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STAFF RESEARCH ACTIVITIES

This document presents the IATTC scientific staff's work plan for 2018-2023 and summarizes its current and planned research activities. Its broader research goals are set out in Document IATTC-93-06a, Strategic Science Plan, and proposed projects that are not currently funded are listed in Document IATTC-93-06c.

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A. INTRODUCTION

This document presents the staff's research and work plans for the next five years, as well as brief summaries of the 42 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.

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

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

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 2017 are listed in Section E.

B. 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 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 by 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	2017	Update	Indicators/ Exploratory	Benchmark	Update	Update	Update
Skipjack tuna	H.4.a	2004	Indicators	Indicators	Indicators	Indicators	Indicators	Indicators/ Tagging*
Bigeye tuna (EPO)	H.4.a	2017	Update	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						
Swordfish (south EPO)	H.7.b	2011				Benchmark		
Sailfish	H.7	2013						
Black marlin		Never						
Silky shark (EPO/Pacific wide)	H.7	2018	Indicators	Indicators	Indicators	Indicators	Indicators	Indicators/ Benchmark
Hammerhead sharks	H.5.b	Never						Indicators

Species	SSP ref.	Last assessed	2018	2019	2020	2021	2022	2023
Dorado	I.3.a	2016		Candidate RP and HCR				
COLLABORATIONS								
Pacific bluefin tuna	H.6.a	2016	Update	Projections	Benchmark	Projections	Update	Projections
North Pacific albacore tuna	H.6.a	2017						
Blue marlin	H.7	2013 benchmark/ 2016 update						
Blue shark	H.6.a	2017						
Shortfin mako shark	H.6.a	2015	Benchmark					
Swordfish (north Pacific)	H.7	2014						

*Conditional on multi-year tagging program

C. 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 (SSP ref.), the time frame for carrying each one out, and their funding status (**green**: funded; **red**: unfunded).

1. WORK PLAN TO IMPROVE STOCK ASSESSMENTS OF BIGEYE TUNA

Assessing the status of the tropical tuna stocks is the scientific staff's main responsibility. It constantly seeks to improve both its conventional stock assessments of yellowfin and bigeye tunas and its stock status indicators for skipjack, and had previously identified some issues that need to be addressed in the bigeye assessment. In particular, spatial structure needs to be considered, in order to minimize or eliminate biases, and the staff has recently initiated activities to introduce this in the assessment.

In the past, the staff has based its recommendation for the duration of the closure of the purse-seine fishery on the *F* multiplier, a parameter that relates fishing effort (*F*) to the maximum sustainable yield (MSY) of a stock. However, the staff concluded that the assessment model has become overly sensitive to the inclusion of new data and to previously-identified issues in the assessment (SAC-09 INF-B). For this reason, the *F* multiplier derived from the bigeye stock assessment is considered compromised, and the staff does not recommend using it to define management measures in 2018. This situation led the staff to refine and prioritize the work plan to improve the assessments of bigeye, to address these issues and improve the assessment in time to establish new management measures for 2021 and subsequent years, after the current tuna conservation resolution (C-17-02) expires. Several of the activities under the work plan will also contribute to improving assessments/indicators for yellowfin and skipjack tuna.

Main expected work plan deliverables (see Section D and IATTC-93-06c for additional results of individual projects)**:**
2018: Develop a spatially-structured stock assessment for bigeye tuna and other model improvements
2019: Exploratory bigeye tuna assessment (Report to SAC-10)
2020: Benchmark bigeye tuna assessment (Report to SAC-11)
2021: Exploratory Pacific-wide bigeye tuna assessment

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					
X.1	CAPAM workshop on recruitment: theory, estimation, and application in stock assessment models					
X.1.a	Workshop to advance spatial stock assessments of bigeye tuna in the Pacific Ocean					

SSP ref.	Target/Project	Timeframe & status				
		2017	2018	2019	2020	2021
H.1.e	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					
X.1	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					
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 Class 1-5 purse-seine vessels					
D.2.c	Pilot study of electronic monitoring of the activities and catches of Class-6 purse-seine vessels					
E.4.a	Multi-year tuna tagging study					

The proposed schedule of main activities leading to a benchmark bigeye tuna assessment in 2020 is summarized below:

2017	
October: CAPAM workshop on recruitment: theory, estimation, and application in fishery stock assessment models	
Collaboration with Japanese scientists on identifying targeting changes	Report, SAC-09
2018	
February: CAPAM workshop on the development of spatiotemporal models of fishery catch-per-unit-effort data to derive indices of relative abundance	SAC-09-09
Investigation of the relationship between fishing mortality and fleet capacity	Project J.2.a
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/February: Proposed longline CPUE workshop	Project H.1.d
March: Proposed bigeye tuna assessment independent review	Project T.1.a
May: Exploratory bigeye tuna assessment	Report, SAC-10
2020	
January: CAPAM workshop on natural mortality	
May: Benchmark bigeye tuna assessment	Report, SAC-11
August: New management recommendations to the Commission	IATTC annual meeting

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 D and IATTC-93-06c 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 preliminary simulation results from spatial OM for bigeye; 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

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												

SSP ref.	Target/Project		2018		2019		2020		2021		2022		2023	
			1	2	1	2	1	2	1	2	1	2	1	2
	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	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														
X.1.b	CAPAM workshop on operating models for MSE													

*Dependent on ISC scheduling

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 D and IATTC-93-06c 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

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 Class 1-5 purse-seine vessels					
D.2.c	Pilot study of electronic monitoring of the activities and catches of Class-6 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 D and IATTC-93-06c 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

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 Class 1-5 purse-seine vessels						
D.2.c	Pilot study of electronic monitoring of the activities and catches of Class-6 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						
H.5.b	Workshop series on data compilation and model development for hammerhead assessments						
H.7.d	Develop priors for shark stock-recruitment relationships						
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”						

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1. DATA COLLECTION FOR SCIENTIFIC SUPPORT OF MANAGEMENT

PROJECT A.1.a: Routine activities of the Bycatch and IDCP Program	
THEME: Data collection for scientific support of management **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
Work plan and status	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.3.a. Conversion of all remaining Visual Basic 6 (VB6) computer programs to Visual Basic Net (VB.net).	
THEME: Data collection for scientific support of management **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.
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	3 years
Work plan and status	• Late 2014: project initiated. • February 2018: conversion about 60% complete. • February-December: Continue conversion, prioritizing the most important computer programs.
External collaborators	
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.b: Develop databases of biological and fisheries parameters to support Ecological Risk Assessment and ecosystem models	
THEME: Data collection for scientific support of management **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	12 months
Work plan and status	• Months 1-6: conduct literature searches for species that interact with EPO fisheries • Months 7-12: 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 C.4.a: Improving data collection for Central American shark fisheries	
THEME: Data collection for scientific support of management **GOAL:** C. Facilitate the improvement of data quality, coverage, and reporting by CPC data collection programs **TARGET:** C.4. Artisanal fisheries (coastal developing CPCs) **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. • 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 2015-2018 from FAO-GEF in the framework of the *Common Oceans* tuna project, IATTC staff and an external consultant produced two reports summarizing the characteristics of Central American shark fisheries and compiled available catch information for the region. • As part of the same project, specific data gaps and areas for improvement in data collection were identified • In September 2017, a "Workshop to Develop a Pilot Study for a Shark Fishery Sampling Program in Central America" was convened 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, based on recommendations from the workshop, was funded in 2018 under the *Common Oceans* tuna project (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	OSPESCA
Deliverables	• Three quarterly reports • Final report describing technical findings

PROJECT D.2.a: Pilot study of electronic monitoring (EM) of the activities and catches of Class 1-5 purse-seine vessels	
THEME: Data collection for scientific support of management **GOAL:** D. Investigate the use of new technologies to improve data quality **TARGET:** D.2. Evaluate the feasibility of implementing on-board electronic monitoring (EM) systems for data collection purposes **EXECUTION**: Bycatch and IDCP Program and Data Collection and Database 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.

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. Obtain life history and stock structure information for spatially-structured stock assessments for tropical tunas **TARGET:** E.1. Initiate a long-term age and growth data collection and research program for 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	24 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.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. 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	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.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. Obtain life history and stock structure information for spatially-structured stock assessments for tropical tunas **TARGET:** E.3. Analyze historical tagging data to improve the assumptions about movement and stock structure in spatially-structured stock assessments of tropical tunas **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.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. Obtain life history and stock structure information for spatially-structured stock assessments for tropical tunas **TARGET:** E.5. Conduct genetic studies to improve the assumptions about life history and stock structure in stock assessments of tropical tunas **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.b: Investigate the spawning ecology of captive yellowfin tuna, using genetic analyses	
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.5. Conduct genetic studies to improve the assumptions about life history and stock structure in stock assessments of tropical tunas **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 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. Obtain key life history information for assessment and mitigation of ecological impacts on prioritized species **TARGET:** F.2. Conduct life history studies of shark species **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 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 the early life history of tunas to improve understanding of recruitment processes to improve assessments and management **TARGET:** G.1. Investigation of the effects of density dependence and the environment on the pre-recruit survival of yellowfin tuna **EXECUTION**: Biology and Ecosystem Program	
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.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 the early life history of tunas to improve understanding of recruitment processes to improve assessments and management **TARGET:** G.2. Conduct comparative studies of the early life histories of yellowfin and Pacific bluefin tunas **EXECUTION**: Biology and Ecosystem Program	
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.3.a: Develop a larval growth index to forecast yellowfin recruitment	
THEME: Life history studies for scientific support of management **GOAL:** G. Investigate the early life history of tunas to improve understanding of recruitment processes to improve assessments and management **TARGET:** G.3. Develop tools to forecast recruitment **EXECUTION**: Biology and Ecosystem Program	
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

3. SUSTAINABLE FISHERIES

PROJECT H.1.a: Improve the bigeye tuna stock assessment	
THEME: Sustainable fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.1. Undertake the research necessary to develop and conduct at least one benchmark stock assessment for yellowfin and bigeye tunas **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 • 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
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 • 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.b: Improve the yellowfin tuna stock assessment	
THEME: Sustainable fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.1. Undertake the research necessary to develop and conduct at least one benchmark stock assessment for yellowfin and bigeye tunas **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 is conducted every year • The current assessment model is an integrated model with a quarterly time step • Comparisons of yellowfin abundance estimates using different methods showed that monthly depletion models using only CPUE-based indices of relative abundance, catch-curve analyses, and the integrated stock assessment model produce similar results • A depletion-type integrated model has been successfully applied to assess the dorado stock in the EPO
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	• 2018: revise the catch estimation routines in R, estimate the catch in a monthly time step, create the monthly population dynamics model, compare the results with the current model • 2019: Apply data weighting, explore different assumptions (*e.g*. time-varying selectivity for floating-object fisheries), conduct diagnostic tests • 2020: Re-evaluate the model assumptions and include new data
External collaborators	
Deliverables	• Reports to SAC in 2019 • Report to SAC in 2020

PROJECT H.4.a: Conduct routine stock assessments of tropical tunas	
THEME: Sustainable fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.4. Develop update assessment and/or stock status indicators for tropical tunas to ensure that management advice is current **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.5.a: Revise trend estimation methods for purse-seine silky shark indices for the EPO	
THEME: Sustainable fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.5. Undertake the research necessary to develop and conduct data-limited assessments for prioritized 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.6.a: Participate in assessments of shared species by the International Scientific Committee (ISC)	
THEME: Sustainable fisheries **GOAL:** H. Improve and implement stock assessments, based on the best available science **TARGET:** H.6. Maintain active participation in 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 differ each year.
Relevance for management	The staff uses the results of the ISC assessments to provide management advice
Duration	Ongoing; ISC meets annually, usually in July
Work plan 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.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 the status of dolphin stocks in the eastern tropical Pacific **EXECUTION**: Stock Assessment Program	
Objectives	Design, in consultation with 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 and statement of the problem	• 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 US 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 requires that the status of all species potentially impacted by the tuna fisheries in the EPO be monitored. • In addition, abundance estimates are needed to ensure that incidental dolphin mortalities are both sustainable and insignificant because the AIDCP 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 status	• January - May: draft a report with survey design and budget. • June-August: obtain an external review of the draft report and revise as necessary.
External collaborators	University of St Andrews, Scotland
Deliverables	• Presentation for SAC-09 (May 2018) • Report and presentation for IATTC Annual Meeting in August 2018

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. Conduct a comprehensive MSE for bigeye tuna and plan MSEs for the other tropical tuna species, including the multi-species fishery for tropical tunas **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 are needed to guide the Commission in adopting a permanent HCR and its components.
Relevance for management	• Project results are 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 be useful for future MSE research that could include yellowfin and an evaluation of yellowfin and bigeye 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 HCRs, expanding on the existing Stock Synthesis simulation model for bigeye, and reports, to be presented to SAC-09/10.

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. Initiate MSE work to evaluate indicator-based harvest strategies for prioritized species and species of specific interest **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 IATTC Members 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), RPs, and HCRs, 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 implementing RPs and HCRs 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; presentation at SAC-10 in 2019.

PROJECT J.2.a: Quantify the relationship between vessel operational characteristics and fishing mortality	
THEME: Sustainable fisheries **GOAL:** J. Improve our understanding of the effects of the operational characteristics of the fishery on fishing mortality, stock assessments, and management advice **TARGET:** J.2. Improve our understanding of the relationship between the operational characteristics of the purse-seine fishery 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 (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 K.1.a: POSEIDON project	
THEME: Sustainable fisheries **GOAL:** K. Improve our understanding the socio-economic aspects of sustainable fisheries for tropical tunas **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 affect 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
Deliverables	• A computer algorithm with which to run simulations to explore management options. • A project report and possibly publications in peer-reviewed journals.

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. Evaluate the ecological impacts of tuna fisheries **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.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. Evaluate the ecological impacts of tuna fisheries **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 are 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.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. Evaluate the ecological impacts of tuna fisheries **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	
Deliverables	Manuscripts demonstrating IATTC's approaches to ecosystem-related research for data-limited species

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. 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**: 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.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.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. Mitigate the ecological impacts of tuna fisheries **TARGET:** M.2. In collaboration with the industry, conduct scientific experiments to develop best practices for the release of prioritized 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.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. Mitigate the ecological impacts of tuna fisheries **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 analyzed 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.5.a: Develop and test non-entangling and biodegradable FADs	
THEME: Ecological impacts of fisheries: assessment and mitigation **GOAL:** M. Mitigate the ecological impacts of tuna fisheries **TARGET:** M.5. In collaboration with the industry, conduct experiments to develop best practices for mitigating the impacts of fishing on habitats in the EPO **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 are an important factor in FAD fishery management. • Results may be useful for CPCs 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 2018: Project report
External collaborators	TUNACONS
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.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. Mitigate the ecological impacts of tuna fisheries **TARGET:** M.5. In collaboration with the industry, conduct experiments to develop best practices for mitigating the impacts of fishing on habitats in the EPO **EXECUTION**: Bycatch and IDCP Program	
Objectives	Identify the key issues to prevent the loss or to recover FADs and propose a plan to mitigate the impacts
Background	• The members of the IATTC have expressed interest in reducing the number of lost FADs at sea, and the strandings in areas of ecological or touristic value, by promoting their recovery, and to minimize their ecological impacts: creation of marine debris, ghost fishing, strandings in sensitive habitats. • If losses or strandings cannot be prevented, alternatives to implement recovery programs should be considered.
Relevance for management	• The Antigua Convention strives to implement the standards of the FAO Code of Conduct for Responsible Fisheries, which include the promotion of use of selective and environmentally safe fishing gear and practices, and the conservation of aquatic ecosystems. • Habitat destruction and the effect on fisheries of derelict fishing gear have been identified as a detrimental consequence of discarded fishing gear.
Duration	1 year
Work plan and status	• Identification of possible stranding sites affected by lost FADs associated with the fishery for tunas. • Attend a workshop convened by ISSF on FAD research in general. • Conduct surveys with fishing entities and operators from the region, and from the western and central Pacific, to estimate the degree of lost gear, and the predominant locations and periods. • Conduct surveys with possible stakeholders affected in coastal areas to assess the level of impact. • Identify the feasibility to use drift models to identify possible areas of impact of abandoned/lost FADs. • Conduct a two-day seminar with relevant stakeholders, to identify possible options for mitigation, retrieval, and/or clean-up of areas impacted by abandoned/lost FADs.
External collaborators	An oceanographer to model movements of FADs based on observer data, and drift models to predict impacted areas.
Deliverables	December 2018: Report for IATTC staff review.

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. Improve our understanding of the interactions among environmental drivers, climate, and fisheries **TARGET:** N.1. Conduct spatiotemporal analyses to better understand the effect of key environmental drivers on the short-term fluctuations of abundance of tunas and prioritized bycatch species **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 staff 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 (2018)
Work plan and status	• Jan-Apr: exploratory analyses of IATTC observer catch data and oceanographic conditions over the past two decades • Apr-May: present results at the international PICES conference, “Understanding Changes in Transitional Areas of the Pacific” and the 69th Tuna Conference • Jun-Jul: Prepare a manuscript for publication in a scientific journal
External collaborators	
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.b: Investigate the effects of wind-induced microturbulence on yellowfin larval survival	
THEME: Interactions among the environment, the ecosystem. and fisheries **GOAL:** N. Improve our understanding of the interactions among environmental drivers, climate, and fisheries **TARGET:** N.1. Conduct spatiotemporal analyses to better understand the effect of key environmental drivers on the short-term fluctuations of abundance of tunas and prioritized bycatch species **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.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. Improve our understanding of the interactions among environmental drivers, climate, and fisheries **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 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 our understanding of the EPO ecosystem **TARGET:** O.2. Improve analytical ecological 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 spatiotemporal 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 analyze 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.

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. Respond in a timely manner to external requests for information and technical support **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 artisanal 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.b: Respond to requests for scientific analyses	
THEME: Knowledge transfer and capacity building **GOAL:** P. Respond in a timely manner to external requests for information and technical support **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	
Work plan and status	The work plan cannot be anticipated
External collaborators	Varies
Deliverables	Varies. Can include reports and/or presentations to SAC and the IATTC meetings.

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. Provide training opportunities for scientists and technicians of CPCs **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 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 through 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

7. SCIENTIFIC EXCELLENCE

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 spatiotemporal 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 used 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

E. PUBLICATIONS AND PRESENTATIONS

1. PEER-REVIEWED JOURNAL PUBLICATIONS

Alatorre-Ramirez, G., V., Galvan-Magaña, F., Rojas, Y. E., and **Olson, R. J.** 2017. Trophic segregation of mixed schools of yellowfin tuna *Thunnus albacares*. U.S. Nat. Mar. Fish. Serv. 115 (1): 252-268.

Aschenbrenner, A., Freitas,M.O, Rocha, G.R.A, Moura, R.L, Francini-Filho, R.B. **Minte-Vera,C.,** Ferreira, B.P. 2017. Age, growth parameters and fisheries indices for the lane snapper in the Abrolhos Bank, SW Atlantic. Fisheries Research 194:155-163

Carvalho, F., Punt, A. E., Chang, Y. J., **Maunder, M. N.**, Piner, K. R. 2017. Can diagnostic tests help identify model misspecification in integrated stock assessments? Fisheries Research. 192: 28-40.

Chang S-K, Liu H-I, Fukuda H, **Maunder M. N.** 2017 Data reconstruction can improve abundance index estimation: An example using Taiwanese longline data for Pacific bluefin tuna. PLOS ONE 12(10): e0185784.

Duffy, L. M., Kuhnert, P. M., Pethybridge, H. R., Young, J. W., **Olson, R. J.,** Logan, J. M., Goñi, N., Romanov, E., Allain, V., Staudinger, M. D., Abecassis, M., Choy, C. A., Hobday, A. J., Simier, M., Galván-Magaña, F., Potier, M., and Ménard, F. 2017. Global trophic ecology of yellowfin, bigeye, and albacore tunas: understanding predation on micronekton communities at ocean-basin scales. Deep Sea Research Part II: Topical studies in Oceanography. 140: 55-73

Freitas, M.O., Abilhoa, V.A., Spach, H.L, **Minte-Vera, C.V**., Francini-Filho, R.B., Kaufman, L., Moura, R.L. 2017. Feeding ecology of two sympatric species of large-sized groupers (Perciformes: Epinephelidae) on Southwestern Atlantic coralline reefs. Neotropical Ichthyology 15(2): e160047

Griffiths, S.P., Fry, G.F., Manson, F.J and Pillans, R. 2017 Morphometric relationships for four Scombridae fish species in Australian waters. Journal of Applied Ichthyology 33(3), 583-585.

Guilltreau, P., Squires, D., Sun, J., and **Compeán, G. A.** 2017. Local, regional and global markets: what drives the tuna fisheries? Rev. Fish Biol. Fish. 27(4): 909-929

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Honryo, T., M. Kurata, A. Guillen, Y. Tamura, A. Cano, **M. S. Stein**, **D. Margulies, V. P. Scholey**, and Y. Sawada. 2017. Optimal period for the effective promotion of initial swim bladder inflation in yellowfin tuna, *Thunnus albacares* (Temminck and Schlegel), larvae. Aquaculture Research, 1-4.

Kai, M., Thorson, J.T., Piner, K.R., **Maunder, M.N.** 2017. Spatiotemporal variation in size-structured populations using fishery data: an application to shortfin mako (*Isurus oxyrinchus*) in the Pacific Ocean. Canadian Journal of Fisheries and Aquatic Sciences, 74(11): 1765-1780.

Kai M, Thorson J.T, Piner K.R, **Maunder M.N.** Predicting the spatio-temporal distributions of pelagic sharks in the western and central North Pacific. Fish Oceanogr., 26:569–582.

Katagiri, R., T. Sasaki, A. Diaz, M. Ando, **D. Margulies**, **V.P. Scholey**, and Y. Sawada. 2017. Effect of taurine enrichment in rotifer (Brachionus sp.) on growth of larvae of Pacific bluefin tuna *Thunnus orientalis* (Temminck & Schlegel) and yellowfin tuna *T. albacares* (Temmink & Schlegel). Aquaculture Research, 48: 3013-3031.

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Lee, H-H., Piner, K.R., **Maunder, M.N**., Taylor, I.G., Methot JR., R.D. 2017. Evaluation of alternative modelling approaches to account for spatial effects due to age-based movement. Canadian Journal of Fisheries and Aquatic Sciences, 74(11): 1832-1844.

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Maunder, M.N., Crone, P.R, Punt, A.E.**, Valero, J.L., Semmens B. X.** 2017. Data conflict and weighting, likelihood functions and process error. Fisheries Research. 192: 1-4.

Maunder, M. N. and Piner, K. R. 2017. Dealing with data conflicts in statistical inference of population assessment models that integrate information from multiple diverse data sets. Fisheries Research. 192: 16-27.

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Pons, M., Branch, T.A., Melnychuk, M.C., Jensen, O.P., Brodziak, J., Fromentin, J.M., Harley, S.J., Haynie, A.C., Kell, L.T., **Maunder, M.N.** and Parma, A.M., 2017. Effects of biological, economic and management factors on tuna and billfish stock status. Fish and Fisheries, 18: 1-21.

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2. REPORTS

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Griffiths, S. and **Duffy, L.** 2017. A preliminary metadata analysis of large-scale tuna longline fishery data in the eastern Pacific Ocean: a precursor to ecological risk assessment. IATTC Document SAC-08-07b.

Griffiths, S., Duffy, L., and **Aires-da-Silva, A.** 2017. A preliminary ecological risk assessment of the large-scale tuna longline fishery in the eastern Pacific Ocean using productivity-susceptibility analysis. IATTC Document SAC-08-07d.

Hall, M. and **Román, M.H.** 2017. The fishery on fish-aggregating devices (FADs) in the eastern Pacific Ocean – update. IATTC Document SAC-08-03e.

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Román, M.H., Lennert-Cody, C.E., Maunder, M.N., Aires-da-Silva, A. and **Vogel, N.W.** 2017. A review of fishery data available for small purse-seine vessels, with emphasis on FADs. IATTC Document SAC-08-06a.

Valero, J.L., Maunder, M.N., Aires-da-Silva, A.M., Minte-Vera, C., and Zhu, J. 2017. Limit reference points in marine resource management and their application for tuna and billfish stocks. IATTC Document SAC-08-05e (ii).

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3. CONFERENCE AND WORKSHOP PRESENTATIONS

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Maunder, M.N. and Piner, K.R. Over 20 years of fisheries stock assessment research and we are back almost where we started: a discussion and some ways forward. ICES Annual Science Conference, Fort Lauderdale, USA, 18–21 September 2017.

Maunder, M.N. Crone, P.R., Semmens, B. X. and **Valero, J.L.** CAPAM Stock Assessment Methods Workshop Series: Successes, Challenges, and Advice for the Future. ICES Annual Science Conference, Fort Lauderdale, USA, 18–21 September 2017. (Invited)

Maunder, M.N. and Piner, K.R. Quest for the holy grail: the stock-recruitment curve in fishery stock assessment. Center for the Advancement of Population Assessment Methodology (CAPAM) workshop - Recruitment: theory, estimation, and application in fishery stock assessment models, Miami, FL, USA, October 30th-November 3rd, 2017

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Minte-Vera, C.V., Maunder, M.N., Crone, P., Thorson,J., Piner., K., **Aires-da-Silva, A**. Improving estimates of abundance using regional recruitment signals derived from meta-analysis of stock assessments. Recruitment: theory, estimation, and application in fishery stock assessment models, Miami, FL, USA, October 30th-November 3rd, 2017

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Scholey, V., Margulies, D., Wexler, J., and Stein, M. 2017. Review of research activities at the IATTC's Achotines Laboratory, 2016-2017. Proceedings of the 68th annual tuna conference, Lake Arrowhead. https://docs.wixstatiC.com/ugd/ba25d2_48bea89fedac488ba999120fa4d50ee2.pdf