
60
80
100
120
140
160
Spawning Stock Biomass (1000 t)

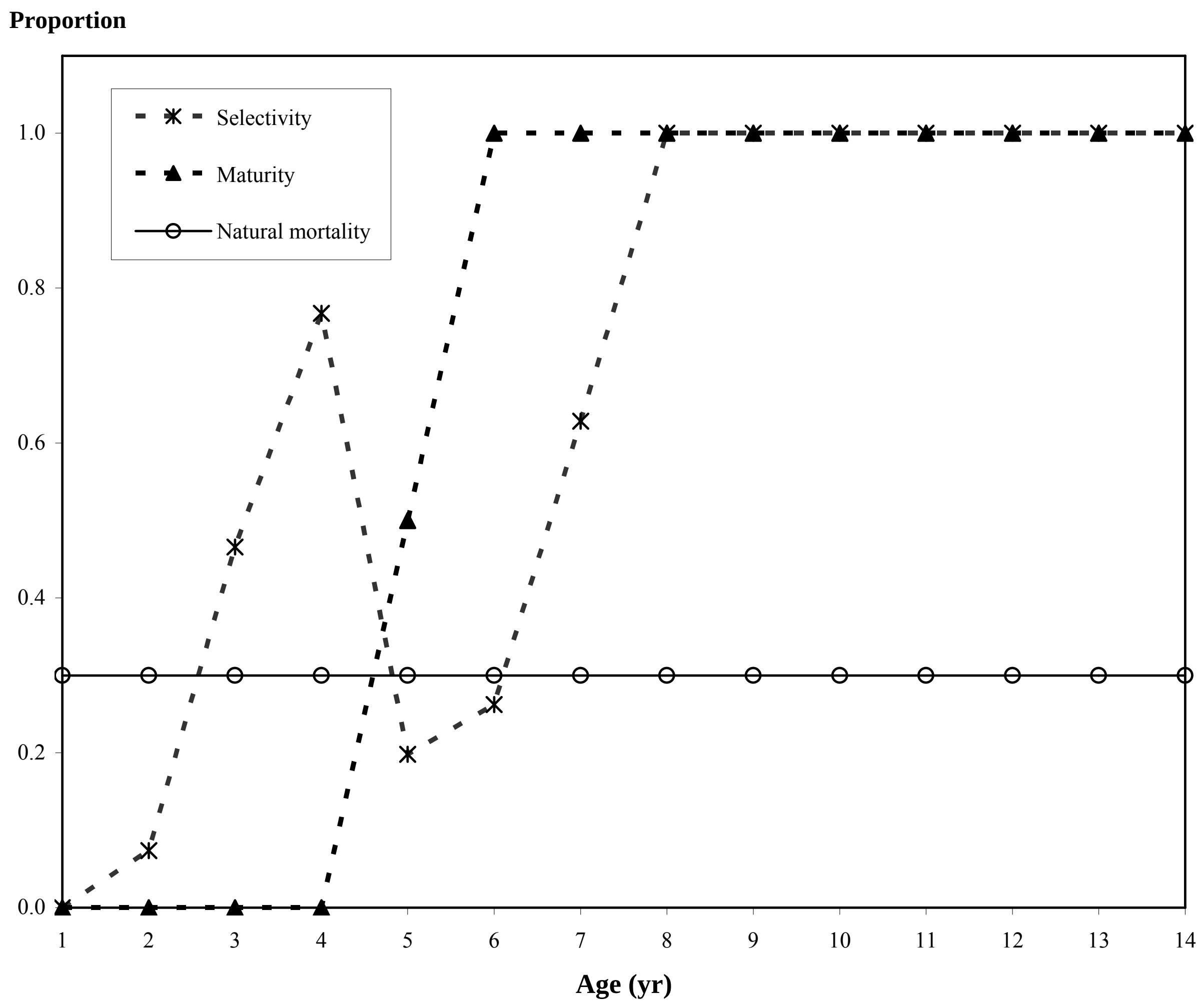
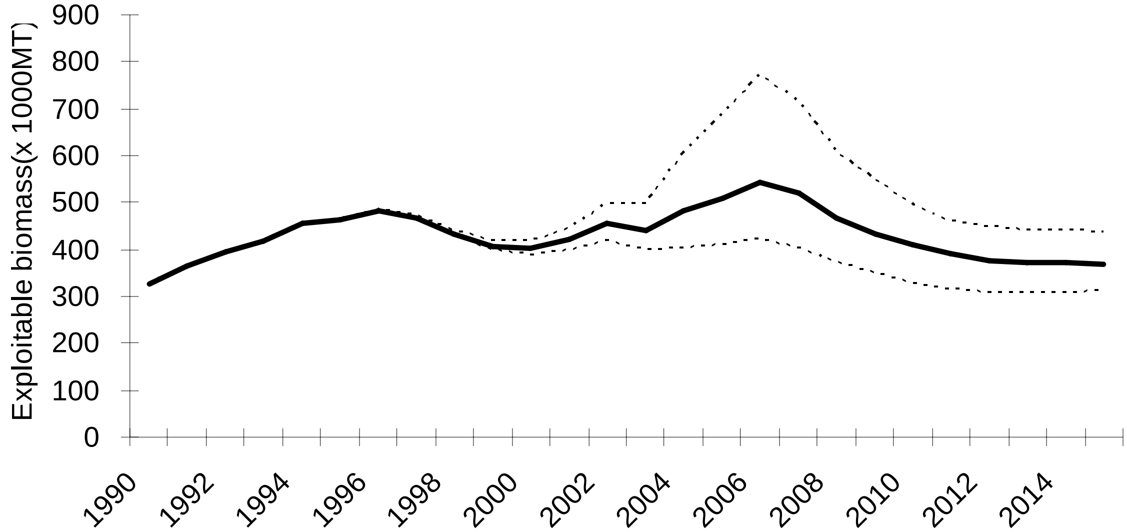


Figure 21. Partial recruitment (i.e., selectivity), maturity (Ueyangi 1957), and natural mortality (M) schedules used to determine biological reference points associated with Model Scenario 1.

Figure 22. Equilibrium yield-per-recruit (Y/R in kg) and % of SSB/R (relative to F=0) for various F-based biological reference points as a function of fishing mortality rate (F) for North Pacific albacore associated with Model Scenario D1. The current F (2003) reflects a 'range' based on a 'low' (0.43) and 'high' (0.68) assumption involved in uncertainty analysis (see Section 6.3.2.).

Projected total biomass



Projected spawning stock biomass

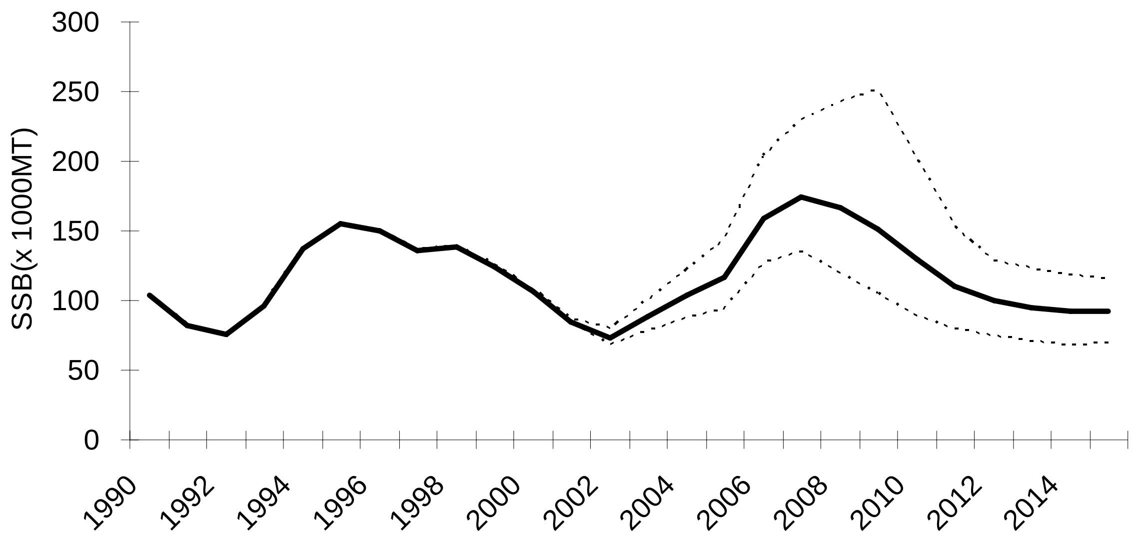


Table 1. North Pacific albacore catches (in metric tons) by fisheries, 1952-2005[1]. Blank indicates no effort. -- indicates data not available. 0 indicates less than 1 metric ton. Provisional estimates in ().

YEAR	CANADA	JAPAN						KOREA		MEXICO
	TROLL	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		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		18,030	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	38,951	32,238	1,068	1,585	123		319	53
1998	4,188	206	35,812	22,926	1,554	1,190	88		288	8
1999	2,641	289	33,364	50,369	6,872	891	127		107	23
2000	4,465	67	30,046	21,550	2,408	645	171		414	79
2001	4,985	117	28,818	29,430	974	416	96		82	22
2002	5,022	332	23,644	48,454	3,303	787	135		(113)	28
2003	6,735	126	20,954	36,114	627	922	106	(0)	(144)	28
2004	(7,842)	61	17,547	32,255	7,200	772	65	(0)	(68)	(104)
2005	(4,810)	(61)	(19,615)	(16,883)	(859)	(772)	(65)	(0)	(520)	(0)

[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			75,023
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	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	106,534
1998		8,617	79	80	1,120	33	1,208	14,410	2	5,871	286	97,966
1999		8,186	60	149	1,540	48	3,621	10,060	1	6,307	261	124,916
2000		8,842	69	55	940	4	1,798	9,645	3	3,654	490	85,344
2001		8,684	139	94	1,295	51	1,635	11,210	0	1,471	127	89,648
2002		7,965	381	30	525	4	2,357	10,387		700	(127)	(104,295)
2003		(7,166)	59	16	524	44	2,214	14,102	0	(2,400)	(127)	(92,409)
2004		(4,988)	(126)	(12)	(560)	(1)	(1,506)	(13,346)	(0)	(2,400)	(127)	(88,981)
2005		(4,692)	(66)	(20)	(277)	(2)	(1,719)	(9,122)	(0)	(2,400)	(127)	(62,011)

Table 2. North Pacific albacore catch-at-age (numbers of fish in 1,000s) matrix used for all VPA-2BOX analysis (1966-05).

YEAR	AGE (yr)									TOTAL
	1	2	3	4	5	6	7	8	≥9	
1966	0	129	2,022	1,118	2,412	261	145	52	41	6,180
1967	0	210	2,293	1,552	2,820	579	171	97	72	7,794
1968	0	92	3,268	1,422	1,118	763	254	97	39	7,053
1969	1	2,046	2,584	1,232	2,493	197	191	194	53	8,990
1970	0	282	3,390	2,220	1,321	410	101	71	61	7,856
1971	0	208	4,634	2,424	2,831	388	175	70	81	10,810
1972	0	4,030	3,514	4,646	2,348	270	118	92	60	15,078
1973	1	2,583	3,619	1,531	4,030	743	141	90	74	12,812
1974	0	1,128	4,483	5,653	1,538	754	153	57	96	13,863
1975	0	828	5,222	2,912	1,907	264	111	78	259	11,581
1976	0	2,325	4,937	5,767	2,766	285	165	106	186	16,538
1977	0	741	2,919	1,955	1,106	426	132	91	160	7,531
1978	2	5,931	2,125	4,729	1,018	387	185	45	83	14,505
1979	0	580	1,215	3,623	1,257	265	190	101	68	7,300
1980	0	2,518	2,830	3,160	801	311	110	87	97	9,916
1981	4	898	1,509	2,854	1,095	450	270	106	115	7,301
1982	78	599	1,949	3,408	435	255	200	213	134	7,272
1983	2	1,182	2,552	2,306	232	186	196	146	141	6,945
1984	5	1,111	4,571	3,031	241	177	126	131	156	9,550
1985	2	318	1,235	2,776	641	118	166	100	325	5,681
1986	0	794	906	2,461	204	128	127	90	131	4,840
1987	1	265	2,155	1,296	474	314	176	102	169	4,953
1988	4	133	1,529	1,156	270	606	223	161	181	4,264
1989	106	377	316	1,335	1,012	276	246	133	158	3,959
1990	109	317	239	1,151	1,606	641	113	213	247	4,635
1991	78	678	1,747	335	339	263	155	119	271	3,984
1992	1	332	2,350	1,664	662	360	150	151	156	5,826
1993	0	485	1,090	1,971	793	202	201	116	293	5,151
1994	28	669	1,575	2,355	1,077	654	206	97	136	6,798
1995	2	496	1,310	3,152	294	310	564	116	119	6,362
1996	8	494	3,938	2,294	603	396	554	477	105	8,869
1997	0	2,453	1,431	4,451	817	124	476	620	391	10,764
1998	0	1,105	4,036	1,568	1,880	302	213	379	282	9,766
1999	77	816	3,761	5,797	757	478	477	185	308	12,656
2000	0	1,231	1,852	2,739	923	415	450	435	247	8,292
2001	4	1,470	4,370	1,396	1,153	410	451	277	338	9,869
2002	0	1,447	7,396	3,141	439	226	381	209	222	13,461
2003	0	3,054	3,619	3,008	709	306	250	181	194	11,321
2004	30	210	4,411	4,363	282	452	332	130	44	10,253
2005	1	2,382	1,547	2,318	305	171	437	189	69	7,418
TOTAL	543	46,948	110,447	106,273	47,010	14,522	9,484	6,404	6,365	347,996

Table 3. North Pacific albacore numbers-at-age (January 1 in 1,000s of fish) as estimated in Model Scenario D1 (1966-06). Recruitment (age-1 fish) from 2005-06 reflects mean estimate from 1966-98; and (2) age-2 fish in 2006 reflects exponential decline (e-Z) of age-1 fish in 2003, see section ?..

YEAR	AGE (yr)								
	1	2	3	4	5	6	7	8	≥9
1966	25,148	20,076	9,549	8,963	5,558	1,035	424	166	131
1967	29,475	18,630	14,762	5,352	5,685	2,083	545	191	142
1968	33,293	21,836	13,622	8,980	2,647	1,842	1,052	259	105
1969	46,100	24,664	16,098	7,312	5,439	1,018	720	563	154
1970	22,784	34,151	16,522	9,721	4,365	1,930	586	371	322
1971	40,983	16,879	25,058	9,353	5,312	2,113	1,081	348	401
1972	39,890	30,361	12,325	14,614	4,869	1,562	1,235	651	427
1973	40,054	29,551	19,050	6,147	6,887	1,632	927	814	669
1974	27,404	29,672	19,683	11,028	3,253	1,735	583	566	958
1975	39,421	20,302	21,015	10,766	3,424	1,116	650	302	999
1976	30,252	29,204	14,331	11,128	5,502	941	602	387	676
1977	35,167	22,411	19,646	6,435	3,405	1,752	455	306	539
1978	21,530	26,052	15,968	12,063	3,108	1,585	936	224	413
1979	24,512	15,948	14,252	10,014	4,940	1,440	845	536	363
1980	18,877	18,159	11,318	9,519	4,353	2,591	840	464	522
1981	25,360	13,984	11,302	5,978	4,374	2,542	1,654	528	574
1982	29,433	18,784	9,591	7,084	2,028	2,310	1,499	995	628
1983	24,877	21,738	13,402	5,445	2,382	1,132	1,493	939	907
1984	12,774	18,428	15,092	7,753	2,088	1,566	680	938	1,123
1985	22,817	9,460	12,700	7,301	3,182	1,341	1,009	396	1,282
1986	18,307	16,901	6,735	8,352	3,062	1,812	892	606	881
1987	11,247	13,562	11,841	4,216	4,099	2,094	1,233	553	913
1988	9,945	8,332	9,819	6,935	2,024	2,631	1,283	763	855
1989	31,766	7,364	6,058	5,969	4,152	1,269	1,433	760	907
1990	32,680	23,442	5,132	4,218	3,286	2,215	705	852	987
1991	25,221	24,116	17,095	3,598	2,147	1,084	1,097	426	971
1992	21,698	18,617	17,285	11,171	2,379	1,301	580	680	704
1993	27,513	16,074	13,507	10,798	6,855	1,200	657	302	765
1994	39,200	20,382	11,492	9,074	6,319	4,401	717	317	444
1995	20,004	29,016	14,527	7,168	4,721	3,762	2,702	356	366
1996	39,104	14,818	21,070	9,641	2,654	3,246	2,522	1,522	335
1997	28,075	28,962	10,554	12,252	5,191	1,453	2,066	1,397	882
1998	20,914	20,798	19,358	6,597	5,311	3,148	970	1,125	836
1999	35,841	15,494	14,461	10,904	3,553	2,343	2,074	537	893
2000	37,465	26,485	10,779	7,516	3,218	1,988	1,329	1,130	642
2001	34,669	27,755	18,566	6,406	3,250	1,600	1,119	603	737
2002	47,669	25,680	19,302	10,036	3,558	1,432	837	448	474
2003	16,028	35,314	17,785	8,047	4,771	2,261	868	299	321
2004	51,196	11,874	23,549	10,093	3,418	2,929	1,414	431	146
2005	27,752	37,901	8,617	13,686	3,798	2,291	1,784	765	279
2006	27,752	20,539	26,040	5,065	8,162	2,552	1,551	950	554

Table 4. Instantaneous rates of fishing mortality-at-age (yr^{-1}) as estimated in Model Scenario D1 (1966-05).

YEAR	AGE (yr)								
	1	2	3	4	5	6	7	8	≥9
1966	0.000	0.007	0.279	0.155	0.681	0.341	0.496	0.439	0.439
1967	0.000	0.013	0.197	0.404	0.827	0.383	0.446	0.859	0.859
1968	0.000	0.005	0.322	0.201	0.656	0.639	0.324	0.561	0.561
1969	0.000	0.101	0.204	0.216	0.736	0.252	0.362	0.499	0.499
1970	0.000	0.010	0.269	0.304	0.426	0.280	0.222	0.247	0.247
1971	0.000	0.014	0.239	0.353	0.924	0.237	0.207	0.263	0.263
1972	0.000	0.166	0.396	0.452	0.793	0.222	0.117	0.177	0.177
1973	0.000	0.106	0.247	0.337	1.079	0.729	0.192	0.137	0.137
1974	0.000	0.045	0.303	0.870	0.770	0.682	0.359	0.123	0.123
1975	0.000	0.048	0.336	0.371	0.992	0.317	0.218	0.354	0.354
1976	0.000	0.096	0.501	0.884	0.844	0.427	0.376	0.379	0.379
1977	0.000	0.039	0.188	0.428	0.465	0.327	0.406	0.415	0.415
1978	0.000	0.303	0.167	0.593	0.470	0.329	0.257	0.263	0.263
1979	0.000	0.043	0.104	0.533	0.345	0.238	0.299	0.244	0.244
1980	0.000	0.174	0.338	0.478	0.238	0.149	0.164	0.242	0.242
1981	0.000	0.077	0.167	0.781	0.339	0.228	0.208	0.262	0.262
1982	0.003	0.038	0.266	0.790	0.283	0.136	0.167	0.282	0.282
1983	0.000	0.065	0.247	0.659	0.119	0.210	0.164	0.197	0.197
1984	0.000	0.072	0.426	0.590	0.143	0.140	0.240	0.175	0.175
1985	0.000	0.040	0.119	0.569	0.263	0.107	0.209	0.344	0.344
1986	0.000	0.056	0.168	0.412	0.080	0.085	0.179	0.188	0.188
1987	0.000	0.023	0.235	0.434	0.143	0.189	0.180	0.239	0.239
1988	0.000	0.019	0.198	0.213	0.167	0.307	0.224	0.279	0.279
1989	0.004	0.061	0.062	0.297	0.328	0.287	0.221	0.224	0.224
1990	0.004	0.016	0.055	0.375	0.809	0.403	0.204	0.338	0.338
1991	0.004	0.033	0.125	0.114	0.201	0.326	0.178	0.385	0.385
1992	0.000	0.021	0.170	0.188	0.384	0.382	0.351	0.294	0.294
1993	0.000	0.036	0.098	0.236	0.143	0.215	0.430	0.576	0.576
1994	0.001	0.039	0.172	0.354	0.219	0.188	0.401	0.431	0.431
1995	0.000	0.020	0.110	0.694	0.075	0.100	0.274	0.467	0.467
1996	0.000	0.039	0.242	0.319	0.302	0.152	0.291	0.445	0.445
1997	0.000	0.103	0.170	0.536	0.200	0.104	0.308	0.703	0.703
1998	0.000	0.063	0.274	0.319	0.518	0.117	0.291	0.487	0.487
1999	0.003	0.063	0.354	0.920	0.281	0.267	0.307	0.501	0.501
2000	0.000	0.055	0.220	0.538	0.399	0.275	0.490	0.578	0.578
2001	0.000	0.063	0.315	0.288	0.520	0.348	0.615	0.738	0.738
2002	0.000	0.067	0.575	0.444	0.153	0.201	0.728	0.757	0.757
2003	0.000	0.105	0.267	0.556	0.188	0.169	0.401	1.149	1.149
2004	0.001	0.021	0.243	0.677	0.100	0.196	0.314	0.425	0.425
2005	0.001	0.075	0.231	0.217	0.097	0.090	0.330	0.333	0.333

(DRAFT 2) Biological reference points for North Pacific albacore. For all cases, length-at-age (cm) is determined from the Suda (1966) growth curve. The acronym WAA is weight-at-age in kg.
The low and high designation for the last four reference points refer to the assumption of low or high productivity, respectively, as used in the 2004 assessment.

Inputs for Estimation of Biological Reference Points									Recent	*Suite of Biological Reference Points*										
Run	Length-Wt	SSB Timing	Vital Rates						Full F	$F_{40\%}$	$F_{35\%}$	$F_{0.1}$	$F_{30\%}$	$F_{20\%}$	F_{max}	$F_{SSB\text{-}Min}$	$F_{SSB\text{-}10\%}$	$F_{SSB\text{-}25\%}$	$F_{SSB\text{-}50\%}$
2004 NPALB Assessment (Stocker 2005)	Suda and Warashina (1961)	July 1	Age	WAA (mid-yr)	WAA (spawning)	Selex	Maturity	M	**0.43-0.68**	**0.30**	**0.35**	**0.37**	**0.42**	**0.61**	**1.07**	**0.89 low 1.05 high**	**0.82 low 0.98high**	**0.72 low 0.86 high**	**0.54 low 0.67 high**
			1	1.6	1.6	0.01	0.0	0.3											
			2	3.9	3.9	0.11	0.0	0.3											
			3	7.2	7.2	0.37	0.0	0.3											
			4	11.2	11.2	0.58	0.0	0.3											
			5	15.8	15.8	0.30	0.5	0.3											
			6	20.6	20.6	0.34	1.0	0.3											
			7	25.5	25.5	0.67	1.0	0.3											
			8	30.3	30.3	1.00	1.0	0.3											
			9	34.9	34.9	1.00	1.0	0.3											
			10	39.2	39.2	1.00	1.0	0.3											
			11	43.2	43.2	1.00	1.0	0.3											
			12	46.9	46.9	1.00	1.0	0.3											
			13	50.2	50.2	1.00	1.0	0.3											
			14	53.2	53.2	1.00	1.0	0.3											
2004 NPALB Assessment but using new length-weight and new timing for spawning	Watanabe et al. (2006)	May 1	Age	WAA (mid-yr)	WAA (spawning)	Selex	Maturity	M	**0.43-0.68**	**0.33**	**0.38**	**0.44**	**0.45**	**0.65**	**1.7**	**na**	**na**	**na**	**na**
			1	2.1	2.3	0.01	0.0	0.3											
			2	4.5	4.8	0.11	0.0	0.3											
			3	7.5	7.9	0.37	0.0	0.3											
			4	10.9	11.3	0.58	0.0	0.3											
			5	14.4	14.9	0.30	0.5	0.3											
			6	18.0	18.5	0.34	1.0	0.3											
			7	21.5	21.9	0.67	1.0	0.3											
			8	24.8	25.1	1.00	1.0	0.3											
			9	27.9	28.2	1.00	1.0	0.3											
			10	30.8	30.9	1.00	1.0	0.3											
			11	33.4	33.4	1.00	1.0	0.3											
			12	35.7	35.7	1.00	1.0	0.3											
			13	37.9	37.7	1.00	1.0	0.3											
			14	39.7	39.5	1.00	1.0	0.3											
2006 NPALB Assessment (this workshop)	Watanabe et al. (2006)	May 1	Age	WAA (mid-yr)	WAA (spawning)	Selex	Maturity	M	**0.72**	**0.32**	**0.37**	**0.44**	**0.44**	**0.63**	**2.0**	**na**	**na**	**na**	**na**
			1	2.1	2.3	0.00	0.0	0.3											
			2	4.5	4.8	0.07	0.0	0.3											
			3	7.5	7.9	0.47	0.0	0.3											
			4	10.9	11.3	0.77	0.0	0.3											
			5	14.4	14.9	0.20	0.5	0.3											
			6	18.0	18.5	0.26	1.0	0.3											
			7	21.5	21.9	0.63	1.0	0.3											
			8	24.8	25.1	1.00	1.0	0.3											
			9	27.9	28.2	1.00	1.0	0.3											
			10	30.8	30.9	1.00	1.0	0.3											
			11	33.4	33.4	1.00	1.0	0.3											
			12	35.7	35.7	1.00	1.0	0.3											
			13	37.9	37.7	1.00	1.0	0.3											
			14	39.7	39.5	1.00	1.0	0.3											

DRAFT 1 - North Pacific Albacore Biological Reference Point (BRP) Table for Managers. Numbers in the body of the table are the fishing mortality rates (F) relative to recent F estimated in the 2004 and 2006 assessments. Recent F is always 1.0 is this table. A table entry less than 1.0 implies that F must be decreased to align with the respective BRP shown above it. On the other hand, a table entry greater than 1.0 implies that recent F is below the BRP. The 2004 BRP presentation was complex in that two scenarios regarding recent F were coupled with two scenarios regarding recent productivity. The BRPs associated with the 2006 assessment are more straightforward, i.e. recent F (1.0) appears to be greater than the F associated with F_20% but less than the F associated with F_max.

	Relative F in Recent Years	***Suite of Biological Reference Points***										***Productivity in Recent Years***
		$F_{40\%}$	$F_{35\%}$	$F_{0.1}$	$F_{30\%}$	$F_{20\%}$	F_{max}	$F_{SSB\text{-}Min}$	$F_{SSB\text{-}10\%}$	$F_{SSB\text{-}25\%}$	$F_{SSB\text{-}50\%}$	
2004 NPALB Assessment (Stocker 2005)	**Low F = 1.0**	0.70	0.81	0.86	0.98	1.42	2.49	2.07	1.91	1.67	1.26	**Low**
	Low F = 1.0							2.44	2.28	2.00	1.56	**High**
	High F = 1.0	0.44	0.51	0.54	0.62	0.90	1.57	1.31	1.21	1.06	0.79	**Low**
	High F = 1.0							1.54	1.44	1.26	0.99	**High**
2006 NPALB Assessment (this workshop)	**F=1.0**	0.45	0.52	0.61	0.61	0.88	2.79	TBD	TBD	TBD	TBD	**Average**

APPENDIX 1

List of Participants

Canada
Max Stocker (chair)
Fisheries and Oceans Canada, Pacific Biological Station
3190 Hammond Bay Road, Nanaimo, B.C., Canada V9T 6N7
Phone: 250-758-0275, Fax: 250-756-7053, E-mail: StockerM@pac.dfo-mpo.gc.ca

Japan
Hiroyasu Hasegawa
Fisheries Agency, 1-2-1, Kasumigaseki, Chiyoda-ku, Tokyo 100-8950 Japan
Phone: 81-3-3502-8111(ex. Number: 7377), Fax: 81-3-3592-0759, E-mail: hiroyasu_hasegawa@nm.maff.go.jp

Hitoshi Honda
National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu-ku, Shizuoka 424-8633 Japan
Phone: 81-543-36-6000, Fax: 81-543-35-9642, E-mail: hhonda@affrc.go.jp

Momoko Ichinokawa
National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu-ku, Shizuoka 424-8633 Japan
Phone: 81-543-36-6039, Fax: 81-543-35-9642, E-mail: ichimomo@fra.affrc.go.jp

Mikihiko Kai
National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu-ku, Shizuoka 424-8633 Japan
Phone: 81-543-36-6039, Fax: 81-543-35-9642, E-mail: kaim@affrc.go.jp

Minoru Kanaiwa
Tokyo University of Agriculture, 196 Yasaka, Abashiri, Hokkai, 099-2493 Japan,
Phone: 81-152-48-3857, Fax: 81-152-48-2940, E-mail: m3kanaiw@bioindustry.nodai.ac.jp

Hirokazu Saito
National Research Institute of Far Seas Fisheries, 5-7-1 Orido, Shimizu-ku, Shizuoka 424-8633 Japan
Phone: 81-543-36-6037, Fax: 81-543-35-9642, E-mail: hisaito@affrc.go.jp

Yukio Takeuchi
National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu-ku, Shizuoka 424-8633 Japan
Phone: 81-543-36-6039, Fax: 81-543-35-9642, E-mail: yukiot@fra.affrc.go.jp

List of Participants (continued)

Koji Uosaki
National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu-ku, Shizuoka 424-8633 Japan
Phone: 81-543-36-6032, Fax: 81-543-35-9642, E-mail: uosaki@affrc.go.jp

Kyuji Watanabe
National Research Institute of Far Seas Fisheries, 5-7-1, Orido, Shimizu-ku, Shizuoka 424-8633 Japan
Phone: 81-543-36-6033, Fax: 81-543-35-9642, E-mail: watanabk@fra.affrc.go.jp

United States

Atilio L. Coan Jr.
NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive
La Jolla, CA 92037, U.S.A.
Phone: 858-546-7079, Fax: 858-546-5653, E-mail: Al.Coan@noaa.gov

Ray Conser
NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive
La Jolla, CA 92037, U.S.A.
Phone: 858-546-5688, Fax: 858-546-5656, E-mail: Ray.Conser@noaa.gov

Paul R. Crone
NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive
La Jolla, CA 92037, U.S.A.
Phone: 858-546-7069, Fax: 858-546-5653, E-mail: Paul.Crone@noaa.gov

Emmanis Dorval
NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive
La Jolla, CA 92037, U.S.A.
Phone: 858-546-5619, Fax: 858-546-5656, E-mail: Emmanis.Dorval@noaa.gov

Kevin Piner
NOAA Fisheries, Southwest Fisheries Science Center, 8604 La Jolla Shores Drive
La Jolla, CA 92037, U.S.A.
Phone: 858-546-5613, Fax: 858-546-7003, E-mail: Kevin.Piner@noaa.gov

Vidar Wespestad
American Fisherman’s Research Foundation, 21231 8th Pl. W., Lynnwood, WA 98036
Phone: 425-672-7603, Fax: 425-672-1357, E-mail: vidarw@verizon.com

APPENDIX 2

Agenda

November 28 *(Tuesday)*, 0900-1700

1. Registration and distribution of documents, **09:00-09:30**

2. Opening of the International Scientific Committee Albacore Working Group (ISC-ALBWG) Stock Assessment Workshop, **09:30-10:00**
   - Welcome remarks by NRIFSF Director Dr. Kobayashi
   - Work program and logistics

3. Agenda
   - Adoption of agenda
   - Appointment of rapporteurs

4. Review of fisheries and highlights of research progress
   - Canada
   - Japan
   - Korea
   - Mexico
   - Chinese Taipei
   - United States
   - IATTC
   - Cook Islands
   - Other

5. Review of biological studies
   - Growth models
   - Reproductive studies
   - Tagging studies

November 28 *(Tuesday)*, 0900-1700 (cont.)

6. Review of fishery data used in stock assessments
   - Status of ALBWG Data Catalog
   - Review and update of catch data (Category I)
   - Review and update of catch/effort data (Category II)
   - Review and update of length-frequency data (Category III)
   - Review and update Miscellaneous fishery data (e.g., IUU fisheries)
   - Conclusions and work assignments

Reception: 1730-1900 (NRIFSF) – Welcome reception with guests and friends

November 29 *(Wednesday)*, 0900-1700

7. Stock Assessment Task Group (SATG) Report and Requirements
    - Review of the recommendations of the SATG Meeting in Nanaimo (i.e., provide update on the ground rules set by the SATG in July 2006 for data inputs and models that will be used in the 2006 stock assessment).

8. Northern Committee requests regarding catch and biological reference points
    - Discuss how the SATG plans to address Northern Committee requirements on IUU catch and biological reference points.

9. Workgroup session on input data used in VPA-2BOX
    - Catch-at-age matrices
    - Size data (i.e., length, weight)
    - CPUE: age-aggregated and age-specific indices of abundance
    - Conclusions and work assignments

10. Workgroup session on input data used in SS2
    - Catch and size frequency data
    - CPUE indices of abundance
    - Conclusions and work assignments

November 30 *(Thursday)*, 0900-1200

11. Review of VPA-2BOX requirements
    - Inputs—time series, estimates, assumptions
    - Baseline model run
    - Sensitivity analysis runs

12. Review of SS2 requirements
    - Inputs—time series, estimates, assumptions
    - Baseline model run
    - Sensitivity analysis runs

1300-1700

13. Small workgroup sessions to perform additional SS2 and VPA-2BOX model runs and sensitivity analyses

December 1 *(Friday)*, 0900-1200

14. Small workgroup sessions to perform additional SS2 and VPA-2BOX model runs and sensitivity analyses

1300-1700

15. Review of results from work assignments/model runs

Reception: Dinner at downtown Shimizu 19:00

December 2 (Saturday), **0900-1400**

16. Review of results from work assignments (*Continued*)

17. Workgroup session on stock projections and biological reference points
    - Refine initial conditions for projections
    - Assess 'hypotheses' used in projections
    - Review potential Biological Reference Points

18. Workgroup session on stock projections

19. Transition from the previous stock assessment (December 2004)
    - The effects of historical database corrections and updates, 1975-2003.
    - The effects of new data, 1966-74 and 2004-05.
    - The effects of employing the SS2 model (vs. VPA)

December 3 (*Sunday*), No Meeting

December 4 *(Monday)*, **0900-1200**

20. Stock status conclusions
    - Comparing results from VPA-2BOX and SS2 models
    - Assess 'current' conditions of B and F in relation to biological reference points
    - Discuss projection estimates
    - Develop conservation advice

21. SATG Workplan for 2007

22. Administrative matters
    - Northern Committee related matters
        1. address impact on the assessment of having no data on IUU fishing
        2. discuss projects that can be initiated to get a handle on the IUU catch or fishery
    - Update National coordinators and data correspondents
    - Procedures for clearing the report
    - Time and place for next meeting

1300-1700

23. Report preparation - rapporteurs and others

December 5 *(Tuesday)*, 0900-1500

24. Clearing of Workshop Report
25. Adjournment

APPENDIX 3

List of Documents

ISC/06/ALBWG/01:	International Scientific Committee Albacore Working Group Data Base Catalog – A.L. Coan
ISC/06/ALBWG/02:	Summary of the 2005 U.S. North and South Pacific Albacore Troll Fisheries – J. Childers and S. Aalbers
ISC/06/ALBWG/03:	North Pacific albacore catch in the U.S. longline fishery – J. Wetherall and A. Coan
ISC/06/ALBWG/04:	A review of Japanese albacore fisheries in the North Pacific – K. Uosaki and Y. Nishikaw
ISC/06/ALBWG/05:	The 2005 Canadian North Pacific albacore troll fishery – M. Stocker
ISC/06/ALBWG/06:	Update of catch-at-age of albacore caught by the Japanese fisheries in the North Pacific, 1966-2005 – K. Watanabe and K. Uosaki
ISC/06/ALBWG/07:	Standardization of age specific abundance index for North Pacific albacore caught by the Japanese large and small longline fisheries, 1966-2005: Improvement of general liner model – K. Watanabe and K. Uosaki
ISC/06/ALBWG/08:	Age specific abundance index for albacore caught by the Japanese pole-and-line fishery, 1972-2005 – K. Uosaki
ISC/06/ALBWG/09:	Critical evaluation of important time series associated with albacore fisheries (United States, Canada, and Mexico) of the eastern North Pacific Ocean – J.D. McDaniel, P.R. Crone, and E. Dorval
ISC/06/ALBWG/10:	Summary on archival tagging for North Pacific albacore, 2005-2006 – K. Uosaki
ISC/06/ALBWG/11:	Considerations in extreme depletion of abundance indices for North Pacific albacore from the Japanese longline fishery observed in 2003-2004 – K. Watanabe, K. Uosaki and Yukio Takeuchi
ISC/06/ALBWG/12:	Report of 2006 research cruise by R/V Shoyo-maru for albacore in the north-western Pacific – H. Saito, T. Tanabe, S. Koyama and K. Uosaki
ISC/06/ALBWG/13:	Classification of horizontal habitats of North Pacific albacore to derive abundance index from considering temporal fluctuations in catch per unit effort and effort, and their geographic distributions – K. Watanabe and K. Uosaki
ISC/06/ALBWG/14:	Revised practical solutions of application issues of length-weight relationship for the North Pacific albacore with respect to the stock assessment. – K. Watanabe, K. Uosaki, T. Kokubo, P. Crone, A. Coan and C.-C. Hsu
ISC/06/ALBWG/15:	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/06/ALBWG/16:	Summary report on software for North Pacific albacore stock assessment – R. Conser and Y. Takeuchi
ISC/06/ALBWG/17:	Biological reference points and stock projections for North Pacific albacore – R. Conser, P. Crone and Y. Takeeuchi
ISC/06/ALBWG/18:	Population analysis of North Pacific albacore based on a length-based, age-structured model: Stock Synthesis 2 – P.R. Crone, K.R. Piner, Y. Takeuchi, K. Uosaki, R.J. Conser, E. Dorval, K. Watanabe, and J.D. McDaniel
ISC/06/ALBWG/19:	Population analysis of North Pacific albacore based on an age-structured model: VPA-2BOX – K. Uosaki, E. Dorval, K. Watanabe, P.R. Crone, Y. Takeuchi, J.M. McDaniel, R.J. Conser, and K.R. Piner

SSBR_Prt_ALB_growth

North Pacific Albacore length (cm) and weight (kg) at age (Draft 1)

2004 Assessment

Using Suda (1966) growth and Suda and Warashina (1961)length-weight
(as used for NPALBW19 2004 assessment). Mid-yr wts were used for SSB calculations.

AGE (yr)	LENGTH (cm)	WEIGHT (kg)
0.50	27.60	0.36
1.00	36.14	0.85
1.50	44.07	1.60
2.00	51.43	2.62
2.50	58.27	3.91
3.00	64.61	5.44
3.50	70.49	7.19
4.00	75.95	9.13
4.50	81.02	11.23
5.00	85.72	13.46
5.50	90.09	15.77
6.00	94.14	18.16
6.50	97.90	20.58
7.00	101.39	23.03
7.50	104.63	25.46
8.00	107.64	27.88
8.50	110.43	30.26
9.00	113.02	32.59
9.50	115.42	34.86
10.00	117.66	37.06
10.50	119.73	39.19
11.00	121.65	41.24
11.50	123.43	43.21
12.00	125.09	45.09
12.50	126.62	46.89
13.00	128.05	48.60
13.50	129.37	50.22
14.00	130.60	51.76
14.50	131.74	53.22
15.00	132.80	54.60

2006 Assessment

Using Suda (1966) growth & Watanabe et al (2006) length-weight for Jan 1 stock biomass (Quarter 1).
Used in 2006 assessment for the mid-year weights associated with all yield & exploited biomass calculations, i.e. using the ages 1.5, 2.5, 3.5, etc.

AGE (yr)	LENGTH (cm)	WEIGHT (kg)
0.50	27.60	0.61
1.00	36.14	1.26
1.50	44.07	2.14

2.00	51.43	3.23
2.50	58.27	4.50
3.00	64.61	5.93
3.50	70.49	7.48
4.00	75.95	9.13
4.50	81.02	10.85
5.00	85.72	12.62
5.50	90.09	14.40
6.00	94.14	16.20
6.50	97.90	17.99
7.00	101.39	19.75
7.50	104.63	21.48
8.00	107.64	23.17
8.50	110.43	24.81
9.00	113.02	26.39
9.50	115.42	27.92
10.00	117.66	29.38
10.50	119.73	30.78
11.00	121.65	32.12
11.50	123.43	33.39
12.00	125.09	34.60
12.50	126.62	35.75
13.00	128.05	36.83
13.50	129.37	37.86
14.00	130.60	38.82
14.50	131.74	39.73
15.00	132.80	40.59

Using Suda (1966) growth & Watanabe et al (2006)length-weight for SSB (Area 2- Quarter 2)
Used in the 2006 assessment for all calculations involving SSB,
e.g. SSB/R, estimated SSB over time, etc.

AGE (yr)	LENGTH (cm)	WEIGHT (kg)
1.33	41.50	2.27
2.33	56.04	4.77
3.33	68.58	7.87
4.33	79.37	11.31
5.33	88.67	14.89
6.33	96.68	18.45
7.33	103.58	21.89
8.33	109.52	25.14
9.33	114.64	28.16
10.33	119.05	30.92
11.33	122.85	33.43
12.33	126.12	35.68
13.33	128.94	37.69
14.33	131.37	39.47

(DRAFT 2) **Biological reference points for North Pacific albacore. For all cases, length-at-age (cm) is determined from the Suda (1966) growth curve. The acronym WAA is weight-at-age in kg.**
The low and high designation for the last four reference points refer to the assumption of low or high productivity, respectively, as used in the 2004 assessment.

			Inputs for Estimation of Biological Reference Points						Recent	*Suite of Biological Reference Points*									
Run	Length-Wt	SSB Timing	Vital Rates						Full F	$F_{40\%}$	$F_{35\%}$	$F_{0.1}$	$F_{30\%}$	$F_{20\%}$	F_{max}	$F_{SSB\text{-}Min}$	$F_{SSB\text{-}10\%}$	$F_{SSB\text{-}25\%}$	$F_{SSB\text{-}50\%}$
			Age	WAA (mid-yr)	WAA (spawning)	Selex	Maturity	M											
2004 NPALB Assessment (Stocker 2005)	Suda and Warashina (1961)	July 1	1	1.6	1.6	0.01	0.0	0.3	**0.43-0.68**	**0.30**	**0.35**	**0.37**	**0.42**	**0.61**	**1.07**	**0.89 low 1.05 high**	**0.82 low 0.98high**	**0.72 low 0.86 high**	**0.54 low 0.67 high**
			2	3.9	3.9	0.11	0.0	0.3											
			3	7.2	7.2	0.37	0.0	0.3											
			4	11.2	11.2	0.58	0.0	0.3											
			5	15.8	15.8	0.30	0.5	0.3											
			6	20.6	20.6	0.34	1.0	0.3											
			7	25.5	25.5	0.67	1.0	0.3											
			8	30.3	30.3	1.00	1.0	0.3											
			9	34.9	34.9	1.00	1.0	0.3											
			10	39.2	39.2	1.00	1.0	0.3											
			11	43.2	43.2	1.00	1.0	0.3											
			12	46.9	46.9	1.00	1.0	0.3											
			13	50.2	50.2	1.00	1.0	0.3											
			14	53.2	53.2	1.00	1.0	0.3											
2004 NPALB Assessment but using new length-weight and new timing for spawning	Watanabe et al. (2006)	May 1	1	2.1	2.3	0.01	0.0	0.3	**0.43-0.68**	**0.33**	**0.38**	**0.44**	**0.45**	**0.65**	**1.7**	**na**	**na**	**na**	**na**
			2	4.5	4.8	0.11	0.0	0.3											
			3	7.5	7.9	0.37	0.0	0.3											
			4	10.9	11.3	0.58	0.0	0.3											
			5	14.4	14.9	0.30	0.5	0.3											
			6	18.0	18.5	0.34	1.0	0.3											
			7	21.5	21.9	0.67	1.0	0.3											
			8	24.8	25.1	1.00	1.0	0.3											
			9	27.9	28.2	1.00	1.0	0.3											
			10	30.8	30.9	1.00	1.0	0.3											
			11	33.4	33.4	1.00	1.0	0.3											
			12	35.7	35.7	1.00	1.0	0.3											
			13	37.9	37.7	1.00	1.0	0.3											
			14	39.7	39.5	1.00	1.0	0.3											
2006 NPALB Assessment (this workshop)	Watanabe et al. (2006)	May 1	1	2.1	2.3	0.00	0.0	0.3	**0.75**	**0.32**	**0.38**	**0.45**	**0.45**	**0.65**	**2.1**	**na**	**na**	**na**	**na**
			2	4.5	4.8	0.07	0.0	0.3											
			3	7.5	7.9	0.47	0.0	0.3											
			4	10.9	11.3	0.77	0.0	0.3											
			5	14.4	14.9	0.20	0.5	0.3											
			6	18.0	18.5	0.26	1.0	0.3											
			7	21.5	21.9	0.63	1.0	0.3											
			8	24.8	25.1	1.00	1.0	0.3											
			9	27.9	28.2	1.00	1.0	0.3											
			10	30.8	30.9	1.00	1.0	0.3											
			11	33.4	33.4	1.00	1.0	0.3											
			12	35.7	35.7	1.00	1.0	0.3											
			13	37.9	37.7	1.00	1.0	0.3											
			14	39.7	39.5	1.00	1.0	0.3											

DRAFT 4 - North Pacific Albacore Biological Reference Point (BRP) Table for Managers. Numbers in the body of the table are the current fishing mortality rates (F) relative to biological reference points. A table entry greater than 1.0 implies that F must be decreased to align with the respective BRP shown above it. On the other hand, a table entry less than 1.0 implies that recent F is below the BRP. The 2004 BRP presentation was complex in that two scenarios regarding recent F were coupled with two scenarios regarding recent productivity. The BRPs associated with the 2006 assessment are more straightforward, i.e. recent F appears to be greater than the F associated with F_20% but less than the F associated with F_max.

	Current F (F_{cur}) scenario	***Suite of Biological Reference Points***										***Productivity in Recent Years***
		$F_{cur}/F_{40\%}$	$F_{cur}/F_{35\%}$	$F_{cur}/F_{0.1}$	$F_{cur}/F_{30\%}$	$F_{cur}/F_{20\%}$	F_{cur}/F_{max}	$F_{cur}/F_{SSB\text{-}Min}$	$F_{cur}/F_{SSB\text{-}10\%}$	$F_{cur}/F_{SSB\text{-}25\%}$	$F_{cur}/F_{SSB\text{-}50\%}$	
2006 NPALB Assessment (this workshop)		2.31	1.97	1.68	1.67	1.16	0.36	TBD	TBD	TBD	TBD	**Average**
2004 NPALB Assessment (Stocker 2005)	**Low F**	1.43	1.23	1.16	1.02	0.70	0.40	0.48	0.52	0.60	0.80	**Low**
	Low F							0.41	0.44	0.50	0.64	**High**
	High F	2.27	1.94	1.84	1.62	1.11	0.64	0.76	0.83	0.94	1.26	**Low**
	High F							0.65	0.69	0.79	1.01	**High**