INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

SEVENTH MEETING

La Jolla, California (USA)
09-13 May 2016

DOCUMENT SAC-07-07a (REV)

CURRENT AND PLANNED ACTIVITIES OF THE IATTC STAFF

CONTENTS

This document describes the current situation regarding certain aspects of the staff's research, data management, and outreach activities, and outlines future activities and planned improvements.

A. RESEARCH

1. STOCK ASSESSMENT

1.1. Schedule for stock assessments and reviews

Three types of stock assessments are carried out: 1) **full assessments,** in which all the major assumptions are reviewed and improved; 2) **updated assessments,** in which new or updated data are analyzed, using the current assumptions; and 3) **exploratory assessments,** in which new assumptions are investigated, but are not used in the assessment on which the staff bases its management advice. In years in which exploratory assessments are conducted, management is based on updated assessments.

Species	Last assessed	2016	2017	2018
IATTC				
Yellowfin	2011 (full); 2014 (update)	Full	Update	Update
Skipjack	2004	Indicators	Indicators	Indicators
Bigeye	2010 (full); 2014 (update)	Full	Update	Full
Striped marlin	2010		Indicators	Indicators
Swordfish (south EPO)	2011		Indicators	
Swordfish (north EPO)	Never as a separate stock		Indicators	Indicators
Sailfish	2013		Indicators	
Black marlin[1]	Never			
Silky shark	Never	Indicators	Indicators	Indicators
Dorado	Never	Full	Indicators	
Independent review / Fall workshop		Dolphin assessment review	CAPAM workshop (recruitment)	
COLLABORATIONS				
Bluefin	2012 (full) 2014 (update)	Full		
Albacore	2014		Full	
Blue marlin[1]	2013	Update ISC		
Blue shark	2014		Full	
Swordfish (north Pacific)	2014		Indicators	

1.2. Plan of work

1. **Preparatory work for the stock assessments in the schedule**. Exploratory assessments of yellowfin and bigeye tuna were conducted during 2014-2016. These assessments involved extensive sensitivity analyses to determine the most appropriate base-case model and considered the input from the external reviews of the yellowfin and bigeye assessments. The two main issues addressed were the Japanese longline composition data and the weighting of different data sets. The results will be presented at the SAC meeting in 2016, together with recommendations for a base case model to use in 2016.

2. **CAPAM[2] stock assessment methodology workshop series**. A CAPAM workshop on data weighting was held in 2015, and the IATTC staff collaborated on several research projects presented at the workshop. The results from this workshop were used to develop the yellowfin and bigeye stock assessments for 2016. A CAPAM workshop on recruitment is contemplated for 2017. Analyses and documents related to research on recruitment will be prepared for the 2017 workshop.

3. **Post-stratification of purse-seine length-composition data.** Software has been developed to post-stratify purse-seine length composition data. It will be used for developing assessments using the new bigeye and yellowfin stock and fishery areas. Work will continue on analyses to define new catch strata within these new areas and, once the longline database has been fully updated, re-

[1] These assessments will be carried out in collaboration with other organizations, so dates cannot yet be set.
[2] Center for the Advancement of Population Assessment Methodology

evaluate minimum sample sizes per catch stratum for catch estimation. Having the ability to revise the spatial strata that are used in the assessments as new information becomes available is an essential part of being able to adapt the assessments to the best scientific information on population structure.

4. **Integrating tagging data/information into stock assessment models**. Develop methods for integrating the available tagging data into the stock assessment models to improve the stock assessments.

5. **Forecasting bigeye catch**. Methods were developed in 2015 and 2016 to investigate the possibility of using spatial closures to reduce the bigeye catch. Work will continue on the development of a forecasting approach to predict the spatial distribution of bigeye tuna catches, based on spatially-explicit weekly report data and environmental covariates. The performance of the predictions in reducing bigeye catch will be evaluated. Research on candidate spatial closures is an important part of exploring all management options for a species that is currently fully exploited.

6. **Stock status indicators**: Conduct research to develop indicators of stock status that can be used for species for which little information is available. Conduct a management strategy evaluation to evaluate the indicators and their use in harvest control rules.

7. **Dolphin assessments.** Host workshop on methods for assessing dolphin stock status. As a result of a hiatus is fishery-independent surveys since 2006, there are currently no reliable indicators with which to monitor the status of dolphin populations in the EPO. The purpose of the workshop is to bring together experts in the fields of line-transect and mark-recapture surveys, abundance estimation and population modelling, and imagery, tagging and genetics data, to discuss options for developing indices with which to monitor dolphin populations. The goal of the workshop is to produce a report on methodological options that can then be considered for management.

8. **Pacific-wide bigeye assessment.** IATTC staff will collaborate with staff of the Secretariat of the Pacific Community (SPC) to conduct research into a Pacific-wide assessment of bigeye tuna.

9. **Pacific-wide swordfish assessment.** IATTC staff will collaborate with SPC/WCPFC to develop their SEAPODYM model for swordfish and to apply it to evaluate Pacific stocks. The model provides information on habitat as well as trends, and it is expected to provide insight and information on areas with relatively low fishing effort**.**

10. **Reference points.** Develop recommendations for reference points for blue, black, and striped marlin, sailfish, and swordfish.

11. **Management Strategy Evaluation (MSE).** Very preliminary MSE work has been conducted for bluefin tuna, bigeye tuna, and dorado. Methods based on using the Stock Synthesis assessments as operating models have been developed. MSEs will be further developed for tropical tunas, funded in part by ISSF and EU, and used to test the interim reference points and candidate harvest control rules (HCRs). The staff will collaborate with the International Scientific Committee (ISC) to implement MSEs for bluefin and albacore tunas. MSEs will also be developed for low-information species.

12. **Evaluation of factors affecting bigeye tuna catch on FADs.** Continue statistical analysis of observer data to study the characteristics of fish-aggregating devices (FADs) and determine what factors increase the catch of bigeye tuna. This work should be part of a more comprehensive bigeye catch reduction research project that involves multiple IATTC programs and a variety of research methods.

13. **Dorado stock assessment.** A preliminary stock assessment was conducted for dorado in the EPO.

Further refinement of the assessment will be made in collaboration with IATTC member countries.

2. FALL-CAPAM WORKSHOPS

The IATTC fall workshop series has been integrated into the CAPAM (workshop series. CAPAM is a collaboration among Scripps Institution of Oceanography, the United States National Oceanic and Atmospheric Administration, and the IATTC. The first two CAPAM workshops, on "Selectivity: theory, estimation, and application in fishery stock assessment models", and "Growth in fishery stock assessment models: theory, estimation, and application", held in 2013 and 2014, respectively, each resulted in a special issue of the journal *Fisheries Research*. The third workshop, on "Data conflict and weighting, likelihood functions, and process error", was held in La Jolla in October 2015, and a special issue of *Fisheries Research* is in development. A CAPAM workshop on recruitment is contemplated for 2017.

3. TAGGING STUDIES

1. Conducted a tuna tagging cruise in the equatorial central Pacific during November 2015, including deploying significant numbers of archival tags in both bigeye and yellowfin tunas. This was a collaborative effort between the Oceanic Fisheries Programme (OFP) of the Secretariat of the Pacific Community (SPC) and the IATTC, within the framework of the Pacific Tuna Tagging Project.
2. Further evaluate tagging data for bigeye from throughout the Pacific, in collaboration with scientists from the SPC, for describing dispersion, mixing, and plausible boundaries for putative stocks in the Pacific.
3. Continued collaborations with scientists from the Marine Biological Association of the UK in analyses of archival tag data sets from bigeye and yellowfin tunas from the EPO, to evaluate behavior relative to environmental data sets.
4. Continue collecting and analyzing archival tag data for yellowfin released at several locations throughout the EPO, for describing the geographic variability in movements, behavior, habitat utilization, and plausible boundaries for putative stocks in the EPO.
5. Continue to explore potential funding sources for an IATTC Regional Tuna Tagging Project for bigeye, yellowfin, and skipjack tunas throughout the EPO.

4. LIFE HISTORY OF TUNAS

4.1. Early life history

The early life history (ELH) group will be conducting research on the ecology, physiology, and pre-recruit dynamics of tunas. Research activities will be centered around the following six projects, based at the IATTC's Achotines Laboratory in Panama, but also involving collaboration with other research organizations.

4.1.1. Comparative studies of the early life history of Pacific bluefin tuna and yellowfin tuna

Funded by Japan International Cooperation Agency (JICA), Japan Science and Technology Agency (JST), and the IATTC; collaborators: Kinki University (KU) and the Autoridad de los Recursos Acuáticos de Panamá (ARAP)

This project commenced in June 2011 and was completed in March 2016. In November 2015, a final review of the project by a panel of the funding agencies gave the project a "High" rating for meeting research objectives. The project included: (1) comparative research on the early life history of Pacific bluefin and yellowfin, with experimental work conducted in Japan and at the Achotines Laboratory; (2) studies of the reproductive biology of Pacific bluefin (Japan) and yellowfin (Achotines Laboratory); (3) development of recruitment prediction models for Pacific bluefin and yellowfin, and of forecasting tools

for management of those stocks; (4) development of technologies for the cage culture of yellowfin juveniles and to provide research guidelines for the improvement of yellowfin mariculture in Central America. During 2015, yellowfin juveniles were transferred and reared in a sea cage near the Achotines Laboratory for the first time worldwide. Publications summarizing the research results from the comparative studies are being developed jointly. Several joint research activities will be continued during 2016, and a proposal will be developed for a new 5-year project to begin in 2017.

4.1.2. Ocean acidification impacts on tropical tunas (2011-2015)

Funded by the Pelagic Fisheries Research Program (PFRP) of the University of Hawaii; collaborators: Secretariat of the Pacific Community (SPC); Macquarie University, Australia; University of Gothenburg, Sweden; Max Planck Institute for Meteorology, Germany; and Collecte Localisation Satellites (CLS).

This project includes experimental research at the Achotines Laboratory (conducted during 2011) and modeling studies conducted by the research group during 2015-2016. Objectives are: (1) quantify the effects of ocean acidification on egg, larval, and early-juvenile stages of yellowfin; and (2) incorporate the effects of egg and larval mortality associated with ocean acidification into models to forecast the integrated impacts of climate change on tuna population dynamics and distribution in the Pacific Ocean. Efforts are ongoing to secure funding for additional experimental and modeling studies on this topic. A joint manuscript (principal author, Donald Bromhead) describing the study results was published in the journal *Deep Sea Research Part II* in early 2015. A second manuscript (principal author, Andrea Frommel) describing histological analyses of the physiological effects of ocean acidification on the internal organs of yellowfin larvae is in final review in the *Journal of Experimental Marine Biology and Ecology*. A workshop was held by the research group in Sydney, Australia, in January 2016 to discuss future directions for the research, and the workshop report will be published in *Reviews in Fish Biology and Fisheries*.

4.1.3. Joint IATTC-University of Miami workshop on yellowfin tuna

A workshop entitled “Physiology and Aquaculture of Pelagics, with Emphasis on Reproduction and Early Developmental Stages of Yellowfin Tuna,” will be held at the Achotines Laboratory in July 2016. This will be the 14th annual workshop coordinated by the IATTC and the University of Miami at the Achotines Laboratory. Participants include selected tuna researchers and University of Miami graduate students, and fees paid by participants and students cover the expenses of the workshop.

A book chapter entitled “Research on the reproductive biology and early life history of yellowfin tuna *Thunnus albacares* in Panama”, co-authored by IATTC scientists, was published in January 2016 in a book entitled “Advances in Tuna Aquaculture,” published by Elsevier-Academic Press. The chapter summarizes the major findings from yellowfin research conducted at the Achotines Laboratory during 1993-2015.

4.1.4. Feasibility study of deploying non-entangling and biodegradable FADs

The Achotines Laboratory will serve as the base for a feasibility study, funded by the European Union, on the use of non-entangling and biodegradable materials in the construction of FADs. This study topic is a priority for the IATTC’s bycatch research program (see Section 5, Bycatch Studies). The study is being planned and managed by the staff of the bycatch program, and will be conducted during 2016 with local assistance and support provided by the staff of the Achotines Laboratory.

4.1.5. Acoustic research study of yellowfin tuna

The International Seafood Sustainability Foundation (ISSF) is funding studies of the acoustic properties of tunas in order to differentiate species and estimate biomass, and as a possible bycatch mitigation

measure for the purse-seine fishery. During mid-2016, two ISSF-affiliated scientists, Drs. Gala Moreno and Guillermo Boyra, will conduct acoustic discrimination trials of yellowfin in a sea cage located 1 km offshore from the Achotines Laboratory. Staff of the Laboratory will collect yellowfin (40-60 cm) in local waters, hold them in a land-based tank, and transfer them to the sea cage for these trials.

4.1.6. Nutrition studies of yellowfin tuna

The ELH group has collaborated in the past with faculty of Texas A&M University (TAMU) to investigate the nutrition of various life stages of yellowfin tuna. During 2016, collaborative nutritional trials of 1-year-old yellowfin, funded by TAMU, will be conducted at the Achotines Laboratory. Various prepared diets, developed by Dr. Alejandro Buentello of TAMU, will be fed to yellowfin, with subsequent analysis of the nutritional condition and growth of the fish. The results of the study will be published, and will have application to both feeding ecology and improved aquaculture of yellowfin.

4.2. Updating life history parameters for yellowfin tuna

An investigation is in progress on the age, growth, maturity, spawning frequency, and fecundity of yellowfin throughout the EPO. Collection of samples by observers aboard purse-seine vessels is continuing, as the required samples from all length class intervals have not yet been obtained. Preparation and analyses of samples are now underway in the IATTC fish ecology laboratory.

5. ECOSYSTEM STUDIES

Ecological research at the IATTC has been focused on studies of food-web dynamics, the effects of the tuna fisheries on the ecosystem, and modeling of ecosystem processes in the EPO.

5.1. Food-web dynamics

Improving the understanding of food-web dynamics in the pelagic EPO is important, given that accurate depictions of trophic connections and flows are the backbone of ecosystem models of any type.

In early 2014 a manuscript was published summarizing an analysis of spatial, temporal, environmental, and biological covariates that explain the predation patterns of 3,362 yellowfin tuna sampled across the EPO during two 2-year periods occurring a decade apart. Classification trees revealed major changes during the decade in the prey communities that support tuna production.

In early 2015 a similar analysis was published of spatial and size covariates that explain the predation patterns of 289 silky sharks sampled as bycatch in floating-object sets across the EPO. FAD-associated prey (often including skipjack and yellowfin tunas) dominated the diet in all regions. Classification trees identified markedly different foraging patterns in the eastern and western regions of the EPO, with a less diverse diet and more FAD-related feeding in the western offshore region than in the eastern inshore region. This work supports the hypothesis that FADs can alter the trophic interactions of these apex predators, presumably resulting in increased vulnerability of small tunas to predation. There are no previous studies of silky shark predation for the entire EPO, and the results of this study will improve the ecosystem models for the EPO.

5.2. Stable isotopes in ecology

A collaborative three-year project initiated in 2010 and involving the IATTC, the University of Hawaii, Scripps Institution of Oceanography, and the Oceanic Institute, Hawaii, entitled “CAMEO 2009: A novel tool for validating trophic position estimates in ecosystem-based fisheries models” was extended into 2014. Its principal goals were to validate the application of amino acid compound-specific isotopic analysis (AA-CSIA) across multiple marine taxa and across systems with contrasting biogeochemical cycling regimes, and to develop the use of AA-CSIA trophic-position estimates for validating trophic

models of exploited ecosystems. Samples of nine species representing a range of trophic positions across a productivity gradient in the EPO were analyzed, using bulk tissue N isotopic analysis, and a subset of samples were analyzed for AA-CSIA. Bulk tissue $\delta^{15}N$ values varied with latitude and longitude across a sample transect for animals representing four trophic guilds: krill, lanternfishes, squids, and tunas. AA-CSIA-derived trophic position (TP) estimates, however, were uniform across the study area, confirming that $\delta^{15}N$ variability was due to biogeochemical variability at the base of the food web and not to diet changes. However, the absolute trophic position estimates were unreasonably low for the higher-trophic level predators, which was likely due to variable trophic discrimination factors across trophic groups. These results suggest that the contemporary methodology for estimating absolute trophic position using AA-CSIA may not be appropriate for species higher in the food web. A Master of Science thesis was developed from this work, and a manuscript has been provisionally accepted for publication in 2016.

Previous studies suggest that differences in $\delta^{15}N$ values of source and trophic amino acids can be used to examine historical changes in the trophic positions of archived samples, to investigate, for example, the potential effects of fisheries removals on system trophic dynamics. Where historical diet data are incomplete or lacking, AA-CSIA of archived specimens may be the only way to determine the past trophic status of key predator and prey species. Given the importance of retrospective ecosystem analyses, capabilities are being developed for conducting these analyses by thoroughly examining the possible artifacts of sample preservation methods on subsamples of key species. In this two-year study, muscle samples from 3 yellowfin tuna and 3 Humboldt squid (*Dosidicus gigas*) were collected, fixed in formalin, and stored in ethanol. Paired samples were frozen for two years to compare with the preserved samples. The duration of preservation and freezing ranged from 1 week to 2 years, and all preserved samples showed a uniform increase in bulk $\delta^{15}N$ values. The $\delta^{15}N$ values for several amino acids (threonine, phenylalanine, and valine) were significantly different between preserved and frozen samples. A follow-up experiment is underway to evaluate whether alteration of $\delta^{15}N$ values was caused by formalin fixation or ethanol preservation.

5.3. Diet studies

1. A draft of a chapter entitled “Bioenergetics, trophic ecology, and niche separation of tunas” was recently accepted for publication in the book serial Advances in Marine Biology. The chapter is a collaboration by eight authors from a variety of countries, led by an IATTC scientist. It reviews current understanding of the bioenergetics and feeding dynamics of tunas on a global scale, with emphasis on yellowfin, bigeye, skipjack, albacore, and Atlantic bluefin tunas in seven oceans or ocean regions. Food consumption balances bioenergetic expenditures for respiration, growth (including gonad production), specific dynamic action, egestion, and excretion. Ontogenetic and spatial diet differences are substantial, and significant inter-decadal changes in prey composition have been observed. Diet shifts from larger to smaller prey taxa highlight ecosystem-wide changes in prey availability and diversity, and have implications for changing bioenergetics requirements into the future. The lack of long-term data limits the prediction of the impacts of climate change on tuna feeding behavior, and thus there is a need for systematic collection of feeding data as part of routine monitoring of these species.

2. A manuscript on the trophic ecology of mesopelagic myctophid fishes in the EPO was accepted for publication in early 2016.

3. Continued collaboration with the international research program CLIOTOP-IMBER. Four workshops organized by CLIOTOP Working Group 3 (WG3) were conducted between 2009 and 2014, to develop and apply standardized, robust statistical methods for analysis of diet and stable-isotope data for pelagic predators in the world’s oceans. During these workshops, held in Sète (France), Hobart

(Australia), Adelaide (Australia), and Honolulu (USA), the first attempt to compile and analyze global datasets for large, upper-trophic level pelagic predators was accomplished. A report summarizing this global effort was published in 2015.

4. Two companion papers are being developed, using the global datasets compiled by CLIOTOP WG3, with the goal of moving from regional to macro-scale understanding of oceanic food webs. (1) A global diet analysis of yellowfin, bigeye, and albacore tunas was conducted in 2015 to assess whether spatial analyses can be used to hypothesize predation changes in a warming ocean. Classification trees showed significant spatial differences in the principal prey consumed by all three tuna species, reflecting regional distributions of micronekton. Generalized additive models revealed that diet diversity was mainly driven by regional-scale processes and tuna size, although oceanographic variables improved model output for all three tuna species. A paper summarizing the analysis will be submitted to a journal for publication in 2016. (2) A task team proposal to conduct a global comparative analysis of oceanic food webs using stable isotope compositions of the same three tuna species was accepted by CLIOTOP's Scientific Steering Committee in early 2016. Analysis is underway, with the aim of submitting a paper to a journal for publication by the end of 2016.

5.4. Effects of fisheries on the EPO ecosystem

5.4.1. Ecological Risk Assessments

Long-term ecological sustainability is a requirement of ecosystem-based fisheries management. The vulnerability to overfishing of many of the stocks caught incidentally in the EPO tuna fisheries is unknown, and biological and fisheries data are severely limited for most of these stocks.

1. Productivity and susceptibility analysis (PSA) was previously tested for measuring vulnerability to overfishing in a preliminary analysis of a subset of species in the EPO purse-seine fishery.

2. In response to requests by SAC participants at the 2015 meeting, the IATTC staff attempted to describe available catch data for the purposes of including additional gear types (i.e. other than large purse seines) used in the EPO in an Ecological Risk Assessment (ERA). A recognized expert in developing ERAs will join the staff as an Ecosystem Specialist in August 2016, and will lead the ERA effort for the EPO. Substantial progress on this work will be made during the latter half of 2016, with a progress report expected by the 2017 SAC meeting

6. BYCATCH STUDIES

Activities under this heading include those conducted in support of the Agreement on the International Dolphin Conservation Program (AIDCP), as well as consideration of other bycatch issues.

6.1. Bycatches on FADs:

1. The staff of the Bycatch Program is working on an EU-funded project to identify means of constructing non-entangling FADs from biodegradable materials, not only to decrease mortality of non-target species but also minimize contributions to ocean debris and pollution by commercial tuna fishing. The durability of these FAD designs will be tested at the Achotines Laboratory, and the best will be tested in regular fishing operations. Options and proposals for future research will be discussed at a workshop sponsored by ISSF, and a pilot project, also funded by the EU, is currently being carried out in Panama. The objective of this project is to reduce the entanglement and mortality of sharks and sea turtles in FADs, and to reduce marine debris and ghost fishing by lost or abandoned FADs.

2. Given the industry's reluctance to provide information on FAD location and drift, different systems for identifying individual FADs should be tested, and a FAD marking and tracking program

implemented. This will help to understand the movements of FADs and the impacts of their drift patterns on the pelagic communities associated to them, and will contribute to studies of the various species of interest (tunas and others) by providing information on the density of FADs in different areas and time periods.

3. With the aim of reducing bycatches of undersized tunas and of small individuals of other species, support sorting grid experiments with scientific designs and analyses, and comparisons of different mesh sizes.
4. Subject to availability of funding, carry out experiments with live-capture of tunas and other species to increase selectivity, using pumps or "wet" brailers to transfer the catch from the purse-seine net to the vessel (Captain R. Stephenson's concepts). Increasing selectivity would improve the survival of individuals that are not wanted and can be returned to the sea alive.
5. Continue studies describing the characteristics of the FADs and fishing operations involving FADs. Continue the collection of data needed to develop FAD management programs and to propose modifications that could reduce bycatches.
6. Continue studies and communication with other tuna RFMOs to harmonize and improve the quality of the data collected by observers, with the aim of improving data quality and supporting comparative studies.
7. Cooperate with researchers in oceanographic studies related to productivity of FAD fisheries. The staff supported research by Dr. Liliana Roa for her doctoral thesis at the University of Montpellier, France, entitled *Mesoscale structure and dynamic of the tropical tuna's associated environment in the Indian and Eastern Pacific oceans; a comparative approach*, and participated in its review as part of her Doctoral Committee .

6.2. Sea turtles:

1. Continue the dissemination of information on techniques for releasing hooked or entangled sea turtles, with the objective of increasing their survival.
2. Cooperate with researchers in oceanographic studies related to habitat use by sea turtles. This may help determine areas critical for sea turtles that can be used for management purposes (*e.g*. avoiding interesting habitat for endangered species). It should also be useful for understanding the changes expected under climate change scenarios.
3. The impacts of hooking location on sea turtle survival in longline fisheries were studied, based on knowledge accumulated during the previous projects on circle hook utilization in the Eastern Pacific region (Peru to Mexico). The published results (Parga *et al*. 2015) should help increase survival of released sea turtles in all oceans of the world.

6.3. Sharks and rays:

The studies that informed Resolution C-15-04 have continued.

1. The bycatches of mobulid rays in the purse-seine tuna fisheries were examined and the results published (Croll *et al*. 2016). This study begins the exploration of spatial/temporal strategies to reduce captures of mobulid rays.
2. Examination of spatial options for bycatch mitigation of these species will continue.
3. Studies of habitat preferences for all the mobulid species present based on observer data are currently under way, with potential application for spatial management actions.

4. Produce catch and effort estimates for artisanal fleets, to understand the global impacts on the different species and determine the sustainability of the harvests or other impacts from the fisheries.
5. Pending funding, cooperate in the planning of mitigation experiments.
6. Analyze data on distribution of sets on whale sharks, and review the guidelines available to improve release techniques. This will help focus the training of vessel crews on avoidance and release methods for this species.

6.3.1. Estimation of post-release survival rates of silky sharks in longline fisheries

This project, funded by the EU and ISSF, is aimed at determining the post-release survival rate of silky sharks following capture in longline fisheries. This estimate will be used to evaluate the extent to which catch-and-release may protect parental biomass of the silky shark in the EPO, and aid in rebuilding the population.

The objective is to tag 30 sharks with pop-up archival transmission tags (miniPATs), programmed to record depth, temperature, and light intensity at optimal intervals for periods of 90 and 180 days. Survival or mortality events for each tagged shark will be determined using the depth and temperature records transmitted from PATs and received through the Argos satellite system.

Melanie Hutchinson, of NMFS, will collaborate with IATTC staff on this project, including evaluations of the data and drafting the report and manuscript.

To date, ten silky sharks have been tagged on longliners operating from Ecuador and Costa Rica.

6.4. Dolphins:

1. The staff continues to conduct research on the tuna-dolphin association. Previous collaborative work has shown that the association occurs in certain oceanographic conditions and likely lowers the risk of predation for the tuna. Continuing research is focused on the effects of changing climate on the association of spinner dolphins and yellowfin tuna.
2. The staff has also conducted collaborative research on potential cryptic mortality of dolphins associated with the purse-seine fishery. Previous studies have examined stress-related changes in blood samples. Continuing research with the US National Marine Fisheries Service (NMFS), and possible future research with the Mexican fishing industry, is focused on determining whether dolphin calves become separated during the chase preceding purse-seine sets.
3. The staff has also conducted tracking studies to study the movements, diving behavior, and feeding activities of spotted dolphins. Continuing studies are focused on swimming speeds during normal activities and activities associated with the fishing process.

6.5. Seabirds:

1. Monitor trends for species affected by fisheries in the EPO, to determine which are the priorities for management actions.
2. Cooperate with the Agreement for the Conservation of Albatrosses and Petrels (ACAP) to maintain the set of mitigation measures adopted up to date, according to the most recent scientific studies and experimental results.

6.6. Ecosystem:

1. The staff continued to participate in the exploration of innovative views on implementing fisheries management programs that take into account characteristics of the ecosystems that are not considered in current stock assessment methods and fisheries management practices (Garcia *et al*.

2015).

2. Research was conducted on the significance and ecological consequences of the impact of fisheries on the ecosystem and on bycatch species. Based on examples from tuna fisheries, a series of recommendations were made on how to assess and evaluate the ecological impact of fisheries bycatches, highlighting the major challenges and research gaps that need to be addressed to progress towards ecosystem-based fisheries management (Hall 2015).

6.7. Whale sharks

Although whale sharks are less frequently caught in the EPO than in other ocean areas, a project was developed in collaboration with a researcher from the Center for Marine Biodiversity, Exploitation & Conservation of the Institut de recherche pour le développement in Marseilles, France, to compare the different oceans, and to identify the main areas of interactions. The staff has also conducted other collaborative research on whale sharks: IATTC data were used in a study (Hearn *et al.* in prep.) to track female whale shark movements around the Galapagos Islands, where large female whale sharks occur seasonally.

6.8. Joint ISSF-IATTC research to reduce fishing mortality of small bigeye tuna and sharks

1. Simultaneous deployments of shallow-draft and normal FADs with echosounder buoys to compare their performance, including the species composition of the tuna catch and potential reductions in catches of bigeye tuna with the use of shallow-draft FADs. An ongoing experiment with deployments of 50 of each FAD type by the purse-seine vessel *Milena A* was initiated in July 2015, and data are being collected.

2. Evaluate the feasibility of the backdown maneuver as a method for the live release of non-tuna species, particularly sharks, following purse-seine sets on drifting FADs. Experiments supported by ISSF are scheduled to be undertaken during a routine fishing trip aboard the vessel *Ljubica*, departing around 1 April 2016, with two IATTC scientists aboard.

B. DATA

7. OBSERVED TRIPS UNDER THE AIDCP

The AIDCP requires that 100% of the trips by Class-6 purse-seine vessels (carrying capacity greater than 363 t) fishing in the EPO carry an observer aboard, and that the IATTC observer program cover at least 50% of the trips. These observer records are the primary source of data on the purse-seine fishery.

Table 1 shows the number of trips covered by the AIDCP On-Board Observer Program, with observers from either the IATTC or national programs, by departure year, under this requirement. Observers accompanied every trip by Class-6 vessels during 2014 and 2015.

Coverage of the US fleet by the IATTC program is less than 50% because some US vessels in the western Pacific intend to also fish in the EPO during a trip but do not do so. Coverage of trips by US vessels that do fish in the EPO is above 50%. Some of these trips are covered by the WCPFC observer program, with which the IATTC has a cross-endorsement agreement.

Table 2 shows trips by smaller (Classes 4 and 5; ≤ 363 t > 182 t) purse-seine vessels that were required to carry an observer or that voluntarily took an observer during a closure of the purse-seine fishery.

TABLE 1. Coverage of Class-6 purse-seine vessels by the IATTC and WCPFC observer programs, 2014-2015

Class 6		2015			
Flag	Total trips	Coverage			
		IATTC		WCPFC	
		Trips	%	Trips	%
Colombia	40	20	(50)		
Ecuador	384	255	(66)		
El Salvador	12	9	(75)	3	(25)
EU (ESP)	19	9	(47)		
Guatemala	3	3	(100)		
Korea	1	0	(0)		
México	213	104	(49)		
Nicaragua	15	6	(40)		
Panamá	77	39	(51)		
Perú	18	18	(100)		
USA	25	18	(72)	7	(28)
Venezuela	46	23	(50)		
Total	**853**	**504**	**(59)**	**10**	**(1)**

TABLE 2. Coverage of Class-4 and 5 purse-seine vessels by the IATTC observer program, 2015

2015		Class 4		Class 5		
Flag	Total trips	Coverage		Total trips	Coverage	
		Trips	%		Trips	%
Colombia	-	-	-	1	1	(100)
Ecuador	15	10	(67)	2	1	(50)
Total	**15**	**10**	**(67)**	**3**	**2**	**(67)**

8. DATA COLLECTION AND DATABASE PROGRAM WORK PLAN

At the meeting of the SAC in 2015, a summary was presented of the work completed by the data group during the previous year, and of activities and objectives planned for future years. This report contains an update of the progress of previously proposed activities, as well as new projects that are planned for the near future.

8.1. Ongoing activities

1. As in previous years, additional improvements to the reporting workflow have been identified and are gradually replacing less efficient existing procedures. Automation of repetitive tasks is applied where possible, and refinements to existing procedures are constantly being implemented.

2. Conversion of existing data entry and editing computer programs from Visual Basic (VB) 6 to the Microsoft dot net framework continues, since VB6 is no longer supported by Microsoft. This is a time-intensive project which will ultimately require thousands of hours to complete, and must be accomplished while simultaneously providing support for the normal activities of the data group, such as staff support, maintenance of existing computer programs, and fullfillment of data requests to IATTC member countries and scientific organizations. IATTC programmers are currently developing

the new programs as standard Windows applications.

3. Development of the new IATTC website is in progress. The IT staff has begun work on the use of a modern Content Management System (CMS), with the help of limited consulting by experienced users of the CMS. The system will give the new website a fresh image and improve access to information by making navigation easier, enhancing search features, and automating various aspects of content management. Once operational, selected areas of the site will be delegated to staff directly responsible for its contents, further expediting updates.
4. Development of a documentation library is still in progress. All of the processes for creating the Best Scientific Estimate, Length Frequency and Stock Assessment databases have been documented, and have been added to the documentation library. We are also exploring the possibility of incorporating the functionality of the documentation library into the new IATTC website, so that the information is available to outside organizations.
5. Work continues on documenting all internal data processing so that all of the procedures are clear and comprehensive.
6. The staff completed the data entry and editing of 516 trips by purse-seine vessels covered by IATTC observers that departed during 2015. Data from an additional 344 purse-seine trips covered by observers of national observer programs were incorporated into the IATTC database, along with summarized data from 10 trips sampled by WCPFC observers.

8.2. Planned work

1. A dedicated Vessel Register database and application redesign, proposed at the SAC meeting in 2011, is scheduled. The current design is workable, though it is labor-intensive. This project has not yet been initiated as it has a lower priority than other tasks assigned to the development group.
2. Development of a data request management application was not initiated due to limited staff resources.
3. A front-end user interface based on R is planned for use with the Best Scientific Estimate (BSE) program. Most IATTC researchers are very familiar with R as an analysis tool, so this addition will greatly facilitate access to the program by the scientific staff. Once development is complete, these same improvements may be applied to other IATTC programs.
4. The Length Frequency data management database and application will be modified to make them more flexible for temporal changes in area stratification. This will include other algorithms which interact with the length-frequency program, such as the process of estimation by flag. An analysis of the importance of flag within strata will be useful for improving this process. This work will be initiated once conversion of VB6 programs to the Microsoft dot net framework is complete.

C. CAPACITY BUILDING, TRAINING AND TECHNICAL SUPPORT

9. TRAINING

9.1. AIDCP observer training

The IATTC staff, which provides the Secretariat for the AIDCP, conducts training courses for observers, mainly for the IATTC program, but with occasional attendees from national programs. Two courses were held during 2015 (Table 3).

TABLE 3. Observer training courses, 2015.

Date	Location	Attendees	
		IATTC	Nat.
6-23 April	Manta, Ecuador	14	3
7-24 September	Panama City, Panama	9	
Total (2 courses)		**23**	**3**

9.2. WCPFC-IATTC observer training

Under a Memorandum of Cooperation, the IATTC and WCPFC programs cross-endorse their observers, enabling them to work in the Convention Areas of both organizations. Observers must meet the necessary training requirements for collecting data at sea, and on 20-25 August 2015 an IATTC staff member participated in a training course, sponsored by the WCPFC, on Kiritimati Island, Kiribati.

9.3. AIDCP seminars for crew, vessel managers, and government officials

The AIDCP requires that the crew and captain of vessels operating with a Dolphin Mortality Limit (DML) receive approved training. The IATTC conducts training seminars, which cover matters related to dolphin mortality, AIDCP requirements, IATTC resolutions and other information to promote efficient management of resources and adoption of good fishing practices.

During 2015, the staff participated in 5 such seminars, with 272 attendees (Table 4).

TABLE 4. AIDCP seminars, 2015.

Date	Location	Attendees
12 January	Manzanillo, México	34
14 January	Mazatlán, México	118
28 January	Manta, Ecuador	13
11 August	Lima, Perú	33
14 August	Manta, Ecuador	74
Total (5 seminars)		**272**

9.4. Alignments of dolphin safety panels

Another requirement of the AIDCP for vessels operating with a DML is to "*perform a periodic net alignment to ensure the proper location of the dolphin safety panel during the backdown procedure*". The IATTC staff participated in four such alignments, carried out during a trial set in which the vessel tests its gear prior to departing on a trip (Table 5).

TABLE 5. Net alignments, 2015.

Date	Location
27 January	Manta, Ecuador
8 April	Puerto Madero, México

10. SHARK FISHERIES

The staff will provide appropriate assistance to developing IATTC Members in:

10.1. Sampling

1. Continue the development of, and promote the adoption of, standardized data collection forms (catch, effort, biological data) for sharks and rays, in cooperation with other regional and

subregional organizations, member nations and, if possible, with organizations collecting data in the Western Pacific.

2. Develop and disseminate sampling designs for landings of sharks and rays, and for observer programs where available, and support the creation and maintenance of databases.

3. In-port collection of data on shark catches, size distributions, and effort, as well as the development of standardized methods to identify shark species. This assistance should be extended to the proper identification of shark species based on body parts (*e.g.* fins or trunks), or on incomplete specimens.

10.2. Data reporting

Improve the Members' capability to report data on catches and effort by gear type, landings, and shark trade, in accordance with IATTC reporting procedures, including available historical data. This assistance will likely include the development of observer programs covering different fisheries. We plan to have one training course per year, dedicated to the development of standardized national observer programs.

10.3. Biological parameters

Conduct research on stock structure and biological parameters such as age, growth, natural mortality, diet, and reproduction. This assistance will likely include, as part of the general training course on data collection, training in biological sample collection and analysis methods.

10.4. Fisheries data studies

Conduct research on the spatial-temporal characteristics of shark catches, including identification of nursery grounds and of specific areas and seasons that contribute to the majority of catches. This assistance will likely include a general training course on quantitative methods in fisheries data analysis, which will also cover methods for estimating fisheries quantities, such as fishing mortality, and inputs for stock assessment (*e.g.*, total catch, standardized trends of CPUE).

10.5. Workshops on stock assessment of sharks

Participation in shark stock assessment workshops, which will include, among their research topics, stock assessment and management of sharks.

10.6. Development of landings database in collaboration with OSPESCA

IATTC staff, in collaboration with the Organization for Fisheries and Aquaculture in Central America (OSPESCA), continued assistance in the development of data collection forms for artisanal fleets operating from ports in Central America. The second and final form, for collecting summarized landing and trip data, has been completed, along with the associated user manuals, database, and data entry/editing program. The database features many data entry-friendly features and a comprehensive error-checking routine. Potential users of the database include fisheries managers in Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, Panama, and the Dominican Republic.

11. LONGLINE DATA COLLECTION WORKSHOP

Staff of the Bycatch and Data Collection programs participated in a workshop, sponsored by ISSF, and held at the National Taiwan Ocean University in Keelung, Taiwan, on 27-29 January 2015. The goal of the workshop was to compare longline data collected by the various tuna RFMOs, and to produce a document with recommendations aiming at achieving consistency among the programs and making progress towards the collection of the data needed to standardize the longline data bases used for studies of catches and bycatches. The forms and manuals developed by the Bycatch program staff, available on the IATTC website, were a significant input to the process. The results were published

(Gilman and Hall 2015).

12. TECHNICAL SUPPORT AND ADVICE TO GOVERNMENTS AND OUTSIDE ORGANIZATIONS

Staff of the Bycatch Program were involved in providing advice and technical support to organizations involved in sustainable fisheries management such as ISSF, the Marine Stewardship Council, and the Seafood Watch Program.

In addition to their obligations to the Commission, the staff also provides scientific advice to member governments. For example, a staff member chairs the Pacific Scientific Review Group, which provides advice to U.S. government agencies on marine mammals in U.S. waters off the Pacific coast and Central Pacific islands. Travel expenses for such activities are typically paid by the organizers, but IATTC staff are not otherwise compensated for their participation.

Peru organized and hosted the second IATTC Technical Meeting on Dorado, held in Lima, Peru, on 27-29 October 2015. The meeting was chaired and facilitated by the members of the Stock Assessment Group, and the Director and Chairman of the Commission also participated. IATTC staff led sessions of collaborative work aiming to analyze and discuss available data, and answer two important questions that need to be addressed in order for regional management to be possible: 1) what are reasonable stock structure assumptions to consider for regional management of dorado in the EPO? and 2) which indicators of stock status should be monitored to produce scientific advice for regional management?

13. PRECAUTIONARY APPROACH, HARVEST STRATEGIES AND MANAGEMENT STRATEGY EVALUATION

Two members of the Stock Assessment Group gave lectures at the "Eastern Pacific Ocean Coastal States Tuna Management Workshop", sponsored by the United Nations Food and Agriculture Organisation (FAO) project *Common Oceans: Sustainable Management of Tuna Fisheries and Biodiversity Conservation in Areas Beyond National Jurisdiction*, which is partially funded by the Global Environment Facility (GEF). The project partners involved in the workshop, held in Panama on 24-26 February 2015, were the IATTC, FAO, World Wildlife Fund (WWF) and the ISSF. The main objective of the workshop was to create a better understanding of the precautionary approach, harvest strategies, and management strategy evaluation for sustainable tuna fisheries. The Director also participated in the workshop, whose audience was IATTC Commissioners and technical advisors to EPO coastal States.

IATTC staff also participated in the 2015 ISSF Stock Assessment Workshop on Characterizing Uncertainty in Stock Assessment and Management Advice. A presentation was given that reviewed the IATTC's progress towards the formal adoption of harvest strategies for the management of the stocks under its jurisdiction, with a special focus on the treatment of uncertainty and the estimation of risk.

IATTC staff participated in the Management Strategy Evaluation Workshop of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC), held on 16-17 April 2015 in Yokohama, Japan. The purpose of the workshop was to review the objectives, benefits, and requirements of implementing an MSE, as well as recent progress made by tuna RFMOs towards adopting and implementing the MSE process. Discussions aimed at defining the roles of managers, stakeholders, and scientists in the MSE process, particularly as they relate to facilitating the completion of an MSE for North Pacific albacore tuna. The IATTC staff made a presentation entitled "Progress towards implementing harvest strategies and MSE in the management of EPO tuna fisheries".

D. REFERENCES

Croll, D. A., H. Dewar, N. K. Dulvy, D. Fernando, M. P. Francis, F. Galván-Magaña, **M. Hall**, S. Heinrichs, A. Marshall, D. McCauley, K. M. Newton, G. Notarbartolo-Di-Sciara, M. O'Malley, J. O'Sullivan, M. Poortvliet, **M. Román**, G. Stevens, B. R. Tershy, and W. T. White. 2016. Vulnerabilities and fisheries impacts: the uncertain future of manta and devil rays. Aquatic Conservation: Marine and Freshwater Ecosystems. DOI: 10.1002/aqc.2591.

Garcia S. M., G. Bianchi, A. Charles, J. Kolding, J. Rice, M-J. Rochet, S. Zhou, G. Delius, D. Reid, P. A.M.Van Zwieten, M. Atcheson, D. Bartley, L. Borges, A. Bundy, L. Dagorn, D. C. Dunn, **M. Hall**, M. Heino, B. Jacobsen, N. S. Jacobsen, R. Law, M. Makino, F. Martin, M. Skern-Mauritzen, P. Suuronen, and D. Symons. 2015. Balanced Harvest in the Real World. Scientific, Policy and Operational Issues in an Ecosystem Approach to Fisheries. International Union for Conservation of Nature and Natural Resources. http://archimer.ifremer.fr/doc/00255/36575/

Gilman, E., and **M. Hall**. 2015. Potentially Significant Variables Explaining Bycatch and Survival Rates and Alternative Data Collection Protocols to Harmonize Tuna RFMOs' Pelagic Longline Observer Programmes. Appendix 1 to WCPFC-SC11-2015/EB-IP-05: 71 pp. Western and Central Pacific Fisheries Commission, Kolonia, Pohnpei, Federated States of Micronesia. https://www.wcpfc.int/system/files/EB-IP-05%20LL%20Obs%20bycatch%20data%20fields%20Rev%201%2028%20July.pdf

Hall, M. A. 2015. More on bycatches: changes, evolution, and revolution. In:. Kruse, G.H, H.C. An, J. DiCosimo, C.A. Eischens, G.S. Gislason, D.N. McBride, C.S. Rose, and C.E. Siddon (editors). Fisheries Bycatch: Global Issues and Creative Solutions. Alaska Sea Grant, University of Alaska, Fairbanks. http://doi.org/10.4027/fbgics.2015.12

Hearn, A.R., Green, J., **Román, M.H**., Acuña-Marrero, D., Espinoza, E., and A.P. Klimley. Adult female whale sharks make long distance migrations movements through past Darwin Island (Galapagos, Ecuador) in the Eastern Tropical Pacific. Marine Biology (manuscript in preparation)

Parga, M. L., M. Pons, S. Andraka, L. Rendón, T. Mituhasi, **M. Hall**, L. Pacheco, A. Segura, M. Osmond, and N. Vogel. 2015. Hooking locations in sea turtles incidentally captured by artisanal longline fisheries in the eastern Pacific Ocean. Fish. Res., 164: 231-237