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RESEARCH PROJECTS WITH SOME EXTRA-BUDGETARY FUNDING

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The information in this document is largely extracted from Document SAC-07-07^a, *Staff activities and research plans*. It describes the current situation regarding certain aspects of the staff’s research, data management, and outreach activities, and outlines future activities and planned improvements for research that are partially funded from sources outside the Commission’s regular budget.

A. RESEARCH

- CAPAM stock assessment methodology workshop series.** A CAPAM (Center for the Advancement of Population Assessment Methodology) workshop on data weighting was held in 2015, and the IATTC staff collaborated on several research projects presented at the workshop. The results from that 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. The CAPAM workshops are funded by the US National Marine Fisheries Service (NMFS) and the International Sustainable Seafood Foundation (ISSF).
- Dorado stock assessment.** A preliminary stock assessment of dorado in the eastern Pacific Ocean (EPO) was conducted. Further refinement of the assessment will be made in collaboration with member countries. This work is partially funded by World Wildlife Fund (WWF).

The IATTC has received funding from the European Union (EU) and ISSF to conduct a preliminary management strategy evaluation (MSE) on tunas in the EPO. This work will start in June 2016, and the results will be presented at the Scientific Advisory Committee (SAC) meeting in 2017. The main focus of the project is to test the recently adopted interim target reference points (TRP) and limit reference points (LRP).

1. CAPAM FALL 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 (NOAA), 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 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 is in development. A CAPAM workshop on recruitment is contemplated for 2017. The CAPAM workshops are funded by NMFS and ISSF. The CAPAM project on developing a Good Practices Guide to Stock Assessment also includes a postdoctoral and visiting scientist funded by NMFS.

2. TAGGING STUDIES

- a. 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.
- b. Continue to explore potential funding sources for an IATTC Regional Tuna Tagging Project for bigeye, yellowfin, and skipjack tunas throughout the EPO.

3. LIFE HISTORY OF TUNAS

3.1. Early life history

The early life history (ELH) group will be conducting research on the ecology, physiology, and pre-recruit dynamics of tunas. Extra-budgetary 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.

a. 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 (Achoines 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.

b. 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*.

c. 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.

d. Feasibility study for non-entangling and biodegradable FADs

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

e. Acoustic research study of yellowfin tuna

ISSF is funding studies of the acoustic properties of tuna species 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 of 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 acoustic testing.

f. 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 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. 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 $\delta^{15}\text{N}$ 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 $\delta^{15}\text{N}$ 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.

5. DIET STUDIES

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.

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.

6. 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..

7. EFFECTS OF FISHERIES ON THE EPO ECOSYSTEM

7.1. Bycatch studies

7.1.1. Bycatches on FADs:

- a. 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, 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.
- b. 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.
- c. Joint ISSF-IATTC research to reduce fishing mortality on small bigeye tuna and sharks:
 - i. 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.
 - ii. 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. CAPACITY BUILDING, TRAINING AND TECHNICAL SUPPORT

8. TECHNICAL SUPPORT AND ADVICE TO GOVERNMENTAL AND NON-GOVERNMENTAL 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.

The staff also provides scientific advice to governments outside the IATTC. 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 sponsoring organization, but IATTC staff are not otherwise compensated for their participation.

9. 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.