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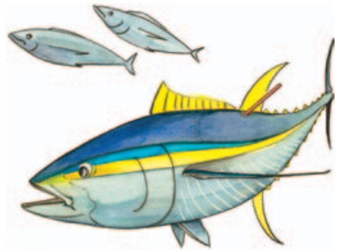

Pelagic Fisheries Research Program
university of hawai'i at mānoa

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The Pacific Albacore Troll and Baitboat Fishery Data Collection Program at the Southwest Fisheries Science Center

John Childers

Data Collected

The albacore fisheries monitoring program is part of the Fisheries Resources Division at the National Marine Fisheries Service Southwest Fisheries Science Center (SWFSC; http://swfsc.noaa.gov). This program collects total catch, catch and effort (logbook), and biological sample data from the commercial troll and baitboat fisheries that target albacore in the North Pacific Ocean. The data are collected in collaboration with state agencies, the Pacific States Marine Fisheries Commission, and the albacore fishing industry.

Albacore troll and baitboat fishers sell their catch to a variety of purchasers (fish dealers, canneries, public, etc.). These ex-vessel sales require a state sales receipt to be completed for each sale. The sales receipt information is maintained by each of the three coastal states. A centralized data collection and management system (PacFIN; http://www.psmfc.org/pacfin/overview.html) also maintains landings data from this receipt information for use by fishery managers and regional fisheries management councils.

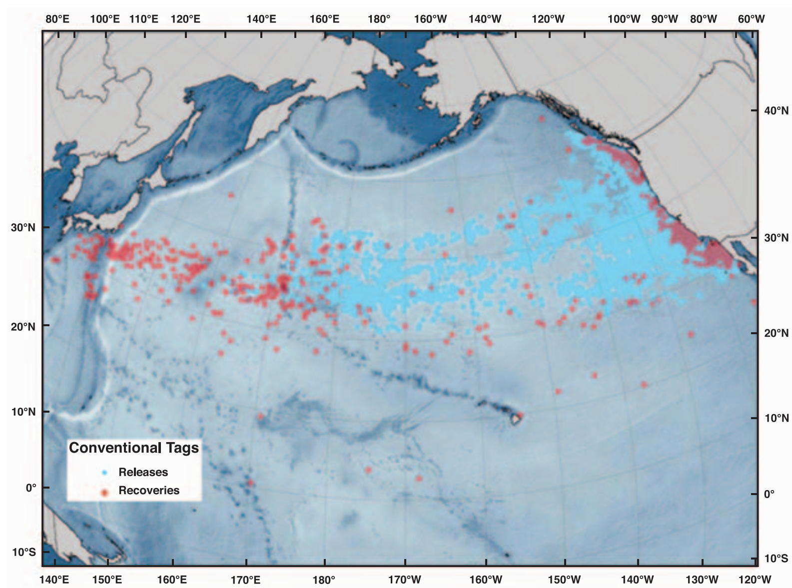

Figure 1. Release and recovery locations from the albacore conventional tagging program

U.S. vessels that fish far offshore may also transship their catches or deliver them directly to two U.S. canneries in American Samoa.

These and other data sources are used to estimate the total catch of albacore from the U.S. fleet. Catch and effort data are obtained from logbooks that are completed by fishers and submitted to SWFSC. Port samplers measure albacore as they are unloaded from catcher vessels in many ports along the west coast. These data are entered, edited, and compiled to fulfill various domestic and international reporting obligations.

Data Collection History

Prior to 1973 California and Oregon had, each for their own state, been collecting logbook catch and effort data from the commercial albacore troll and baitboat fleet. Boats operating out of Washington state completed logbooks issued by Oregon or California. In 1973 SWFSC consolidated those collection programs into a single, coast-wide, logbook program. Size information has been collected from albacore catches by U.S. vessels since the early 1950s and continues today. In the past observers have measured captured albacore onboard troll vessels and periodically collected biological samples for special projects.

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In 2005 a Fisheries Management Plan was implemented for all U.S. Highly Migratory Species fisheries (including the albacore troll and baitboat fisheries). The plan requires fishers to submit logbook and landings data from each trip. All these data (both current and historical) are maintained by SWFSC.

Collaboration with the Troll/Baitboat Fishing Industry

Since the early 1970s SWFSC has collaborated closely with the American Fishermen's Research Foundation (AFRF) in research on albacore tuna in the Pacific. AFRF is a non-profit organization sponsored by the troll and baitboat fishing industry to promote scientific research on Pacific albacore (http://afrf.org/index/shtml). Throughout the years SWFSC and AFRF have collaborated on numerous projects and investigations that have enhanced our knowledge of the North Pacific albacore stock.

Conventional Tagging Program

In collaboration with AFRF, a conventional dart-tagging program was initiated in 1970 that lasted through 1995. Release and recovery information obtained from this and other tagging programs targeting North Pacific albacore have revealed significant patterns of the trans-pacific migration of juvenile albacore. Data collected have identified travel between areas in the subtropical western and central Pacific, the western Pacific and Kuroshio extension, and the west coast of North America (Figure 1). Information from these tagging studies also has documented the interaction between the albacore stock and the various international fisheries that have targeted albacore through the years (U.S. troll/baitboat; Japanese pole and line; Japanese, Korean, and Taiwanese longline; and others).

Electronic Archival Tagging Program

Recently significant concerns have been expressed regarding the status of the North Pacific albacore stock. These concerns, in conjunction with impending regional and international management of the stock, have prompted the recognition of the need for still more detailed information on the distribution, migration, and life history of the albacore stock.

In 2001, utilizing newly available technologies, SWFSC and AFRF began an electronic archival tagging program. The goal of this program is to identify previously unavailable detailed migration and behavioral information for North Pacific albacore.

Archival tags are mini-data-loggers collecting and recording ambient light levels, depths, water temperatures, and the visceral temperatures of a tagged fish (Figure 2). These tags are implanted in the peritoneal cavity of captured fish with a thin stalk from the tag allowed to protrude through the flesh of the fish. The stalk has sensors to collect light levels and water temperatures while sensors in the body of the tag collect depths and visceral temperatures.

Figure 2. Archival tags used in the albacore electronic archival tagging program

Light levels and water temperatures are used to estimate daily locations of the fish. Depth data and visceral temperature data indicate diving and foraging behaviors which change throughout the annual migration cycle of the fish.

The tags are programmed to collect data from these sensors at user-defined intervals for four or more years. These data are stored within the tag and can be recovered even after the tag battery has failed—however tagged fish must be recaptured and the tag retrieved and read to secure the data.

Based on results from past conventional and other archival tagging programs, SWFSC scientists anticipate a recovery rate of approximately ten percent for these implanted tags. This recovery rate is expected to supply sufficient information to significantly improve our knowledge of the life history of albacore in the North Pacific. This new information will greatly improve our assessments of the health of this regional albacore stock.

As of July 12, 2007, eighteen tags had been recovered resulting in over 5,800 daily location estimates (Figure 3) and nearly 8.5 million samples of depth and temperatures at sixty-second

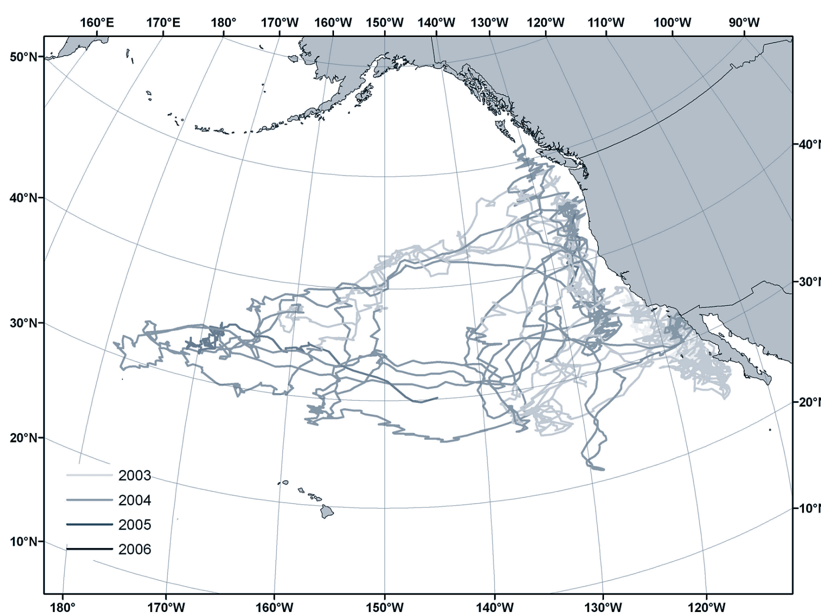

Figure 3. Preliminary tracks of the seventeen archival tags recovered to date

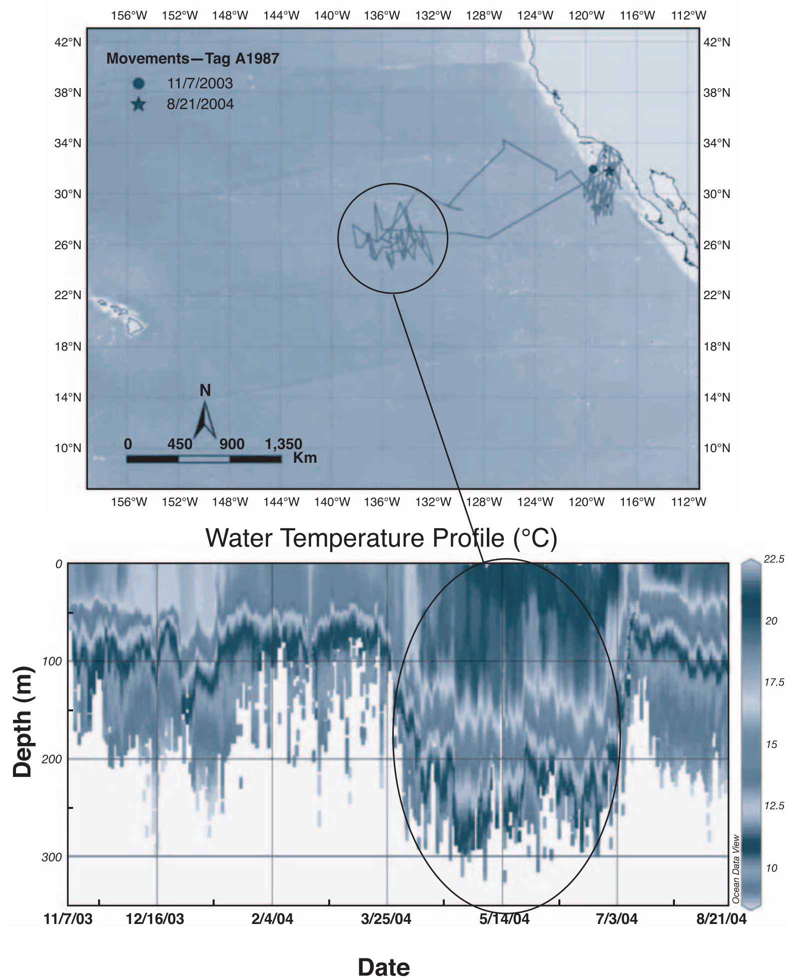

Figure 4. An example of how albacore exploit different environments throughout their migration cycle

intervals. Data from the most recently recovered tag are still being processed.

Conclusion

This new information has already added significantly to our knowledge of North Pacific albacore. Further analysis continues to provide even more specific details on the temporal and spatial distribution of these animals as well as on regional and temporal behaviors and habitat use (Figure 4).

The Southwest Fisheries Science Center continues to pursue all of these research programs as the demand grows for ever-more-detailed fisheries data. Continuing collection and management of these data are critical to generating the best possible scientific information—and this information is critical to generating the best possible management of the regional fisheries that target the North Pacific albacore stock.

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A Study of the Swimming Behavior of Skipjack and Small Yellowfin and Bigeye Tunas Around Drifting FADs to Develop Mitigation Measures Reducing the Incidental Catch of Juvenile Yellowfin and Bigeye Tunas

Takayuki Matsumoto, Keisuke Satoh, Yasuko Semba, and Mikio Toyonaga

Introduction

Nowadays many purse-seine sets are targeting tuna schools associated with floating objects including the floating man-made Fish Aggregating Devices (FADs). Ideally the incidental catch (“bycatch”) of juvenile tunas (mostly those less than a year old), especially juvenile bigeye tuna (*Thunnus obesus*), should be minimized for optimal stock management of the tuna fisheries.

Mitigation measures for reducing the incidental catch of small yellowfin (*Thunnus albacares*) and small bigeye tuna are currently being discussed by several international tuna commissions. However decisive and effective solutions have not yet been identified and mandated.

It has been hypothesized that in fish schools including skipjack *(Katsuwonus pelamis),* small yellowfin, and small bigeye tunas, generally: a) the skipjack tuna are in the shallowest layer, b) the small yellowfin tuna are in the middle layer, and c) the small bigeye tuna are in the deepest layer. If this hypothesis is valid it may be possible to selectively catch skipjack tuna while significantly reducing the bycatch of small yellowfin and small bigeye tuna.

Especially regarding drifting FADs, however, to date the details of the swimming behaviors of the different tunas associated with floating objects have not been well documented. Such knowledge

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is essential for developing effective mitigation measures for reducing the bycatch of small yellowfin and small bigeye tuna.

Identification (ID) pingers (coded ultrasonic transmitters) attached to tunas can enable researchers to simultaneously monitor depth and horizontal position behaviors of numerous target tunas. With a tracking system using such transmitters we have now observed and documented the behavior of different tunas schooling around drifting FADs. We have collected this information to aid in the development of mitigation measures for bycatch of small tunas—especially juvenile bigeye tuna.

Between 2001 and 2005 we conducted three such studies. This article focuses on the 2005 study during which the swimming behavior of skipjack tuna was successfully observed and documented for the first time.

Catching, Releasing, and Monitoring Fish

The 2005 study was conducted in the equatorial area of central Pacific Ocean (Figure 1) from June through August. We used the Fisheries Agency of Japan research vessel *Shoyo-maru* in conjunction with the chartered commercial purse-seine vessel *Taijin-maru* Number 18.

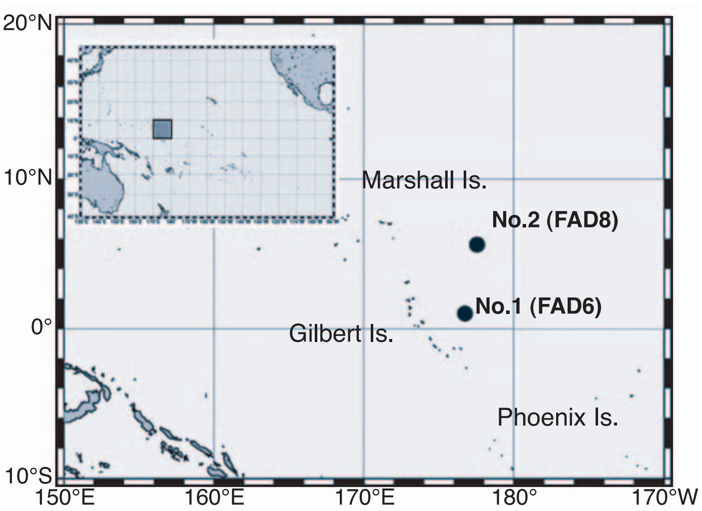

Figure 1. Geographical locations for each of the two tracking series at the start of tracking; numbering indicates the sequence of the successful trackings

Catch and release and monitoring of the fish were conducted close to two drifting FADs. Fish were caught by jigging or trolling. After being caught the fish had ID pingers (VEMCO V16P-1H [62 mm long, 16 mm diameter, and 9 g underwater weight] or V16P-3H [74 mm long, 16 mm diameter, and 14 g underwater weight]) attached externally on their dorsal area (Figure 2) and then the fish were released. These pingers transmit signals irregularly at 20–69 second intervals.

We monitored the swimming behaviors of the pinger-attached fish using the VEMCO Track170 biotelemetry system aboard the *Shoyo-maru*.

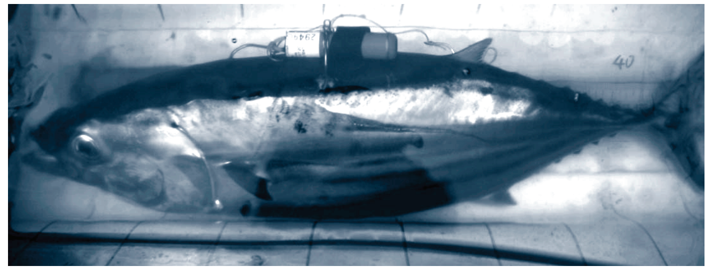

Figure 2. Skipjack tuna with a pinger attached

This system enabled us to monitor depth and approximate horizontal position simultaneously for up to 56 individuals. The VEMCO system provided a signal detection range of ca. 1000 m. Figure 3 shows a graphic image of monitoring fish schooling around a FAD.

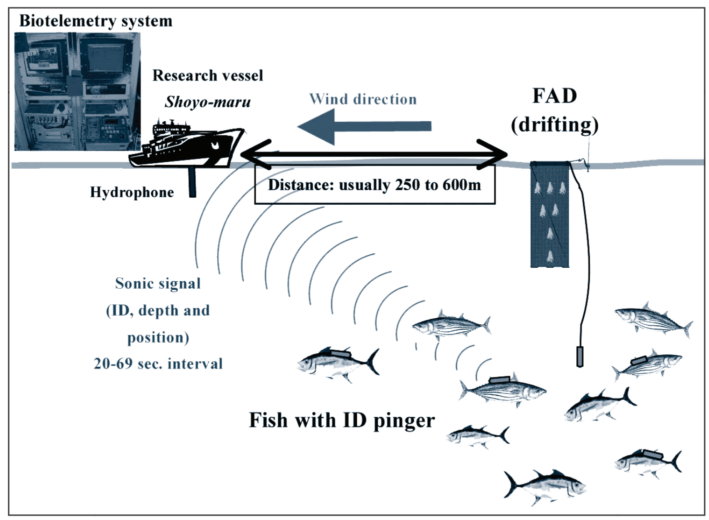

Figure 3. Graphic image of monitoring, through the use of a biotelemetry system, fish (with pingers attached) schooling around a drifting FAD

Oceanographic conditions were observed every six-to-eight hours during tracking. We worked primarily with Expendable Bathythermograph monitors and partly with either Conductivity/Temperature/Depth or Expendable Conductivity/Temperature/Depth monitors.

Summary Results of the Tracking

We had two successful tracking series—hereafter the first and the second trackings, respectively. A total of 105 individual tuna were released with ID pingers and monitored: 30 skipjack (34.5–65.0 cm fork length [FL]); 43 yellowfin (31.6–93.5 cm FL), and 32 bigeye (32.8–85.5 cm FL). The two tracking series lasted about 26 days in total. Geographical locations for each of the two tracking series are shown in Figure 1.

After catch and release some pinger-attached yellowfin and bigeye individuals remained around the FADs in both tracking series.

However, in the first series (tracking around FAD6) most skipjack tuna left the FAD immediately after release, providing little information regarding their behavior. In the second series (tracking around FAD8) we were extremely fortunate that some skipjack individuals stayed around the FAD for several days. With this significant data we were successful in monitoring all three species schooling together at the same location for a sustained period of time.

Swimming Depth and its Difference Among Species

Figure 4 shows a typical second tracking pattern of time-series swimming depth for each species with all three species being monitored simultaneously. All three species showed comparatively clear diurnal patterns of swimming depth.

Skipjack tuna usually stayed above the 100 m depth. They only occasionally dove into the thermocline (ca. 80–200 m depth) even during daytime so their depth was generally shallower than that of the other two species.

Yellowfin and bigeye tunas usually stayed in the mixed layer or the upper part of the thermocline (0 to 120 m depth) during the night while they frequently dove into the thermocline (to around 200 m depth) during daytime. Figure 5 shows frequency distribution of swimming depth recorded for each species (all individuals aggregated) in the second tracking. While the swimming depth of skipjack tuna in the second tracking was a bit shallower than that of yellowfin and bigeye tunas, little difference was observed for the swimming depths between bigeye and yellowfin tunas.

Conclusions

In this study in the second tracking (Figure 4 and Figure 5) we successfully simultaneously monitored the depth and horizontal distribution of skipjack, yellowfin, and bigeye tunas while schooling together in the immediate vicinity of a FAD. We documented the swimming depth of skipjack tuna as being somewhat shallower than that of yellowfin and bigeye tunas. This species-differentiated swimming depth was observed occurring during both day and night.

Purse-seine sets in the vicinity of floating objects, including FADs, usually start before dawn. Given this timing, it may be assumed that the species catchability of such purse-seine sets in the vicinity of floating objects will mainly be affected by the swimming depth of the fish during the night.

This study indicates that there are opportunities to somewhat reduce the bycatch of small yellowfin and small bigeye tunas by setting the net for a shallow range. However there is much overlap of swimming depths among the three tuna species. Also, the vertical height in the ocean of a commercial purse-seine net is more than 100 m.

Therefore the results of this study are not sufficient to develop mitigation measures to significantly reduce the bycatch of juvenile yellowfin and juvenile bigeye tuna. More detailed analyses, including spatial (especially horizontal positioning) and temporal

(continued on page 6)

UPCOMING EVENTS

Second International Symposium on Tagging and Tracking Marine Fish with Electronic Devices

October 8–11, 2007, Donostia-San Sebastian, Spain
http://unh.edu/taggingsymposium/

PFRP Principal Investigators Workshop

November 13–15, 2007, Honolulu, Hawai'i
Contact: John Sibert <sibert@hawaii.edu>
http://imina.soest.hawaii.edu/PFRP/

GLOBEC-CLIOTOP, 1st CLIOTOP Symposium

December 3–7, 2007, La Paz, Mexico
Contacts: Olivier Maury <Olivier.Maury@ird.fr> or Patrick Lehodey <Plehodey@cls.fr>
https://www.confmanager.com/main.cfm?cid=722

Advances in Tagging and Marking Technologies for Fisheries Management and Research

February 24–28, 2008, Auckland, New Zealand
http://www.fisheries.org/units/tag2008/index.html

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distributions of juvenile yellowfin and juvenile bigeye tuna associated with skipjack tuna schools, remain needed to further examine the behavioral differences among these species.

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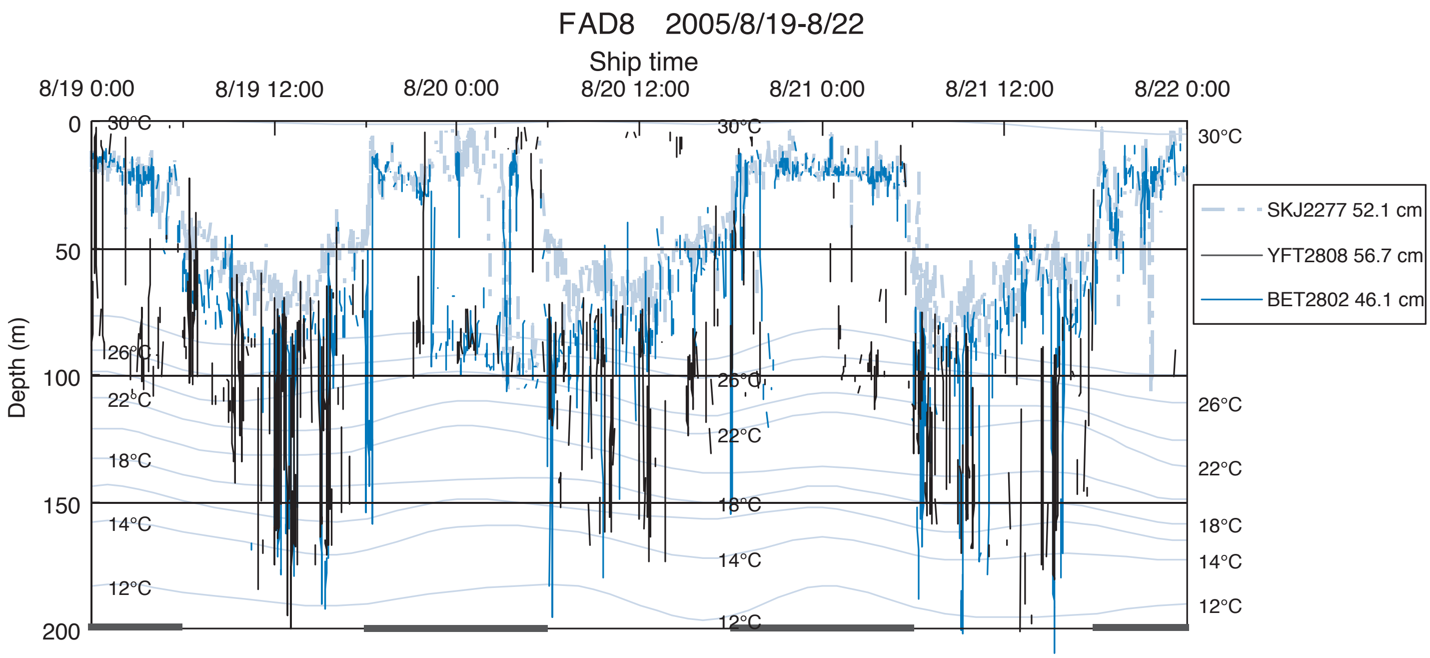

Figure 4. Typical pattern for the second tracking of time-series swimming depth of the fish around FAD, noting isotherms. Black bars show nighttime and the legend shows species, pinger number, and average length of the fish.

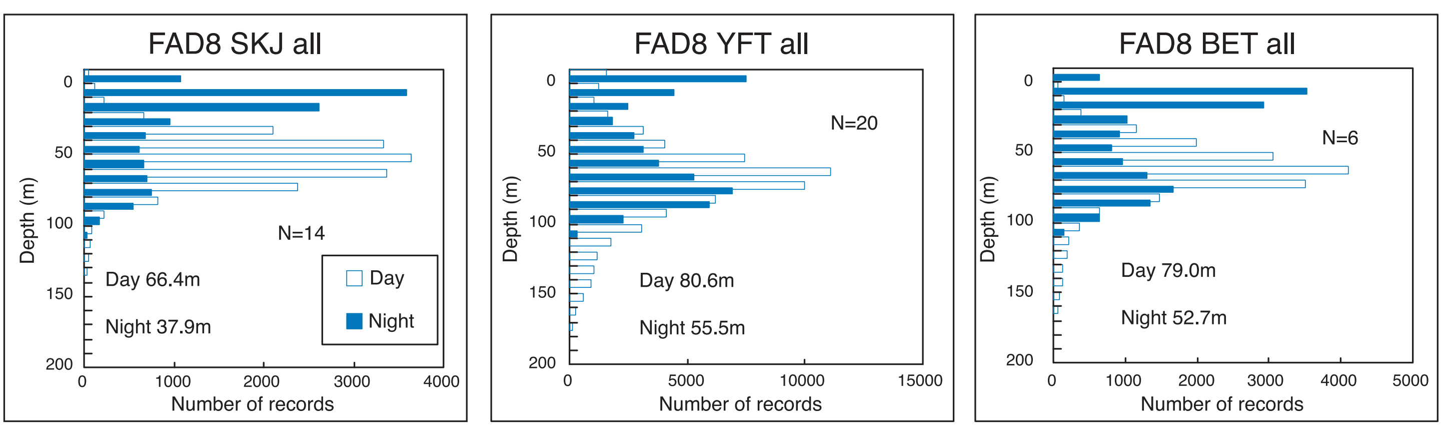

Figure 5. Frequency distribution of swimming depth of day and night for all individuals aggregated by species (left—skipjack tuna; middle—yellowfin tuna; right—bigeye tuna) of the second tracking following FAD8. N shows the number of individuals and the values in the graph show average swimming depth for day and night.

Pelagic Longline Catch-Rate Standardization

Keith Bigelow

Introduction

A "Pelagic Longline Catch-Rate Standardization" meeting was held February 12–16, 2007, at the Hawai'i Imin International Conference Center at Jefferson Hall of the East-West Center adjacent to the University of Hawai'i at Mānoa campus, Honolulu, Hawai'i.

The meeting was jointly hosted by the Pelagic Fisheries Research Program (PFRP)-funded project "Performance of Longline Catchability Models in Assessments of Pacific Highly Migratory Species" and the Secretariat of the Pacific Community (SPC). Workshop conveners were Keith Bigelow of the Pacific Islands Fisheries Science Center (National Marine Fisheries Service, National Oceanic and Atmospheric Administration [NOAA]) and Simon Hoyle of the Oceanic Fisheries Programme, SPC. The meeting was attended by twenty-four scientists from national and international organizations.

For longline fishing the basic technical evaluation of what the fisher experiences is described as the "nominal catch rate" or "nominal CPUE" (catch per unit of effort in number of fish/1000 hooks). Nominal longline catch rates for a particular species will change through time with the absolute regional abundance and as fishers change fishing areas, re-configure their longline gear to target different species, and/or upgrade their vessels with various advanced equipment to increase efficiency.

Fishery scientists develop "standardized CPUE" indices by removing time-series changes in "catchability" due to differing fishing areas and gear and vessel attributes. The remaining signal, the standardized CPUE, is taken to represent changes in abundance and therefore is important for stock assessments of yellowfin and bigeye tuna in the western and central Pacific Ocean (WCPO). These CPUE indices are among the most influential components in generating such assessments.

An Example of Gear Effects on Catchability

Japanese longline fisheries data have long been critical for scientists developing CPUE indices because of the large-scale spatial coverage, the duration (more than fifty years) of the available time series, and the consistency of the Japanese reporting. The Japanese data are not matched by any other time series of catch and effort data.

Over time there have been significant changes in the fishing gear used within the Japanese longline fishery. The metric of "hooks between floats" (HBF) has been commonly used when attempting to standardize longline fishing effort to indicate set depth and as a proxy for species targeting. Adding additional hooks between floats also extends the amount of fishing line deployed between floats, leading to more hooks being deployed at greater depths.

Between 1975 and the present, Japanese longliners have progressively deployed more HBF to target the more valuable bigeye tuna deeper in the water (Figure 1). Prior to 1975 the HBF was not reported in the Japanese data. While, for statistical purposes, the pre-1975 HBF for the Japanese longline fishery is frequently assumed to be five, this assumption may be problematic because of a lack of precise knowledge regarding longline gear configuration in the initial twenty-five years of the fishery.

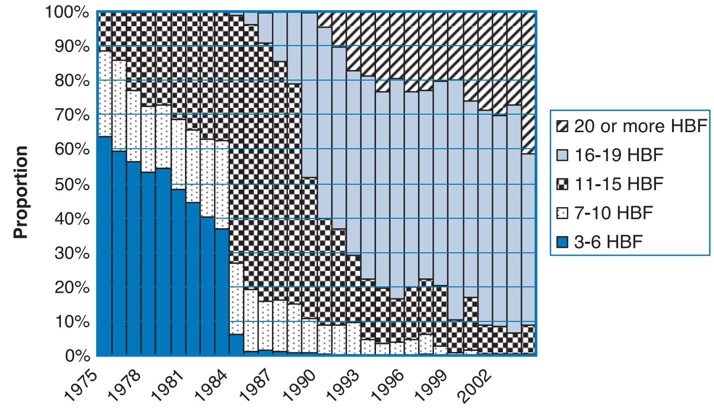

Figure 1. Time-series change in gear configuration (number of hooks between floats [HBF]) for the Japanese longline fleet in the western Pacific Ocean (Multifan-CL assessment region 3, 10°S–15°N, 110°–170°E).

In longline effort-standardization analysis, catch and effort are aggregated spatially (typically by 5° latitude, 5° longitude) and temporally (by month and year) and by HBF. Sometimes the catch of targeted species is also considered in proportion to the catch of other species. A Generalized Linear Model (GLM) has been used to model the yellowfin tuna catch in the WCPO as a function of effort and other parameters. For the yellowfin, the GLMs generally find the expected relationship between CPUE and HBF, i.e. CPUE generally declines with increasing HBF (increased hook depth) because the hooks are set below the shallower-swimming yellowfin.

The corresponding yellowfin "standardized CPUE" (Figure 2) has been modified by the explanatory variables (HBF and proportion of bigeye tuna being caught), resulting in a more optimistic view of the yellowfin tuna index through time. While the GLM typically estimates the expected relationship between CPUE and HBF for yellowfin tuna, the estimated relationship for the deeper-swimming bigeye tuna is more complicated because deeper gear doesn't always produce the expected higher CPUE.

Workshop Objectives and Recommendations

The primary objectives of the meeting were to 1) generate a technical review of current and alternative longline CPUE standardization techniques used in pelagic stock assessments in the Pacific Ocean and 2) to formulate a research plan to meet the objectives of the PFRP longline catchability project.

SPC had the additional objectives of securing guidance on the analysis of CPUE data from WCPO longline fleets and addressing key issues of modeling approaches of CPUE standardization and

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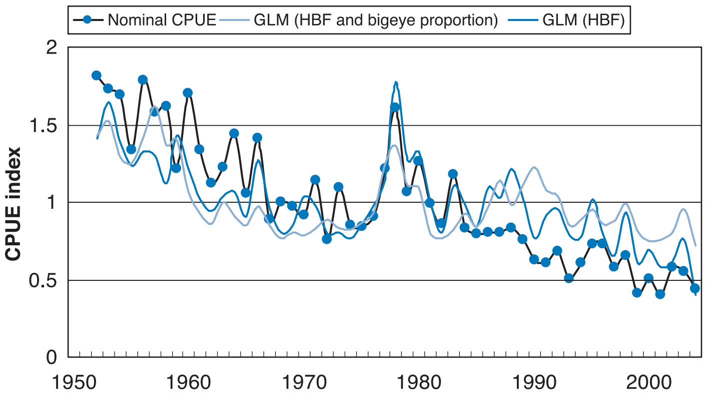

Figure 2. Comparison among nominal and standardized longline CPUE indices for yellowfin tuna derived from Generalized Linear Model (GLM) in region 3 of the WCPO assessment. Standardizing by hooks between floats (HBF) gives an index quite different from nominal CPUE. The most optimistic trend occurs when the "bigeye proportion in the catch" is incorporated.

quantifying time-series changes in catchability earlier identified by Western and Central Pacific Fisheries Commission Scientific Committee 2.

Presentations and discussion focused on: 1) overviews of longline-effort and CPUE standardizations in current Pacific Highly Migratory Species (HMS) assessments; 2) Standardization models: GLMs, Generalized Additive Models (GAMs), neural networks, and covariates; 3) models for longline-effort standardizations considering depth-related and habitat-related vulnerability; 4) targeting; 5) longline gear depth, shoaling, and HMS vulnerability; 6) longline CPUE simulations; 7) time-series changes in catchability: quantifying technological improvements; 8) regional weighting; 9) spatial considerations; and 10) data: resolution, stratification, and data from other fleets (Korean, Taiwanese, and U.S.).

Recommendations were drafted for stock assessments to be conducted in 2007, longer-term stock assessments, and stock assessments relating to the PFRP longline catchability project. Workshop proceedings (available at http://www.soest.hawaii.edu/PFRP/pdf/bigelow_ATT00089.pdf) were compiled by Simon Hoyle (SPC), Keith Bigelow (NOAA), Adam Langley (SPC), and Mark Maunder (Inter American Tropical Tuna Commission). These proceedings contain summaries of recommendations, summaries of meetings, presentation abstracts, summaries of gear configurations from observer programs and research cruises, and longline standardization methods and analyses.

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