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

Report of the Marlin Working Group [1]

January 30 and 31, 2004
Honolulu, Hawai`i

[1] A report adopted at the Fourth Meeting of the Interim Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), January 30 and 31, 2004, Honolulu, Hawaii

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1.0 INTRODUCTION

The first meeting of the Marlin Working Group (MARLIN-WG) of the Interim Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean was convened at the Ala Moana Hotel in Honolulu, Hawaii, during 30-31 January 2004. The purpose of the meeting was to bring together scientists conducting research on Pacific marlins, review information concerning marlin resources in the North Pacific, including the quality and limitations of existing data, and develop a work plan to support stock assessments. Gerard DiNardo, Chairman of the MARLIN-WG, welcomed participants (Attachment 1) and appointed William Walsh and Bert Kikkawa as rapporteurs. Working papers were distributed (Attachment 2) and the meeting agenda adopted (Attachment 3).

2.0 REVIEW OF FISHERIES AND RESEARCH PROGRESS

Hirokazu Saito reported on the size composition and sex ratios for blue and striped marlins caught by Japanese longliners (ISC/04/MARLIN-WG/1). The data were obtained from the commercial vessels from 1975 through 2002 and from fishery training vessels from 1975 through 2000. One important feature of the two data sets was that they were not fully comparable; because the training vessels tend to fish in particular areas, they probably do not encounter the full range of conditions experienced by commercial longline vessels. Thus, caution is advisable in using the training vessel data. Results demonstrated that the main fishing grounds for blue and striped marlins were Areas 4 and 2, respectively. The greatest percentage of fish identified to sex occurred in Area 3 for both species. Sex ratios also differed between vessel types. Greater numbers of males than females were reported for both species by the training vessels, whereas commercial vessels reported greater numbers of male blue and female

striped marlin. Highest blue marlin female sex ratios reported by commercial vessels were observed in Area 10, compared to Area 5 reported by training vessels. Highest striped marlin female sex ratios reported by commercial vessels were observed in Areas 5 and 10, compared to Area 9 reported by training vessels. Results also included length-frequency plots by area and plots of the distribution of fishing effort.

Kotaro Yokawa described research intended to standardize CPUE for striped marlin caught by Japanese offshore and distant water longliners in the northwest and central Pacific Ocean (ISC/04/MARLIN-WG/2) . This work expanded upon previous efforts to standardize CPUE for striped marlin in its use of both the traditional GLM method and a habitat-based model. The study employed two data sets: a 50-year time series (1952-2002), with catch and effort (hooks) aggregated by months in 5°x5° squares; and a second that covered 1975-2002 and included additional information regarding gear configuration (i.e., the number of branch lines between floats). The CPUE standardizations were conducted separately for the data sets because of the differences in data pertaining to gear configuration. The data sets were linked after 1975 following the standardization.

The first standardization of CPUE (GLM method) employed the model

$$\ln(CPUE_{ijk}+const)=\ln(\mu)+\ln(YR_i)+\ln(QT_j)+\ln(AR_k)+\ln(INTER)+\varepsilon,$$

while the analysis of the second data set employed the model

$$\ln(CPUE_{ijkl}+const)=\ln(\mu)+\ln(YR_i)+\ln(QT_j)+\ln(AR_k)+\ln(GE_l)+\ln(INTER)+\varepsilon_{ijkl}$$

where $CPUE_{ijk}$ represents nominal CPUE (catch per 1,000 hooks) in year i, quarter j, and area k, and the constant equals the overall mean multiplied by 0.05. The remaining terms represent effects of years ($YR_{i)}$, quarters ($QT_{j)}$, areas (AR_k), gear configuration (GE_l), and interactions between YR*AR, YR*QT and AR*QT for the first data set and YR*AR, YR*QT, AR*QT, and GE*QT for the second. Both models included ε as a normal error term.

Results generated by the two analyses exhibited important differences. The habitat model indicates that the current stock level is greater than in the1950s, whereas the GLM analysis indicates that the current stock level is about half that of 50 years ago.

It appears that the absence of gear configuration effects from the GLM analysis may have caused it to yield questionable results. This may require reparameterization of the GLM with extraneous operational or oceanographic data. The habitat model permits direct estimation of the gear configuration effect and the consequent effective fishing effort by set if the requisite information about underwater movements of fish and gear is available. Though some habitat model input parameters, such as vertical distribution pattern of striped marlin, are preliminary and in need of refinement, the results suggest that this model also underestimated the current stock status of striped marlin.

William A. Walsh reported on the analysis of fishery observer and logbook data accuracy for blue marlin catch rates in the Hawaii-based longline fishery (ISC/04/MARLIN-WG/3). The analysis involved use of observer data to fit a statistical model that described blue marlin catch rates, followed by application of the model coefficients to the appropriate predictor variables in the logbooks to generate estimates of the catch per set. The residuals from this application were then used to identify trips requiring further examination, which entailed use of commercial sales data from the public fish auction in Honolulu. Results demonstrated that catch of blue marlin reported in the logbooks submitted to the NMFS Pacific Islands Fishery Science Center (formally Honolulu Laboratory) from March 1994 through June 2002 was approximately 21% greater than actually occurred. This reflected reporting of striped marlin, and to a lesser extent, shortbill spearfish, as blue marlin.

Michael G. Hinton provided an overview of stock structure hypotheses that have been presented for the Pacific marlins (ISC/04/MARLIN-WG/5).

Black Marlin (*Makaira indica*): This species is believed to consist of two or three stocks, one in the eastern Pacific Ocean and one or two in the western Pacific Ocean, on the basis of fishery data and close proximity to shore of areas with high catch rates

Blue Marlin (*Makaira nigricans*): Biological and fishery data indicate that there is a single stock of blue marlin in the Pacific Ocean. This assumption is currently used in analyses of the stock status.

Striped Marlin (*Tetrapturus audax*): This species is distributed throughout the temperate and warmer waters of the Pacific Ocean, but the stock structure of striped marlin in the Pacific has not been well defined. The two most frequently considered hypotheses are:

1. A single-unit stock in the Pacific, which is supported by the continuous "horseshoe-shaped" distribution of striped marlin; and

2. A two-stock structure, with the stocks separated roughly at the Equator, albeit with some intermixing in the eastern Pacific.

Suzanne Kohin described efforts conducted by the Center's (SWFSC) Billfish Research Program in support of billfish conservation and management in the Pacific Ocean (ISC/04/MARLIN-WG/4). An annual International Billfish Angling Survey, distributed to US anglers to gather data on distribution of catch and effort of recreational billfish fishing, has provided a 33-year time series of recreational catch and effort by species in the Pacific and Indian Oceans. Area-specific CPUEs for striped and blue marlins have been calculated from survey responses in those areas where recreational fishing pressure is traditionally highest (i.e., Hawaii, southern California and Baja California). The Center also sponsors a billfish tagging program. As of December 2003, 21,730 striped marlin had been tagged, primarily off Southern California, Baja California or Hawaii, and 334 been recaptured. Movements from California or Baja California were predominantly to the south or west out into the Pacific, whereas movement from Hawaii was generally dispersive in all directions. Over 6,000 blue marlin have been tagged, with 71 recaptured. Nearly half were released and recovered within 200 nm of Hawaii. Three others tagged near Hawaii traveled great distances to the South China Sea, the Marquesas Islands, and New Caledonia. Blue marlin tagged in Southern California moved south into waters off Baja California Sur. A third program is the analysis of historical catch records of southern California recreational angling clubs. The recreational data must be used cautiously because anglers probably differ in the quality of tagging practices and the accuracy of various measurements and because reporting is voluntary. However, cooperation with recreational anglers does grant researchers access to billfish for both conventional and electronic tagging efforts that elucidate migration patterns, and the recreational catch and effort data may prove useful in efforts to improve stock assessment models.

Michael Musyl reported on ongoing efforts to understand post-release mortality of large pelagic fishes, including marlins. This work is very important for research programs that employ pop-up satellite tags, a sophisticated but costly technology. The objective is to develop a sensitive, relatively straightforward, and nonlethal indicator of stress (e.g., heat shock protein, changes in hematocrit, or changes in serum electrolytes, etc.).

3.0 EMERGING ISSUES, DATA QUALITY, AND DATA LIMITATIONS

A general discussion was held after the working paper presentations in order to identify research needs and potentially fruitful avenues to pursue. The responses fell into five categories.

The first series of comments and questions were related to stock assessment plans and procedures. Gerard DiNardo inquired whether a striped marlin stock assessment was necessary. At ISC2, Mexico proposed that a Pacific-wide striped marlin stock assessment be undertaken, but none has been conducted. There was general agreement among participants that such an assessment should be conducted. Pierre Kleiber proposed a preliminary session before the next full meeting of the MARLIN-WG to allow the interested parties an opportunity to show full details of data needs and analytical procedures, to ensure that all participants at the full meeting are adequately prepared. Most participants agreed that an intersessional meeting to assemble requisite data would be beneficial. Gerard DiNardo inquired as to whether an operational model should be developed to assist in the identification of appropriate stock assessment models. Kleiber commented that modifications to the existing swordfish operational model would probably suffice.

The second question, raised by Gerard DiNardo, was concerned with the necessity for additional growth studies. There was no clear consensus regarding the need for additional studies, although Kotaro Yokawa did mention that Japanese scientists (at the National Research Institute of Fars Seas Fisheries and academia) have documented that the second dorsal spine is acceptable for ageing as a hard part.

The third series of questions, again initiated by Gerard DiNardo, were related to the potential benefit to be gained by incorporation of fisheries oceanography data into stock assessment models. Suzanne Kohin offered the opinion that such information would in fact be quite useful for habitat-based models. Michael Hinton was similarly in favor of such uses, and went on to describe the status and capabilities of the ARGO array.

Gerard DiNardo raised the question of whether a Pacific-wide marlin tagging program would be beneficial. While all participants agree that tagging programs provide valuable information, there are a number of countries and/or scientific organizations already tagging Pacific marlins. As a first step, participants agreed that the working

group should communicate with the scientists conducting marlin tagging to express interest as a collaborator in future work. David Itano described marlin tagging research that scientists at the University of Hawaii are proposing in conjunction with ongoing tagging programs around the Hawaiian Islands using internally and externally applied sonic tags. Marlins will be tagged in the vicinity of FADs, and tracked locally with hydrophones that have already been attached to existing FADs around the island of Oahu. This research will yield insight into the behavior of large pelagics near FADs and into the problem of external tag shedding.

The final question was concerned with research prioritizations, particularly as it relates to stock assessments. While a number of marlin species are caught in Pacific fisheries, catches of striped marlin and blue marlin constitute the majority of reported catches. The MARLIN-WG agreed that future stock assessments, at least in the short term, should focus on these two species. The need to expand assessments to other marlin species would be reviewed during regular meeting of the MARLIN-WG.

4.0 FUTURE WORK PLAN

Based on the presentations and discussions, a work plan was drafted to address critical needs for research to support marlin stock assessments (Attachment 4). The working group agreed on the fundamental importance of establishing a comprehensive database of marlin fishery data and making it accessible to MARLIN-WG scientists engaged in stock assessments and related research. Progress in support of this objective was made at the meeting of the Statistics Working Group, but, with respect to marlin, data gaps in the database remain; filling these gaps remains a high priority.

It was noted that the Inter-American Tropical Tuna Commission (IATTC) will be presenting a striped marlin assessment at its June 2005 Annual Meeting. The assessment will be conducted in early 2005 with collaboration from various members of the MARLIN-WG and made available to the full MARLIN-WG for comment prior to the 2005 meeting.

Working group participants regarded CPUE standardization as a research priority. Further efforts are planned particularly with respect to incorporation of oceanographic and operational factors.

The MARLIN-WG noted the request made by the Statistics Working Group to (1) define a standard length measurement, (2) evaluate conversion relationships among various length and/or weight measurements, and (3) define subareas of the Pacific suitable for reporting of Category I data . Working group participants decided on eye-to-fork length as the standard length measurement. A project will be undertaken to address the second concern (conversion relationships) and the MARLIN-WG agreed to address the third concern at its next meeting.

5.0 TIME AND PLACE OF NEXT MEETING

To facilitate completion of a comprehensive database of marlin fishery data to support stock assessments, an intersessional meeting of the working group is tentatively scheduled for June 2005. Participants further agreed that the working group should also meet in conjunction with the next scheduled ISC plenary meeting.

6.0 CLOSING REMARKS

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

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Attachment 2. Working Papers

ISC/04/MARLIN-WG/1. Size composition and sex ratio for Pacific blue marlin, *Makaira mazara*, and striped marlin, *Tetrapturus audax*, caught by Japanese longliners in the Pacific (Hirokazu Saito and Kotaro Yokawa).

ISC/04/MARLIN-WG/2. Standardizations of CPUE of striped marlin caught by Japanese offshore and distant water longliners in the northwest and central Pacific (Kotaro Yokawa).

ISC/04/MARLIN-WG/3. Analysis of blue marlin (*Makaira nigricans*) catch rates in the Hawaii-based longline fishery with a generalized additive model and commercial sales data (William Walsh)

ISC/04/MARLIN-WG/4. Billfish angler catch rates and movements (Dave Holts, presented by Suzanne Kohin)

ISC/04/MARLIN-WG/5. Summary of stock structure hypotheses advanced for marlins in the Pacific (Michael G. Hinton)

Attachment 3. Agenda

Marlin Working Group Meeting

Fourth Meeting of the Interim Scientific Committee
for Tuna and Tuna-like Species in the North Pacific Ocean (ISC)

30-31 January 2004
Plumeria Room, Ala Moana Hotel, Honolulu, Hawaii

Chairman: Gerard DiNardo

1. Opening
    - Welcome remarks and introduction of participants
    - Review of Agenda
    - Selection of rapporteurs

2. Review of Fisheries and Research Progress

3. Emerging Issues (Round Table Discussion)

4. Data Quality and Limitations

5. Development of Research Plan and Assignments

6. Future Arrangements

7. Drafting, Review, and Adoption of Report

Attachment 4. Future Work Plan of the ISC4 Marlin Working Group

Objective	Research Project	Collaborators
1. Conduct biological and oceanographic research in support of improved stock assessment	MOVEMENT: a) Estimate patterns of movement using conventional tags	Holts, Kazama
	b) Determine patterns of movement, behavior and post release mortality using PSAT tags	Musyl, Yokawa
	STOCK STRUCTURE: a) Assess stock structure of striped marlin using genetic techniques	Hinton, Univ. Southern Cal., PIFSC
	AGE AND GROWTH: a) Continue to evaluate regional differences in size and sex ratio, and potential biases	Saito, Yokawa, PIFSC, NTU
	b) Evaluate utility of existing age and growth information	PIFSC, NRIFSF, NTU
	c) Assemble conversion relationships among various length and/or weight measurements	PIFSC, NRIFSF
2. Develop and apply stock assessment models	Develop and apply integrated, spatially-explicit models of stock and fishery dynamics incorporating effects of environment, gear, fishing practices, fleet dynamics, and other factors	Kleiber, Yokawa, Hinton, DiNardo
3. Develop comprehensive marlin fishery database	a) Construct abundance indices for major fisheries	Kleiber, Yokawa, Hinton
	b) Collect and incorporate marlin fishery statistics from North Pacific countries not yet included in the database	All ISC member nations, MARLIN-WG, ISC Database Administrator