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SCIENTIFIC ADVISORY COMMITTEE

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STAFF ACTIVITIES AND RESEARCH PLAN

This document is an update of Document IATTC-93-06a, which summarized the IATTC scientific staff's work plans for 2018-2023 and its current and planned research activities under the proposed Strategic Science Plan. Projects that were proposed but not funded were listed in Document IATTC-93-06c.

CONTENTS

A. INTRODUCTION

This document presents the staff's research and work plans for the next five years, as well as brief summaries of the 52 research projects that are currently under way, or planned for the near future and funded. The summaries include, for each project, background information, a work plan, and a status report, as well as details of its relevance and purpose, external collaborators, duration, and deliverables; also, for existing projects, an update on activities since the previous year's report.

The staff's research activities are no longer structured in accordance with the Commission's four research programs[1], as they were prior to 2018. Instead, they are classified into the seven main areas of research,

[1] Stock Assessment; Biology and Ecosystem; Data Collection and Database; Bycatch and International Dolphin Conservation Program (IDCP)

called *Themes*, of the proposed Strategic Science Plan (SSP; IATTC-93-06a). In addition to better accommodating a strategic planning approach, this new structure is intended to foster stronger collaboration among the different programs (recommendation 17 of the 2016 IATTC Performance Review), with researchers from different programs contributing to activities under a common *Theme*. The seven *Themes,* the strategic pillars of the SSP, are the following:

1. Data collection for scientific support of management
2. Life history studies for scientific support of management
3. Sustainable fisheries
4. Ecological impacts of fishing: assessment and mitigation
5. Interactions among the environment, ecosystem, and fisheries
6. Knowledge transfer and capacity building
7. Scientific excellence

Each *Theme* is divided into strategic *Goals*, and the principal tasks that will be carried out to achieve a particular goal within the SSP's five-year window are called *Targets* (IATTC-93-06a). The specific activities that the staff will carry out in order to fulfil those tasks are called *Projects*, which are in some cases grouped into *Work Plans* aimed at achieving a broad objective not limited to a particular *Theme* or *Goal*.

The general *Themes*, and the more specific *Goals*, reflect what the staff considers to be its primary responsibilities, and form an integral part of the five-year SSP. The more focused *Targets*, and the concrete *Projects*, are generally of shorter duration, and operate on a biennial cycle. Whether any *Projects* are undertaken under a particular *Goal* or *Target* in any given period will depend on the staff's research priorities, the human, logistic, and financial resources available, and any specific instructions from the Commission.

A measure of the staff's activities is the presentation of its research and the resulting publications. Presentations and publications from 2018 are listed in Section F.

B. INDEX OF PROJECTS

C. ASSESSMENTS OF TUNAS AND OTHER SPECIES CARRIED OUT BY THE IATTC STAFF

The staff's main responsibility is to analyze and assess the status of the stocks of tunas and tuna-like species in the EPO, and provide scientific advice to the Commission to aid in its management decisions regarding these stocks. It prepares assessments of the principal species of tropical tunas (bigeye, yellowfin, and skipjack) and, on request by IATTC Members, of other species such as silky shark and dorado. It also collaborates with the International Scientific Committee (ISC) for Tuna and Tuna-Like Species in assessments of North Pacific bluefin and North Pacific albacore tunas, and some billfish and shark species, and with other organizations, such as the SPC and WCPFC, and conducts dolphin assessments for the AIDCP.

Three types of stock assessments are carried out: 1) **benchmark assessments** (previously called "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. Other less intensive methods, such as stock status indicators, are also used.

Stock assessment work during 2018-2020 will focus primarily on delivering benchmark assessments of bigeye and yellowfin tunas in 2020, when Resolution C-17-02 expires and new management measures for tropical tunas will be needed.

Species	SSP ref.	Last assessed	2018	2019	2020	2021	2022	2023
IATTC								
Yellowfin tuna	H.4.a	2018	Update	Indicators/ Update[2]/ Exploratory/ Review	Benchmark	Update	Update	Update
Skipjack tuna	H.4.a	2004/2018 Indicators	Indicators	Indicators	Indicators	Indicators	Indicators	Indicators/ Tagging[3]
Bigeye tuna (EPO)	H.4.a	2017/2018 Indicators	Indicators/ Update[4]	Indicators/ Exploratory/ Review	Benchmark	Update	Update	Update
Bigeye tuna (Pacific wide)	H.7.a	2016				Exploratory		
South Pacific albacore tuna	H.7.c						Benchmark	
Striped marlin	H.7	2010						

[2] The yellowfin update assessment was not originally planned for 2019, but was conducted for completeness

[3] Conditional on multi-year tagging program

[4] A bigeye update assessment was conducted, but was not considered reliable enough to use for management advice

Species	SSP ref.	Last assessed	2018	2019	2020	2021	2022	2023
Swordfish (south EPO)	H.7.b	2011				Benchmark		
Sailfish	H.7	2013						
Black marlin		Never						
Silky shark	H.7	2018 (EPO indicators/ Pacific-wide benchmark)	Indicators	Indicators	Indicators	Indicators	Indicators	Indicators/ Benchmark
Dorado	I.3.a	2016		Candidate RP and HCR				
COLLABORATIONS								
Pacific bluefin tuna	H.6.a	2016 benchmark/ 2018 update	Update	Projections	Benchmark	Projections	Update	Projections
North Pacific albacore tuna	H.6.a	2017			Benchmark			
Blue marlin	H.7	2013 benchmark/ 2016 update						
Blue shark	H.6.a	2017						
Shortfin mako shark	H.6.a	2018	Benchmark					
Swordfish (north Pacific)	H.7	2014						

D. WORK PLANS

Work Plans combine research activities from different parts of the SSP in order to achieve certain broad scientific objectives that span more than one *Theme* or *Goal*. The following summary work plans list the specific *Targets* and *Projects* that are included, the time frame for carrying each one out, and their status.

1. WORK PLAN TO IMPROVE STOCK ASSESSMENTS OF TROPICAL TUNAS

Assessing the status of the tropical tuna stocks is the scientific staff's main responsibility. The staff constantly seeks to improve both its conventional stock assessments of yellowfin and bigeye tunas and its stock status indicators for skipjack, and in 2018 identified some issues in the bigeye assessment that need to be addressed. In particular, spatial structure needs to be considered, and the staff has recently initiated research to introduce this in the assessment. In 2019 similar issues were identified with the yellowfin assessment, in addition to the previously-identified inconsistencies among the indices of abundance used in the assessment (SAC-10 INF-F).

In the past, the staff based its recommendation for the duration of the closure of the purse-seine fishery on the *F* multiplier, a parameter in the assessment model that relates fishing effort (*F*) to the maximum sustainable yield (MSY) of a stock. However, the results of the bigeye assessment in 2018 led the staff to conclude that the model had become overly sensitive to the inclusion of new data and to previously-identified issues in the assessment (SAC-09 INF-B), and that the resulting *F* multiplier should not be used to define management measures in 2018. In order to address these issues, the staff developed a work plan to improve the bigeye assessments before management measures have to be decided for 2021 and subsequent years, after the current tuna conservation resolution (C-17-02) expires. The objective is to present new bigeye and yellowfin base-case assessments at SAC-11 in May 2020, and new management recommendations to the subsequent annual meeting of the Commission.

In 2019, issues arose with the yellowfin assessment that again led to the *F* multiplier not being used to define management measures. Evidently, the yellowfin assessment also needs improvement before it can be used as a basis for management advice. Although some of the activities under the bigeye work plan are specific to bigeye, several will also contribute to improving the yellowfin assessments, so the staff refined and rearranged the bigeye work plan to form a **tropical tuna work plan** that aims to improve both assessments. It includes a core set of projects developed specifically to address the issues identified in the assessments within the required time frame (Table A), as well as other projects that will contribute to improving the assessments in general, some of which extend beyond 2020.

Several of the work plan tasks have been completed, and significant progress has been made towards developing a new and improved bigeye assessment, which has also helped with understanding the issues with the yellowfin assessment. CAPAM workshops (Target X.1) have been held on recruitment (2017), spatio-temporal models (2018), and spatial stock assessment models (2018). In early 2019 workshops on age and growth methods for bigeye and yellowfin tuna and on longline CPUE analysis were held, as was the external review of the bigeye tuna assessment (report). A spatial model has been implemented and applied for bigeye, and several analyses have been conducted to investigate the cause of the apparent regime shift in bigeye recruitment (SAC-10 INF-G), and of the inconsistencies among the indices of abundance in the yellowfin assessment (SAC-10 INF-F). An additional longline CPUE workshop has been added to the work plan to complete this component, but requires funding (Project H.1.e).

Main expected work plan deliverables (see Staff activities report for additional results of individual projects)**:**
2018: Develop a spatially-structured stock assessment for bigeye tuna and other model improvements
2019: Exploratory bigeye and yellowfin assessments (Report to SAC-10; SAC-10 INF-F)
2020: Benchmark bigeye and yellowfin assessments (Report to SAC-11)
2021: Exploratory Pacific-wide bigeye assessment

TABLE A. Timeline for tropical tuna work plan, 2017-2020.

2017	
Collaboration with Japanese scientists on identifying targeting changes	Report, SAC-09
2018	
February: CAPAM workshop on the development of spatiotemporal models of fishery CPUE data to derive indices of relative abundance (Special Issue of Fisheries Research)	SAC-09-09
Developing a spatially structured stock assessment for bigeye tuna and other model improvements	Project I.1.a
October: CAPAM workshop on spatial stock assessment models focusing on bigeye tuna	Project X.1.a
2019	
January: Workshop to evaluate differences in bigeye tuna age estimation methods and resulting growth models utilized in current stock assessments by the IATTC and WCPFC	Project E.2.b
February: Workshop to improve the longline indices of abundance of bigeye and yellowfin tunas in the EPO	Project H.1.d
March: Independent review of bigeye assessment (report)	Project T.1.a
May: SAC-10, exploratory bigeye and yellowfin assessments	SAC-10 INF-G
Oct-Nov: Construct indices of abundance and composition data for longline fleets	Project H.1.e
Nov-Dec: Independent review of yellowfin assessment	Project T.1.b
2020	
May: Benchmark bigeye and yellowfin assessments	Report, SAC-11
July: New management recommendations to the Commission	IATTC annual meeting

TABLE B. Projects included in the tropical tuna work plan, 2017-2021. **Green**: completed; **blue**: funded; **red**: unfunded; **pink**: partially funded (funded components completed, other components pending). Text ~~struck through~~ indicates completed or terminated projects.

SSP ref.	Target/Project	Timeframe & status				
		2017	2018	2019	2020	2021
1. MONITORING STOCK STATUS AND MANAGEMENT ADVICE						
H.4.a	Conduct routine stock assessments of tropical tunas and indicators					
J.2.a	Quantification of the relationship between vessel operational characteristics and fishing mortality					
2. ASSESSMENT RESEARCH						
H.1.a	Improve the bigeye tuna stock assessment					
H.1.b	Improve the yellowfin tuna stock assessment					
~~X.1.a~~	~~Workshop to advance spatial stock assessments of bigeye tuna in the Pacific Ocean~~					
~~X.1~~	~~CAPAM workshop on recruitment: theory, estimation, and application in stock assessment models~~					
E.2.b	Workshop to evaluate differences in bigeye tuna age estimation methods and resulting growth models utilized in current stock assessments by the IATTC and WCPFC					
~~T.1.a~~	~~External review of bigeye tuna assessment~~					
T.1.b	External review of yellowfin tuna assessment					
X.1.c	CAPAM workshop on natural mortality					
H.7.a	Pacific-wide bigeye tuna exploratory assessment					
3. LIFE HISTORY DATA						
E.1.a	Evaluate potential improvement of growth model for bigeye in the EPO based on presumed annuli counts from otoliths of large fish					
E.5.a	Evaluate the Pacific-wide population structure of bigeye and skipjack tunas, using genetic analyses					
4. CPUE						
~~X.1~~	~~CAPAM workshop on the development of spatiotemporal models of fishery CPUE data to derive indices of relative abundance (Document SAC-09-09)~~					
H.1.c	Investigate potential changes in the selectivity of the longline fleet resulting from changes in gear configuration					
H.1.d	Improve indices of abundance based on longline CPUE data			*		
H.1.f	Construct indices of abundance and composition data for longline fleets					
5. NEW DATA SOURCES						
C.1.a	Develop an effective and reliable floating-object marking scheme to assist scientific advance					
D.2.a	Pilot study of electronic monitoring of the activities and catches of purse-seine vessels					
E.4.a	Multi-year tuna tagging study					

* Partially funded; workshop held in 2019 ** Project D.2.c combined with D.2.a; see SAC-10-12

2. WORK PLAN FOR MANAGEMENT STRATEGY EVALUATIONS (MSE)

The process of developing MSEs, a major objective of the IATTC and other organizations, consists of two parts. One is highly technical, and is carried out by scientific experts, but the other, which involves defining objectives, performance metrics, and candidate management strategies, requires input and participation of managers and other stakeholders. Those two parts should evolve in synergy. However, although the IATTC Performance Review, the Strategic Science Plan, and the SAC all endorsed improving knowledge-sharing, human-institutional capacity-building, and communication of scientific advice, there are currently no dedicated channels of communication about MSE within the IATTC. Stakeholder participation throughout the MSE process is central to its success, and will be facilitated by an understanding of the MSE process and its components, and by strengthening communication among scientists, managers, and other stakeholders. The proposed work plan combines support for the staff in the technical development of MSE for tropical tunas with a series of workshops for training and enhancing dialogue and communication among all interested parties regarding the MSE process for tropical tunas. The initial MSE work will continue to focus on bigeye tuna, and will move to the other species towards the end of the 5-year timeframe. The work will include improvements to the bigeye stock assessment model, which will be used as a basis for the operating model used in the MSE. The IATTC staff is also collaborating with other organizations, such as the ISC, in Pacific-wide MSEs for albacore and Pacific bluefin tunas.

Main expected deliverables (see Section E for additional results of individual projects):

2018: Improved bigeye assessment for use as spatial operating model (OM)
Workshop on training, communication and evaluation of management strategies for tuna fisheries in the EPO

2019: SAC-10: Report improvements to bigeye model for its use as OM; work on alternative reference points and harvest control rules (HCRs) for dorado.
Workshops for scientists-managers to elicit objectives, performance metrics, alternative HCRs

2020: Workshops with managers and other stakeholders to show initial results and gather feedback, plus a technical workshop
SAC-11: Report on revised MSE plan and preliminary results based on outcomes of workshops

2021: Updated MSE results based on input from managers and stakeholders
SAC-12: Report on revised MSE plan and preliminary results based on outcomes of workshops

2022: Final MSE results based on revised input from managers and stakeholders
SAC-13: Report on revised MSE plan and preliminary results based on outcomes of workshops

2023: SAC-14: Report final results
IATTC annual meeting: Recommend evaluated HCR/Management procedure for bigeye for adoption; present plan for other tropical tunas

Green: completed; **blue**: funded; **red**: unfunded

SSP ref.	Target/Project		2018		2019		2020		2021		2022		2023	
			1	2	1	2	1	2	1	2	1	2	1	2
1. SUSTAINABLE FISHERIES														
Goal I: Test harvest strategies using Management Strategy Evaluation (MSE)														
I.1.	MSE for tropical tunas in the EPO: bigeye tuna													
I.1.a	1. Conduct an MSE for tropical tunas in the EPO													
	a. Improve the bigeye assessment for use as spatial OM													
	b. Run preliminary simulations with spatial OM													
	c. Technical meeting to agree on overall/revised MSE Plan by IATTC staff and collaborators													
	2. Continue technical development of MSE, HCR, MP, outputs (with Project R.1.b)													
	a. Run preliminary MSE based on initial input from managers and stakeholders													
	b. Run final MSE based on revised input from managers and stakeholders													
	c. Propose evaluated HCR/MP to Commission for adoption, plan work for other tropical tunas													
I.2.	Collaborate with ISC in Pacific-wide MSEs for albacore and Pacific bluefin tunas (*dependent on ISC scheduling)	ALB						*	*	*	*	*	*	*
		PBF				*		*	*	*	*	*	*	*
I.3	Initiate MSE work to evaluate indicator-based harvest strategies for prioritized species and species of specific interest													
I.3.a	Evaluate potential reference points for dorado in the EPO													
2. KNOWLEDGE TRANSFER AND CAPACITY BUILDING														
Goal R: Improve communication of scientific advice														
R.1.	Improve communication of the staff's scientific work to CPCs													
R.1.a	Workshop on training, communication and evaluation of management strategies for tuna fisheries in the EPO													
	a. Other MSE workshops for scientists-managers (to be planned)													
R.1.b	Technical development, communication and evaluation of MSEs for tropical tuna fisheries in the EPO involving managers, scientists and other stakeholders													
R.2	Participate in global initiatives for the communication of science: t-RFMO MSE working group													
3. SCIENTIFIC EXCELLENCE														
Goal T: Implement external reviews of the staff's research														
T.1.	Facilitate external reviews of stock assessments: External review of bigeye assessment													
T.2.	Facilitate external reviews of scientific studies: Publications in journals													
Goal X: Promote the advancement of scientific research														

3. WORK PLAN FOR THE FAD FISHERY: IMPROVE DATA COLLECTION AND MANAGEMENT, AND MITIGATE ECOLOGICAL IMPACTS

The expansion of FAD fisheries worldwide poses several challenges for tuna RFMOs. First, with the expansion has come the need for improved data collection to provide better management advice on an ever-evolving fishery. Currently, much of the detailed data on the EPO FAD fishery is collected by observers aboard Class-6 vessels. However, new resolutions and technological advances offer the possibility of collecting additional detailed data on FAD-related activities, including information provided by fishing crews on FAD form 9/2016 (Resolution C-16-01), FAD buoy data to be provided to the IATTC staff under Resolution C-17-02 (plus supplements recommended by SAC-09 and the FAD Working Group), and the use of electronic monitoring to supplement data collected by on-board observers. Second, because the FAD fishery has different impacts on the ecosystem, in terms of marine pollution, bycatches of non-target species, and catches of juveniles of target species, than other components of the purse-seine fishery, there is an urgent need to develop and test conservation and management measures that will contribute to mitigating these effects, such as gear modifications and new FAD designs, among others.

The IATTC staff is currently working on numerous projects related to the FAD fishery, and has submitted proposals for funding to help fill remaining data and knowledge gaps; these are shown in the work plan below.

Main expected deliverables (see Section E for additional results of individual projects):
2018: Reports summarizing current data gaps and potential improvements
2018-2019: Training workshops to expand and improve data collection
2020: Prototype scheme for reliable floating-object marking
Data-driven recommendations for the implementation of electronic monitoring in the purse-seine fleet
Quantitative evaluation of the relationship between the FAD fishery, fishing mortality and its ecological impacts
2021: State-of-the-art data-collection procedures for the purse-seine fishery; improved data quality and reporting procedures
New ecologically-friendly FAD designs, and guidelines for their implementation and use

Green: completed; **blue**: funded; **red**: unfunded

SSP ref.	Target/Project	Timeframe & status				
		2017	2018	2019	2020	2021
1. DATA						
Goal B: Identify and prioritize opportunities to improve data quality and expand data types and coverage						
B.2.	Expand on-board data collection to small purse seiners: train observers					
Goal C: Facilitate the improvement of data quality, coverage, and reporting by CPC data collection programs						
C.1.	Purse-seine fleet: Improve data reporting and content (Resolutions 16-01 and 17-02; SAC-09 and WG-FADs recommendations)					
C.1.a	Develop an effective and reliable floating-object marking scheme to assist scientific advance					
Goal D: Investigate the use of new technologies to improve data quality						
D.2.a	Pilot study of electronic monitoring of the activities and catches of purse-seine vessels					

SSP ref.	Target/Project	Timeframe & status				
		2017	2018	2019	2020	2021
Goal Q: Provide training opportunities for scientists and technicians of CPCs						
Q.3	Workshops for vessel crews, industry, and national authorities on requirements of C-16-01 and C-17-02 (WG-FADs Recommendation endorsed by SAC-09)					
2. CONSERVATION AND MANAGEMENT						
Goal J: Improve our understanding of the effects of the operational characteristics of the fishery on fishing mortality, stock assessments, and management advice						
J.2.a	Quantification of the relationship between vessel operational characteristics and fishing mortality					
Goal M: Mitigate the ecological impacts of tuna fisheries						
M.1.a	Evaluate the effect of the depth of non-entangling FADs on catches of tunas and bycatches of other species in the purse-seine fishery					
M.1.b	Test sorting grids (with emphasis on reducing catches of juvenile bigeye)					
M.3.a	Estimate bycatch and discard rates at FADs, by species, and identify “hot spots”					
M.5.a	Develop and test non-entangling and biodegradable FADs					
M.5.b	Reducing losses, and fostering recovery, of FADs in the purse-seine fishery in the EPO					

4. WORK PLAN TO IMPROVE DATA COLLECTION AND STOCK ASSESSMENTS FOR SHARKS

Paragraph 1 of Resolution C-16-05 on the management of shark species requires that "the IATTC scientific staff shall develop a workplan…, for completing full stock assessments for the silky shark … and hammerhead sharks ..."

As the staff has noted previously, improving shark fishery data collection in the EPO is essential if conventional stock assessments and/or other indicators of stock status are to be developed for sharks. An attempt to assess the status of the silky shark in the EPO using conventional stock assessment models was severely handicapped by major uncertainties in the fishery data, and stock assessment work on hammerhead sharks is currently not possible due to the scarcity of data for this taxon. Without reliable catch and composition data and indices of abundance for all fisheries catching sharks in the EPO, any further attempts at such assessments are problematic. In this regard, the lack of funding for Project C.4.b (see IATTC-93-06c) is also problematic, since the current funding from FAO-GEF finishes in early 2019.

The staff developed a work plan to improve data collection and stock assessments for sharks, focused on all EPO fisheries that interact with silky and hammerhead sharks, and obtained funds from FAO-GEF to improve data collection for the coastal longline and gillnet fisheries, which have the greatest deficiencies and are estimated to take a large fraction of the shark catches. The staff is developing an experimental design for a long-term shark fishery sampling program in the EPO, for presentation to the SAC and the Commission in 2019, and hopes to deliver some form of stock assessments of silky and hammerhead sharks by the end of the SSP time frame in 2023. In addition, the work plan involves bycatch mitigation activities aimed at reducing fishing mortality of sharks.

Main expected deliverables (see Section E for additional results of individual projects)**:**
2019: Proposal for long-term sampling program for shark catches by artisanal fisheries in Central America
2023: Assessments of silky and hammerhead sharks in the EPO

Green: completed; **blue**: funded; **red**: unfunded

SSP ref.	Target/Project	Timeframe & status					
		2018	2019	2020	2021	2022	2023
1. DATA							
Goal B: Conduct a review of current IATTC/AIDCP data collection programs, identify and prioritize opportunities to improve data quality and expand data types and coverage							
B.2.	Expand on-board data collection to small purse seiners						
Goal C: Facilitate the improvement of data quality, coverage, and reporting by CPC data collection programs							
C.4	Artisanal fisheries (coastal developing CPCs)						
C.4.a	Improving data collection for Central American shark fisheries: develop sampling protocols for catch and effort estimation (FAO-GEF ABNJ project)						
	a. Identify all unloading sites and obtain order-of-magnitude estimates of total catch and effort						
	b. Design and test sampling protocols for species and size composition sampling						
C.4.b	Long-term sampling program for shark catches of artisanal fisheries in Central America						

SSP ref.	Target/Project	Timeframe & status					
		2018	2019	2020	2021	2022	2023
Goal D: Investigate the use of new technologies to improve data quality							
D.2.a	Pilot study of electronic monitoring of the activities and catches of purse-seine vessels						
2. LIFE HISTORY DATA							
F.2.a	Investigate the movements, behavior, and habitat utilization of silky sharks in the EPO						
3. MONITORING POPULATION STATUS AND MANAGEMENT ADVICE							
Goal H: Improve and implement stock assessments, based on the best available science							
H.5	Undertake the research necessary to develop and conduct data-limited assessments for prioritized species (Assessments of silky and hammerhead sharks in the EPO)						
H.5.a	Revise trend estimation methods for purse-seine silky shark indices for the EPO						
Goal L: Evaluate the ecological impacts of tuna fisheries							
L.1.a	Develop habitat models for bycatch species caught in the EPO to support ecological risk assessments (ERAs)						
L.1.b	Develop a flexible spatially-explicit ERA approach for quantifying the cumulative impact of tuna fisheries on data-limited bycatch species in the EPO						
L.2.a	Develop and update Productivity-Susceptibility Analyses (PSAs) of tuna fisheries in the EPO						
Goal N: Improve our understanding of the interactions among environmental drivers, climate, and fisheries							
N.1.a	Analyze EPO bycatch data to assess the influence of environmental drivers on catches and vulnerability						
4. BYCATCH MITIGATION							
Goal M: Mitigate the ecological impacts of tuna fisheries							
M.1.a	Evaluate the effect of the depth of non-entangling FADs on catches of tunas and bycatches of other species in the purse-seine fishery						
M.2.a	Evaluate the post-release survival of silky sharks captured by longline fishing vessels in the equatorial EPO, using best handling practices						
M.2.b	Evaluate best handling practices for maximizing post-release survival of silky sharks in longline fisheries, and identification of silky shark pupping areas for bycatch mitigation						
M.3.a	Estimate bycatch and discard rates at FADs, by species, and identify “hot spots”						

E. CURRENT AND PLANNED PROJECTS, BY THEME

1. DATA COLLECTION FOR SCIENTIFIC SUPPORT OF MANAGEMENT

PROJECT A.1.a: Routine activities of the Bycatch and IDCP Program	
THEME: Data Collection **GOAL:** A. Database maintenance, preservation, and access **TARGET:** A.1. Routine tasks **EXECUTION**: Bycatch and IDCP Program	
Objectives	Continue routine Bycatch-IDCP program activities required by the Antigua Convention and the AIDCP
Background	• The AIDCP requires that all trips by Class-6 purse-seine vessels (carrying capacity > 363 t) in the EPO carry an observer aboard; the IATTC observer program covers 50% of trips. • Observer records are the primary source of data on the purse-seine fishery. • The Antigua Convention and various IATTC resolutions require that observers collect information on the tuna purse-seine fishery. • The Bycatch-IDCP program is instrumental in training observers from national programs and under agreements with other organizations.
Relevance for management	Observer data are a key element for stock assessments and recommendations by the IATTC scientific staff
Duration	Continuous
Workplan and progress report (for ongoing projects)	Continue to process new data. Seek opportunities to improve data collection and processing.
External collaborators	Coordination with national and regional observer programs is essential and required.
Deliverables	• IATTC staff processed data from 526 observed trips initiated during 2017. • Observer training, 2017: two courses, in Ecuador (for IATTC and Ecuadorian national program) and Federated States of Micronesia (with WCPFC western Pacific program). • Required AIDCP seminars for crew, vessel managers and government officials, 2017: three (two in Ecuador, one in Panama), with a total of 128 attendees. • Required alignment of dolphin safety panel in purse-seine net, 2017: four, all in Ecuador.

PROJECT A.1.a: Routine activities of the Bycatch and IDCP Program
Updated: May 2019
Progress summary for the reporting period • IATTC staff processed data from 526 observed trips initiated during 2018. • Observer training, 2018: three courses, two in Ecuador, one for IATTC observers, one for the Ecuadorian observer program (TUNACONS), and one in Solomon Islands for cross-endorsed WCPFC observers. • Participated in three seminars for captains and fishers, one a requirement for inclusion in the AIDCP list of qualified captains, and two on bycatch reduction, in coordination with ISSF. • Participated in five alignments of dolphin safety panels in purse-seine nets, two in Ecuador and three in Mexico. • Updated the observer *Flotsam Information Record* and relevant database, to include information on compliance with Resolution C-18-05 and to better track FAD activity by obtaining information on makes and models of satellite buoys.
Challenges and key lessons learnt -
Reports/publications/presentations Presentations for the AIDCP seminar were updated with new resolution requirements relevant to operators, and made available to the national programs.
Comments: -

PROJECT A.3.a. Conversion of all remaining Visual Basic 6 (VB6) computer programs to Visual Basic Net (VB.net).	
THEME: Data Collection **GOAL:** A. Database maintenance, preservation, and access **TARGET:** A.3. Standardize and automate data submissions **EXECUTION**: Data Collection and Database Program	
Objectives	• Re-write all VB6 computer programs still in use by the IATTC and supported national observer programs in VB.net. • Work with national programs to install and test in the local environments, and train national program staff.
Background	• IATTC staff developed customized data entry and editing programs using VB. • Microsoft has terminated support for VB6, so the development environment no longer runs on current Microsoft operating systems. • The code must be re-written in a supported programming language. • Decision made to use existing staff to complete the project, rather than hire outside programmers.
Relevance for management	At some point the compiled VB6 programs will cease to work, and data required for stock management would not be available.
Duration	2 more years – planned completion in 2021
Work plan and status	• Late 2014: project initiated. • March 2019: conversion 68% complete. • April-December: Continue conversion, prioritizing the most important computer programs.
External collaborators	None
Deliverables	• Completion of conversion of all VB6 computer programs. • Replacement of all VB6 computer programs in IATTC and national programs with VB.net programs. • Provide technical support to national programs during transition.

PROJECT A.3.a. Conversion of all remaining Visual Basic 6 (VB6) computer programs to Visual Basic Net (VB.net).
Updated: May 2019
Progress summary for the reporting period • IATTC and all national observer programs have incorporated database modifications and are using the VB.net version of all main data processing computer programs. • Remaining VB6 programs are either not critical to the functioning of the observer program, or are used exclusively by IATTC.
Challenges and key lessons learnt • Thorough testing is time-consuming. This was not included in original project duration estimates, so timelines were extended. • The staff's routine and other duties severely limit the time available for this project.
Reports/publications/presentations
Comments: -

PROJECT A.3.b: Develop databases of biological and fisheries parameters to support Ecological Risk Assessment and ecosystem models	
THEME: Data Collection **GOAL:** A. Database maintenance, preservation, and access **TARGET:** A.3. Standardize and automate data submissions **EXECUTION**: Data Collection and Database Program, Biology and Ecosystem Program	
Objectives	Develop a comprehensive database of best-available biological and fisheries data to provide key parameters for Ecological Risk Assessment (ERA) and ecosystem models
Background	• The Antigua Convention requires the IATTC to ensure the sustainability of target, associated, and dependent species affected by EPO tuna fisheries, and the ecosystem to which they belong. • ERA and ecosystem models, used by IATTC staff to assess the ecological impacts of tuna fisheries in the EPO, require information on biological, physiological and trophodynamic characteristics of thousands of species in the EPO ecosystem. • A database with the most up-to-date information for impacted species is required to expedite the initial parameterization, or updating, of future models.
Relevance for management	• The database will contain data needed for ERAs and ecosystem models, used to identify and prioritize data collection, mitigation, and/or management measures for vulnerable species. • The databases could be shared with scientists of CPCs.
Duration	48 months
Workplan and status	• Jan–Apr 18: Create a basic database structure ready to be populated with biological parameters and associated literature sources. • Ongoing: Conduct biological and ecological literature searches for species that interact with EPO fisheries • Ongoing: Conduct literature searches for species that interact with EPO fisheries, identify fishery-related susceptibility parameters for bycatch species, create database
External collaborators	Scientists from CPCs interested in contributing to and/or using the databases
Deliverables	Comprehensive life history and susceptibility database with fishery-specific information that can be shared with IATTC CPCs for those wishing to develop ERAs for a particular region and/or fishery.

PROJECT A.3.b: Develop databases of biological and fisheries parameters to support Ecological Risk Assessment and ecosystem models
Updated: May 2019
Progress summary for the reporting period • A life-history database is in development for all species reported to have interacted with purse-seine and large-scale longline fisheries • Values for fisheries-related susceptibility parameters have been obtained for many of the bycatch species
Challenges and key lessons learnt -
Reports/publications/presentations • Two manuscripts that use these life history and susceptibility data have been submitted to scientific journals
Comments: -

PROJECT C.4.a: Improving data collection for Central American shark fisheries	
THEME: Data Collection **GOAL:** C. Facilitate the improvement of data quality, coverage, and reporting by CPC data collection programs **TARGET:** C.4. Artisanal Longline fleet **EXECUTION**: Stock Assessment Program	
Objectives	• Obtain an order-of-magnitude estimate of shark catch for the artisanal fleet. • Design and test sampling protocols for estimating shark species and size composition for the industrial fleet.
Background	• There is a critical need for stock assessments of sharks to better inform their management and conservation. • Unfortunately, this has not been possible in the eastern Pacific Ocean (EPO) to date due to the lack of reliable fishery statistics from all important fisheries. • With funding in 2015-2017 from the FAO and the GEF in the framework of the Common Oceans Tuna project, IATTC staff and an external consultant produced two reports that summarize characteristics of Central American shark fisheries and complied available catch information for the region. • Also as part of the project same, IATTC staff and the external consultant identified specific data gaps and areas for improvement in data collection. • In September 2017, IATTC and the external consultant convened a "Workshop to Develop a Pilot Study for a Shark Fishery Sampling Program in Central America" to bring together sampling design experts, and scientific and technical experts from OSPESCA's GTEAM, to discuss how to address data deficiencies. • The current project, which is based on recommendations for the September 2017 workshop, was funded in 2018 under the *Sustainable Management of Tuna Fisheries and Biodiversity Conservation in the Areas Beyond National Jurisdiction* (GCP/GLO/365/GFF)
Relevance for management	Improving catch data collection will help to fill the current data gaps and thus lead to better management of shark fisheries in the EPO
Duration	12 months
Work plan and status	• Collect data to create a Google Earth map of all landing sites of artisanal shark fisheries in Central America, with associated levels of fishing activity. • Using this map to guide sampling of catches at select landing sites in Central America. • Compute an order of magnitude estimate of total shark catch for the artisanal fleet from sample data and map information. • Conduct a survey of industrial vessel unloading characteristics that can be used to develop catch sampling protocols. • Develop and test several sampling designs for shark catch size and sex composition of the industrial fleet.
External collaborators	
Deliverables	• Three quarterly reports • Final report describing technical findings

PROJECT C.4.a: Improving data collection for Central American shark fisheries
Updated: May 2019
Progress summary for the reporting period • Progress report pending

PROJECT D.2.a: Pilot study of electronic monitoring (EM) of the activities and catches of purse-seine vessels	
THEME: Data Collection **GOAL:** Investigate use of new technologies (pilot studies) **TARGET:** D.2 Electronic monitoring **EXECUTION**: Bycatch and IDCP Program	
Objectives	A proof-of-concept study to evaluate the types of data that can be reliably collected by electronic monitoring (EM) on Class 1-5 purse-seine vessels.
Background	• Fisheries management and assessments require complete catch and bycatch information. • Logbook data for Class 1-5 vessels provide basic catch information for target species, but no information on tuna discards and incomplete information on catches of non-target species. • EM systems may provide cost-effective and practical solutions.
Relevance for management	Better-quality and higher-resolution data on catches and discards of target and non-target species by unobserved purse-seine vessels would improve the staff's stock assessments and management advice
Duration	23 months
Work plan and status	• 2018: January-February: Identify EM capabilities from manufacturers. • March-May: Survey of infrastructure configuration and fishing operations of small vessels. Identify candidate vessels; purchase EM equipment. • June 2018-January 2019: collect EM and observer data on small purse-seine vessels. • 2019: February-April: process EM data. • May-August: Statistical comparisons of EM and observer data; write project report. • September-November: if proof-of-concept warranted, development of a sampling design for a pilot study using EM aboard small purse-seine vessels.
External collaborators	Collaboration of fishing industry, observers and technology companies is essential.
Deliverables	May 2018: Progress report to SAC-09 meeting.

PROJECT D.2.a: Pilot study of electronic monitoring (EM) of the activities and catches of purse-seine vessels
Updated: May 2019
Progress summary for the reporting period **2018**: • September: Meetings with Class 1-5 vessel owners to seek their participation. • November: Two Class-6 vessels offered to participate; reference to "Class 1-5" vessels deleted from project title, combined with project D.2.c • December: Memorandum of Understanding (MOU) with four vessels (2 Class 6, 1 Class 5, 1 Class 2). **2019**: • January: EM equipment purchased; installed on both Class-6 vessels. • February: EM equipment started collecting data for these two vessels. • April: EM equipment installed on the Class-2 vessel.
Challenges and key lessons learnt • Difficulties in finding Class 1-5 vessels willing to participate have hampered the study.
Reports/publications/presentations May 2018: • Progress report presented at SAC-09. • Presentation: *Electronic Monitoring (EM) of Purse-Seine Vessel Activities and Catches*, 69th Tuna Conference, May 2018 • Poster: *Electronic monitoring (EM) of small purse-seine vessels. Basic standards for monitoring fishing activities and catches.* 9th International Fisheries Observer and Monitoring Conference, June 2018 SAC-10-12 Electronic monitoring of purse-seine vessel activities and catches
Comments: For Class-6 vessels, the objective is to assess which activities of the on-board observers can be performed by EM (Project D.2.c, now combined with this project).

2. LIFE-HISTORY STUDIES FOR SCIENTIFIC SUPPORT OF MANAGEMENT

PROJECT E.1.a: Evaluate potential improvement of growth model for bigeye in the EPO based on presumed annuli counts from otoliths of large fish	
THEME: Life-history studies for scientific support of management **GOAL:** E. Life history, behavior, and stock structure of tropical tunas **TARGET:** E.1. Age and growth of tropical tunas **EXECUTION**: Biology and Ecosystem Program	
Objectives	Evaluate the potential improvement in accuracy of the growth model for bigeye in the EPO resulting from including more age-at-size data for large fish
Background	• Growth model for bigeye is based on validated counts of daily otolith increments, corroborated by extensive tagging data, but age-at-size data for larger fish (150-200 cm) are lacking • High-confidence tagging data for bigeye >150 cm are limited • The National Research Institute for Far Seas Fisheries (NRIFSF) of Japan's collections of otoliths from large bigeye captured in the EPO are now available for evaluating age estimates from counts of presumed annuli
Relevance for management	Improving the accuracy of the bigeye growth model, particularly for larger fish, would help resolve some of the uncertainty regarding the status of the stock, and improve the framework on which management advice is based
Duration	XX months; initiated November 2017
Work plan and status	• Fish Ageing Services (FAS) in Australia counted annuli on 140 pairs of bigeye otoliths from up to 20 fish within each 10 cm length interval between 110 and 200 cm and estimated the ages of the fish • FAS age estimates for 110-150 cm fish will be compared to published age-at-size data • Growth rates for 150-180 cm fish based on EPO tagging data will be compared with growth rates based on the FAS age estimates. • Age estimates from otoliths of 150-200 cm fish will be combined with the existing data set and used in an integrative growth model.
External collaborators	NRIFSF, Japan
Deliverables	• Presentation for SPC-OFP bigeye pre-assessment workshop, 2018 • Potential update of bigeye growth model for use in stock assessments

PROJECT E.1.a: Evaluate potential improvement of growth model for bigeye in the EPO based on presumed annuli counts from otoliths of large fish
Updated: May 2019
Progress summary for the reporting period • This progress report is pending the return of staff from fieldwork

PROJECT E.2.a: Investigate spatiotemporal variability in the age, growth, maturity, and fecundity of yellowfin tuna in the EPO	
THEME: Life-history studies for scientific support of management **GOAL:** E. Life history, behavior, and stock structure of tropical tunas **TARGET:** E.2. Reproductive biology of tropical tunas **EXECUTION**: Biology and Ecosystem Program	
Objectives	Estimate age, growth, maturity, and fecundity of yellowfin from four distinct areas of the eastern Pacific for use in spatially-structured stock assessment models
Background	• Current estimates of age, growth, maturity, and fecundity of yellowfin are based on otolith and ovarian tissue samples collected over 30 years ago. • During 2009-2016 observers collected otolith and ovarian tissues samples at sea throughout the EPO • Tagging and morphometrics data indicate there are multiple stocks of yellowfin in the EPO, probably with different life history characteristics • Heavily-exploited fish stocks often show trends towards earlier maturation
Relevance for management	Spatially-structured stock assessments based on geographically-explicit life history parameters will provide a more accurate basis for the staff's management advice
Duration	4 years; initiated in 2017
Work plan and status	• 2017-2019: Preparation and reading of otolith samples for age estimates • 2018-2019: Preparation and reading of ovarian tissues for fecundity estimates • 2019-2020: Analyses of age and growth and reproductive biology data, and preparation of manuscripts
External collaborators	
Deliverables	• Presentation for SAC-10 • Updated, geographically-explicit life-history parameters for use in spatially-structured stock assessments

PROJECT E.2.a: Investigate spatiotemporal variability in the age, growth, maturity, and fecundity of yellowfin tuna in the EPO
Updated: May 2019
Progress summary for the reporting period • This progress report is pending the return of staff from fieldwork

PROJECT E.2.b: Workshop to evaluate differences in bigeye tuna age estimation methods and resulting growth models utilized in current stock assessments by the IATTC and WCPFC	
THEME: Life history studies for scientific support of management **GOAL:** E. Obtain life history and stock structure information for spatially-structured stock assessments for tropical tunas **TARGET:** E.2. Conduct spatiotemporal research on the reproductive biology of tropical tunas **EXECUTION**: Biology and Ecosystem Program	
Objectives	Resolve concerns about differences in age estimation methods and resulting growth models used in bigeye tuna stock assessments by IATTC and WCPFC
Background	Although there are documented differences in the life history characteristics of the bigeye stocks from the EPO and WCPO, the magnitude of the discrepancies in the estimated length-at age data, growth models, and L_∞ estimates used in the recent IATTC and WCPFC stock assessments, along with the dramatic shift in stock status of WCPO bigeye population is concerning. The estimated L_∞ from the WCPO bigeye growth model is 157 cm, unrealistically low, and is highly influential in the assessment model and resulting stock status determination.
Relevance for management	Age and growth models and their estimates of L_∞ are highly influential in assessing the status of bigeye in integrated assessment models
Duration	2 days
Work plan and status	Workshop to be held in La Jolla, November 2018, or as soon as possible in 2019
External collaborators	SPC; CSIRO and FAS, Australia; FSFRL, Japan; PIFSC
Deliverables	A workshop report to be shared with all interested parties

E.3.a. Investigate geographic variation in the movements, behavior, and habitat utilization of yellowfin tuna in the EPO	
THEME: Life-history studies for scientific support of management **GOAL:** E. Life history, behavior, and stock structure of tropical tunas **TARGET:** E.3. Analyze historical tagging data to improve spatially-structured tropical tuna assessments **EXECUTION**: Biology and Ecosystem Program	
Objectives	Evaluate geographic variation in movements, behavior, and habitat utilization of yellowfin tuna via analyses of existing archival tag data sets from several discrete areas of the EPO
Background	• Yellowfin exhibit restricted movements; tagged fish are normally recovered within about 1000 nm of point of release • Future stock assessments of yellowfin should be spatially structured, because there are probably at least three stocks in the EPO • Understanding movements, dispersion, and mixing between stocks, as well as behavior and habitat utilization, is essential for understanding population dynamics, estimating exploitation rates within stocks, and preventing localized depletions
Relevance for management	Spatially-structured stock assessments based on geographically-explicit life history parameters will provide a more accurate basis for the staff's management advice
Duration	2020
Work plan and status	• Several existing archival tag data sets from discrete areas of the EPO will be analyzed and compared to describe geographic variation in movements, behavior, and habitat utilization • Historical conventional tag data sets for yellowfin from the EPO will also be included in the evaluations of movements and dispersion
External collaborators	
Deliverables	• Presentation for SAC-11 • Manuscript for publication in a scientific journal

PROJECT E.3.a: Investigate geographic variation in the movements, behavior, and habitat utilization of yellowfin tuna in the EPO
Updated: May 2019
Progress summary for the reporting period • This project starts in 2020

PROJECT E.4.a: Multi-year tuna tagging study	
THEME: Life-history studies for scientific support of management **GOAL:** E. Life history, behavior, and stock structure of tropical tunas **TARGET:** E.4. Initiate a multi-year tagging program for tropical tunas **EXECUTION**: Biology and Ecosystem Program	
Objectives	• Obtain data that will contribute to, and reduce uncertainty in, EPO tuna stock assessments, particularly for skipjack tuna; • Obtain information on the rates of movement, dispersion, and mixing of skipjack, yellowfin, and bigeye tunas in the EPO, and between this region and other adjacent regions of the Pacific basin; and • Obtain estimates of sex-specific growth, mortality, abundance, selectivity, and exploitation rates for those species of tuna in the EPO
	This project is described in detail in Appendix 2 of Document CAF-05-04, prepared for the meeting of the Committee on Administration and Finance in July 2017
Duration	3 years (2019-2021)

PROJECT E.4.a: Multi-year tuna tagging study
Updated: May 2019
Progress summary for the reporting period • This progress report is pending the return of staff from fieldwork

PROJECT E.5.a: Evaluate the Pacific-wide population structure of bigeye and skipjack tunas, using genetic analyses	
THEME: Life-history studies for scientific support of management **GOAL:** E. Life history, behavior, and stock structure of tropical tunas **TARGET:** E.5. Genetic studies on stock structure **EXECUTION**: Biology and Ecosystem Program	
Objectives	Determine whether bigeye and skipjack tuna from discrete areas of the Pacific Ocean show significant genetic heterogeneity
Background	• Genetic studies can be used to evaluate and validate the results of tagging experiments • Modern genetic analyses can be used to assess genetic heterogeneity between tropical tuna stocks • Data from tagging experiments and genetic studies can inform spatially-structured stock assessments
Relevance for management	Spatially-structured stock assessments based on geographically-explicit life history parameters will provide a more accurate basis for the staff's management advice
Duration	2 years (2017-2018)
Work plan and status	• 2017: Tissue samples from the Pacific and other oceans processed at CSIRO using genotyping and sequencing techniques • 2018: Analyses of genetic data at CSIRO with software specifically designed for uncovering and evaluating genetic heterogeneity in population structure • 2018: Manuscript in preparation on assessment of skipjack population structure from samples from Indian Ocean, western and eastern Pacific. • 2018: Manuscript in preparation on assessment of bigeye population structure from samples from western, central, and eastern Pacific
External collaborators	CSIRO, Hobart, Australia
Deliverables	• Relevant information on population structure of bigeye and skipjack tunas in the Pacific for informing future stock assessments • Manuscripts for publication in scientific journals

PROJECT E.5.a: Evaluate the Pacific-wide population structure of bigeye and skipjack tunas, using genetic analyses
Updated: May 2019
Progress summary for the reporting period • This progress report is pending the return of staff from fieldwork

PROJECT E.5.b: Investigate the spawning ecology of captive yellowfin tuna, using genetic analyses	
THEME: Life-history studies for scientific support of management **GOAL:** E. Life history, behavior, and stock structure of tropical tunas **TARGET:** E.5. Genetic studies on stock structure **EXECUTION**: Biology and Ecosystem Program	
Objectives	Assess the spawning ecology of captive yellowfin tuna at the Achotines Laboratory, by estimating the number of females that contribute to single spawning events, and their spawning periodicity and frequency
Background	• Determining spawning patterns and maternal lines of inheritance using genetic techniques contributes to understanding of the stock structure of tropical tunas • Captive spawning populations are useful for identifying genetic markers for female spawning patterns and matching parental markers to those found in progeny • During 2011-2014, spawning female yellowfin at the Achotines Laboratory were sampled to develop mitochondrial DNA markers, and these markers are being analyzed in the eggs and larvae to estimate spawning periodicity and frequency of females
Relevance for management	Better understanding of reproductive processes contributes to understanding of recruitment and population structure of yellowfin, essential for stock assessment
Duration	12 months (June 2018-June 2019)
Work plan and status	• June-December 2018: Complete laboratory analysis of genetic markers from spawning adults, eggs and larvae sampled in 2014 • January-June 2019: Preparation of final study results and submission of manuscript
External collaborators	Kindai University, Japan
Deliverables	• Presentations for SAC-09 and SAC-10 (May 2018 and 2019) • Publication of results in a scientific journal

PROJECT E.5.b: Investigate the spawning ecology of captive yellowfin tuna, using genetic analyses
Updated: May 2019
• **Progress summary for the reporting period**Laboratory analysis of genetic markers from spawning adults, eggs and larvae sampled in 2014 completed. • Analysis of DNA markers to estimate spawning periodicity and frequency of females during 2011-2013 completed; analysis of 2014 data is continuing. • Results for 2011-2013 presented at 69th Tuna Conference.
Challenges and key lessons learnt • The genetic analyses for this study are time-consuming and require specialized analytical equipment, available to the group only at Kindai University. This delayed completion of the analysis.
Reports/publications/presentations • Results of genetic analysis presented at SAC-09 and 69th Tuna Conference, May 2018 • SAC-10-18 Review of research at the Achotines Laboratory
Comments: The genetic study will be completed in 2019. An ancillary activity will be the preliminary testing of a kit designed to identify male sex markers from the skin mucus of fish.

PROJECT F.2.a: Investigate the movements, behavior, and habitat utilization of silky sharks in the EPO	
THEME: Life-history studies for scientific support of management **GOAL:** F. Life-history studies for species at risk **TARGET:** F.2. Life history of sharks **EXECUTION**: Biology and Ecosystem Program	
Objectives	Evaluate movements, behavior, and habitat utilization of silky sharks in the equatorial and tropical EPO from in-depth analyses of existing data obtained from archival tags
Background	• Understanding population structure and movements is essential for stock assessments, particularly for sharks • The information available about movements, behavior, and habitat utilization of silky sharks in the EPO is limited • Understanding behavior and habitat utilization is important for effective conservation measures and for ecological risk assessment analyses
Relevance for management	Improve management advice on silky sharks based on spatially-structured stock assessments; habitat utilization information is useful for mitigation and spatial management
Duration	12 months (2020)
Work plan and status	The archival tag data for silky sharks collected for previous projects will be analyzed in depth and compared for describing geographic variation in movements, behavior and habitat utilization in a manuscript to be submitted to a scientific journal
External collaborators	INAPESCA, Mexico
Deliverables	• Presentation for SAC-11, May 2020 • Manuscript for publication in a scientific journal

PROJECT F.2.a: Investigate the movements, behavior, and habitat utilization of silky sharks in the EPO
Updated: May 2019
Progress summary for the reporting period • This project starts in 2020

PROJECT G.1.a: Studies of pre-recruit survival and growth of yellowfin tuna, including expanding studies of early-juvenile life stages	
THEME: Life-history studies for scientific support of management **GOAL:** G. Investigate early life-history of tunas **TARGET:** G.1. Investigation of the factors affecting pre-recruit survival of yellowfin **EXECUTION**: Biology and Ecosystem Group	
Objectives	Investigate the effects of key biological and physical factors on the survival and growth of pre-recruit life stages of yellowfin, with a new emphasis on studies of early-juvenile life stages
Background	• Research on the early life history of yellowfin is designed to develop a more complete understanding of pre-recruit mortality and the influence of key environmental and biological factors on mortality • Ongoing research has examined the effects of physical (turbulence, light, water temperature, dissolved oxygen) and biological (food concentration) factors on growth and survival of larval stages of yellowfin • Recent rearing success now allows experimental studies of the growth and survival dynamics of early-juvenile yellowfin (1-6 months of age), a life stage rarely studied worldwide
Relevance for management	The ability to estimate the effects of key biological and physical factors on survival and growth of pre-recruit (0-6 months) life stages of yellowfin provides potentially key information on recruitment processes in yellowfin
Duration	3 years
Work plan and status	January 2018-December 2020: Continued experimental studies of pre-recruit life stages at the Achotines Laboratory and University of Miami, with a focus on early-juvenile life stages
External collaborators	University of Miami
Deliverables	• Presentations for SAC-09, SAC-10 and SAC-11 • Publication of results in one or more scientific journals

PROJECT G.1.a: Studies of pre-recruit survival and growth of yellowfin tuna, including expanding studies of early-juvenile life stages
Updated: May 2019
Progress summary for the reporting period • Analysis of survival and growth patterns of larval and early-juvenile yellowfin continued through 2018 and into 2019. • Current analyses focus on the early-juvenile (1-6 months) stages of yellowfin, which have been reared in land-based tanks and a sea cage since 2015. A retrospective analysis of early-juvenile growth patterns in captivity over the past 18 years is ongoing.
Challenges and key lessons learnt -
Reports/publications/presentations Presentations: • SAC-09 (May 2018) • 69th Tuna Conference (May 2018) • 42nd Larval Fish Conference (May 2018). Two publications on this topic are being developed SAC-10-18 Review of research at the Achotines Laboratory
Comments: -

PROJECT G.2.a: Develop comparative models of pre-recruit survival and reproductive patterns of Pacific tunas	
THEME: Life-history studies for scientific support of management **GOAL:** G. Investigate early life-history of tunas **TARGET:** G.2. Comparative studies of early life histories of yellowfin and Pacific bluefin **EXECUTION**: Biology and Ecosystem Group	
Objectives	Investigate important comparative aspects of the reproductive biology, genetics and early life histories of yellowfin and Pacific bluefin tuna
Background	• Pre-recruit life stages of tunas are potentially key to understanding variations in abundance and reproductive patterns of tuna populations • Ongoing since 2011, this project has investigated the comparative growth, nutrition and survival of larval yellowfin and Pacific bluefin tuna • Experimental results are being used to comparatively model mortality processes occurring during the pre-recruit life stages of both species
Relevance for management	Comparative models of pre-recruit mortality processes are promising for assessing recruitment patterns of both species
Duration	18 months
Work plan and status	• June 2018-June 2019: Complete experimental studies of comparative larval growth and finalize data analyses • June-December 2019: Complete manuscript and submit to scientific journal
External collaborators	Kindai University, Fisheries Laboratory
Deliverables	• Presentations for SAC-09 and SAC-10 • Publication of results in a scientific journal

PROJECT G.2.a: Develop comparative models of pre-recruit survival and reproductive patterns of Pacific tunas
Updated: May 2019
Progress summary for the reporting period • Comparative experimental studies of pre-recruit life stages of yellowfin and Pacific bluefin continued during 2018 and 2019. Experimental investigations of the growth and feeding patterns of Pacific bluefin larvae were carried out at the Aquaculture Institute of Kindai University in July 2018, and further experiments are scheduled for July 2019. • A comparative analysis of the larval traits (survival, growth, starvation rates) of yellowfin and Pacific bluefin is being developed to gain insights into differences in spawning patterns and nursery habitats of the two species in the Pacific Ocean. • Experimental results are being incorporated into models of the pre-recruit mortality processes for both species.
Challenges and key lessons learnt -
Reports/publications/presentations Presentations: • SAC-09 (May 2018) • 69th Tuna Conference (May 2018) • 42nd Larval Fish Conference (May 2018). • World Aquaculture Conference (March 2019) SAC-10-18 Review of research at the Achotines Laboratory Two publications on this topic are being developed
Comments: -

PROJECT G.3.a: Develop a larval growth index to forecast yellowfin recruitment	
THEME: Life-history studies for scientific support of management **GOAL:** G. Investigate early life-history of tunas **TARGET:** G.3. Tools to forecast recruitment **EXECUTION**: Biology and Ecosystem Group	
Objectives	To develop a larval or early-juvenile growth index for yellowfin tuna in the Panama Bight which might prove useful as an index of recruitment strength of yellowfin in the EPO
Background	• Growth rate variability in the larval and juvenile stages of pelagic marine fishes is substantial, and has strong potential to influence mortality patterns during pre-recruit life stages • Previous research by the Early Life History group has identified some local correspondence in the Panama Bight between high growth rates/density-dependence in growth of yellowfin larvae and recruitment estimates for yellowfin • Quarterly or seasonal nightlight surveys of early-juveniles in the Panama Bight are recommended at the Achotines Laboratory, with aging analysis conducted for growth rate estimation and comparison to quarterly recruitment estimates for yellowfin
Relevance for management	The development of a larval or early-juvenile growth index is promising as a forecasting tool for assessing yellowfin recruitment patterns
Duration	2.5 years
Work plan and status	• June 2018-December 2020: Conduct quarterly or seasonal nightlight surveys of yellowfin at the Achotines Laboratory • January 2019-June 2020: Conduct otolith aging analysis on field-caught fish • Analyze and compare growth data and recruitment estimates for yellowfin, and complete manuscript and submit to scientific journal
External collaborators	
Deliverables	• Presentations for SAC-09, SAC-10 and SAC-11 • Publication of results in a scientific journal

PROJECT G.3.a: Develop a larval growth index to forecast yellowfin recruitment
Updated: May 2019
Progress summary for the reporting period • Analysis of *in situ* growth of yellowfin larvae and early-juveniles in relation to ocean temperature, availability of forage, larval density and availability of potential predators in nursery grounds in the Panama Bight, determined from past at-sea surveys at the Achotines Laboratory, is continuing during 2019.
Challenges and key lessons learnt • Funding has not yet been secured for the at-sea surveys and subsequent analyses necessary for the development of the growth index
Reports/publications/presentations Presentations: • SAC-09 (May 2018) • 42nd Larval Fish Conference (May 2018) SAC-10-18 Review of research at the Achotines Laboratory
Comments: -

3. SUSTAINABLE FISHERIES

PROJECT H.1.a: Improve the bigeye tuna stock assessment	
THEME: Sustainable fisheries **GOAL:** H. Research and development of stock assessment models and their assumptions **TARGET:** H.1. Improve routine tropical tuna assessments **EXECUTION**: Stock Assessment Program	
Objectives	Improve the bigeye tuna stock assessment
Background	• The assessment of bigeye is conducted every year, using Stock Synthesis • The apparent regime shift in recruitment when the floating-object fishery expanded in the 1990s indicates that the assessment model is misspecified • Management quantities are highly sensitive to the longline CPUE data • The current assessment is no longer considered reliable for management advice and stock status indicators are used • Recent advances in stock assessment modelling allow several important improvements of the assessment model, with regard to a spatial stock assessment model, growth curves, time-varying selectivity, recruitment assumptions, data weighting, and diagnostics • A benchmark assessment is scheduled for 2020
Relevance for management	• The stock assessment is used to provide management advice • The duration of recommended seasonal closures is based on the multipliers of fishing effort (*F*) estimated in the bigeye and yellowfin assessments • Improvements in the bigeye assessment will make the staff's management advice more accurate and precise
Duration	2018-2020
Work plan and status	• 2018: Create a spatial model, integrate the new growth curve into the assessment, and implement time-varying selectivity • 2019: Explore different recruitment assumptions, apply data weighting, conduct diagnostic tests • 2019: Conduct a workshop to finalize the improvements to the longline CPUE and length composition data (see unfunded proposal) • 2020: Re-evaluate the model assumptions
External collaborators	Work conducted under the MSE project will contribute to this project
Deliverables	Reports for SAC-10 and SAC-11 in 2019 and 2020

PROJECT H.1.a: Improve the bigeye tuna stock assessment
Updated: May 2019
Progress summary for the reporting period • Identified stock and spatial structure • Developed spatial stock assessment model • February 2018: CAPAM workshop on the development of spatio-temporal models of fishery CPUE data to derive indices of relative abundance. • October 2018: CAPAM workshop on the development of spatial stock assessment models. • January 2019: workshop to evaluate bigeye and yellowfin tuna ageing methodologies and growth models in the Pacific Ocean. • February 2019: workshop to improve the longline indices of abundance of bigeye and yellowfin tunas in the EPO. • Analyses for the external review, including exploring different recruitment assumptions, applying data weighting, and conducting diagnostic tests • March 2019: External review of IATTC staff's stock assessment of bigeye tuna in the EPO.
Challenges and key lessons learnt • The operational level longline data essential for improving the assessment are not permanently available to the staff • An additional workshop to finalize the work on improving the longline CPUE and length-composition data is needed (Project H.1.e), but not currently funded.
Reports/publications/presentations See links above for workshop reports and presentations
Comments: -

PROJECT H.1.b: Improve the yellowfin tuna stock assessment	
THEME: Sustainable fisheries **GOAL:** H. Research and development of stock assessment models and their assumptions **TARGET:** H.1. Improve routine tropical tuna assessments **EXECUTION**: Stock Assessment Program	
Objectives	Improve the yellowfin tuna stock assessment by exploring the use of an age-structured length-based catch-at-age statistical model with a monthly time step
Background	• The assessment of yellowfin tuna is conducted every year, using Stock Synthesis • There are inconsistencies between the indices based on CPUE for longline and purse-seine sets on dolphins • Management quantities are sensitive to the longline CPUE data • The current assessment is no longer considered reliable for management advice and stock status indicators are used instead • Recent advances in stock assessment modelling allow several important improvements of the assessment model, with regard to a spatial stock assessment model, growth curves, time-varying selectivity, recruitment assumptions, data weighting, and diagnostics • A benchmark assessment is scheduled for 2020
Relevance for management	• The stock assessment is used to provide management advice • The duration of recommended seasonal closures is based on the multipliers of fishing effort (*F*) estimated in the bigeye and yellowfin assessments • Improvements in the yellowfin assessment will make the staff's management advice more accurate and precise
Duration	2018-2020
Work plan and status	• 2019: Explore different hypotheses to explain the difference between the indices of abundance, improve estimates of growth, re-evaluate the natural mortality assumptions, apply data weighting, conduct diagnostic tests • 2019: Workshop to finalize improvements to the longline CPUE and length-composition data (Project H.1.e) • 2020: Re-evaluate the model assumptions
External collaborators	
Deliverables	• Report(s) to SAC in 2019 • Report to SAC in 2020

PROJECT H.1.b: Improve the yellowfin tuna stock assessment
Updated: May 2019

Progress summary for the reporting period
• Most of the research and analyses to improve the bigeye stock assessment (Project H.1.a) is also applicable to yellowfin.
• Several workshops were conducted that highlighted other areas where the stock assessment of yellowfin could be improved
  • February 2018: CAPAM workshop on the development of spatio-temporal models of fishery catch-per-unit-effort data to derive indices of relative abundance.
  • October 2018: CAPAM workshop on the development of spatial stock assessment models.
  • January 2019: workshop to evaluate bigeye and yellowfin tuna ageing methodologies and growth models in the Pacific Ocean.
  • February 2019: workshop to improve the longline indices of abundance of bigeye and yellowfin tunas in the EPO.

Challenges and key lessons learnt • Management quantities are sensitive to the longline index, and the research had to be refocused to address several issues identified with the assessment • Lessons learnt from work on the bigeye assessment are applicable to yellowfin • The operational level longline data essential for improving the assessment are not permanently available to the staff • An additional workshop to finalize the work on improving the longline CPUE and length-composition data is needed (Project H.1.e), but not currently funded.
Reports/publications/presentations • See links above for workshop reports and presentations • SAC-10 INF-F Evaluating inconsistencies in the yellowfin abundance indices • Xu *et al*., *Fisheries Research* 213
Comments: The workplan for improving the bigeye assessment was changed to include yellowfin

PROJECT H.1.c: Investigate potential changes in the selectivity of the longline fleet resulting from changes in gear configuration	
THEME: Sustainable fisheries **GOAL:** H. Research and development of stock assessment models and their assumptions **TARGET:** H.1. Improve routine tropical tuna assessments **EXECUTION**: Stock Assessment Program	
Objectives	Evaluate potential changes in targeting on the size composition of the longline catches of bigeye and yellowfin
Background	• The current yellowfin stock assessment shows a pattern of residuals for the recent longline length-composition data • Analyses of operational-level longline data from the Japanese fleet have identified possible changes in targeting that may affect the indices of relative abundance and size composition of the catch • The changes in targeting appear to be related to changes in longline gear configuration. • The effect on catch rates and species composition is being investigated in related collaborative research between the IATTC staff and NRIFSF, Japan
Relevance for management	Currently, the longline indices are the main information in the stock assessments of yellowfin and bigeye, therefore unaccounted-for changes in the longline selectivity may compromise management advice
Duration	12 months
Work plan and status	• Month 1: match set-by-set gear characteristics and catch data with the size-composition data from the Japanese fleet • Months 2-3: analysis of the set-by-set data • Months 5-11: Apply the lessons learnt from the set-by-set data to the aggregated level data used in the stock assessment
External collaborators	NRIFSF, Japan
Deliverables	• Presentation for SAC-10, 2019 • Procedure to be used in the next full assessment of yellowfin

PROJECT H.1.c: Investigate potential changes in the selectivity of the longline fleet resulting from changes in gear configuration
Updated: May 2019
Progress summary for the reporting period • This project was not funded, but advances were made in the context of Project H.1.d
Challenges and key lessons learnt • Matching the length-frequency and operational data has proved difficult, and is not yet completed
Reports/publications/presentations • SAC-10 INF-F • Materials for the workshop held under Project H.1.d
Comments: The work related to this project will be continued In Project H.1.e, pending funding

PROJECT H.1.d: Improve indices of abundance based on longline CPUE data	
THEME: Sustainable fisheries **GOAL:** H. Research and development of stock assessment models and their assumptions **TARGET:** H.1. Improve routine tropical tuna assessments **EXECUTION**: Stock Assessment Program	
Objectives	• Improve the yellowfin and bigeye indices of relative abundance from longline data • Determine methods to identify targeting in longline fisheries • Develop spatio-temporal models for creating indices of relative abundance from longline data • Develop appropriate longline length composition data for the index of abundance and for the catch
Background	• Indices of relative abundance derived for longline CPUE data are the most important piece of information in the bigeye and yellowfin stock assessments • Only the Japanese data are currently used to create these indices • The characteristics, tactics, and spatial distribution of the fishery have been changing over time • The same length composition data is used for the index and for the catch, but these could differ • New methods, such as spatio-temporal modelling, have been developed and should be used in the creation of the indices
Relevance for management	The indices have direct impact on the stock assessment and any improvements in the indices will directly improve the management advice for bigeye and yellowfin
Duration	18 months, starting June 2018
Work plan and status	• June-Dec 2018: Evaluate the data available in the IATTC database and implement the spatio-temporal models • Jan-Feb 2019: Hold a one-week workshop to discuss approaches to resolve issues in using the longline CPUE data • May-June 2019: Hold a two-week working group to analyze the data
External collaborators	• NRIFSF, Japan • Invited speakers
Deliverables	• Workshop report • Working group report • Indices of relative abundance • Project report to SAC

PROJECT H.1.d: Improve indices of abundance based on longline CPUE data
Updated: May 2019

Progress summary for the reporting period
• The proposed meeting in May-June 2019 was not funded.
• Preparations for the workshop included:
  • Provision of operational-level longline data for main distant-water longline fleets
  • Visits by Japanese and Korean scientists to work with the staff on analyses:
  • Visit by external expert (supported by ISSF).
• 23 participants, including 7 invited speakers, attended the workshop in February 2019

Challenges and key lessons learnt • The operational data essential for improving the assessment are not permanently available to the staff. • Matching size-composition and operational data proved difficult, and is not yet completed • The additional workshop needed to finalize the work (Project H.1.e) is not currently funded.
Reports/publications/presentations • Materials for the workshop • Presentation at SAC-10
Comments: The work related to this project will be continued In Project H.1.e, pending funding

PROJECT H.1.e: Construct indices of abundance and composition data for longline fleets	
THEME: Sustainable fisheries **GOAL:** H. Research and development of stock assessment models and their assumptions **TARGET:** H.1. Improve routine tropical tuna assessments **EXECUTION**: Stock Assessment Program	
Objectives	• Construct indices of relative abundance from longline data for the yellowfin and bigeye, ideally using spatiotemporal models by length class
Background	• Indices of relative abundance derived for longline CPUE data are the most important piece of information in the bigeye and yellowfin stock assessments • Only the Japanese data are currently used to create these indices • A workshop was held in February 2019 to understand the data from other CPCs that could be used to improve the indices of abundance (WSLL-01) • Preliminary results on constructing indices on combined data were obtained during the workshop • The work needs to be advanced so indices are obtained to be used in the benchmark assessments of bigeye and yellowfin tuna
Relevance for management	The indices have direct impact on the stock assessment and any improvements in the indices will directly improve the management advice for bigeye and yellowfin
Duration	18 months, starting June 2019
Work plan and status	• Jun- Sept 2019: Preparatory work depending on the availability of operational level data • October-December 2019: Collaborative work and workshop • January- May 2019: Preparation of documents
External collaborators	• Scientists from Japan, Korea, Chinese Taipei, China • Invited researchers
Deliverables	• Indices of relative abundance • SAC documents

PROJECT H.4.a: Conduct routine stock assessments of tropical tunas	
THEME: Sustainable fisheries **GOAL:** H. Undertake stock assessments **TARGET:** H.4. IATTC tropical tuna assessments **EXECUTION**: Stock Assessment Program	
Objectives	Update the assessments of bigeye, yellowfin, and skipjack tunas
Background	• Assessments of bigeye, yellowfin, and skipjack are conducted every year • Bigeye and yellowfin assessments use the Stock Synthesis modeling platform • Skipjack assessment is based on stock status indicators • Assessments are updated annually, using the most recent data • Major improvements to the assessments (methods and assumptions) are implemented periodically
Relevance for management	• The staff's management advice for tunas is based on its stock assessments • The duration of the seasonal closures recommended by the staff for bigeye and yellowfin are based on the *F* multipliers estimated in the assessments
Duration	Every year (March-May)
Work plan and status	• 15 March: data for previous year available; assessments initiated • Three weeks before SAC meeting: Assessment reports posted on IATTC website • Mid-May: Present assessments at SAC meeting
External collaborators	
Deliverables	Stock assessment reports for the SAC and the IATTC; presentations at SAC and IATTC meetings

PROJECT H.4.a: Conduct routine stock assessments of tropical tunas
Updated: May 2019
Progress summary for the reporting period • Indicators constructed for bigeye • Update assessment conducted for yellowfin • Indicators constructed for yellowfin • Indicators constructed for skipjack
Challenges and key lessons learnt • The results of the bigeye assessment in 2018 were considered unreliable, and the assessment is being improved for the 2020 full assessment (Project H.1.a). • The model used for the assessment of yellowfin is unable to reconcile data that apparently carry contradictory signals about the status of the stock. A work plan for improving several aspects of the model, additional to Project H.1.b., was drafted.
Reports/publications/presentations SAC-10-06 Bigeye tuna: indicators of stock status SAC-10-07 Yellowfin tuna: update stock assessment SAC-10-08 Yellowfin tuna: indicators of stock status SAC-10-09 Skipjack tuna: indicators of stock status
Comments: -

PROJECT H.5.a: Revise trend estimation methods for purse-seine silky shark indices for the EPO	
THEME: Sustainable fisheries **GOAL:** H. Research and development of stock assessment models and their assumptions **TARGET:** H.5. Improve stock assessments for data-limited species **EXECUTION**: Stock Assessment Program	
Objectives	Develop new methods to estimate trends in relative abundance of silky sharks from purse-seine observer data that are less influenced by inter-annual variability in oceanographic conditions.
Background	• Fluctuations in the index of relative abundance for juvenile silky sharks correlate with inter-annual variability in oceanographic conditions in the offshore area of the northern EPO. • Recent fluctuations in the index are not biologically realistic, compromising the reliability of the index as a stock status indicator. • The index based on purse-seine observer data is the only index available for management because of data deficiencies in other fisheries. • New methods are necessary to estimate more reliable trends in relative abundance for the silky shark using purse-seine observer data.
Relevance for management	Improving the reliability of the purse-seine index will improve management advice for the silky shark in the EPO.
Duration	9 months
Work plan and status	• Months 1-6: develop new methods for catch-per-set standardization. • Months 7-9: apply new methods to estimate a revised index.
External collaborators	
Deliverables	Presentation for SAC-10, May 2019

PROJECT H.5.a: Revise trend estimation methods for purse-seine silky shark indices for the EPO
Updated: May 2019
Progress summary for the reporting period • Pacific-wide analysis of environmental effects on silky shark indices finalized. • Current options for revising the silky shark indices evaluated.
Challenges and key lessons learnt • A recent Pacific-wide silky shark assessment was unable to fit to EPO and western Pacific indices simultaneously, even though movement was considered, which may indicate a lack of movement or assessment model mis-specification; tagging data were not available to be included in the assessment model. • Absent better information on specific environmental processes affecting silky shark distribution and movement, current options for revising the indices are problematic and may lead to additional bias. • A Pacific-wide tagging project, in collaboration with EPO coastal nations and the WCPFC, would produce invaluable information on movement and stock structure with which to improve indices.
Reports/publications/presentations • SAC-10-17 Purse-seine indicators for silky sharks in the EPO • Lennert-Cody, *et al*. *Fisheries Oceanography* 28. • Clarke, S.C., *et al.*, WCPFC Scientific Committee, August 2018. • Invited presentation, Institute of Statistical Mathematics, Tokyo, Japan, March 2019.
Comments:

PROJECT H.6.a: Participate in assessments of shared species by the International Scientific Committee (ISC)	
THEME: Sustainable fisheries **GOAL:** H. Undertake stock assessments **TARGET:** H.6. ISC stock assessments **EXECUTION**: Stock Assessment Program	
Objectives	• Staff participation in development and improvement of assessments for North Pacific-wide species of interest to the IATTC, especially Pacific bluefin and albacore tunas, but also billfishes and sharks • Understand the assessment results, and communicate them to the Commission
Background	• The ISC and its various working groups assess stocks in the north Pacific that are covered by both the IATTC and WCPFC • The IATTC staff provides data and advice for the assessments • Assessments are periodic, and the stocks assessed differ each year.
Relevance for management	The IATTC uses the results of the ISC assessments to provide management advice
Duration	Ongoing; ISC meets annually, usually in July
Workplan and status	2018 ISC schedule: April: Working groups on sharks, billfishes May: Working groups on albacore, MSE July: Plenary; also working groups on albacore, Pacific bluefin, billfishes, sharks, statistics
External collaborators	ISC
Deliverables	Report to SAC meetings

PROJECT H.6.a: Participate in assessments of shared species by the International Scientific Committee (ISC)
Updated: May 2019
Progress summary for the reporting period • May 2018: Attended the Albacore working group workshop • January 2019: data preparation for benchmark stock assessment for Swordfish in the western and central north Pacific Ocean • March 2019: Attended the Pacific bluefin working group workshop Several improvements to the Pacific bluefin tuna assessment were identified and will be implemented for the full assessment in 2020
Challenges and key lessons learnt **-**
Reports/publications/presentations See working group reports on the ISC website
Comments: -

PROJECT H.7.b: South Pacific swordfish assessment	
THEME: Sustainable fisheries **GOAL:** H. Undertake stock assessments **TARGET:** H.7. Other assessments **EXECUTION**: Stock Assessment Program	
Objectives	Conduct an assessment for South Pacific swordfish
Background	• The South Pacific swordfish stock has not been assessed since 2011. • The longline fishery has recently increased targeting of swordfish • An updated assessment is needed to provide management advice
Relevance for management	The stock assessment is needed to provide management advice
Duration	2019-2021
Workplan and status	• Obtain data • Conduct assessment • Report to SAC-11 in 2021
External collaborators	
Deliverables	Report to SAC-11 in 2021

PROJECT H.7.b: South Pacific swordfish assessment
Updated: May 2019
Progress summary for the reporting period • Progress on this project to date is incidental to research on other topics (CAPAM workshop on spatio-temporal models; workshop on longline indices of abundance); the majority of the work will be conducted in 2020-2021 • The staff gained considerable experience in analyzing operational data, and developed methods and code. • Exploratory work for the workshop in February 2019 included analyses that used the data for swordfish.
Challenges and key lessons learnt • Access to operational longline data is essential for conducting the assessment • Collaboration with CPCs will be needed to complete the assessment • Funding is needed for a workshop in 2020
Reports/publications/presentations See links above for workshop reports and presentations
Comments: -

PROJECT H.8.a: Design a survey for dolphins in the eastern tropical Pacific Ocean (ETP)	
THEME: Sustainable Fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.8. Assess status of dolphin stocks in the eastern tropical Pacific **EXECUTION**: Stock Assessment Program	
Objectives	Design, in consultation with the IATTC staff and other relevant scientists, a ship-based line-transect survey for ETP dolphin species, including development of a comprehensive budget for implementation of the survey and analysis of survey results.
Background	• Population dynamics modelling has been the preferred approach for evaluating the stock status of ETP dolphins, and those models have relied on estimates of abundance from fishery-independent surveys that were conducted by the National Marine Fisheries Service (NMFS). • As a result of a hiatus in the NMFS surveys since 2006, there are currently no reliable indicators with which to monitor the status of ETP dolphin populations. • This lack of information poses obvious problems for management. For example, the Antigua Convention of the Inter-American Tropical Tuna Commission (IATTC) requires that the status of all species potentially impacted by the tuna fisheries in the eastern Pacific Ocean be monitored. • In addition, abundance estimates are needed to ensure that incidental dolphin mortalities are both sustainable and insignificant because the stock mortality limits are based on estimates of abundance. • These needs provide impetus for a new ship-based line-transect survey to obtain new estimates of absolute abundance so that population trends can be updated.
Relevance for management	Improve the management of dolphin stocks in the ETP.
Duration	8 months
Work plan and status	• January - May: draft a report with survey design and budget. • June-August: obtain an external review of draft the draft report and revise as necessary.
External collaborators	University of St Andrews, Scotland
Deliverables	• Presentation for SAC9 (May 2018) • Report and presentation for IATTC Annual Meeting in August 2018

PROJECT H.8.a: Design a survey for dolphins in the eastern tropical Pacific Ocean (ETP)
Updated: May 2019
Progress summary for the reporting period • Multiple survey design options were developed, and presented at SAC-09 in May 2018, and at the IATTC and AIDCP meetings in August 2018.
Challenges and key lessons learnt
Reports/publications/presentations • MOP-37-02 Design of a survey for eastern tropical Pacific dolphin stocks • Presentation at SAC-09 • Presentation at MOP-37 • Presentation at IATTC-93
Comments:

PROJECT I.1.a: Conduct a Management Strategy Evaluation (MSE) for tropical tunas in the EPO	
THEME: Sustainable fisheries **GOAL:** I. Test harvest strategies using management strategy evaluation (MSE) **TARGET:** I.1. MSE for tropical tunas in the EPO **EXECUTION**: Stock Assessment Program	
Objectives	Test the current harvest control rule (HCR) with respect to the adopted limit (LRP) and target (TRP) reference points for bigeye tuna and alternatives under different sources of uncertainty
Background	• Preliminary testing of informal HCR was performed for bigeye, but neither recently-adopted HCR nor alternative management measures associated with stock status relative to the adopted or alternative TRP and LRP have been evaluated yet. • In-depth analyses of the adopted TRP, LRP and HCRs and alternatives needed to guide the Commission in adopting a permanent HCR and its components.
Relevance for management	• Project results expected to inform the Commission about the appropriateness of the current TRPs, LRPs and HCR compared to alternatives, and to help guide the adoption of a permanent HCR and its components. • The tools developed will useful for future MSE research that could include yellowfin and an evaluation of yellowfin and BET combined, to better simulate the current HCR.
Duration	12 months, starting January 2018
Work plan and status	• Month 1. Convert bigeye model to the latest Stock Synthesis (SS) version (3.3), to take advantage of major updates allowing better modelling of population processes. • Months 1 to 3. Further develop IATTC staff work on a spatially-structured model for consideration as bigeye operating model. • Months 2 to 5. Resolve bigeye model misspecifications before using it as an operating model. Resolve recruitment shift likely due to the expansion of the FAD fishery. This might be corrected using a spatial model. • Months 3 to 6. Explore a systematic way to evaluate the parameter and model structure uncertainty by putting probabilities on alternative models conditioned to data. • Months 6 to 12. Test alternative harvest strategies, actions at LRP and TRP. Use simplified or full assessment model, depending on re-evaluation of performance after fixing bigeye model.
External collaborators	Work to be carried out by external contractor
Deliverables	The project will produce an evaluation of candidate reference points and harvest control rules, expanding on the existing Stock Synthesis simulation model for bigeye, and reports, to be presented to SAC 09/10.

PROJECT I.1.a: Conduct a Management Strategy Evaluation (MSE) for tropical tunas in the EPO

Updated: May 2019

Progress summary for the reporting period

- The bigeye model was converted to the latest Stock Synthesis (SS) version (3.3), allowing for better modelling of population processes. A comparison between versions was successfully conducted.
- Alternative explicit spatially-structured models with different spatial structures were developed for the EPO and for the combined central and eastern Pacific Oceans (CEPO). In addition, several fleet-as-areas models were developed, treating spatial structure and dynamics implicitly using different spatial structure assumptions.
- Several alternative models were implemented to resolve model misspecifications and reduce/remove the recruitment shift.
- Alternative ways to incorporate uncertainty in parameters and model structure during the MSE modeling phase were discussed.

Challenges and key lessons learnt

Issues with the bigeye assessment model (the basis of MSE components such as its operating and estimation models) resulted in changes in the work plan for this project. Alternative models had to be developed to remove the misspecifications in the bigeye assessment.

Reports/publications/presentations (selected)

Presentations:

- January 2018: MSE Communications Workshop
- February 2018: Shark-Tuna Stock Synthesis Workshop
- June 2018: Tuna RFMO MSE WG meeting
- August 2018: MSE workshop for EPO Latin American countries
- October 2018: CAPAM workshop on the development of spatial stock assessment models
- March 2019: Independent review of bigeye assessment

Publications:

- SAC-09-08 Exploratory spatially-structured assessment model for bigeye tuna
- WSBET-02-02 Stock structure for bigeye tuna in the eastern Pacific Ocean
- WSBET-02-05 Growth used in the eastern Pacific Ocean bigeye tuna assessment
- WSBET-02-07 Natural mortality used in the eastern Pacific Ocean bigeye tuna assessment
- Valero, J. L. 2019. Conversion of BET 2017 base case assessment from Stock Synthesis version 3.23b to 3.3. 2nd Bigeye Assessment Review. La Jolla, California (USA), 11-15 March 2019.
- Valero, J. L., Maunder, M., Xu, H., Minte-Vera, C. V., Lennert-Cody, C., Aires-da-Silva, A. 2019. Investigating potential causes of misspecification-induced regime shift in recruitment in the EPO bigeye tuna (*Thunnus obesus*) assessment. 2nd Bigeye Assessment Review. La Jolla, California (USA), 11-15 March 2019.
- Valero, J. L., Maunder, M., Xu, H., Minte-Vera, C. V., Lennert-Cody, C., Aires-da-Silva, A. 2019. Spatial stock assessment model options for bigeye tuna (*Thunnus obesus*) in the EPO and beyond. 2nd Bigeye Assessment Review. La Jolla, California (USA), 11-15 March 2019.

Comments:

PROJECT I.3.a: Evaluate potential reference points for dorado in the EPO	
THEME: Sustainable fisheries **GOAL:** I. Test harvest strategies using management strategy evaluation (MSE) **TARGET:** I.3. Evaluation of harvest strategies for data-limited species based on stock status indicators **EXECUTION**: Stock Assessment Program	
Objectives	• Build upon the previous collaborative work and continue to develop dorado stock assessment methodologies • Expand the MSE for dorado by evaluating alternative reference points and harvest control rules.
Background	• Some Members of the IATTC are interested in obtaining MSC certification for their dorado fisheries, and have requested guidance in developing of reference points (RPs) and harvest control rules (HCRs). • Other Members are seeking guidance regarding data collection, research efforts, and management options
Relevance for management	The results of the project, such as alternative estimates of stock status (*e.g.* assessments, depletion estimator), reference points, and harvest control rules, could be used by the Commission, or by individual Members, in developing, adopting, and subsequently modifying as necessary, a harvest strategy for dorado.
Duration	6 months, starting January 2019
Work plan and status	• Alternative RPs and HCRs will be evaluated, and their respective advantages and disadvantages will be discussed, to assist Members considering the implementation of reference points and harvest control rules for dorado. • The performance of alternative assessment methods, HCRs and RPs will be evaluated by simulation methods, using Stock Synthesis. Candidates for the different components of a management strategy (data, assessment method, HCR, RPs) and the performance measures to judge such strategies will be identified. • Options will include minimum size limits, precautionary lower CPUE levels that would trigger management actions. Alternative RPs will be developed with yield-per-recruit considerations, as well as alternative expected reductions of recruitment without fishing (R_0) and unfished biomass (B_0).
External collaborators	Work to be carried out by external contractor
Deliverables	• List of candidate RPs and HCRs to be tested using a management strategy evaluation (MSE) framework; • Simulation study to evaluate candidate HCRs and RPs; • Written report summarizing the results; and presentation at SAC-10.

PROJECT I.3.a: Evaluate potential reference points for dorado in the EPO
Updated: May 2019
Progress summary for the reporting period • A review of potential reference points (RPs) and harvest control rules (HCRs) for dorado in the South EPO was conducted, using updated catch, CPUE, and size-composition data.
Challenges and key lessons learnt • This simulation study was delayed to accommodate work required for the bigeye assessment review in March 2019. • The lack of stock assessments for dorado in the South EPO be problematic, since determining RPs and HCRs depends on assessment estimates. • Obtaining complete and timely data is critical, given the dynamics of dorado and of the fishery, but this is not always easy.
Reports/publications/presentations SAC-10-11 Potential reference points and harvest control rules for dorado in the EPO
Comments: -

PROJECT J.2.a: Quantify the relationship between vessel operational characteristics and fishing mortality	
THEME: Sustainable fisheries **GOAL:** J. Relationship between purse-seine fishing strategies and fishing mortality **TARGET:** J.2. Relationship between vessel operational characteristics and fishing mortality **EXECUTION**: Stock Assessment Program	
Objectives	• Evaluate the reliability of the data obtained on identification of FADs. • Investigate methods to determine purse-seine set type from various sources of data (i.e. Observers, vessel logbooks, canneries, etc.). • Evaluate the relationship between catch and number of FAD deployments. • Investigate more precise measures of fishing capacity that take into consideration days fished, set type, and vessel characteristics. • Investigate the relationship between fishing mortality and fleet capacity. • Evaluate alternative management measures such as closed areas, individual vessel limits, and gear restrictions.
Background	• The constantly increasing capacity of the purse-seine fleet in the EPO requires more stringent management measures. • Several management measures have been investigated as an alternative to increasing the seasonal closure. • However, the measure of fishing capacity used to determine the days of closure is somewhat simplistic, and a more precise measure of capacity, and the relationship between capacity and fishing mortality, need to be investigated. • Also, the relationship between the number of FADs deployed and catches needs to be better understood. • Although the staff has conducted some initial analyses, further studies need to be carried out to provide alternative management measures.
Relevance for management	The results of the project will enable the staff to refine current measures and develop alternative recommendations for managing tropical tunas in the EPO, and provide the Commission with additional tools when developing management measures.
Duration	24 months
Work plan and status	• 2018 – Initial analyses of the data that will lead to new insights • 2019 – Further analyses to improve the staff's management advice • 2020 – Apply the lessons learnt from the project and provide recommendations on both alternative management measures and additional data collection.
External collaborators	
Deliverables	• Multiple reports for the meetings of the SAC and the Commission, including recommendations on tuna conservation and possibly on improvements to data collection. • Software will be created that can be used to update the analyses with new data and/or alternative assumptions and new methods.

PROJECT J.2.a: Quantify the relationship between vessel operational characteristics and fishing mortality

Updated: May 2019

Progress summary for the reporting period

- **Task 1** (*Evaluate the reliability of the data obtained on identification of FADs*): an extensive review of FAD data reporting under Resolutions C-16-01 and C-17-02 led to:
  i. modifications of FAD form 9/2018 and the *Flotsam Information Record* to enable FADs to be tracked over time;
  ii. a series of training workshops on the use of the new forms;
  iii. the creation of a database on buoys reported under Resolution C-17-02; and
  iv. a proposal (C.1.a) for a pilot project on FAD marking and tracking.
- **Task 2** (*Investigate methods to determine purse-seine set type*): following promising tests of a preliminary set type classification algorithm, a new version is being developed, incorporating additional information to reduce the error rates.
- **Task 3** (*Evaluate the relationship between catch and number of FAD deployments*): see SAC-08-06d. Further analysis may be required once FAD tracking data are available for the entire fleet.
- **Task 4, 5** (*Investigate more precise measures of fishing capacity/the relationship between fishing mortality and fleet capacity*): the staff expects to incorporate the results of its preliminary research in in-depth analyses during year 2 of the project.
- **Task 6** (*Evaluate alternative management measures*): the staff is pursuing various alternatives, including a dynamic management approach and reducing the number of active buoys allowed per vessel.

Challenges and key lessons learnt

- Current limits on the number of active buoys per vessel may be too high to be effective.
- The dynamic management approach looks promising for developing alternative conservation and management measures for bigeye.
- Despite the new forms and training workshops, FAD data reporting is still imperfect. Training of managers, fishers and observers should continue, and the reporting formats standardized.
- High-resolution buoy data are needed to link IATTC databases (*i.e.* observers, FAD logbooks, buoy data). Also, a single reporting format for all CPCs would be desirable.
- Because active FADs, not FAD deployments, are subject to limits, analyses similar to those in SAC-08-06d may need to be repeated with FAD tracking data

Reports/publications/presentations

Presentations:

- October 2018: 4th CLIOTOP symposium

Reports:

- FAD-03 INF-A Review of resolutions C-16-01 and C-17-02
- SAC-10-10 Relationship between purse-seine vessel characteristics and fishing mortality
- SAC-10 INF-D Bigeye tuna Dynamic Ocean Management
- SAC-10 INF-K Analysis of increase in floating-object sets

Comments:

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PROJECT K.1.a: POSEIDON project	
THEME: Sustainable fisheries **GOAL:** K. Improve our understanding the socio-economic aspects of sustainable tropical tuna fisheries **TARGET:** K.1. Collaborate in socio-economic studies by other organizations **EXECUTION**: Stock Assessment Program	
Objectives	Build and evaluate an agent-based, adaptive fishing fleet model as an analytic tool to support management
Background	• POSEIDON is a coupled human-ecological model that combines an agent-based, adaptive fishing fleet model with existing fishery models or simple biological data, to simulate vessel behavior and fishery outcomes based on policies, market influences, and environmental factors. • POSEIDON provides a powerful platform for policy evaluation and decision support, with a strong focus on the spatial and human dimensions of fisheries management. • POSEIDON was originally developed by a multidisciplinary team from the University of Oxford, Ocean Conservancy, George Mason University, the University of California, Santa Barbara, and Arizona State University, as part of an effort to advance innovation in fisheries management. • The model has been calibrated and validated to the U.S. West Coast groundfish fishery. It is now being adapted to explore MSC certification for Indonesia's deep-water snapper fishery (in partnership with The Nature Conservancy, Indonesia).
Relevance for management	The model will be used to explore timely research questions, including FAD management, understanding the spatial dynamics of the fishery, as well as some of the social and economic issues which effect management.
Duration	18 months (end year 2020)
Work plan and status	• A post-doctoral researcher will be based at the IATTC's office in La Jolla, and will be charged with 1) scoping model application and designing a use cases that are supportive of IATTC policy evaluation processes, 2) understanding and accessing relevant datasets from IATTC, and 3) conducting statistical analyses of data to support model development. • This researcher will work closely with the modeling team based at the University of Oxford and Ocean Conservancy to drive model design, calibration and validation of the tool and its outputs, as well as evaluation of model results.
External collaborators	University of Oxford, Ocean Conservancy, Arizona State University, International Seafood Sustainability Foundation
Deliverables	• A computer algorithm with which to run simulations to explore management options. • A project report and possibly publications in peer-reviewed journals.

PROJECT K.1.a: POSEIDON project

Updated: May 2019

Progress summary for the reporting period

- **Researcher**: Dr. Katyana Vert-pre Kirk will work on this project. She has extensive experience in modeling and statistical analysis of fisheries data.
- **Refinement of research to match IATTC management priorities**. The project has been modified to address specific management questions, including:
  i. biological and social/economic impact of FAD limits, alongside measures to reduce mortality of small bigeye;
  ii. impact of advances in FAD technology on catchability of skipjack;
  iii. ecosystem impacts and management implications of FAD drift.
- **Modification of model framework**. This involves adapting (a) the model infrastructure to better represent the EPO tuna fishery, including oceanographic currents and FAD drift, and (b) the dynamic fleet model to represent the decision-making process, information flow, and trip structure of the purse-seine fishery. A decision-flowchart representing a typical purse-seine fishing trip has been developed, also a survey of vessel captains, to be implemented in August 2019.
- **Analysis of IATTC datasets.** The parameterization, calibration, and cross-validation of the model require supplemental analyses of IATTC fishery datasets, including:
  i. Statistical analysis of trends in logbook data to understand fleet dynamics, spatial patterns of fishing effort;
  ii. Assessment of spatial and temporal patterns of FAD handling and drift; and
  iii. Assessment of effect on skipjack catchability of changes in technology and spatial patterns in FAD sets.

Challenges and key lessons learnt

Having a team member onsite has already yielded great benefits in terms of project coordination and efficient communication with IATTC staff.

Reports/publications/presentations

February 2019: Presentation to IATTC scientific staff

Comments:

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4. ECOLOGICAL IMPACTS OF FISHERIES: ASSESSMENT AND MITIGATION

PROJECT L.1.a: Develop habitat models for bycatch species caught in the EPO to support ecological risk assessments (ERAs)	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** L. Evaluating ecological impacts **TARGET:** L.1. Develop analytical tools to identify and prioritize species at risk for data collection, research and management **EXECUTION**: Biology and Ecosystem Program	
Objectives	• To use presence-only catch data to develop habitat models for all bycatch species caught in EPO tuna fisheries to facilitate mapping of their geographic range. • To make distribution maps available in a format suitable for use as base maps for ecological risk assessment models (PSA, EASI-Fish)
Background	• Many bycatch species caught in EPO tuna fisheries lack sufficient biological and catch data to undertake traditional stock assessment to determine their vulnerability to fishing. • Data-limited Ecological Risk Assessment (ERA) methods are now increasingly used to determine the most vulnerable species to fishing, which have a strong reliance on estimating impacts using the overlap of fishing effort with a species' distribution.
Relevance for management	Developing habitat models for bycatch species will improve the fishing mortality estimates using ERAs, from which their status can be determined and guide managers.
Duration	12 months
Work plan and status	• Jun-Dec 18: model development using data-rich species • Jan-Feb 19: apply habitat model to bycatch species • Mar-April 19: Finalize habitat maps for bycatch species • May 19: present final model and assessment results at SAC-10.
External collaborators	CPCs
Deliverables	• Presentations at SAC-10 • Procedure, if successful, to be used annually within ERA models to assess the vulnerability of bycatch species in the EPO.

PROJECT L.1.a: Develop habitat models for bycatch species caught in the EPO to support ecological risk assessments (ERAs)
Updated: May 2019
Progress summary for the reporting period • Models were developed using Generalized Additive Models (GAMs), using presence-absence data, and simple Relative Environmental Suitability (RES) models, using presence-only data • GAMs run on data-rich species (bigeye) produced unreliable habitat maps; a reduced dataset (resembling a non-target species, like blue marlin) made the predictions too unreliable for use in ERAs. • RES models produced habitat maps suitable for ERAs, provided various models with different thresholds of probability of occurrence, which define habitat boundaries, are used. • RES models have been constructed for about half of the bycatch species known to be impacted by EPO tuna fisheries.
Challenges and key lessons learnt • Even highly sophisticated models in data-rich settings can predict habitat poorly, depending on the environmental data used for the prediction. • Simple RES models can produce ecologically plausible habitat predictions, especially if the presence points are widely spread spatially.
Reports/publications/presentations • BYC-09-01 Ecological risk assessment of Mobulid rays in the eastern Pacific Ocean • A manuscript entitled "*EASI-Fish: A flexible ecological risk assessment to quantify the cumulative impacts of fishing in data-limited settings*" has been submitted for publication.
Comments: -

PROJECT L.1.b: Develop a flexible spatially-explicit ERA approach for quantifying the cumulative impact of tuna fisheries on data-limited bycatch species in the EPO	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** L. Evaluating ecological impacts **TARGET:** L.1. Develop analytical tools to identify and prioritize species at risk for data collection, research and management **EXECUTION**: Biology and Ecosystem Program	
Objectives	• To develop a spatially-explicit model for quantifying the cumulative impact of multiple fisheries on data-limited bycatch species in the EPO • To use the model to prioritize potentially vulnerable species for further research and/or management • To design the model in a user-friendly format to maximize uptake and utilization by IATTC CPCs
Background	• IATTC is committed, through the Antigua Convention, to ensure the long-term sustainability of all target and associated species impacted by EPO tuna fisheries. • Many associated (*i.e*. bycatch) species lack detailed biological and fisheries data for stock assessment, so data-limited approaches required to identify and assess the most vulnerable species. • Productivity-Susceptibility Analysis (PSA) has been widely used, but it cannot provide a quantitative measure of risk, nor can it assess cumulative impacts of multiple fisheries.
Relevance for management	The new model will more reliably identify potentially vulnerable bycatch species and assess their status under current fishing effort regimes to better guide managers
Duration	48 months
Work plan and status	• Jan-Apr 18: complete the development of a preliminary model • May 18: present preliminary model and results at SAC-09. • Jun-Dec 18: continue model development with feedback from CPCs • Jan-Feb 19: Finalize model and user-friendly module • Mar-May 19: Finalize assessment of cumulative impacts of EPO tuna fisheries for all bycatch species to identify most vulnerable species. • May 19: present final model and assessment results at SAC-10.
External collaborators	CPCs
Deliverables	• Presentations at SAC-09 and SAC-10 • Scientific journal publication • Procedure, if successful, to be used annually to assess the vulnerability of bycatch species in the EPO.

PROJECT L.1.b: Develop a flexible spatially-explicit ERA approach for quantifying the cumulative impact of tuna fisheries on data-limited bycatch species in the EPO
Updated: May 2019
Progress summary for the reporting period • The EASI-Fish model was applied to a subset of target and non-target species in the EPO to demonstrate how it prioritizes potentially vulnerable species for further research and/or management. • EASI-Fish was applied to the spinetail devil ray to assess its vulnerability under 18 hypothetical conservation and management measures.
Challenges and key lessons learnt • More sophisticated habitat models (*e.g.* MaxEnt, INLA) may provide more reliable base maps for habitat and will be considered in future analyses.
Reports/publications/presentations • BYC-09-01 Ecological risk assessment of Mobulid rays in the eastern Pacific Ocean • A manuscript entitled "*EASI-Fish: A flexible ecological risk assessment to quantify the cumulative impacts of fishing in data-limited settings*" has been submitted for publication.
Comments: EASI-Fish was developed in Microsoft Excel to maximize its acceptance and utilization

PROJECT L.2.a: Develop and update Productivity-Susceptibility Analyses (PSAs) of tuna fisheries in the EPO	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** L. Evaluating ecological impacts **TARGET:** L.2. Conduct ERAs of EPO fisheries to identify and prioritize species at risk **EXECUTION**: Biology and Ecosystem Program	
Objectives	• To improve the currently used PSA methodology by reducing the number of redundant biological attributes without compromising PSA results. • Apply the new PSA methodology to existing assessments of the purse seine fishery (class 6 vessels) and the industrial longline fishery. • To prepare manuscripts for publication in a peer-reviewed scientific journal for (1) improved PSA methodology, and (2) purse seine and longline fishery PSA results.
Background	IATTC's PSAs have not yet been published in a peer-reviewed journal therefore access of this information to the broader scientific community is limited to IATTC's website. Publication of IATTC's approaches to ecosystem-based research is one step towards demonstrating IATTC's commitment to ecosystem-based fisheries management.
Relevance for management	• Results in the PSA papers may be used to prioritize data collection, mitigation, and/or management measures for species identified as vulnerable by the method. • Improving the methodology by reducing the number of biological parameters will optimize reliability of results from the PSA method, while decreasing the data requirements to further expedite this rapid assessment approach for data-limited fisheries.
Duration	8 months
Work plan and status	• Jan-Jun 18: prepare a manuscript for the existing PSA for the large purse-seine fishery and submit to co-authors for review • Aug 18: submit PSA manuscript on the large purse-seine fishery for publication in a peer-reviewed scientific journal • Jan-May 18: Submit PSA-methods manuscript for publication in a peer-reviewed scientific journal
External collaborators	None
Deliverables	Manuscripts demonstrating IATTC's approaches to ecosystem-related research for data-limited species

PROJECT L.2.a: Develop and update Productivity-Susceptibility Analyses (PSAs) of tuna fisheries in the EPO
Updated: May 2019
Progress summary for the reporting period • A manuscript of impacts of bycatch species by large purse-seine vessels using the PSA approach is in review at *Fisheries Research* • A manuscript describing the redundancy of attributes used in the PSA is in review at *Aquatic Living Resources*
Challenges and key lessons learnt -
Reports/publications/presentations See progress above
Comments: -

PROJECT M.1.a: Evaluate the effect of the depth of non-entangling FADs on catches of tunas and bycatches of other species in the purse-seine fishery	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** M. Mitigating ecological impacts **TARGET:** M.1. Investigate gear technology to reduce bycatch and bycatch mortality **EXECUTION**: Biology and Ecosystem Program	
Objectives	Evaluate the performance of shallow non-entangling versus normal depth FADs in the EPO purse-seine fishery, with an emphasis on the tuna and non-tuna species catch composition; seeking a practical solution to reduce fishing mortality on small undesirable sizes of bigeye tuna
Background	• The purse-seine fishing mortality on small undesirable sizes of bigeye tuna, caught in sets on tuna aggregations associated with FADs, should be reduced to increase the maximum sustainable yield from the bigeye tuna fisheries in the EPO • Bigeye tuna associated with FADs in the EPO exhibit deeper depth distributions than skipjack or yellowfin tunas • The presence of bigeye in the EPO purse seine catch was reported to be more likely with deeper floating objects
Relevance for management	A potential solution for reducing fishing mortality on small undesirable sizes of bigeye and/or reducing fishing mortality on bycatch species associated with FADs, including sharks and turtles
Duration	2015-2018
Work plan and status	• 2015-2017: ISSF arranged for experiments to be undertaken at-sea in collaboration with NIRSA, a large seafood company located in Posorja, Ecuador, with a fleet of 11 purse seine tuna vessels. • The first experiment began in June-July 2015 with deployments of 50 shallow and 50 normal depth FADs and concluded on 31 October 2016. The second experiment began in March-May 2017 with deployments of 100 shallow and 100 normal depth FADs and concluded on 31 December 2017. • 2018: The catch data collected by observers aboard NIRSA vessels from sets on the experimental FADs from the two experiments is being examined to confirm FAD types • 2018: A statistical evaluation of the performance of the shallow non-entangling versus normal depth FADs, including the tuna and non-tuna species catch compositions will be conducted
External collaborators	ISSF, NIRSA
Deliverables	• Relevant information on performance of shallow non-entangling FADs versus normal FADs based on field experiments • Manuscript for peer review and publication in a scientific journal

PROJECT M.1.a: Evaluate the effect of the depth of non-entangling FADs on catches of tunas and bycatches of other species in the purse-seine fishery
Updated: May 2019
Progress summary for the reporting period ● This progress report is pending the return of staff from fieldwork

PROJECT M.1.b: Test sorting grids	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** M. Mitigate the ecological impacts of tuna fisheries **TARGET:** M.1. In collaboration with the industry, conduct scientific experiments to identify gear technology that will reduce bycatches and mortality of prioritized species **EXECUTION**: Bycatch and IDCP Program	
Objectives	Reduce bycatches of small fishes (tunas and others) in purse-seine sets.
Background	• Small individuals of any species (target or non-target) of no market value should be released to reduce the impacts of fishing operations and improve the sustainability of the fishery. • Many seiners have sorting grids, different types of panels to allow the escape of fish of a size determined by the dimensions of the grid used, but their use has not been well documented because captains can lift them out of the water, and they do so not to lose any potential catches. • Previous experiments have quantified unwanted species passing through the grid. It is necessary to test their survival after escaping, since they may have been injured while going through the grid. • Experiments to verify survival should follow the tests of the grid to release unwanted individuals.
Relevance for management	Reduce the impacts of fishing operations and improve the sustainability of the fishery
Work plan and status	• Convene a workshop with fishing captains and gear experts to decide on the standard design for all tests, using previous experience from the region. • Build the design in 2 seiners, with a commitment to cooperate by leaving the grid fully underwater in all sets. • Monitor with a camera the utilization of the grid in all sets. • Deploy a speedboat with a researcher to film escape through the grid. • This initial pilot program will attempt to measure the quantity and characteristics of escaped fish, not their survival • Evaluate the significance of the releases, assuming survival. • If significant, design a project to measure survival in a floating pen. • Discuss with captains ways to improve their operation if needed.
Duration	18 months
External collaborators	
Deliverables	May 2019: progress report for SAC-10

PROJECT M.1.b: Test sorting grids
Updated: May 2019
Progress summary for the reporting period See WSSG-01 Meeting Report

PROJECT M.2.a: Evaluate the post-release survival of silky sharks captured by longline fishing vessels in the equatorial EPO, using best handling practices	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** M. Mitigating ecological impacts **TARGET:** M.2. Develop best practices for release of bycatch species **EXECUTION**: Biology and Ecosystem Program	
Objectives	Estimate the post-release survival of silky sharks captured by longline vessels in the equatorial EPO with Wildlife Computers Mini-PATs, utilizing a best handling practice
Background	• Apparent severe decline in the population of silky sharks in the EPO, based on trends in standardized catch-per-unit-of-effort indices • Domestic longline fleets from Latin America conduct multi-species fisheries including retaining silky sharks
Relevance for management	Resolution C-16-06 on conservation measures for silky sharks stipulates to improve handling practices for live sharks to maximize post-release survival
Duration	2016-2018
Work plan and status	• 2016-2017: 40 total silky sharks were tagged and released with MiniPATs, and the resulting data obtained through ARGOS satellites has been analyzed to estimate a post-release survival rate, evaluate any potential entanglement in FADs, and evaluate movements and dispersion • 2017: A final report for this project was submitted and accepted by the EU (funding source) • 2018: A manuscript is in progress and expected to be completed and submitted to a scientific journal
External collaborators	INCOPESCA, Costa Rica; WWF, Ecuador; University of Hawaii
Deliverables	• Silky shark post-release survival rate following capture by longline vessels, utilizing a best handling practice • Presentation of preliminary results at SAC8 • Manuscript for peer review and publication in a scientific journal

PROJECT M.2.a: Evaluate the post-release survival of silky sharks captured by longline fishing vessels in the equatorial EPO, using best handling practices
Updated: March 2019
Progress summary for the reporting period This progress report is pending the return of staff from fieldwork

PROJECT M.2.b: Evaluate best handling practices for maximizing post-release survival of silky sharks in longline fisheries, and identification of silky shark pupping areas for bycatch mitigation	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** M. Mitigating ecological impacts **TARGET:** M.2. Develop best practices for release of bycatch species **EXECUTION**: Biology and Ecosystem Program	
Objectives	Estimate post-release survival of silky sharks captured by Mexican longline vessels in the eastern tropical Pacific, utilizing a best handling practice, and define boundaries encompassing the probable distribution silky shark pupping areas in the EPO
Background	• Apparent severe decline in the population of silky sharks in the EPO, based on trends in standardized catch-per-unit-of-effort indices • Domestic longline fleets from Latin America conduct multi-species fisheries including retaining silky sharks • Defining the probable distribution of silky shark pupping areas would be useful for better understanding population structure and for consideration of conservation measures including spatiotemporal closures
Relevance for management	Resolution C-16-06 on conservation measures for silky sharks stipulates to improve handling practices for live sharks to maximize post-release survival, and identification of pupping areas of the silky shark
Duration	2018-2020
Work plan and status	• 2018-2019: 69 silky sharks will be tagged and released from Mexican longline vessels with MiniPATs, using a best handling practice. • 2019-2020: The subsequent data obtained from ARGOS satellites will be analysed for post-release survival and movements during 2019 and 2020. • 2019-2020: Exploratory analyses of silky shark size at capture data, compiled from various fisheries in the EPO, will be conducted to determine the areas and times where silky shark pupping most likely occurs
External collaborators	INAPESCA, Mexico
Deliverables	• Silky shark post-release survival rate following capture by Mexican longline vessels, utilizing a best handling practice • Defining probable distribution of silky shark pupping areas

PROJECT M.2.b: Evaluate best handling practices for maximizing post-release survival of silky sharks in longline fisheries, and identification of silky shark pupping areas for bycatch mitigation
Updated: March 2019
Progress summary for the reporting period This progress report is pending the return of staff from fieldwork

PROJECT M.5.a: Develop and test non-entangling and biodegradable FADs	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** M. Mitigating ecological impacts **TARGET:** M.5. Develop best practices to mitigate anthropogenic impacts on EPO habitats **EXECUTION**: Bycatch and IDCP Program	
Objectives	Construction of non-entangling FADs from biodegradable materials, not only to decrease mortality of non-target species by net-webbing entanglement, but also minimize contributions to ocean debris and pollution by commercial tuna fishing.
Background	• Non-target species are also found in association with FADs, and in some instances, may become entangled in the FADs and perish. • Some FAD components that are lost at sea or not retrieved, particularly those including plastics or other materials that are not readily degradable may last many years in the environment as pollutants, and threatening vulnerable ecosystems. • There is an increasing interest in identifying non-entangling and biodegradable components that could be used in FAD construction, while still providing similar function in terms of tuna aggregation.
Relevance for management	• Ecological impacts on vulnerable ecosystems may be considered an important factor for FAD fishery management purposes. • Results may be used by the Commission members in the development of best fishing practices and management measures
Duration	29 months
Work plan and status	• August 2015 – April 2017: Purchase of FAD and mooring materials. FAD deployment at test site. FAD monitoring. • April – December 2017: Ongoing research on alternative non-entangling and biodegradable materials to extend the durability of the FADs. • January: Project report
External collaborators	
Deliverables	• May 2016. Ad hoc working group on FADs. La Jolla – CA • May 2017. 68th Tuna Conference. Lake Arrowhead – CA • October 2017. ECOFAD meeting. Manta – Ecuador • March 2018. Project final Report

PROJECT M.5.a: Develop and test non-entangling and biodegradable FADs
Updated: May 2019
Progress summary for the reporting period • February–December 2018: Research on alternative non-entangling and biodegradable materials to extend the durability of the FADs. • December 2018: Agreement with vessel companies concerning methodology and allocation of FAD prototypes to vessels through Memorandums of Understanding. • April 2019: Agreement with companies regarding purchase and allocation of materials. • 2019. Collection of data on previously-deployed NEDs similar to prototypes; observers record condition of NEDs and catches. Database on interactions with NEDs created.
Challenges and key lessons learnt • Reaching agreement with vessel captains on using a limited number of standard FAD prototypes. • Simplifying the materials to purchase. The flotation of NEDs made of natural materials (balsa wood, bamboo) was satisfactory during the period observed
Reports/publications/presentations • Presentations made at workshops in the region • Online technical meetings with researchers involved in similar projects in the Atlantic and Indian Oceans, and ISSF staff. • SAC-09: Progress report.
Comments: Project was suspended during March-July 2018, thus missing the fishing season off Peru. Next opportunity for deployment will be second half of 2019, for the season west of Galapagos.

PROJECT M.5.b: Reducing losses, and fostering recovery of FADs in the purse-seine fishery in the EPO	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** M. Mitigating ecological impacts **TARGET:** M.5. Develop best practices to mitigate anthropogenic impacts on EPO habitats **EXECUTION**: Bycatch and IDCP Program	
Objectives	• Evaluate the extent of stranded, abandoned or lost FADs (SAL-FADs) in the EPO. • Evaluate the impact of SAL-FADs on coastal areas and islands of the EPO, with special emphasis on identification of deploying locations. • Identify or develop oceanographic models to forecast strandings of FADs. • Based on findings, develop mitigation and management measures and strategies to minimize SAL-FADs. Promote recovery of SAL-FADs and evaluate its effectiveness.
Background	• Coastal areas in the EPO are being impacted by SAL-FADs, but most information is anecdotal. • Some FAD components lost at sea or not retrieved, particularly those made of plastics or other materials that are not readily degradable, can last many years in the environment as pollutants and threaten vulnerable ecosystems. • SAL-FADs can also be a danger to navigation. • SAL-FADs may produce 'ghost-fishing' in the EPO.
Relevance for management	• Ecological impacts on vulnerable ecosystems are an important factor in FAD fishery management. • Results may be useful for Commission Members in the development of best fishing practices and management measures for FADs
Duration	28 months
Work plan and status	• May 2019-March 2020: Survey stakeholders about areas and impacts of SAL-FADs. • May-Dec 2019: Identify or develop ocean circulation model to forecast FAD trajectories beyond fishing grounds. • May 2020: Present results of ocean circulation model at SAC-11 • June-Dec 2020: Based on models and surveys, identify levels of sensitivity and categorize possible stranding areas. • Dec 2020: Workshop with stakeholders and ISSF scientists to identify mitigation strategies for SAL-FADs, based on findings of survey and models • May 2021: Present a report of all findings and proposals for mitigation strategies at SAC-12.
External collaborators	TBD. An oceanographic modeler, and ISSF scientists working on similar projects on other oceans
Deliverables	• May 2020. Report survey and circulation model results at SAC-11 • December 2020. Workshop with stakeholders • March 2021: Workshop report • May 2021: Report findings at SAC-12 • October 2021: Propose mitigation strategies and management options to reduce SAL-FADs

PROJECT M.5.b: Reducing losses, and fostering recovery of FADs in the purse-seine fishery in the EPO
Updated: May 2019
Progress summary for the reporting period • Development and distribution of survey on impact of SAL-FADs. 14 responses to date: academic (1), consultant (1), industry (2), environmental NGOs (3), industry NGO (5), government (2). • Two staff members attended the ISSF-sponsored workshop on the reduction of the impact of FADs in September 2018.
Challenges and key lessons learnt -
Reports/publications/presentations -
Comments: • Original project start date was early 2018, but it was delayed, and to date only the first objective has been addressed. • The modelling of FAD movements may require hiring an oceanographer

5. INTERACTIONS AMONG THE ENVIRONMENT, THE ECOSYSTEM, AND FISHERIES

PROJECT N.1.a: Analyze EPO bycatch data to assess the influence of environmental drivers on catches and vulnerability	
THEME: Interactions among the environment, the ecosystem, and fisheries **GOAL:** N. Understanding the interactions among environmental drivers, climate, and fisheries **TARGET:** N.1. Understanding the effects of short-term environmental fluctuations **EXECUTION**: Biology and Ecosystem Program	
Objectives	To better understand environmental drivers that might be responsible for increasing the vulnerability of non-target species to being caught in EPO fisheries, and devise management measures that may reduce their vulnerability to capture (*e.g*. space-time closures).
Background	• Each year the IATTC reports catch estimates for non-target species in its Fishery Status Report. • Nominal catches of bycatch species may not fully explain the magnitude of inter-annual variability in fishing effort, since environmental factors may drive key processes such as recruitment. • To improve our understanding of processes affecting catches in the EPO purse-seine fishery, we assess ecosystem components including catches of vulnerable shark species in relation to variability in oceanographic conditions and life history characteristics.
Relevance for management	Catch prediction models to better manage data-poor species
Duration	12 months
Work plan and status	• Jan-Apr 18: exploratory analyses of IATTC observer catch data and oceanographic conditions over the past two decades • Apr-May 18: present results at the international PICES conference, "Understanding Changes in Transitional Areas of the Pacific" and the 69th Tuna Conference • Jun-Jul 18: Prepare a manuscript for publication in a scientific journal
External collaborators	None
Deliverables	• Reporting of bycatch estimates in the Ecosystem Considerations report • Manuscript that contributes to IATTC's ecosystem approach through evaluation of potential environmental drivers influencing catches in the EPO purse-seine fishery and relationships between environment and life history characteristics

PROJECT N.1.a: Analyze EPO bycatch data to assess the influence of environmental drivers on catches and vulnerability
Updated: May 2019
Progress summary for the reporting period • Bycatch estimates for 2018 documented in the *Ecosystem Considerations* report • Oceanographic data (SST, chlorophyll-*a,* etc.) and environmental indices (ONI, PDO, others) included in the *Ecosystem Considerations* report • Work is in progress to evaluate life history parameters of sharks and the delay in catch peaks in the south EPO following extreme El Niño events
Challenges and key lessons learnt • Catch data for sharks need updating to include data from after the strong El Niño of 2015-2016 • The large number of zeros in the catch data for sharks may inhibit modeling progress
Reports/publications/presentations Presentations: • PICES International Symposium on Understanding Changes in Transitional Areas of the Pacific (April 2018) • 69th Tuna Conference (May 2018) • A manuscript is in preparation.
Comments: • The Ecosystem Group will collaborate with the Stock Assessment Group to determine the appropriate model. • Members of the Ecosystem Group attended a NOAA Ocean Satellite Data Course in August 2018 to improve knowledge of available oceanographic datasets.

PROJECT N.1.b: Investigate the effects of wind-induced microturbulence on yellowfin larval survival	
THEME: Interactions among the environment, the ecosystem. and fisheries **GOAL:** N. Understanding the interactions among environmental drivers, climate, and fisheries **TARGET:** N.1. Understanding the effects of short-term environmental fluctuations **EXECUTION**: Biology and Ecosystem Program	
Objectives	Estimate the optimal microturbulence and wind speed for the survival of yellowfin larvae and examine any association between yellowfin recruitment and historical wind speeds in the EPO
Background	• Studies have shown that feeding success and survival of marine fish larvae can be influenced by the levels of wind-induced microturbulence in the larval feeding environment • Multiple experiments were conducted over 4 years to examine microturbulence effects on yellowfin larval survival, and optimal turbulence estimates for larval survival were converted to optimal wind speeds • Estimated optimal wind speeds for larval survival have been examined for correlations with yellowfin recruitment during 1987-2007
Relevance for management	The wind speed-recruitment analysis is promising for assessing yellowfin recruitment patterns in relation to larval survival
Duration	18 months
Work plan and status	• June-December 2018: Refine analyses of survival and feeding data and finalize wind speed-recruitment analysis • January-December 2019: Complete manuscript and submit to scientific journal
External collaborators	University of Tokyo
Deliverables	• Presentations for SAC-09 and SAC-10 • Publication of results in a scientific journal

PROJECT N.1.b: Investigate the effects of wind-induced microturbulence on yellowfin larval survival
Updated: March 2019
Progress summary for the reporting period • Analysis of experimental survival and feeding data in response to microturbulence completed. • Feeding parameters examined in relation to microturbulence included average prey and biomass consumption and size of prey captured. • A manuscript summarizing experimental estimates of optimal microturbulence and a wind speed-recruitment analysis of select areas of the EPO is nearing completion
Challenges and key lessons learnt • Measuring microturbulence in experimental tanks is difficult on a scale that is relevant to the foraging environment of larval yellowfin. This was addressed by using a microacoustic doppler velocimeter (ADV) to measure turbulent dissipation rates in the tanks at microscale (5 mm x 5 mm) precision; they were also estimated using a small-scale (m3) model developed by a colleague at the University of Tokyo.
Reports/publications/presentations • Presentations at SAC-09 and SAC-10
Comments: This project will be completed with the submission of a manuscript by the end of 2019.

PROJECT N.2.a. Develop models of the effects of climate change on pre-recruit life stages of tropical tunas	
THEME: Interactions among the environment, the ecosystem. and fisheries **GOAL:** N. Improving our understanding of the EPO ecosystem **TARGET:** N.2. Understanding the effects of long-term climate drivers **EXECUTION**: Biology and Ecosystem Program	
Objectives	• Investigate experimentally the effects of important climate change factors on early life stages of tropical tunas, and incorporate those results into models that can predict climate change effects on the distribution and abundance of tropical tunas
Background	• Tuna populations are key components of pelagic ecosystems, but the effects of climate change on tuna biomass, distributions and recruitment are almost unknown • The Achotines Laboratory provides an essential experimental center for investigations of the effects of climate change factors on pre-recruit life stages of tropical tunas • A study of the effects of ocean acidification on yellowfin egg and larval stages was conducted at the Achotines Laboratory in 2011 and the results published in two papers in 2015 and 2016 with an additional two papers in preparation • The effects of additional climate change factors, such as ocean warming and anoxia, can be studied at the Achotines Laboratory and incorporated into models of multifactor effects on pre-recruit life stages
Relevance for management	Potential impacts of climate change on early life stages are an important consideration in future assessments of tunas in the EPO, and experimental results can allow models to be parameterized to include climate change effects on pre-recruit survival and spawning and nursery habitat
Duration	3 years
Work plan and status	• January 2018-June 2019: Completion of analyses and manuscripts describing ocean acidification effects on larval otolith morphology and genetic expression of resistant traits in yellowfin • January 2019-December 2020: Development of experimental investigations to study the effects of ocean warming and anoxia on pre-recruit life stages of yellowfin
External collaborators	ABARES and AFMA, Australia; Macquarie University, Australia
Deliverables	• Presentations for SAC-09, SAC-10 and SAC-11 • Publication of results in several scientific journals

PROJECT N.2.a. Develop models of the effects of climate change on pre-recruit life stages of tropical tunas
Updated: May 2019
Progress summary for the reporting period • Analysis of the effects of ocean acidification on yellowfin larval otolith morphology and genetic expression of resistant traits continued. • The larval otolith analysis will be completed and submitted as a manuscript by mid-2019. • The experimental results from the 2011 study have been used in several efforts to estimate the impacts of ocean acidification on yellowfin in the Pacific Ocean
Challenges and key lessons learnt • Combining rearing larval tunas with precise control of the physical carbonate system was particularly challenging. • Studies of the effects of additional climate change factors, such as ocean warming and anoxia, will require additional funding.
Reports/publications/presentations Presentations: • SAC-09 • SAC-10 • 69th Tuna Conference (May 2018) • 42nd Larval Fish Conference (May 2018) • A draft manuscript estimating the effects of ocean acidification on yellowfin early life stages, based on a workshop held by the study group in 2016, has been submitted for review. • One additional modeling study of the effects of acidification on yellowfin early life stages is in journal review for 2019.
Comments: The analysis of experimental results should be completed in 2019.

PROJECT O.1.b: Quantifying spatial and ontogenetic variation in the feeding ecology of skipjack tuna in the eastern Pacific Ocean	
THEME: Interactions among the environment, the ecosystem, and fisheries **GOAL:** O. Improve our understanding of the EPO ecosystem **TARGET:** O.1. Conduct trophodynamic studies for defining key assumptions in EPO ecosystem models **EXECUTION**: Biology and Ecosystem Program	
Objectives	• To broadly describe the trophic ecology of skipjack tuna in the EPO using classical stomach-contents analysis • To quantitatively disentangle spatial, temporal, and ontogenetic differences in diet to identify important habitats of skipjack and their forage
Background	• Early accounts of skipjack stomach contents in the EPO have been limited to measurements of prey volume by size class with sampling strata determined *a priori* based on presumed areas of high skipjack densities • Other studies have used calculations of prey weight, number and frequency of occurrence of skipjack sampled opportunistically throughout the EPO • Little attention has been placed on quantitatively assessing the potential relationships between oceanography, ontogeny and skipjack feeding ecology Such information is essential for informing a planned spatially-explicit ecosystem model of the EPO (Project O.2.b) to account for direct and indirect impacts from fishing on the ecosystem, as mandated by the Antigua Convention
Relevance for management	Quantifying trophic linkages in ecosystem models provide descriptions of the magnitude of biomass transfer through the ecosystem and assist in assigning a more reliable proportion of both predator and prey in spatial strata using spatially-explicit ecosystem models, such as Ecospace.
Duration	12 months
Work plan and status	**Task 1:** Exploratory analysis of skipjack tuna diet data 1.1: Map locations of skipjack stomach samples overlaid with Longhurst bio-geochemical Provinces; 1.2: Assess size distribution of skipjack sampled for stomach-contents analysis; 1.3: Explore the relationship of predator-prey size. **Task 2:** Diet composition and classification tree analysis using analytical tools developed by staff at CSIRO in collaboration with IATTC 2.1: Compute gravimetric, numeric and occurrence indices of diet composition to examine prey importance; 2.2: Run classification trees using skipjack diet data as the response variable and Longhurst Province and skipjack size as the explanatory VARIABLES; 2.3: Interpret results with respect to ecosystem-related goals outlined in the SSP; 2.4: Prepare manuscript
External collaborators	• CICIMAR, La Paz, Mexico
Deliverables	• Manuscript that contributes to IATTC's ecosystem approach to fisheries management through identification of ontogenetic functional groups and quantifying their predator-prey interactions for use in ecosystem models.

PROJECT O.1.b: Quantifying spatial and ontogenetic variation in the feeding ecology of skipjack

tuna in the eastern Pacific Ocean
Updated: April 2019
Progress summary for the reporting period • Task 1: Exploratory analyses completed. • Task 2: calculations of the gravimetric index of diet importance completed, and classification trees run. • Interpretation of results is in progress.
Challenges and key lessons learnt • An extensive exploratory analysis is essential for appropriate interpretation of the classification tree results.
Reports/publications/presentations • A journal manuscript is in preparation.
Comments: This project will help improve diet matrices in EPO ecosystem models.

PROJECT O.1.c: A review of methods to determine prey consumption rates, gastric evacuation and daily ration of pelagic fishes: a precursor to experimental estimation for key predators in eastern Pacific Ocean	
THEME: Interactions among the environment, the ecosystem, and fisheries **GOAL:** O. Improve our understanding of the EPO ecosystem **TARGET:** O.1. Conduct trophodynamic studies for defining key assumptions in EPO ecosystem models **EXECUTION**: Biology and Ecosystem Program	
Objectives	• To provide a comprehensive review of the methods available to estimate prey consumption and gastric evacuation rates and daily ration in order to obtain reliable estimates of the consumption biomass ratio (Q/B) that can be used in ecosystem models for tropical tunas and tuna-like fishes. • To make recommendations as to which method(s) is most feasible, practical, cost-effective, and reliable for estimating Q/B for key predatory species within the EPO ecosystem.
Background	• Fisheries management strategies are increasing considering impacts on the ecosystems that support target species, such as tunas. Tuna fisheries impact apex predators in marine ecosystems and have the potential to disrupt the structure and function of the ecosystem. • Ecosystem models, such as Ecopath with Ecosim, are being increasingly used to explore and forecast the potential effects of fishing and climate on marine ecosystems. • A key parameter in many ecosystem models is the consumption/biomass ratio (Q/B). However, this highly influential parameter can be difficult to estimate experimentally, especially for large pelagic fishes caught by tuna fisheries. • A review of methods to estimate Q/B is required to determine which methods are feasible for the IATTC to parameterize ecosystem models into the future.
Relevance for management	The Antigua Convention requires the IATTC to consider the ecological impacts of tuna fisheries in the EPO. The IATTC has detailed plans to develop a spatially-explicit ecosystem model of the EPO in moving towards an ecosystem approach to fisheries management. Without reliable estimates of Q/B for key species in the EPO ecosystem, the ecosystem model will produce unreliable results that will be of little use for tactical or strategic fisheries management.
Duration	12 months
Work plan and status	• Jan–Mar 19: Collate all available literature on methodologies used to estimate prey consumption and Q/B in marine fishes, with an emphasis on predatory pelagic fishes. • Mar–Apr 19: Write a comprehensive literature review of methods to estimate Q/B and make recommendations as to which method(s) may be feasible for IATTC to use in future. • May 19: Present the document at SAC-10 and at the 70th Tuna Conference • Jun–Sept 19: Complete and submit a manuscript of the literature review to an international peer-reviewed scientific journal.
External collaborators	• None
Deliverables	• An information paper for SAC-10 • Publish the literature review to an international scientific journal.

PROJECT O.1.c: A review of methods to determine prey consumption rates, gastric evacuation and daily ration of pelagic fishes: a precursor to experimental estimation for key predators in eastern Pacific Ocean
Updated: May 2019
Progress summary for the reporting period • All available literature collated. • Journal paper in early stages of development.
Challenges and key lessons learnt • Obtaining biomass and fishing mortality estimates for target species from the stock assessment group to update the Ecopath model for SAC can be challenging since they are conducting assessments at the same time. Update of these parameters need to be undertaken between July and December.
Reports/publications/presentations • SAC-10 INF-E Predation.
Comments: This project is a critical precursor to the work required to estimate values of Q/B for ecosystem models. The Achotines Laboratory is one of the few facilities in the world where experimental work to estimate Q/B for large pelagic fishes is possible.

PROJECT O.2.a: Develop and implement analytical tools for understanding the trophic ecology of apex predators	
THEME: Interactions among the environment, the ecosystem. and fisheries **GOAL:** O. Improve understanding of the EPO ecosystem **TARGET:** O.2. Improve analytical tools to evaluate anthropogenic and climate impacts on the EPO ecosystem **EXECUTION**: Biology and Ecosystem Program	
Objectives	• To further develop and validate statistical tools for the analysis of complex datasets in trophic studies of apex predators. • To enhance external collaborations and professional development through the analysis of Atlantic bluefin tuna diets in relation to biological and environmental variables.
Background	• IATTC staff have developed an innovative approach for analyzing complex diet data using classification trees. The approach has been used for regional diet studies of yellowfin tuna in the EPO and for a broad-scale global comparison of yellowfin, bigeye and albacore diets. • To facilitate more widespread adoption of the method, it requires validation of regional studies in other ocean basins, given the importance of spatio-temporal differences in available prey taxa. • Collaboration with other scientists studying the trophic ecology of apex predators can assist with validating the approach, while also enhancing collaborative relationships.
Relevance for management	• Optimizing statistical tools to analyse trophic data is crucial for understanding the trophodynamics of apex predators in the EPO and whether predator-prey relationships may be impacted by fishing. • Diet analyses are fundamental for the identification of ecological functional groups, which are required in the development of ecosystem models to understand the potential ecological impacts of fishing. • Integrating environmental factors into analyses of regional studies provides managers with information on effects of climate change on variation in forage communities to verify observed global patterns.
Duration	9 months
Work plan and status	• Jun 2018: data analyses • Aug – Nov 2018: Discuss preliminary outputs with collaborators and implement necessary collaborator inputs into method development • Nov 2018-Mar 2019: Manuscript preparation
External collaborators	Massachusetts Division of Marine Fisheries; numerous other universities and government agencies
Deliverables	Manuscript summarizing the revised approach, using an Atlantic-wide analysis of bluefin trophic ecology as a case study.

PROJECT O.2.a: Develop and implement analytical tools for understanding the trophic ecology of apex predators
Updated: May 2019
Progress summary for the reporting period • Improvements have been made to a statistical tool for analyzing complex diet data, developed in collaboration with scientists at CSIRO (Australia), used to represent trophic interactions in ecosystem models
Challenges and key lessons learnt • The project is stalled pending provision of data by external collaborators
Reports/publications/presentations • The statistical tool is being used by various organizations, including IRD (France) and SPC.
Comments: -

PROJECT O.2.b: An updated ecosystem model of the eastern tropical Pacific Ocean for providing standardized ecological indicators for monitoring of ecosystem integrity	
THEME: Interactions among the environment, the ecosystem, and fisheries **GOAL:** O. Improve our understanding of the EPO ecosystem **TARGET:** O.2. Improve analytical tools to evaluate anthropogenic and climate impacts on the EPO ecosystem **EXECUTION**: Biology and Ecosystem Program	
Objectives	• To update the Ecopath ecosystem model developed for the eastern tropical Pacific Ocean (ETP) by Olson and Watters (2003). • Conversion of the model to Ecopath with Ecosim (EwE) software version 6.5. • Update the model with annual catch, discards, fishing mortality and fishing effort data for each functional group from 1993 to present. • Calibrate the model with new catch and effort time series to improve the reliability of model forecast outputs. • Produce annual ecological indicators for inclusion in the IATTC *Ecosystems Considerations* report as standardized measures of ecosystem integrity.
Background	• IATTC is committed, through the Antigua Convention, to ensure the long-term sustainability of all target, associated and dependent species impacted by EPO tuna fisheries. • Although the IATTC undertakes stock assessments for economically important species and ecological risk assessments (e.g. PSA, EASI-Fish) to prioritize research and management of non-target species, these single-species assessments do not take into account possible impacts on ecosystem dynamics through changes in the strength of trophic linkages due to anthropogenic and/or climate impacts. • Olson and Watters (2003) developed an Ecopath ecosystem model of the eastern tropical Pacific Ocean (ETP) to characterize the year 1993 and dynamic simulations extended to 1999. • No further updates or development of ecosystem models for the EPO has been undertaken by the IATTC staff due to the departure of key staff with ecological modelling expertise.
Relevance for management	• The ETP model will be available in EwE 6.5 that can more rapidly provide annual updates of a range of ecological indicators to provide standardized measures of the integrity of the ETP ecosystem. • The ETP model can be used to simulate 'what if' hypotheses relating to changes in fishing activities (e.g. use of FADs) and/or climate drivers on the ETP ecosystem structure, and individual functional groups and key species. • Conservation and Management Measures may be developed for vulnerable species based on model outputs.
Duration	36 months
Work plan and status	• Feb–May 18: conversion model to EwE version 6.5. • Mar 19: Update model with new catch data for 1993-2017. • Apr–May 19: Produce ecological indicator values for 1993-2017 and run hypothetical fishery scenarios and present findings at SAC-10. • Jun–Dec 19: Collaborate with the IATTC stock assessment group to update time series of biomass, fishing mortality and catch data for the ETP region. • Jan–Mar 20: Calibration of model to new data time series.

	• Apr–May 20: Produce ecological indicator values for 1993-2018 and run hypothetical fishery scenarios and present findings at SAC-11. • Jun–Dec 20: Explore expansion of ETP model to be spatially explicit using Ecospace. • Jan–Mar 21: Update model with new data for 1993-2019 and calibrate model to new data time series. • Apr–May 21: Produce ecological indicator values for 1993-2017 and run spatially explicit hypothetical fishery scenarios and present findings at SAC-12.
External collaborators	• None
Deliverables	• A new version of the ETP model Olson and Watters (2003) that will exist in the latest version of EwE software with updated data time series of catch, effort, and also biomass and fishing mortality where available. • Annual updates of ecological indicators to provide standardized measures of the integrity of the ETP ecosystem. • A preliminary spatially explicit version of the ETP model constructed in Ecospace software.

PROJECT O.2.b: An updated ecosystem model of the eastern tropical Pacific Ocean for providing standardized ecological indicators for monitoring of ecosystem integrity
Updated: May 2019
Progress summary for the reporting period • Olson and Watters (2003) model successfully transferred to EwE version 6.5 • New model updated with new catch data time series for 1993–2017. • Ecological indicator values for 1993–2017 produced from new model and hypothetical scenarios run relating to changes in effort in the EPO FAD fishery.
Challenges and key lessons learnt • The predator-prey matrix underlying the ecosystem model is based on stomach contents data from the early 1990s. The staff recommends that Proposal O.1.a be funded, to obtain updated samples • Obtaining biomass and fishing mortality estimates for target species from the stock assessment group to update the Ecopath model for SAC can be challenging since they are conducting assessments at the same time. Update of these parameters need to be undertaken between July and December.
Reports/publications/presentations • Presentation at SAC-10 • SAC-10-14 Ecosystem considerations • SAC-10-15 Towards standardized ecological indicators for monitoring ecosystem health: an updated ecosystem model of the tropical EPO
Comments: -

6. KNOWLEDGE TRANSFER AND CAPACITY BUILDING

PROJECT P.1.a: Fulfil requests for development of database and data processing applications for entities outside the IATTC	
THEME: Knowledge transfer and capacity building **GOAL:** P. Responding to requests from CPCs and other organizations **TARGET:** P.1. Respond to requests by CPCs **EXECUTION**: Data Collection and Database Program	
Objectives	Provide support to CPCs through the development of data collection forms and the most appropriate computer application to allow the collection, entry, editing and analysis of locally-collected datasets.
Background	• IATTC staff receives requests to develop data entry and editing solutions for data collected by outside organizations. • IATTC staff possesses years of experience in these tasks, which is not otherwise available to outside organizations. • Through a policy of Capacity Building the IATTC collaborates with outside organizations to develop the requested applications.
Relevance for management	Through collaboration with data collectors, IATTC may be granted access to new sources of fisheries management data.
Duration	Ongoing
Work plan and status	• Currently developing an Access database to process FAD information collected through Resolution C-16-01. • Request for additional form to be incorporated into the OSPESCA artesanal longline database. • Evaluate ability to accept participation in additional requests as they occur.
External collaborators	
Deliverables	• Completion of requested computer applications. • Provide technical support and training of the new applications.

PROJECT P.1.a: Fulfil requests for development of database and data processing applications for entities outside the IATTC
Updated: May 2019
Progress summary for the reporting period • All requests received have been addressed.
Challenges and key lessons learnt -
Reports/publications/presentations -
Comments: The current system for dealing with such requests appears adequate.

PROJECT P.1.b: Respond to requests for scientific analyses	
THEME: Knowledge transfer and capacity building **GOAL:** P. Responding to requests from CPCs and other organizations **TARGET:** P.1. Respond to requests by CPCs **EXECUTION**: Stock Assessment Program	
Objectives	Respond to requests by CPCs and other entities in a timely manner
Background	• The necessary information to make important management decisions is often situation dependent and evolves as discussions progress. • CPCs and other entities regularly make requests for analyses and other work that is not already contained in the Staff Work-Plan • The type of requests varies widely.
Relevance for management	Many requests by CPCs are directly used to inform management decisions
Duration	Ongoing
Work plan and status	The workplan cannot be anticipated
External collaborators	Varies
Deliverables	Varies. Can include reports and/or presentations to SAC and the IATTC meetings.

PROJECT P.1.b: Respond to requests for scientific analyses
Updated: May 2019
Progress summary for the reporting period ● This is an ongoing project that responds to *ad hoc* requests and the progress is dependent on the nature of the requests and the staff availability.
Challenges and key lessons learnt • The time needed to fulfill requests cannot be anticipated and therefore some requests may not be addressed in a timely manner depending on other responsibilities of staff
Reports/publications/presentations Various depending on the requests
Comments: The progress for this project is difficult to detail and interested parties are referred to the relevant documents prepared for each request

PROJECT P.1.b: Respond to requests for scientific analyses
Updated: May 2019
Progress summary for the reporting period • All requests received have been addressed.
Challenges and key lessons learnt -
Reports/publications/presentations -
Comments: The current system for dealing with such requests appears adequate.

PROJECT Q.1.a: Achotines Laboratory support of Yale University's Environmental Leadership Training Initiative (ELTI) in Panama	
THEME: Knowledge transfer and capacity building **GOAL:** Q. Training **TARGET:** Q.1. Host visiting scientists and students from CPCs **EXECUTION**: Biology and Ecosystems Program	
Objectives	To support the ELTI objectives of facilitating cooperation, training and research on the conservation, rehabilitation and restoration of forest lands and watersheds in Panama, and to conserve coastal and marine living resources and ecosystems
Background	• The Yale-ELTI Program has been holding training workshops at the Achotines Laboratory for several years and has created a teaching trail in the Achotines Forest which is a key component of their training workshops • To demonstrate good stewardship of the Achotines Forest and surrounding watershed, the Achotines Laboratory has expanded its support of the ELTI Program and will serve as the host center for the ELTI Program and training workshops • The ELTI training workshops have no footprint on the tuna research facilities at the Achotines Laboratory, and are restricted to the Laboratory conference center and the Achotines Forest
Relevance for management	The Achotines Laboratory support of the ELTI Program in Panama provides an important contribution to regional watershed restoration and conservation of coastal ecosystems in Panama
Duration	3 years
Work plan and status	April 2018-March 2021: Four training courses will be held each year at the Achotines Laboratory, with ELTI affiliates coordinating periodic updates and annual technical reports of activities
External collaborators	Yale University, ELTI Program
Deliverables	• Presentations for SAC-09, SAC-10 and SAC-11 • Annual technical reports prepared by ELTI affiliates

PROJECT Q.1.a: Achotines Laboratory support of Yale University's Environmental Leadership Training Initiative (ELTI) in Panama
Updated: May 2019
Progress summary for the reporting period • Four training courses, focused on the conservation, rehabilitation and restoration of forest lands and watersheds in Panama, were held at the Achotines Laboratory during April 2018-March 2019.
Challenges and key lessons learnt -
Reports/publications/presentations • Brief summaries of this initiative were included in presentations at SAC-09 and SAC-10. • An ELTI technical report covering the April 2018-March 2019 period is in preparation.
Comments: This initiative has been very successful. The Yale/ELTI Program has continued its focus on training for reforestation without any footprint on the tuna research facilities of the Achotines Laboratory. The IATTC has promoted good stewardship of the Achotines forest and is supporting watershed restoration and conservation of coastal ecosystems in Panama.

PROJECT R.1.a: Workshop on training, communication and evaluation of management strategies for tuna fisheries in the EPO	
THEME: Knowledge transfer and capacity building **GOAL**: R. Improve communication of scientific advice **TARGET**: R.1. Improve communication of the staff's scientific work to CPCs **EXECUTION**: Stock Assessment Program	
Objectives	Provide training and enhance communication between scientists and managers on management objectives, harvest strategies and management strategy evaluation (MSE).
Background	• Several tuna RFMOs are strengthening communications among scientists, managers and other stakeholders throughout similar workshops, including an initial one for the EPO in Panama (2015). • The IATTC Performance Review and Strategic Science Plan recommend improving knowledge sharing, human-institutional capacity building and communication of scientific advice.
Relevance for management	• Key elements of IATTC's management strategy, such as its harvest control rule and reference points, along with alternatives, are being evaluated via MSE. • Improving participation and communication among all stakeholders is important throughout the development, evaluation and implementation of a management strategy
Duration	• Planning and organization: 1-2 weeks • Workshop: 2 days (last quarter of 2018)
Work plan and status	• Form organizing committee to develop Workshop agenda. • Develop/tailor workshop materials (preferably in Spanish) to EPO tuna-management needs. • Likely topics: Objectives, tactics and strategies, Kobe plots, harvest control rules, reference points. MSE components, development and implementation. • Logistics: Confirm presenters, host country (Ecuador has expressed interest), travel, venue, accommodations, invite Commissioners (mainly from coastal states). • Conduct workshop with a format of both presentations and hands-on sessions with MSE "toy" models to illustrate main points, issues, trade-offs, and foster dialogue among Workshop participants.
External collaborators	WWF; Ocean Outcomes; ISSF
Deliverables	Workshop report and associated materials.

PROJECT R.1.a: Workshop on training, communication and evaluation of management strategies for tuna fisheries in the EPO
Updated: March 2019
Progress summary for the reporting period • The workshop was conducted in August 2018.
Challenges and key lessons learnt • The full cycle of an MSE will need several iterations of dialogs with stakeholders.
Reports/publications/presentations • Presentations, glossary and workshop report available on request. • Interactive application (In Spanish) illustrating major MSE features
Comments: The workshop was very well received. The participants from other t-RFMOs and institutions (FAO, ISSF, WWF, *etc*.) with direct experience of MSE greatly enriched the discussions. Doing the workshop in Spanish engaged better the native Spanish speakers in the discussions of the sophisticated concepts involved in the MSE process.

7. SCIENTIFIC EXCELLENCE

PROJECT T.1.a: External review of bigeye tuna assessment	
THEME: Scientific Excellence **GOAL:** T. Implement external reviews of the staff's research **TARGET:** T.1. Facilitate external reviews of stock assessments **EXECUTION**: Stock Assessment Program	
Objectives	• Review the assessment model used for bigeye tuna • Improve the assumptions made in the assessment
Background	• The bigeye tuna stock assessment was last independently reviewed in 2010 • Several issues have been identified in the stock assessment • The CAPAM workshop series has identified several modelling good practices that should be incorporated into the bigeye tuna assessment • Major improvements to the stock assessment are underway, including modelling of spatial structure • Review of the assessment is important to get external input into improving the assessment
Relevance for management	• The results of the bigeye assessment are used for management advice • Improvements in the stock assessment will improve the management advice
Duration	The project will extend over 2019, but the workshop will be a single week in Fall
Work plan and status	• Early 2019 identify review panel • Mid 2019 prepare documents describing major developments in the model • Fall 2019 Hold workshop • Fall 2019 Write workshop report
External collaborators	Independent reviewers
Deliverables	Workshop report

PROJECT T.1.a: External review of bigeye tuna assessment
Updated: May 2019
Progress summary for the reporting period • The review was conducted in March 2019 by a panel of 7 independent reviewers • The panel identified several potential improvements to the assessment
Challenges and key lessons learnt Several hypotheses were identified to explain the regime shift in recruitment, a few were able to substantially reduce the shift, but the cause could not be clearly identified
Reports/publications/presentations • Presentation at SAC-10 • Documents prepared by the staff for the review • Report of the Review panel
Comments:

PROJECT X.1.a: Workshop to advance spatial stock assessments of bigeye tuna in the Pacific Ocean	
THEME: Scientific excellence **GOAL:** X. Promote the advancement of scientific research **TARGET:** X.1. Continue the annual CAPAM workshops **EXECUTION**: Stock Assessment Program	
Objectives	• Bring together researchers to present and discuss the development and application of spatial stock assessments • Improve the bigeye tuna stock assessment
Background	• Properly accounting for the spatio-temporal distribution of both fishing effort and fish abundance has been one of the largest sources of uncertainty ignored in most stock assessments • Substantial progress has been made in both the statistical methodology and the practical implementation (e.g. software) of spatial stock assessment models • Tagging data show substantial directional movement of bigeye tuna in the EPO. • The current stock assessment model for bigeye lacks spatial structure, and does not explicitly take local depletion into account, thus resulting in apparent regime shifts in the estimated recruitment.
Relevance for management	• Knowledge gained from the workshop will be uses to improve the bigeye tuna stock assessment • Improvements in the bigeye assessment will improve management advice
Duration	October 2018
Work plan and status	• April 2018 – invite keynote speakers • August 2018 – prepare background material • October 2018 – Conduct workshop • November 2018 – Write workshop report • May 2019 – report to SAC
External collaborators	
Deliverables	Workshop report

PROJECT X.1.a: Workshop to advance spatial stock assessments of bigeye tuna in the Pacific Ocean
Updated: May 2019
Progress summary for the reporting period • The workshop was held in October 2018, with 10 invited presentations and 18 contributed presentations • IATTC staff gave six presentations and conducted a tutorial on implementing spatial models in Stock Synthesis
Challenges and key lessons learnt There are few examples of spatial models used for management advice
Reports/publications/presentations • Six presentations by staff members • A special issue of *Fisheries Research*, containing the presentations from the workshop, is in preparation
Comments: The workshop informed the staff's assessment of bigeye in the EPO

F. PUBLICATIONS

8. Peer-reviewed journal publications

Frisk, M. G., Dolan, T. E., McElroy, A. E., Zacharias, J. P., **Xu, H.**, & Hice, L. A. (2018). Assessing the drivers of the collapse of Winter Flounder: Implications for management and recovery. Journal of sea research, 141, 1-13.

Gilman, E., Chaloupka, M., Dagorn,L., **Hall, M**., Hobday,A., Musyl,M., Picher,T., Poisson,F., Restrepo,V., Suuronen,P. Robbing Peter to Pay Paul; replacing unintended cross-taxa conflicts with intentional tradeoffs by moving from piecemeal to integrated fisheries bycatch management.January 2019.Rev Fish Biol. Fisheries Online Dec 2018

Griffiths, S.P.; Allain, V.; Hoyle, S.D.; Lawson, T.A.; Nicol, S.J. 2018. Just a FAD? Ecosystem impacts of tuna purse-seine fishing associated with fish aggregating devices in the western Pacific Warm Pool Province. Fisheries Oceanography. 28: 94-112.

Lennert-Cody, C. E., Buckland, S. T, Gerrodette, T., Webb, A., Barlow, J., Fretwell, P., **Maunder, M. N**., Kitakado, T., Moore, J. E., **Scott, M. D**., Skaug, H. J. 2018. Review of potential line-transect methodologies for estimating abundance of dolphin stocks in the eastern tropical Pacific. Journal of Cetacean Research and Management, 19: 9-21.

Lennert-Cody, C.E. Moreno, G., Restrepo, V., **Román, M.H**., **Maunder, M.N.** 2018. Recent purse-seine FAD fishing strategies in the eastern Pacific Ocean: what is the appropriate number of FADs at sea? ICES Journal of Marine Science 75 (5), 1748-1757.

Lezama-Ochoa, N; Hall,M; Roman,M; Vogel, N. Spatial and temporal distribution of mobulid ray species in the eastern Pacific Ocean ascertained from observer data from the tropical tuna purse-seine fishery. 2019. Springer Nature B.V.pdf Online Dec 2018

Maunder, M.N., Deriso, R.B., Schaefer, K.M., Fuller, D.W., Aires-da-Silva, A.M., Minte-Vera, C.V., Campana, S.E. 2018. The growth cessation model: a growth model for species showing a near cessation in growth with application to bigeye tuna (Thunnus obesus). Marine Biology (2018) 165:76.

Minte-Vera,C.V., Maunder, M.N., Schaefer, K.M. Aires-da-Silva, A. M. in press The influence of metrics for spawning output on stock assessment results and evaluation of reference points: An illustration with yellowfin tuna in the eastern Pacific Ocean. Fisheries Research (https://doi.org/10.1016/j.fishres.2018.09.022)

Pethybridge, H.; Choy, C.; Logan, J.; Allain, V.; Lorrain, A.; Bodin, N.; Somes, C.J.; Young, J.; Ménard, F.; Langlais, C.; **Duffy, L**.; Hobday, A.; Kuhnert, P.; Fry, B.; Menkes, C.; **Olson, R.** 2018. A global meta-analysis of marine predator nitrogen stable isotopes: Relationships between trophic structure and environmental conditions. Global Ecology and Biogeography. 27:1043-1055.

Stein, M., **Margulies, D., Wexler, J.B., Scholey, V.P**., Katagiri, R., Honryo, T., Sasaki, T., Guillen, A., Agawa, Y., Sawada, Y. 2018. A comparison of the effects of two prey enrichment media on growth and survival of Pacific bluefin tuna, *Thunnus orientalis*, larvae. Journal of the World Aquaculture Society, 49: 240-255.

Valencia-Gasti, J.A., Weber, E. D., Baumgartner, T., Durazo, R., **Lennert-Cody, C.E.** and McClatchie, S. 2018. Spring Spawning Habitat of Pacific Sardine in US and Mexican Waters. CalCOFI Reports 59: 79-85.

Xu, H., Miller, T. J., Hameed, S., Alade, L. A., & Nye, J. A. (2018). Evaluating the utility of the Gulf Stream Index for predicting recruitment of Southern New England-Mid Atlantic yellowtail flounder. Fisheries oceanography, 27(1), 85-95.

Xu, H., Thorson, J. T., Methot, R. D., & Taylor, I. G. (2018). A new semi-parametric method for autocorrelated age-and time-varying selectivity in age-structured assessment models. Canadian Journal of Fisheries and Aquatic Sciences, 76(2), 268-285.

9. Reports

Clarke, S., Langley, A., **Lennert-Cody, C., Aires-da-Silva, A., and Maunder, M**. 2018. Pacific-wide Silky Shark (Carcharhinus falciformis) Stock Status Assessment. Western and Central Pacific Fisheries Commission Document WCPFC-SC14-2018/SA-WP-08.

Duffy, L.; Griffiths, S. 2018. Ecosystem Considerations. SAC-09-11. Inter-American Tropical Tuna Commission Scientific Advisory Committee Ninth Meeting. La Jolla, CA USA. 14–18 May 2018.

Griffiths, S.P.; Kesner-Reyes, K.; Garilao, C.V.; **Duffy, L.; Roman, M**. 2018. Development of a flexible ecological risk assessment (ERA) approach for quantifying the cumulative impacts of fisheries on bycatch species in the eastern Pacific Ocean. SAC-09-12. Inter-American Tropical Tuna Commission Scientific Advisory Committee Ninth Meeting. La Jolla, CA USA. 14–18 May 2018.

Johnson, K.F., Punt, A.E. and **Lennert-Cody, C.E**. 2018. Report fo the workshop on methods for monitoring the status of eastern Tropical Pacific dolphin populations. IATTC Special Report 22.

Lennert-Cody, C.E., Aires-da-Silva, A., Maunder, M.N. 2018. Updated stock status indicators for silky sharks in the eastern Pacific Ocean, 1994-2017. IATTC Document SAC-09-13.

Margulies, D., Scholey, V.P., Wexler, J.B., Mauser, E. Review of research at the Achotines Laboratory. IATTC Document SAC-09-14.

Maunder, M.N. 2018. Updated indicators of stock status for skipjack tuna in the eastern Pacific Ocean. Pages 25-31 in IATTC Stock Assessment Report 19.

Maunder, M.N., Xu, H., Minte-Vera, C., and Aires-da-Silva, A. 2018. Investigation of the substantial change in the estimated F multiplier for bigeye tuna in the eastern Pacific Ocean. IATTC Document SAC-09-INF-B.

Maunder, M.N., Lennert-Cody, C.E., and Román, M. 2018. Stock status indicators for bigeye tuna in the eastern Pacific Ocean. Pages 18-24 in IATTC Stock Assessment Report 19

Minte-Vera, C.V., Maunder, M.N., and Aires-da-Silva, A. 2018. Status of yellowfin tuna in the eastern Pacific Ocean in 2017 and outlook for the future. Pages 3-17 in IATTC Stock Assessment Report 19.

Moreno, G; Murua, J; **Hall, M; Altamirano, E**; Cuevas, N; Grande, M; Moniz, I; Sancristobal, I; Santiago, J; Uriarte, I; Zudaire, I y Restrepo, V. 2018. Technical Report ISSF 19A. Workshop for the reduction of the impact of fish aggregating devices structure on the ecosystem.

Murua, J., Moreno, G., Itano, D., **Hall, M**.., Dagorn, L., and Restrepo, V., 2018. ISSF Skippers Workshop Round 7. ISSF Technical Report 2018-01, International Seafood Sustainability Foundation, Washington, D.C., USA..pdf

Oedekoven, C.S., Buckland, S.T., Marshall, L., and **Lennert-Cody, C.E.** 2018. Design of a survey for eastern tropical Pacific dolphin stocks. IATTC Document MOP-37-02.

Scott, M.D.; Lennert-Cody, C.; Gerrodette, T.; Chivers, S.J.; Danil, K.; Hohn, A.A.; **Duffy, L.M.; Olson, R.;** Skaug, H.J.; **Minte-Vera, C.V**.; Fiedler, P.C.; Ballance, L.T.; Forney, K.A.; Ferguson, M.C.; Barlow, J. 2018. Data available for assessing dolphin population status in the eastern tropical Pacific Ocean. Inter-American Tropical Tuna Commission, Special Report 23:1-31.

Valero, J.L., Aires-da-Silva, A., Maunder, M.N., and Lennert-Cody, C. 2018. Exploratory spatially-structured assessment model for bigeye tuna in the eastern Pacific Ocean. Pages 32-97 in IATTC Stock Assessment Report 19.

Wang, S-P., **Maunder, M.N., Lennert-Cody, C.E., Aires-da-Silva, A**. 2018. CPUE standardization for bigeye tuna and yellowfin tuna caught by Taiwanese longline in the eastern Pacific Ocean. IATTC Document SAC-09-INF-F.

Xu, H., Minte-Vera, C., Maunder, M.N., Aires-da-Silva, A. 2018. Status of bigeye tuna in the eastern Pacific Ocean in 2017 and outlook for the future. IATTC Document SAC-09-05.

Xu, H., Lennert-Cody, C.E., Maunder, M.N., and Minte-Vera, C. 2018. Spatiotemporal dynamics of the dolphin-associated purse-seine fishery for yellowfin tuna in the eastern Pacific Ocean. IATTC Document SAC-09-09.

10. Conference and workshop presentations

Cusatti, S., **Scholey, V**., Agawa, Y., **Margulies, D., Wexler, J.,** Sawada, Y. 2018. Spawning ecology of captive yellowfin tuna (*Thunnus albacares*) broodstock inferred by the use of mitochondrial DNA sequencing analysis. Proceedings of the 69th Annual Tuna Conference, Lake Arrowhead.

Duffy, L.; Griffiths, S.; Lennert-Cody, C. 2018. Can we predict vulnerability of shark species in eastern Pacific Ocean tuna fisheries using environmental drivers and life history? PICES International Symposium: Understanding Changes in Transitional Areas of the Pacific, La Paz, Mexico. 24–26 April 2018.

Duffy, L.; Griffiths, S.; Lennert-Cody, C. 2018. Can we predict vulnerability of shark species in eastern Pacific Ocean tuna fisheries using environmental drivers and life history? The 69th Tuna Conference, Lake Arrowhead, CA. 21–24 May 2018.

Griffiths, S.; Duffy, L.; Roman, M. 2018. A flexible spatially-explicit ecological risk assessment approach for quantifying the cumulative impact of tuna fisheries on data-poor bycatch species caught in eastern Pacific Ocean transition areas. PICES International Symposium: Understanding Changes in Transitional Areas of the Pacific, La Paz, Mexico. 24–26 April 2018.

Griffiths, S.; Duffy, L.; Roman, M. 2018. A flexible spatially-explicit ecological risk assessment approach for quantifying the cumulative impact of tuna fisheries on data-poor bycatch species caught in the eastern Pacific Ocean. The 69th Tuna Conference, Lake Arrowhead, CA. 21–24 May 2018.

Lennert-Cody, C.E., Moreno, G., Restrepo, V., Lopez, J., **Román, M., Maunder, M.N**. Recent purse-seine FAD fishing strategies in the eastern Pacific Ocean: What is the appropriate number of FADs at sea? ISSF Side Event at IATTC Annual Meeting, August 24, 2018, San Diego, CA.

Lennert-Cody, C.E., Maunder, M.N., Minte-Vera, C., Xu, H., Valero, J., Aires-da-Silva, A., Lopez, J. A Multivariate Tree-based Method for Exploring Stock Structure in Multiple Data Sets. CAPAM workshop on the development of spatial stock assessment models, La Jolla, CA, USA, October 1-5, 2018.

Maunder, M.N. 2018. Likelihood functions for including CPUE based indices of abundance in stock assessment. CAPAM workshop on the development of spatio-temporal models of fishery catch-per-unit-effort data to derive indices of relative abundance in La Jolla, CA, USA, February 26-March 2, 2018.

Maunder, M.N., Thorson, J.T., **Xu, H**. 2018. Using spatio-temporal models of tagging data to deal with incomplete mixing. CAPAM workshop on the development of spatial stock assessment models, La Jolla, CA, USA, October 1-5, 2018.

Mauser, E., Margulies, D., Wexler, J., Stein, M., Scholey, V., Cusatti, S., Honryo, T., Katagiri, R., Kurata, M., Agawa, Y., Sawada, Y. 2018. Updated comparative analysis of the laboratory growth of yellowfin tuna (*Thunnus albacares*) and Pacific bluefin tuna (*Thunnus orientalis*) larvae, and growth of early-

juvenile yellowfin reared in land based tanks and a sea cage. Proceedings of the 69th annual Tuna Conference, Lake Arrowhead.

Valero, J.L. 2018. Modeling of EPO Tropical tunas and dorado. Shark-Tuna Stock Synthesis Workshop, La Jolla, Feb 21-23, 2018.

Valero, J.L. 2018. Spatial models in Stock Synthesis. CAPAM workshop on the development of spatial stock assessment models, La Jolla, CA, USA, October 1-5, 2018.

Valero, J.L. 2018. Incorporating tagging data in Stock Synthesis. CAPAM workshop on the development of spatial stock assessment models, La Jolla, CA, USA, October 1-5, 2018.

Valero, J.L. 2018. Estrategias de ordenación: objetivos, estrategias y tácticas, RCE. Taller de entrenamiento, comunicación y evaluación de estrategias de ordenación para pesquerías de atunes en el OPO. San Diego, USA, 25-26 de agosto de 2018.

Valero, J.L. 2018. Evaluación de estrategias de ordenación mediante simulación. Taller de entrenamiento, comunicación y evaluación de estrategias de ordenación para pesquerías de atunes en el OPO. San Diego, USA, 25-26 de agosto de 2018.

Valero, J.L., Minte-Vera, C. 2018. Progress on MSE work at IATTC. MSE Communications Workshop, San Diego, 14-16 January 2018.

Valero, J.L., Minte-Vera, C. 2018. Progress on MSE work at IATTC. Tuna RFMO Management Strategy Evaluation Working Group Meeting, Seattle, USA, 13-15 June 2018.

Valero, J.L., Maunder, M. N., Haikun Xu, Minte-Vera, C., Lennert-Cody, C., Aires-da-Silva, A. 2018. Exploratory spatial stock assessment of Bigeye tuna (*Thunnus obesus*) in the EPO. CAPAM workshop on the development of spatial stock assessment models, La Jolla, CA, USA, October 1-5, 2018.

Xu, H., Lennert-Cody, C.E., Maunder, M.N., and Minte-Vera, C. 2018. Spatiotemporal dynamics of the dolphin-associated purse-seine fishery for yellowfin tuna in the eastern Pacific Ocean. The 69th Tuna Conference, Lake Arrowhead, CA. 21–24 May 2018.

Xu, H., Lennert-Cody, C.E., Maunder, M.N., and Minte-Vera, C. 2018. Spatiotemporal dynamics of yellowfin tuna in the eastern Pacific Ocean. CAPAM workshop on the development of spatio-temporal models of fishery catch-per-unit-effort data to derive indices of relative abundance in La Jolla, CA, USA, February 26-March 2, 2018.

Xu, H., Lennert-Cody, C.E., Maunder, M.N., Minte-Vera, C., Valero, J., Lopez, J., Schaefer, K., Fuller, F., Hampton, J., and **Aires-da-Silva, A**. 2018. Estimating the movement rate of bigeye tuna in the eastern Pacific Ocean. CAPAM workshop on the development of spatial stock assessment models, La Jolla, CA, USA, October 1-5, 2018.

11. Awards

The Center for the Advancement of Population Assessment Methodology (CAPAM), cofounded by Mark Maunder of the IATTC staff, received the 2018 American Fisheries Society's (AFS) William E. Ricker Resource Conservation Award for improving the quantitative methods used in fisheries stock assessment.