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Interim Scientific Committee for Tuna and Tuna-like Species
in the North Pacific Ocean

Report of the Swordfish Working Group [1]

January 25-26, 2002
Nagasaki, Japan

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[1] A report adopted at the Third Meeting of the Interim Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), January 28-30, 2002, Nagasaki, Japan

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1.0 INTRODUCTION

A meeting of the Swordfish Working Group (SWO-WG) of the Interim Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean was convened at Merca Tsukimachi Hall in Nagasaki, Japan, during 25-26 January 2002. The purpose of the meeting was to review information concerning swordfish resources in the North Pacific, including fishery statistics, the status of swordfish stocks, and progress in biological and oceanographic research in support of stock assessment. R Michael Laurs, chairman of the SWO-WG, welcomed participants (Attachment 1) and appointed Kotaro Yokawa and Jerry Wetherall as rapporteurs. Working papers were distributed (Attachment 2) and the meeting agenda was adopted (Attachment 3).

2.0 SUMMARY

Significant progress was reported toward improved stock assessments of swordfish in the North Pacific. Results from recent studies suggest that swordfish stocks in the North Pacific are not overexploited. Preliminary results from a MULTIFAN-CL model indicate that the swordfish stock in the central and western North Pacific is not overexploited under current levels of fishing effort; this result is similar to findings at the last meeting of the ISC in 1999. Independent research on an index of swordfish abundance in the North Pacific, based on historical data from Japanese longline fisheries, was in agreement with swordfish biomass trends predicted by the MULTIFAN-CL model.

Significant advances have been made in biological and oceanographic research to support improved stock assessment since the last meeting of the SWO-WG. This includes progress in age and growth, size and age at maturation, food habits, and movement and behavior in relation to frontal structure, depth, temperature, and other features of the ocean environment. The SWO-WG noted that considerable additional research is required to improve the stock assessments; the development of stock assessment models is still in early stages.

3.0 REVIEW OF FISHERIES

Reports were presented describing fisheries of Japan, Chinese Taipei, and the United States that catch swordfish in the North Pacific. These fisheries account for a large percentage of the annual swordfish catch in the North Pacific.

3.1 Japan

Kotaro Yokawa provided an update on Japan's swordfish catch and fisheries in the North Pacific. The primary methods used by Japan to catch swordfish in the North Pacific are longline, harpoon, and drift gill net. Longline fisheries are conducted by three fleets: coastal, offshore, and distant-water. Harpoon and drift gill net fisheries operate in coastal waters within Japan's 200 mile EEZ. Swordfish are targeted in the harpoon fishery and, to some extent, the drift gill net and offshore longline fisheries. In the distant-water longline fishery swordfish are caught incidentally. Minor catches of swordfish are also reported in coastal purse seine, set net, and troll fisheries.

During the most recent 5-yr period (1996-2000), the combined swordfish catch by the offshore and distant-water fisheries in the North Pacific ranged from 5,848-6,916 metric tons (Table 1). During 1996-1999 (the most recent data available), annual catches of swordfish ranged from 1,047-1,213 mt in the coastal longline fishery, 428-724 mt in the drift gill net fishery, and 416-597 mt in the harpoon fishery. In all fisheries, the annual catch of swordfish has been relatively stable.

3.2 Republic of Korea

Jeong Rack Koh reported to the working group that swordfish are caught incidentally by longline vessels of the Republic of Korea fishing for tuna in the North Pacific, but that catch data for the fishery are not available.

3.3 Chinese Taipei

Chi-Lu Sun presented an update of information about fisheries of Chinese Taipei catching swordfish in the North Pacific (ISC3/SWO-WG/02/05; ISC3/Plenary/02/03). Swordfish are caught in the longline and harpoon fisheries of Chinese Taipei. They are an incidental catch of the distant-water and offshore tuna longline fleets which operate in both the North Pacific and South Pacific and of minor importance to the harpoon fishery which operates in coastal waters east of Taiwan, along the edge of the Kuroshio current. In 2000, 2,842 t of swordfish were caught by Chinese Taipei in the Pacific, of which 2,577 t (91%) were taken in the North Pacific.

The distant-water longline fleet is comprised of vessels larger than 100 gross registered tons (GRT) and has been operating since 1963. The fishery targets albacore tuna, primarily in the South Pacific. Annual catches of swordfish have fluctuated (Table 1). The total Pacific swordfish catch by the distant-water fleet was 372 t in 2000, with 107 t (29%) coming from the North Pacific.

Two groups of vessels operate in the offshore longline fishery. Vessels of 20-50 GRT, based in domestic fishing ports, take short trips (7-10 days) in the general vicinity of their homeport and land their catch there. Vessels of 50-70 GRT are based in fishing ports of western Pacific island countries. Both groups of vessels target yellowfin and bigeye tuna for the Japanese sashimi market and catch swordfish incidentally. The annual catch of swordfish in the offshore tuna longline fishery, while fluctuating, has been higher than 1,000 t since 1986. In 2000, the catch was 2,396 t.

Annual swordfish catches in the harpoon fishery are variable, generally ranging from 10-300 t. Peak catches were reported between 1991 and 1994 (200-300 t). During 1995-1999 the harpoon catch was less than 5 t. In 2000, 74 t were taken by harpoon.

3.4 United States

Jerry Wetherall presented a status report on U.S. fisheries for swordfish in the North Pacific (ISC3/SWO-WG/02/02). The United States is a major swordfish consuming and harvesting nation. U.S. fisheries in the North Pacific harvested 5,689 t of swordfish in 2000, accounting for about 65% of total domestic swordfish production. U.S. fisheries catching swordfish in the North Pacific include coastal harpoon and drift gill net fisheries based in California, and longline fleets based in Hawaii and California.

The California harpoon fishery targets swordfish and dates back to the early 1900's. In 1978, the fishery reached a high of 309 vessels catching 1,699 t of swordfish. The fleet and catch have declined since then. In 2000, there were 31 active harpoon vessels catching 86 t of swordfish (Table 1).

The California-based drift gill net fishery, which targets shortfin mako shark and common thresher shark, as well as swordfish, was the dominant swordfish fishery on the U.S. West Coast from 1981-1998. The fleet peaked at 220 vessels in 1985. Fleet size and swordfish catch have declined since then. During the 1999-2000 fishing season there were 78 drift gill net vessels in operation, catching 681 t of swordfish.

In Hawaii, longline fishing for tunas began in the early 1900's. Longline fishing directed at swordfish started in 1988, and grew rapidly (Table 1). The number of Hawaii-based longline vessels peaked in 1991 at 141 vessels, with 115 targeting swordfish and the others fishing primarily for tunas. Swordfish catch peaked at 5,942 t in 1993. During 2000, 125 longline vessels were active in the Hawaii-based fleet, catching 2,949 t of swordfish; 57 of the vessels targeted swordfish. Beginning in 1999, restrictions were placed on Hawaii-based longline vessels to reduce their interactions with sea turtles. These culminated in a U.S. Federal Court order, issued in mid-2001, which prohibits Hawaii-based longline vessels from targeting swordfish north of the equator; these vessels may no longer deploy shallow-set, “swordfish style” longline gear. Consequently, many swordfish longline vessels have left Hawaii to join the California-based longline fleet, which is not subject to the same restrictions. The California-based fleet, which was established in 1991, grew significantly in 1999 and 2000, as did its swordfish catch (Table 1). In 2000, there were 40 California-based longliners catching 1,918 t of swordfish.

4.0 FISHERY STATISTICS

Swordfish catch statistics from Japan, Chinese Taipei, and the United States for fisheries in the North Pacific were updated and presented in Table 1. The table does not reflect the total catch of swordfish in the North Pacific, as data were unavailable from other fleets operating in the region; only statistics tabled at the SWO-WG meeting are included. There is a need to complete the catch table by incorporating information for Japanese fisheries in years prior to 1980 and for other countries whose vessels catch swordfish in the North Pacific, e.g., China, the Republic of Korea, Mexico, and the Philippines. Compilation of a comprehensive and up-to-date catch table is a recommended task of the SWO-WG work plan (Attachment 4).

5.0 PROGRESS IN BIOLOGY, ECOLOGY, AND OCEANOGRAPHY

5.1 Biological Research

Robert Humphreys presented a report on biological research undertaken in support of swordfish stock assessment (ISC3/SWO-WG/02/01). The work was carried out as a priority task of the SWO-WG work plan developed at the second meeting of the ISC in January 1999 (ISC3/SWO-WG/02/Inf-02).

In one part of the research, a collaborative evaluation of inter-laboratory variability in swordfish age estimates using sections of the second anal fin ray was conducted. A sample of 20 sections was prepared by each of the five Pacific fisheries laboratories (CICESE (Mexico), IFOP (Chile), NMFS Honolulu Laboratory (U.S.), NRIFSF (Japan), and the Institute of Oceanography, National Taiwan University (Chinese Taipei). These 100 sections were digitally imaged by the NMFS Honolulu Laboratory and distributed to the 5 laboratories for age estimation, with the identity of images cloaked. An analysis of covariance (ANCOVA) performed on each laboratory's age estimates versus the agreed mode age (age based on a subset of 59 sections where at least 3 of the 5 laboratory's age estimates coincided) indicated that 4 of the 5 laboratories were ageing the specimens equivalently. The fifth laboratory appears to have generally underestimated fish ages. Age estimates were also analyzed by region to evaluate possible geographic variation in swordfish growth rate. An ANCOVA on length versus agreed median age by region revealed apparent regional differences in length-at-age, with fish from Hawaii and Chile generally aged younger than swordfish of the same length sampled off Japan or Taiwan. These preliminary results are based on small sample sizes; further analysis with larger samples is required for corroboration. Validation of the presumed annual growth bands observed in the fin ray sections remains an outstanding need for both the age equivalency and geographical growth rate studies.

In a second study, meristic counts of total dorsal and anal fin ray elements were conducted on two samples of post-larval (n=34) and young-of-year juvenile (n=115) swordfish captured off Hawaii. This study was part of an initial attempt to evaluate the usefulness of meristics as an indicator of stock separation among nursery areas. Swordfish in both samples had similar mean total dorsal (46) and anal (17) fin counts. Dorsal ray counts exhibited greater variation (range of 40-50) than anal rays (16-19). Meristics data from other regions in the Pacific are needed for comparison with the Hawaii data to determine the feasibility of this approach.

Kotaro Yokawa described preliminary studies of swordfish food habits in subtropical waters of the western North Pacific (ISC3/SWO-WG/02/08). The frequency of occurrence of forage items was determined in stomachs of 59 swordfish caught by commercial longliner in the upper 100 m during Spring of 2000; 2 of the 59 stomachs were empty. The swordfish ranged from 101 to 240 cm EFL. Numerically, neon flying squid (*Ommastrephes bartramii*) and Pacific pomfret *(Brama japonica*) were the principal food items found, making up 42% and 22%, respectively, of the total gut contents. There was no relationship between the size of prey and the size, or gender, of the swordfish. Both fresh and heavily digested flying squid were found, indicating they had been consumed during day and night and are a major prey of swordfish in this region. On the other hand, pomfret were all freshly killed. Pacific pomfret reside in the upper 100 m, so swordfish feed on them only during the night; this may account for the fresh condition of the pomfret.

Chi-Lu Sun reported on studies of sex ratios and sexual maturity in swordfish in waters of Taiwan (ISC3/SWO-WG/02/06). Gonad samples from 208 female swordfish were collected in Shinkang fish market from July 1998 to June 2000. The range of lower jaw fork lengths (L_{LJF}) was 95 to 257 cm. The sex ratio (proportion of females to the total number of females and males) was predicted as sex ratio = $2 \times 10^{-4} L_{LJF}{}^{1.55534}$ based on 551 female and 387 male samples collected through monthly sampling in Tungkang, Nanfangao, and Shinkang fish markets from September 1997 to July 2000. Sex ratio increased with L_{LJF} greater than 150 cm and was equal to 1.0 (100% female) for L_{LJF} greater than 210 cm. The estimate of the mean body length at sexual maturity (L_{50}) for females was 168.2 cm, and the smallest mature individual was 135 cm. Most of the mature females were in the developmental stage of ripening, some were in the resting stage, and none were in spawning or recently spawned stages. No hydrated oocytes were observed in the female gonad samples. These phenomena indicate that swordfish are reproductively inactive in the waters of Taiwan.

Mio Takahashi described the use of an archival tag to study the swimming behavior of a swordfish off the east coast of Japan (ISC3/SWO-WG/02/Inf-01). The fish was harpooned and tagged in July 1999 and recaptured 11 months later 64 miles from the release location. To estimate the fish's migration route, archived data on water temperature and swimming depth were compared with daily ambient sea temperature data from an oceanographic database defined by month, depth (0-m, 80-m, 160-m levels) and a horizontal spatial resolution of 2° latitude X 5° longitude. Two plausible migration routes were estimated, both indicating a cyclical, seasonal migration between food-rich waters of the Oyashio current (40-45°N) in the summer and subtropical waters (10-20°N) in the winter. On most observed days, the swordfish swam primarily in cold water (3-6°C) at depths below 200 m during the day and usually occupied warmer waters near the sea surface (21-27° C) at night. The maximum swimming depth was estimated at 900 m based on the archival tag data and concurrent CTD data. The swimming depth and behavior pattern of the swordfish changed in response to ambient water temperature.

5.2 Oceanographic Research

Keith Bigelow presented a summary of research on oceanographic characterization of swordfish longline fishing grounds in the subtropical North Pacific during Spring (ISC3/SWO-WG/02/10). The work was carried out by scientists at the NMFS Honolulu Laboratory and their collaborators at the University of Hawaii and the University of South Florida. During January-May, surface manifestations of multiple, individual planetary-scale fronts accentuate the central North Pacific Subtropical Frontal Zone (STFZ) system. The most prominent of these fronts are climatologically located at 32°-34° N and at 28°-30° N latitudes (herein nominally referred to as the "Subtropical Front" (STF) and the "South Subtropical Front" (SSTF), respectively) although considerable interannual variability in both position and intensity is observed. This seasonally dynamic system is also the region typically targeted by the Hawaii-based swordfish longline fishing fleet, where the presence, position, and strength of the convergent fronts are believed to play a key role with regards to the catch and catch rates of swordfish. Information furnished by a recent series of meridional hydrographic surveys and concurrent satellite remote sensing data elucidate structural patterns and coupling of the physics and biology associated with these fronts. This enables a re-characterization of the winter-spring North Pacific STFZ and offers new insight into seasonal variability of the phytoplankton dynamics in the subtropical North Pacific.

On synoptic time scales, geographic positioning of the fronts may be systematically identified through surface outcropping of diagnostic thermohaline isopleths and is therefore readily discerned from both shipboard surveys and spaceborne sensors. The STF during winter-spring can be characterized by the surface expression of the 34.8 isohaline and the 17°C isotherm within the frontal gradient. Biologically, the STF marks the transition between low chloropigment (chlorophyll + phaeopigments), nutrient depleted surface waters to the south and a more productive regime to the north. To the south, the 20°C and 35.0 surface isotherm and isohaline, respectively, are characteristically embedded in the thermohaline gradients associated with the SSTF. A sharp increase in depth-integrated chloropigment is also observed at the SSTF and is ascribed to an increase in the concentration and thickness of the subsurface chloropigment maximum (SCM) prompted by the shoaling of the nutricline with the thermocline structure into the euphotic zone.

Keith Bigelow presented initial results of movement studies involving the attachment of pop-up archival transmitters (PSATs) on swordfish near Hawaii (ISC3/SWO-WG/02/11). During March and April 2001, PSATs were attached to 8 swordfish (about 140-200 cm LJFL) caught by harpoon near 28°30' N, 160°W. The PSATs were programmed to automatically release from the fish and transmit data if the fish: 1) experienced no significant pressure changes during four consecutive days; 2) reached a depth greater than 1,200 m; or 3) was still at large on a pre-determined pop-off date. As of December 2001, 6 of the 8 tags had transmitted data; however all 6 tags had shed prior to their anticipated release date. For the three PSATS that transmitted data, tags were attached to the animals for 5, 14, and 33 days. Straight-line distances between tagging locations and the locations of data upload were 17, 88, and 366 nautical miles (nmi), corresponding to maximum movement rates of 3.5, 6, and 11 nmi per day. Swordfish #3, transmitting data after 33 days, was usually distributed in the upper 100 m of the water column during the night and to a maximum depth of 700 m during the day. Ambient water temperature ranged from 6° to 28°C, with the fish mostly occupying a thermal habitat between 8° and 24°C. Swordfish #3 typically commenced an upward vertical migration approximately one hour prior to sunset and a downward vertical migration one hour prior to sunrise. The vertical distribution results from swordfish #1 (transmitting after 5 days) and #2 (14 days) were not similar. Swordfish #2 remained in the upper 150 m of the water column throughout the four days. Swordfish #1 had the most erratic behavior of the three swordfish and spent most of the time shallower than 100 m.

5.3 Other Research

Michael Laurs described a comprehensive research program underway at the NMFS Honolulu Laboratory to assess and reduce the bycatch of sea turtles in longline fisheries (ISC3/SWO-WG/02/03). The rationale for this research is related to the critical need to develop longline fishing gear technologies and fishing strategies for reducing sea turtle capture rates throughout the Pacific. In Hawaii, interactions between longline gear and sea turtles have been much more frequent in operations targeting swordfish in the Subtropical Frontal Zone (using shallow-set gear) than in operations deploying deeper-set gear for tunas, typically in waters further south. The long-term benefits to sea turtle populations of developing new fishing strategies that may be adopted by U.S. domestic pelagic longline fisheries and potentially exported to other longline fishing nations probably outweigh the sea turtle mortality likely to be caused by the experiments.

The research topics linked to longline sea turtle bycatch issues include: 1) research to reduce longline fishery bycatch of sea turtles, 2) research to reduce mortality of sea turtles caught in longline fishing, and 3) research to assess sea turtle population status and evaluate management alternatives.

Much of the research to reduce longline fishery bycatch of sea turtles will be conducted with the Hawaii longline fishing industry to test and evaluate changes in longline fishing gear and tactics to reduce rates of sea turtle interaction or capture. This is a proposed 3-year project involving contracts with fishing vessels to conduct fishing gear experiments. All vessels must carry a scientific technician and follow rigid protocols. The research requires a permit issued under the U.S. Endangered Species Act.

Laboratory physiology and behavior research on captive sea turtles and pelagic fish, as well as laboratory tests on modified baits and fishing gear are also being conducted to obtain information that may be used to reduce bycatch of sea turtles. The physiology and behavior research is categorized into three topics: 1) odor receptors and olfaction in sea turtles, 2) auditory capabilities of sea turtles and pelagic fishes, and 3) visual capabilities of sea turtles and pelagic fishes. Because sea turtles, which evolved from terrestrial reptiles, are evolutionarily distant from commercially targeted pelagic species of fishes, their sensory capabilities should have conclusive differences and defining these should be achievable. Techniques that exploit the differences, i.e., that repel turtles or make longline gear less attractive to them without reducing catch rates of tuna and billfish species may then be developed.

Research to reduce mortality of sea turtles caught in longline fishing is making extensive use of satellite remote sensing technology, including conventional ARGOS satellite-linked depth recorders and 'pop-up' archiving satellite-linked sensors (PSATs).

6.0 STATUS OF STOCKS

Pierre Kleiber presented a progress report on early stages of a North Pacific swordfish stock assessment using MULTIFAN-CL (ISC3/SWO-WG/02/04). The project is a collaborative effort between the NMFS Honolulu Laboratory and the NRIFSF in Shimizu, Japan. To date swordfish catch and effort data have been assembled for Japanese and Hawaiian longline gear in the North Pacific. Data from other longline fleets and other gear have yet to be assembled. Nevertheless, a preliminary analysis of the present data set was undertaken with MULTIFAN-CL. The results showed the North Pacific swordfish stocks are not currently over-fished, with a noticeable but mild (less than 30%) depression of abundance due to fishing. In the late 1950s and early 1960s a stronger influence of fishing was evident. Not all capabilities of MULTIFAN-CL could be realized, probably due in part to complications arising from the strong sexual dimorphism in swordfish growth. Continued assembly of the database is suggested to include all fleets that catch significant numbers of swordfish in the North Pacific. Also suggested is further development of MULTIFAN-CL to deal appropriately with catch and sample data split by sex.

Kotaro Yokawa presented results of a study to standardize catch rate data for North Pacific swordfish in the Japanese longline fishery and develop an index of swordfish abundance (ISC3/SWO-WG/02/07). The study used longline fishery statistics from 1952-2000 on catch (number of swordfish) and effort (number of hooks) by month and latitude and longitude of fishing. Data since 1975 included additional information on the number of branch lines between longline floats, which influences the fishing depth of the gear. A general linear model was estimated to predict catch per 1,000 hooks (CPUE) as a function of year, quarter of year, geographical area, gear configuration, and 2-way interactions between these factors. The analysis predicted a negative correlation between standardized CPUE and the number of branch lines between floats. However, the relationship may be affected by time of fishing, as most sets deploying 3-4 branch lines between floats are made at night; those deploying more than 6 branch lines between floats are made during daylight. An annual abundance index was computed as the mean of area-specific standardized CPUEs weighted by size of the areas. Whereas the nominal (non-standardized) swordfish CPUE data showed a steep decline during the 1960's and early 1970's, the abundance index was relatively constant from 1952-1973, then increased until 1987. From 1988 through 2000 the index has trended downward, but is still higher than in the early 1970's. The abundance index is generally consistent with predicted biomass trends in the preliminary MULTIFAN-CL model.

Michael Hinton reported on research into the status of swordfish and swordfish fisheries in the eastern Pacific (ISC3/SWO-WG/02/09). Swordfish are harvested in target and non-target fisheries throughout the eastern Pacific Ocean (EPO, east of 150°W). The status of these stocks has not been well-determined, due in part to questions about stock structure. Previous works have indicated that when considered as a single stock, the resource is exploited at levels less than those associated with average maximum sustainable yield, though caution has been urged due to the declining trends in catch rates for various fisheries and subareas in the EPO.

Analyses of standardized trends in relative abundance, based on general linear models, indicate that there are two stocks of swordfish in the EPO, with the northern-southern stock boundary considered to occur at about 5°S latitude. The relative abundance of these stocks does not appear to be declining, and with annual catches fairly stable in the region since 1989 (at about 13,000 mt), it appears swordfish are not overfished in the EPO. However, given the changing nature of those gillnet and longline fisheries, which are increasingly targeting swordfish in the region, the stocks should be monitored closely for changes in these trends.

6.1 Conclusion concerning status of stocks:

Results from these studies suggest that swordfish stocks in the North Pacific are not overexploited. Preliminary results from a MULTIFAN-CL model indicate that the swordfish stock in the central and western North Pacific is not overexploited under current levels of fishing effort; this result is similar to findings at the last meeting of the ISC in 1999. Independent research on an index of swordfish abundance in the North Pacific, based on historical data from Japanese longline fisheries, was in agreement with swordfish biomass trends predicted by the MULTIFAN-CL model. The SWO-WG noted that considerable additional research is required to improve the stock assessments; the development of stock assessment models is still in early stages.

7.0 FUTURE WORK PLAN

Based on the presentations of progress in stock assessment and biological and oceanographic research, the work plan developed at the January 1999 meeting of the SWO-WG was reviewed and updated. The updated plan (Attachment 4) identifies research projects addressing critical needs to improve stock assessments of swordfish in the North Pacific. It also lists SWO-WG participants who expressed interest in collaboration on specific projects or have responsibility for particular tasks. These scientists would be expected to initiate or continue the research and coordinate activities with their collaborators, including arrangements for data sharing. Most of the projects have already been started.

One of the critical needs remains to develop spatially explicit, integrated models for stock assessment. Significant progress has been made already, as reported above, and research will continue under the revised work plan.

A second need is to continue the biological and oceanographic research in support of improved stock assessment. Relevant biological research includes studies of age and growth, studies of movement patterns using conventional, archival, and PSAT tags; and genetics and meristics research to clarify stock structure. Considerable progress has been achieved in these areas since the last meeting of the working group and participants agreed to continue the research. In order to test and evaluate stock assessment models, the group agreed to continue the development and application of the swordfish simulator constructed by Marc Labelle (Oceanic Fisheries Program, Secretariat of the Pacific Community). Work is already underway using data generated by the simulator to test the MULTIFAN-CL model. This research will continue as a collaborative project among SWO-WG participants.

There is a critical need to develop longline fishing gear technologies and fishing strategies for reducing bycatch, especially in swordfish fisheries using shallow-set gear. The working group noted that this issue has been taken up already at the COFI/FAO.

The working group agreed on the fundamental importance of establishing a comprehensive database of swordfish fishery data and making it accessible to SWO-WG scientists engaged in stock assessments and related research. Significant progress in support of this objective was made at the meeting of the Statistics Working Group (STATWG). With respect to swordfish data, gaps remain in the database; filling these gaps remains a high priority.

Finally, the SWO-WG noted the request made by the STATWG to consider sub-areas for reporting Category I statistics and formed a small committee including Bob Skillman, Kotaro Yokawa, and Chi-Lu Sun to consider this matter.

8.0 TIME AND PLACE OF THE NEXT MEETING

Participants agreed that the working group should plan to meet in conjunction with the next scheduled ISC plenary meeting.

9.0 CLOSING REMARKS

The working group adopted the report and forwarded it to the plenary. The Chairman expressed his appreciation to all participants and to the rapporteurs for their contributions and cooperation in completing a successful meeting.

Table 1. Swordfish catch (metric tons) in the North Pacific reported by ISC participants[1].

Year	Japan						Chinese Taipei			United States [3]						Total
										Hawaii	California					
	Distant-water and Offshore Longline	Coastal Longline	Driftnet	Harpoon	Others	Total	Distant-water Longline	Offshore Longline [2]	Total	Longline	Longline	Gill Net	Harpoon	Unknown	Total	
1967							-	261	261							261
1968							-	281	281							281
1969							0	292	292							292
1970							-	182	182	5	-	-	612	10	627	809
1971							-	257	257	1	-	-	99	3	103	360
1972							-	352	352	0	-	-	171	4	175	527
1973							-	460	460	0	-	-	399	4	403	863
1974							1	460	461	0	-	-	406	22	428	889
1975							29	470	499	1	-	-	557	13	571	1,070
1976							23	487	510	1	-	-	42	13	56	566
1977							36	527	563	17	-	-	318	19	354	917
1978							-	436	436	9	-	-	1,699	13	1,721	2,157
1979							7	608	615	7	-	-	329	57	393	1,008
1980	6,005	824	1,746	389	72	9,036	10	679	689	5	-	160	566	62	793	10,518
1981	7,039	675	1,848	129	125	9,816	2	567	569	3	1	486	243	21	754	11,139
1982	6,064	839	1,257	195	102	8,457	1	758	759	5	2	936	132	42	1,117	10,333

[1] Swordfish catch data are available in FAO statistics for some countries not included here, including Mexico, Republic of Korea, and the Philippines.
[2] Includes offshore longline (mainly), harpoon, and other fisheries. Does not include catches unloaded in foreign ports.
[3] Estimated round weight of retained catch. Does not include discards.

Table 1. Swordfish catch (metric tons) in the North Pacific reported by ISC participants[1] (continued).

Year	Japan						Chinese Taipei			United States [3]						Total
										Hawaii	California					
	Distant-water and Offshore Longline	Coastal Longline	Driftnet	Harpoon	Others	Total	Distant-water Longline	Offshore Longline [2]	Total	Longline	Longline	Gill Net	Harpoon	Unknown	Total	
1983	7,692	955	958	166	85	9,856	0	798	798	5	3	1,336	42	379	1,765	12,419
1984	7,177	1,141	906	117	147	9,488	-	954	954	3	15	2,129	80	666	2,893	13,335
1985	9,335	980	1,006	191	98	11,610	-	742	742	2	47	2,379	194	798	3,420	15,772
1986	8,721	960	1,157	123	133	11,094	-	652	652	2	5	1,612	227	685	2,531	14,277
1987	9,495	819	903	87	97	11,401	3	1,515	1,518	24	5	1,300	205	293	1,827	14,746
1988	8,574	665	937	173	40	10,389	-	1,041	1,041	24	19	1,101	173	343	1,660	13,090
1989	6,690	742	1,064	362	41	8,899	50	1,491	1,541	281	19	1,064	54	221	1,639	12,079
1990	5,833	687	962	128	15	7,625	143	1,309	1,452	2,436	18	1,047	50	121	3,672	12,749
1991	4,809	799	424	153	33	6,218	40	1,390	1,430	4,508	39	827	16	147	5,537	13,185
1992	7,234	1,173	840	381	22	9,650	21	1,473	1,494	5,700	83	1,234	64	167	7,248	18,392
1993	8,298	1,394	292	309	48	10,341	77	1,174	1,251	5,909	148	1,387	168	63	7,675	19,267
1994	7,146	1,357	421	308	41	9,273	21	1,155	1,176	3,176	743	767	154	30	4,870	15,319
1995	6,422	1,386	561	423	42	8,834	142	1,135	1,277	2,713	283	754	97	30	3,877	13,988
1996	6,916	1,063	428	597	53	9,057	21	1,130	1,151	2,502	347	728	80	24	3,681	13,889
1997	6,796	1,213	365	346	68	8,788	20	2,177	2,197	2,881	665	694	83	15	4,338	15,323
1998	6,474	1,186	471	476	74	8,681	12	1,900	1,912	3,263	414	899	47	26	4,649	15,242
1999	5,848	1,047	724	416	54	8,089	93	2,234	2,327	3,100	1,304	584	79	52	5,119	15,535
2000	6,503	-	-	-	-	6,503	107	2,470	2,577	2,949	1,918	681	86	55	5,689	14,769

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Attachment 2. Working Papers and Information Papers

ISC3/SWO-WG/02/01 Updated Biological Research in Support of Swordfish Stock Assessment
(Edward E. DeMartini, Robert L. Humphreys, Jr., and James H. Uchiyama)

ISC3/SWO-WG/02/02 U.S. Swordfish Fisheries in the North Pacific Ocean
(Russell Y. Ito and Atilio L. Coan, Jr.)

ISC3/SWO-WG/02/03 NMFS Honolulu Laboratory Research to Reduce Bycatch of Sea Turtles
(Michael Laurs, Chris Boggs, Richard Brill and Yonat Swimmer)

ISC3/SWO-WG/02/04 Stock Assessment of Swordfish in the North Pacific using MULTIFAN-CL
(Pierre Kleiber and Kotaro Yokawa)

ISC3/SWO-WG/02/05 An Update of Taiwan's North Pacific Swordfish Fishery
(Chi-Lu Sun, Su-Zan Yeh and Sheng-Ping Wang)

ISC3/SWO-WG/02/06 Sex Ratios and Sexual Maturity of Swordfish *Xiphias gladius* in the Waters of Taiwan
(Chi-Lu Sun, Sheng-Ping Wang and Su-Zan Yeh)

ISC3/SWO-WG/02/07 Standardized Catch Rate and Abundance Index for Swordfish Caught by Japanese Longliner in the North Pacific in 1975-2000
(Hiroshi Minami and Kotaro Yokawa)

ISC3/SWO-WG/02/08 Preliminary Result of Food Habits of the Swordfish, *Xiphias gladius,* in the Subtropical Waters of the Western North Pacific
(Hikaru Watanabe and Kotaro Yokawa)

ISC3/SWO-WG/02/09 Status of Fisheries and Swordfish in the Eastern Pacific Ocean
(Michael G. Hinton)

ISC3/SWO-WG/02/10 An Oceanographic Characterization of Swordfish Longline Fishing Grounds in the Subtropical North Pacific During Spring
(Michael P. Seki, Jeffrey J. Polovina and Donald R. Kobayashi, Robert R. Bidigare and Gary T. Mitchum)

ISC3/SWO-WG/02/11 Initial Results from Pop-up Satellite Archival Transmitter (PSAT) Attachments to Swordfish in Hawaii
(Mike Musyl, Rich Brill, Christofer Boggs and Keith Bigelow)

ISC3/SWO-WG/02/Inf-01 Analysis of Swimming Behavior of a Swordfish Using an Archival Tag
(Mio Takahashi, Makoto Okazaki, Hiroshi Okamura and Kotaro Yokawa)

ISC3/SWO-WG/02/Inf-02 Report of the Swordfish Working Group Meeting (tabled at the second meeting of the ISC, convened in Honolulu, Hawaii, U.S.A., January 1999)

Attachment 3. Agenda

Swordfish Working Group Meeting

Third Meeting of the Interim Scientific Committee
for Tuna and Tuna-like Species in the North Pacific Ocean

25-26 January 2002
Merca Tsukimachi Hall

1. Opening
    - Welcome and Introductions
    - Review of Agenda
    - Selection of Rapporteurs
    - Tabling of Documents

2. Review of Fisheries
    - Japan
    - People's Republic of China
    - Republic of Korea
    - Chinese Taipei
    - Mexico
    - United States

3. Compilation of Fishery Statistics
    - Appointment of committee to compile tables of catch, effort, etc.

4. Review of Research Progress
    - Work Plan of SWFWG adopted at 2nd ISC Meeting
    - Status of Stocks
    - Biological and Oceanographic Research
        - Biology
        - Oceanography
    - Other topics
        - Research on methods to reduce takes of protected species in swordfish longline gear

5. Research Recommendations and Revised Work Plan

6. Future Arrangements

7. Drafting, Review and Adoption of Report

Attachment 4. Future Work Plan of the Swordfish Working Group

Objective	**Research Project**	**Collaborators**
1. Conduct biological and oceanographic research in support of improved stock assessment	AGE AND GROWTH:	
	a) Validate age and growth estimates, e.g., otolith increment studies	Humphreys, Sun
	b) Evaluate regional differences in age and growth	Humphreys, Sun, Yokawa
	c) Expand collection of data on size- and sex-composition of catch	Skillman, Yokawa, Sun
	MOVEMENT:	
	a) Estimate patterns of movement and growth rates using conventional tags	Boggs, Yokawa, NTU
	b) Determine patterns of movement and behavior using archival and PSAT tags	Boggs, Yokawa, Takahashi, NTU
	STOCK STRUCTURE:	
	a) Set priorities for reanalysis of genetics samples and collect samples of young swordfish from specific areas	Hinton, Yokawa, Sun, Humphreys
	b) Conduct meristics sampling and analysis	Humphreys, Yokawa, Sun

Attachment 4. Future Work Plan of the Swordfish Working Group (continued).

Objective	Research Project	Collaborators
2. Develop and apply stock assessment models	a) Develop and apply integrated, spatially-explicit models of stock and fishery dynamics incorporating effects of environment, gear, fishing practices, fleet dynamics, and other factors. b) Develop sex-specific age-structured model	Kleiber, Bigelow, Yokawa, Hinton Sun, Yokawa, Conser, Kleiber, Wetherall
3. Develop, test, and apply basin-scale swordfish simulation model	Use simulator to help develop and evaluate stock assessment models	Kleiber, Bigelow, Yokawa
4. Develop comprehensive swordfish fishery database	a) Incorporate data on swordfish catch by Japanese fisheries prior to 1980 b) Incorporate swordfish statistics for fisheries of Mexico, Republic of Korea, the Philippines, and other countries catching swordfish in the North Pacific but not yet included in the database. c) Report swordfish fishery statistics according to ISC protocols and time schedules.	Japan ISC Database Administrator Coan, Yamada, Wang