INTER-AMERICAN TROPICAL TUNA COMMISSION

SCIENTIFIC ADVISORY COMMITTEE

NINTH MEETING

La Jolla, California (USA)
14-18 May 2018

REPORT OF THE MEETING

AGENDA

	Documents
1. Opening of the meeting	
2. Adoption of agenda	
3. Research planning:	
a. Strategic Science Plan	SAC-09-01
b. Staff activities and research work plan	SAC-09-02
4. Review of the implementation of recommendations adopted in previous SAC meetings, progress and outcomes	
5. The fishery:	
a. The fishery in 2017	SAC-09-03
b. National reports	
c. Longline observer program reports	
d. The fishery on FADs in the EPO (update)	SAC-09-04
6. Stock assessments:	
a. Bigeye tuna: assessment for 2017	SAC-09-05
b. Yellowfin tuna: assessment for 2017	SAC-09-06

	c. Skipjack tuna: indicators of stock status	SAC-09-07
	d. North Pacific albacore tuna: update on management strategy evaluation (MSE) work	
	e. Report of the ISC Shark Working Group: shortfin mako assessment	
7.	Modelling:	
	a. Analyses of the effects of target selection by fisheries on longline CPUE standardization for bigeye tuna in the EPO	
	b. Exploratory spatially-structured assessment model for bigeye tuna	SAC-09-08
	c. Spatial-temporal modeling of yellowfin CPUE data	SAC-09-09
	d. Design of a tropical EPO dolphin survey	
	e. Pacific bluefin tuna:	
	i. Report of the ISC Bluefin Working Group	
	ii. Joint tuna RFMO meeting	
8.	Data collection:	
	a. Electronic monitoring of small purse-seine vessel activities and catches: progress report	
9.	FADs	
	a. Non-entangling and biodegradable FADs: progress report	SAC-09-10
	b. Report of the *Ad Hoc* Working Group on FADs	
10.	Ecosystem and bycatch:	
	a. Ecosystem considerations report	SAC-09-11
	b. An ecological risk assessment (ERA) approach for quantifying the impact of tuna fisheries on bycatch species in the EPO	SAC-09-12
	c. Report of the Working Group on Bycatch	
11.	Sharks:	
	a. Updated results of FAO-GEF shark project: pilot study for shark fishery sampling program in Central America	
	b. Updated purse-seine indicators for silky sharks in the EPO	SAC-09-13
12.	Life history	
	a. Review of research at the Achotines Laboratory	SAC-09-14
13.	Staff recommendations to the Commission	SAC-09-15
14.	SAC recommendations to the Commission	
15.	Other business:	
	a. Strengthening and streamlining the IATTC scientific process and the presentation to the Commission of the conclusions and recommendations of the SAC	
16.	Adjournment	

1. OPENING OF THE MEETING

The Director of the IATTC and Chairman of the SAC, **Guillermo Compeán**, opened the meeting, for which a quorum had been achieved. He welcomed the participants, and introduced the IATTC's new Coordinator of Scientific Research, **Alexandre Aires da Silva**, of whose appointment, effective 1 October 2017, CPCs had been already informed.

Luis Fleischer was appointed rapporteur for the meeting.

2. ADOPTION OF AGENDA

The provisional agenda was adopted with the following amendments:

a. Sub-item 15.a, *Review of the implementation of recommendations adopted in previous SAC meetings, progress and outcomes*, was moved to a new item 4;
b. Sub-item 6.d on Pacific bluefin tuna was moved to item 7, *Modelling*;
c. Items 9 and 10, *Ecosystem* and *Bycatch*, were combined into a single item 10, *Ecosystem and bycatch*;
d. Sub-item 10.a on sharks was moved to a new item 11, *Sharks*.

Unlike in previous years, the staff would present its recommendations on a particular topic individually, under the agenda item on that topic, rather than collectively at the end. However, they would be discussed under agenda item 13.

3. RESEARCH PLANNING

3.1. Strategic Science Plan (SAC-09-01)

Guillermo Compeán introduced this item, recalling that the drafting of the Strategic Science Plan (SSP; Document SAC-09-01) was part of a process that emerged from the 2016 performance review of the Commission. The SSP was part of a broader strategic plan that would also affect the staff's other activities.

Alexandre Aires da Silva gave a detailed presentation of the SSP. It establishes research goals, activities, and priorities for the 2019-2023 period. The staff's activities are classified into seven main areas, called *Themes*, which form the principal strategic pillars of the SSP:

1. Data collection
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*, which constitute the scientific staff's primary responsibilities. They form a structured framework for the staff's research activities during the SSP's five-year window, a road map for the principal tasks that will be carried out to achieve a particular goal. These are called *Targets*, and 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*.

These *Projects*, which together constitute the staff's concrete work plan, are not specified in Document SAC-09-01; they are elaborated in detail in Document SAC-09-02a, *Staff Activities and Research Work Plan.*

Whether a *Project* is undertaken at any given period (*e.g.* year) within the five-year time frame of the SSP will depend on the staff's research priorities, the human, logistic, and financial resources available, and any specific instructions from the Commission.

After the presentation, several participants made comments or asked questions.

a. Most participants expressed satisfaction, highlighting the merits and value of such a plan, which would allow the various projects and programs in the future to be integrated into the structured roadmap proposed for implementing the Commission's mandate under the Antigua Convention. Some participants complimented specific components of the SSP, such as its mission and vision, and the Strengths-Weaknesses-Opportunities-Threats (SWOT) analysis.
b. Several participants emphasized that the plan should not be for the scientific staff and its activities alone, but for the Commission as a whole, which would require a balance between its internal aspects and those related to relationships with CPCs, individually and collectively, and with relevant international organizations, including other RFMOs, especially in the Pacific region, and particularly the WCPFC.
c. Some participants expressed concern about the resources required for full implementation of the SSP, and stressed the importance of specifying priorities and of including only attainable objectives. It was clarified that more concrete priorities become more obvious at the project level and specific projects would be discussed under other agenda items.
d. Various comments were made on the drafting and content of the SSP, including: introducing new topics and emphasizing existing ones (capacity-building, cooperation, coordination and dialogue with CPCs and relevant international organizations (other RFMOs, WCPFC), *etc.*); greater precision regarding processes, schedules, and deadlines; including estimates of budgetary and other needed resources; more appropriate language (for instance, "maintenance" and "review" are not strategic objectives, unless suitably defined); and formulating objectives in a way that would allow measurement of performance and degree of achievement, including adopting SMART (Specific-Measurable-Attainable-Relevant-Timely) objectives.
e. The staff stressed that the document was a draft, which would be amended before being presented to the Commission, and that concrete suggestions for improvements were welcome.
f. Since a detailed review of the SSP would not be possible during the meeting, various proposals for conducting that process during the intersessional period were considered. **Ecuador** suggested a special meeting of CPCs, but other participants, noting the timing and funding difficulties for such a meeting, preferred working by correspondence.

3.2. Staff activities and research work plan (SAC-09-02a)

Alexandre Aires da Silva introduced this item. He informed the SAC about the new structure of the staff activities and research work plan report, and how it is linked with the SSP.

The new structure of this report reflects the structure of the SSP, and is different from previous years. Activities (projects) are no longer categorized by the staff's four research programs, but by the seven themes in the SSP. A one-page summary is provided for each ongoing or planned (but already funded) project included in the staff's activities. These summaries describe the objectives of each project, as well on its duration, workplan, status, external collaborators, and deliverables. Also, although the SSP has a five-year time frame, individual research projects are planned with two-year time frames (biennial activity research plan). The intention is that, in future years, this report will serve two purposes: 1) report on progress in the previous year; 2) present the workplan for the following two years. However, this initial report is presented in draft form for consideration by the SAC, and the projects it contains may extend beyond that time frame, and do not include certain elements, like budgets. The timing and duration of projects should be regarded as indicative, since they will be subject to many factors that are sometimes difficult to predict and beyond the staff's control.

After this introduction, the head of each research program made a presentation on its activities:

Mark Maunder (Stock Assessment);
Dan Margulies (Biology and Ecosystem);
Nick Vogel (Data Collection and Database);
Martín Hall (Bycatch and International Dolphin Conservation Program (IDCP)).

Additionally, **Shane Griffiths** (Biology and Ecosystem; Ecosystem Group) and **Kurt Schaefer** (Biology and Ecosystem; Biology Group) made presentations on the activities of their respective groups,

During the ensuing discussion, the following general points were made:

a. **Venezuela**, noting that some activities are carried out by the Commission staff and some by external individuals or entities in collaboration with the staff, suggested that these two categories be identified in posted documentation, perhaps via a list of external collaborators involved in specific projects.
b. The **European Union** stressed the importance of indicating clearly which projects or components of projects were supported by the regular IATTC budget, by extrabudgetary funds, or by a combination of both. **Alexandre Aires da Silva** noted the distinction between "projects" (SAC-09-02a), which were already funded, and "proposals" (SAC-09-02b), referring to projects whose funding was still pending.
c. The **European Union** made the following drafting suggestions:
    i. add tables with schedules and deadlines for the implementation of the projects;
    ii. include specific references to the process of dialogue and meeting with stakeholders;
    iii. include links in the projects to some of their most important outputs.
d. **Alexandre Aires da Silva** pointed out that the expected deliverables were specified for each project in its respective summary table, to allow progress to be evaluated and quantified.

The following questions were asked on specific projects:

a. **Tuna tagging project** and **dolphin population survey**: **Mexico** asked about the status of these projects, both of which it considered very important and worthy of the necessary resources. The staff explained that funding for both projects was still being sought.
b. **South Pacific albacore tuna and swordfish,** and **sharks**: Project H.6.a focused on North Pacific albacore; South Pacific albacore, which was being assessed by the WCPFC, could be included in section H.7 of the SSP, on other species of interest, which already includes a South Pacific swordfish assessment. South Pacific blue shark and mako sharks are not mentioned specifically in the SSP because, in view of the trans-Pacific character of the stocks, the staff relies mainly on collaborations with the ISC (for northern stocks) and the Secretariat of the Pacific Community (SPC) and WCPFC (for southern stocks). In recent years, the staff has collaborated with the ISC to conduct assessments of blue and mako sharks in the North Pacific. Depending upon the quality of the data, availability of staff resources, and opportunities for external collaborations, assessments of the southern shark stocks could be planned under Targets H.5 and H.7 of the SSP.
c. **Data collection:** The staff's ongoing efforts to improve the quality of the longline data are covered under agenda item 7.
d. **Early life history studies:** The studies of the effects of climate change on tunas require a captive spawning population, and only yellowfin are available at the Achotines Laboratory. Extending the studies to other species, such as skipjack or bluefin tuna, would require additional funding and approval by Kindai University, the IATTC's partner in this research.

4. REVIEW OF THE IMPLEMENTATION OF RECOMMENDATIONS ADOPTED IN PREVIOUS SAC MEETINGS, PROGRESS AND OUTCOMES

Guillermo Compeán and **Alexandre Aires da Silva** presented a summary table of follow-up actions to recommendations made by the SAC at its previous meeting.

a. **Dorado:** The staff confirmed that funds for the work on reference points for dorado (Project I.3.a) had been approved in 2017, but became available only in 2018, and work would start this year.
b. **Sorting grids:** The staff would coordinate research and a schedule with the industry and government of **Ecuador**, although funding is not expected until later in 2018.
c. **Limits on FADs:** The staff's recommendations (SAC-09-15) included a limit on the number of sets on FADs, as adopted by several other RFMOs, and in accordance with Resolution C-99-07, which calls for the development of a study on the "establishment of a maximum number of sets on floating objects which the tuna fishery in the EPO can support". Such limits should be meaningful and based on objective elements, as recommended by the SAC, rather than on a negotiated compromise.
d. **Fin-to-carcass ratio for sharks:** The shark research plan needed to address this and other issues, and the **European Union** asked that the staff develop a proposal to advance in this evaluation, pending since 2005, in particular to define what is needed from CPCs. The current project on shark sampling in Central America covered only some CPCs and fleets. **Costa Rica** requested that the forms used for the shark sampling project include a field for recording weight of fins.
e. **Analysis of impacts of mortality of juvenile tropical tunas.** This was included in the stock assessments, whose results would be presented to the meeting.

The **European Union** thanked the staff for the review, which had proved very positive and useful, and requested that this exercise be continued at future meetings of the SAC, as requested by the Committee at a previous meeting.

5. THE FISHERY:

5.1. The fishery in 2017 (SAC-09-03)

Nick Vogel presented SAC-09-03.

Key points:

a. **Catches:** The catches of 606,000 metric tons (t) of yellowfin, skipjack, bigeye, and Pacific bluefin tunas by purse-seine and recreational gears in the EPO in 2017 were 6% higher than the 15-year average.
b. **Catches by species and flag:** Ecuadorian vessels took about 47% of the total tuna catch in the EPO in 2017, including 58% of the skipjack and 57% of the bigeye. Mexican vessels caught 39% of the yellowfin and nearly all the bluefin.
c. **Yellowfin:** Most of the catches in 2017 were taken in sets associated with dolphins in three main areas: from 10°N to the coast of Mexico, east of the Galapagos Islands to the coast of South America, and offshore below the equator between 110° and 130°W. Overall catches in 2017 decreased by 8% from the previous 5-year average. The average weight in 2017, 7.2 kg, was higher than in 2016, but lower than any of the other annual averages during 2012-2017.
d. **Skipjack:** The distribution of catches in the EPO in 2017 closely matched the previous 5-year average, in both total catches and types of sets. Most of the catch was taken in sets associated with floating objects throughout the EPO, with lesser amounts taken in unassociated sets east of the Galapagos Islands and near the coast of Peru. The total 2017 catch, 326,000 t, was 11% higher than the previous 5-year average. The average weight was also higher than in 2016, and consistent with the average annual weights during 2012-2017.
e. **Bigeye:** The catch distributions in 2017 were very similar to the average annual distributions for 2012-2016 throughout the EPO. Most of the catches occurred between 10°N and 15°S in sets associated with floating objects. The total 2017 catch, 66,000 t, was 12% higher than the 2012-2016 average. The average weight in 2017 was consistent with the previous two years.

Discussion:

a. **South Pacific albacore**: Longline vessels do not register to fish for albacore specifically. Total catches remain within historic levels, but catches in the EPO have increased in recent years.
b. **Dolphin-associated fishery:** The reduction in the number of dolphin sets, and the decrease in catches on dolphins, could be due to changes in abundance of yellowfin, whose recruitment had been low in recent years, but also to other factors that could affect its availability, and hence catches and effort: oceanographic variations, fisheries effects, and vulnerability due to vertical distribution, among others.
c. **Floating-object sets**: the increase in the number of these sets might be due to vessels rushing to maximize their catches ("race to fish") before the catch limit in Resolution C-17-01 was reached. However, these sets had been increasing consistently since about 2011, before that resolution was implemented (SAC-09-03, Tables A-7 and A-8). Separate analyses of catches and effort in the first and second semesters of the year should be presented at the Commission meeting in August.
d. **Bigeye**: Some fleets are increasing their catches of bigeye, and redirecting their effort by set type, possibly due to changes in the geographical distribution of effort. The average weight of bigeye in the purse-seine catch was 4.7 kg in 2017. The staff's conservation recommendations do not include a specific strategy to reduce the catch of juveniles, but rather a reduction of fishing effort (if needed) which will achieve the Commission's target reference point (F_{MSY}) for the current mix of size selectivities operating in the fishery. However, the current conservation measures, which include temporal and spatial closures for the purse-seine fishery, reduce catches regardless of the size of the fish.
e. **Longline data:** CPUE data from Japanese longline fisheries are currently the only indices of abundance from longline fisheries used in the tropical tuna assessment. The staff is exploring stronger collaborative efforts on longline CPUE research with scientists from China, Chinese Taipei, and Korea, and plans to incorporate any other reliable CPUE in the assessments of bigeye and yellowfin in the future.
f. **Pacific bluefin:** The catch of 4,019 t in 2017 is preliminary, since it includes only purse-seine catch; longline catch data are not yet available. However, Pacific bluefin is not targeted by the longline fishery, and its catch is typically low, around 10 t. The catch of Pacific bluefin in the EPO is very seasonal and confined to a small area off the coast of Southern California and the northern coast of Mexico, where there is no longline effort.
g. **Mexico** had provided size data for Pacific bluefin to the IATTC staff from 2012 to present, and intended to also provide size data from 2013-2017, obtained with stereoscopic underwater cameras, previously provided to the ISC.

5.2. National reports

Guillermo Compeán introduced this item, noting that only the European Union had submitted a national report for consideration by the SAC. He clarified that the report is voluntary, and that a template for the report had been sent to CPCs on 26 March 2018.

5.3. Longline observer program reports (SAC-09 INF-A)

Brad Wiley presented SAC-09-INF-A, *Summarized overview of longline observer reporting by CPCs pursuant to Resolution C-11-08*.

Key points:

a. The SAC established three reporting requirements under C-11-08: 1) annual summary reports, in a format developed in 2014; 2) operational-level longline observer data, in a format adopted at SAC-08

(2017); 3) metadata descriptions of fleet characteristics, in a format adopted at SAC-07 (2016).

b. Only one of the ten CPCs providing summary reports for 2017 reported its longline effort and observer coverage rate using the measure of effort established by the SAC in 2012 of "effective days fished." This suggests that the SAC should establish a new standard measure of effort.
c. The IATTC staff proposed new standard data fields for the summary reports, including the use of total hooks as the new measure of effort, and increased longline observer coverage.
d. Only two CPCs have provided their operational longline observer data for 2013-2017, the period that C-11-08 has been in force.
e. Only one CPC has completed the metadata form for its longline fleet that was adopted by SAC-07.

Discussion:

a. In Table 3 of SAC-09 INF-A, Chinese Taipei and the United States are shown as the only CPCs to submit operational observer data for 2013-2017. Red and yellow cells meant no data submitted; however, a yellow cell also indicated that the CPC had difficulty in submitting 2016 data by the deadline of 31 March 2017 established in the Resolution. The deadline for submitting other fisheries data under C-03-05 is 30 June, and some CPCs might not be able to provide complete longline observer data by the earlier deadline.
b. **Nicaragua**, **Peru** and **Venezuela** noted that their classification as non-compliant with reporting requirements was incorrect because they had no longline vessels subject to Resolution C-11-08 fishing in the EPO in 2017. The staff undertook to update SAC-09-INF-A accordingly.
c. The staff's statement that it did not know how many longline vessels operate in the EPO caused surprise and disappointment. Although the Regional Vessel Register includes all vessels authorized by CPCs to fish in EPO, the staff did not have data on which vessels were actually active in the area and fishing for IATTC species in any given year. The staff requests this type of information, but reporting it is not obligatory, and this was one of the issues addressed by the staff proposal for summary reporting standards.
d. With the new reporting requirements for operational observer data, the staff could in principle generate some of the information in the national summary reports, but only if CPCs submitted all operational observer data. Additionally, the data submitted would need to be truly operational, set-by-set data, and a proposal submitted by **Japan** to amend the minimum data standards for longline observers agreed by SAC-08 in 2017 might prevent this. **Japan** then withdrew its proposal, so the minimum standards remained unchanged.
e. **Chile** noted that it had 100% observer coverage of its longline vessels, and thus collected important data, but they targeted swordfish rather than tuna, and only one vessel was greater than 20 m length overall.
f. **Martín Hall** suggested that longline observer data should distinguish between "Manta rays and other mobulids" and "pelagic stingrays", as the latter are highly abundant and the former a conservation concern. He also stressed that the condition of mobulids upon release should be recorded.

5.4. The fishery on FADs in the EPO (update) (SAC-09-04)

Martín Hall presented SAC-09-04.

Key points:

a. The presentation described some characteristics of the FAD fishery, including effort by set type, numbers and proportions over time, and increases in some types of sets.
b. The number of sets with no catch has not changed, despite increases in the number of FADs deployed.
c. The difference between the number of FADs deployed and subsequently recovered has been increasing since 2010.

d. Large-scale deployments of FADs by a few vessels have increased the average number deployed per vessel, but the median is slightly lower.

Discussion:

a. **Class 1-5 vessels:** Understanding fleet dynamics, especially spatiotemporal relationships between FAD deployments and later catches by small vessels (Class 1-5) in specific regions, is important. Logbook data are not always available for Class 1-5 vessels, and the lack of observer data impedes progress on this issue, so electronic monitoring may help considerably. The difficulties for expanding the fishing area for smaller vessels were also noted.
b. **Entanglements in FADs:** The reasons for the very low frequency of recorded entanglements in FADs, especially of sharks and turtles, include the wider use of non-entangling designs, lower shark densities compared to other oceans, and the use of finer mesh. However, observations are opportunistic, and these values are difficult to quantify.
c. **FAD retrievals:** The increasing difference between the number of deployments and retrievals of FADs since 2010 could be due to: i) more FADs are being lost or abandoned simply because more are being deployed, ii) the fishery has expanded to the western EPO, and FADs are being allowed to drift westward out of the EPO.
d. **FAD deployments:** Although some vessels are deploying greater number of FADs compared to previous years, the median number of FAD deployments per vessel had not changed much in recent years, although some very large values had been observed. The number of deployments is only one of the metrics that can be considered for managing the fishery, others include the number of sets.
e. **Catch-per-set (CPS):** Regarding CPS dynamics on FADs, including the relationship with number of FADs deployed, historically and recently, obtaining robust CPS indices is difficult, for several reasons (lack of FAD density information, inability to track FADs between fishing trips, *etc*.); both negative and positive results had been obtained in different studies. Interviews with vessel captains indicated negative relationships in some areas, due to school fragmentation linked to high FAD densities as well as to changes in fishing strategy (sets conducted on FADs with less time in the water). A detailed analysis on the FAD deployment-CPS relationship (Document SAC-09-INF-D) found positive relationships. Good data are needed to better understand the impact of FAD densities on CPS, which may not be related to individual vessel deployments.
f. **Definition of FAD sets:** The IATTC does not have a specific definition of a FAD set for observers, who do not decide the set type, but record various parameters of a set (use of helicopter, characteristics of the object, *etc*.) which, along with other data (port sampling, catch data, *etc*.), are used to classify it. The staff is working to develop a classification algorithm for set types, using different data sources (observer, logbook, port sampling, set time, position, *etc*.).
g. **Species composition around FADs:** The species composition of aggregations around FADs is of limited use for defining set type, since it can change over time, with higher proportions of bycatch species at the beginning.

6. STOCK ASSESSMENTS:

The results of the staff's bigeye assessment, and particularly the large change in the *F* multiplier[1] from the 2017 value, had led the staff to re-examine the methodology used and to develop alternatives. Nonetheless, the assessment was presented to the SAC (6.1), followed by an analysis of the reasons for

[1] *F* multiplier = F_{MSY} (the fishing mortality that will produce the maximum sustainable yield) divided by $F_{current}$ (the average fishing mortality for the three most recent years). An *F* multiplier of 1.0 means that the fishery is meeting the management goal of fishing at the level of the maximum sustainable yield ($F_{current} = F_{MSY}$); if it is below 1.0, fishing mortality is excessive ($F_{current} > F_{MSY}$).

the change (6.1.1), and the presentation of stock status indicators as an alternative basis for conservation recommendations (6.1.2).

The assessment results, specifically the *F* multiplier, suggested that the current 72-day seasonal closures should be extended to 107 days. However, the staff was recommending no change in the duration of the closures, for two reasons: 1) there is too much uncertainty in the current bigeye tuna assessment to support modifying the current management measure; and 2) the current fishing mortality for yellowfin is at about the level corresponding to the MSY. However, taking into account the continuing increase in effort in the purse-seine fishery, in terms of the number of sets, the staff was recommending, in the context of precautionary management, a limit on the total number of floating-object and unassociated sets (see section 13).

6.1. Bigeye tuna: assessment for 2017 (SAC-09-05)

Haikun Xu presented SAC-09-05.

Key points:

a. The assessment model is the same as in the previous assessment, but includes new and updated data from both surface and longline fisheries.
b. Fishing mortality (*F*) rates for young fish (associated with floating-object fisheries) reached a historical high level in 2017.
c. The base case assessment suggests that the stock is not overfished ($S_{recent}/S_{MSY} = 1.02$), but overfishing is occurring (*F* multiplier = 0.89).
d. The spawning biomass ratio (SBR) declined to a historical low level of 0.15 in 2013, then increased markedly to 0.23 in 2016, due mainly to a strong recruitment in 2012.
e. SBR is estimated to have decreased to 0.22 in 2017, which in the model is mainly caused by the decreases in the CPUE of the longline fisheries for bigeye from 2016 to 2017.
f. At current levels of *F* and average recruitment for the future, SBR is predicted to drop below SBR_{MSY}.
g. The terminal year estimates are very uncertain (low precision), but the proposed limit reference points of 0.38 S_{MSY} and 1.6 F_{MSY} have not been exceeded.
h. It is likely that the strong 2016 El Niño had a positive effect on bigeye recruitment, but this cannot yet be detected in the assessment model. Therefore, future SBR is probably underestimated by the base case model.

This presentation was discussed jointly with the presentation on the next item (6.1.1).

6.1.1. Investigation of the substantial change in the *F* multiplier for bigeye tuna in the eastern Pacific Ocean

Mark Maunder presented SAC-09-INF B.

Key points:

a. The *F* multipliers estimated in the assessments of bigeye and yellowfin tuna in the EPO are used as a basis for the IATTC scientific staff's recommendations for management measures, specifically the duration of the seasonal closures.
b. The *F* multiplier for bigeye estimated in the SAC-09 assessment (0.87; SAC-09-05) is substantially lower than that estimated in the SAC-08 assessment (1.15; SAC-08-04a).
c. This is due mainly to the new data for the indices of relative abundance, based on longline CPUE, which resulted in lower estimates of recent biomass.
d. The new length-composition data incorporated in the SAC-09 assessment also contribute to a lower *F* multiplier.

e. There is substantial uncertainty in the estimates of the *F* multiplier and in the model assumptions.
f. In view of this substantial uncertainty and need to improve the bigeye assessment, the staff will not base its management recommendations to the Commission on this year's assessment (see section XX-recommendations below). and has developed a comprehensive work plan to address this uncertainty and model misspecification, which will greatly improve the assessment of the bigeye stock.

Discussion

Several participants thanked the staff for its transparency in pointing out the weaknesses of the current stock assessment model, and expressed full support for the plan to improve the assessment, as the radical change in the *F* multiplier could provoke critical and difficult management decisions. Although not conducting a new assessment until 2020 might be later than ideal to inform management, the planned schedule, with the independent review in March 2019, gives the staff enough time to both do the research required to inform the review panel and incorporate its suggestions in time to present an improved exploratory model at SAC-10 in May 2019.

a. **Japan** noted that in 2017 and 2018 the Japanese longline fishery experienced low bigeye CPUE, so the pessimistic assessment may reflect reality, and proposed that, if the stock assessment in 2019 was similarly pessimistic, the SAC should recommend a revision of management measures, in accordance with paragraph 22 of C-17-02. Other participants suggested that waiting until 2020 would allow sufficient time to evaluate the effect of the current measures.
b. The effect of the large catches of bigeye in 2017 and the apparently similar trend in 2018 is difficult to predict, but if the increased catches are due to increased recruitment, it may not be a problem.
c. Despite the uncertainties, the assessment indicates strongly that the high mortality of juveniles should be reduced; catches could be larger if the average size was greater. However, skipjack, not bigeye, is the main target of this multi-species fishery; also, longline *F* would have to be increased about 4-5 times to match the level of the purse-seine catches, which might not be feasible.

Japanese longline data, currently the best available information, are used as the basis of the CPUE estimates used in the assessment. The staff is working actively with Japan to improve the indices, with plans to incorporate data from other fleets to further improve CPUE estimates. **Carolina Minte-Vera** described the nominal CPUE data available for the distant-water longline fleets.

The staff also has a longline CPUE standardization exercise planned, similar to those conducted in other oceans, in which data for all fleets will be combined through collaboration with longline fishing nations and the WCPFC. Several CPCs had expressed interest in participating, and **Korea** confirmed its commitment to this collaboration.

The following recommendations were made:

a. Strengthen research on spatiotemporal dynamics, including tagging, to clarify the spatial structure of the populations and the effects of fishing in both the eastern and western Pacific, and collaborate with the WCPFC to achieve those goals.
b. Collaborate with the WCPFC on growth studies, to investigate differences in assumptions regarding age and growth. A workshop on estimating growth of tunas was also suggested, since assumptions about growth are determinant of the results of stock assessments by both commissions, and recently resulted in a major change in the stock status of bigeye at the WCPFC.

6.1.2. Stock status indicators for bigeye tuna

Mark Maunder presented SAC-09-16.

Key points:

a. The staff developed a suite of stock status indicators for bigeye because several uncertainties were identified in the update assessment of bigeye conducted in 2018, which made its usefulness for management questionable
b. All bigeye indicators, except catch, show strong trends over time, indicating increasing fishing mortality and reduced abundance, and are at, or above, their reference levels.
c. Additional analyses suggest that the method currently used to calculate the number of days fished on floating objects is biased towards an increasing trend in days fished, which also will bias the catch-per-day-fished (CPDF).
d. The increasing number of floating-object sets, particularly sets on fish-aggregating devices (FADs), and the decreasing mean weight of the bigeye in the catch, continue to indicate that the bigeye stock in the EPO is under increasing fishing pressure.
e. Measures additional to the current seasonal closures, such as limits on the number of floating-object sets, are required.
f. The number of floating-object sets, per day and per vessel, is increasing, probably due to the vessels' increased efficiency in finding FADs with tuna due to the increased number of FADs and the increased use of satellite-linked fish-detecting sonar buoys, and further investigation into this phenomenon should be conducted.

Discussion:

This was combined with the discussion of item 6.1.3 below.

6.1.3. Adjusting set limits for number of FAD deployments

Mark Maunder presented this topic.

Key points:

a. Any limit on the number of sets needs to consider the increase in the catch per set (CPS) resulting from the improved fishing efficiency of the purse-seine fleet.
b. The catch-per-successful-set (CPSS) has been shown to increase with the number of FAD deployments.
c. Limiting the number of FADs per vessel is problematic because the number of FADs owned per vessel is not known, the appropriate number of FADs per vessel cannot be determined with the available data, and there would be several issues associated with monitoring the number of FADs per vessel.
d. The staff developed a factor to adjust the annual limits on the number of sets to compensate for the increase in the number of FAD deployments.
e. Due to the practical difficulties of monitoring floating-object sets alone, the staff recommends that the limit be applied to both floating-object and unassociated sets combined.

Discussion:

a. Different opinions were expressed on whether, if a limit on FAD sets led to a "race to fish", this would lead to more sets on sub-optimal FADs, with resulting reduced catches, or whether it would motivate vessels to find the most productive FADs in order to maximize the catch per set, although the seasonal closure would offset this by limiting the time available to search for the best FADs.

6.2. Yellowfin tuna: assessment for 2017 (SAC-09-06)

Carolina Minte-Vera presented SAC-09-06.

Key points:

a. The same model was used as for the 2016 assessment, but with new and updated data included.
b. The annual recruitments during 2015-2017 were estimated to be at, or above, the average.
c. The spawning biomass ratio (SBR) at the start of 2018 was above the MSY level, and is predicted to increase during 2019-2020 and level off at about the MSY level, if fishing mortality (F) remains at current levels and recruitment is average.
d. Recent F is slightly above the MSY level (F_{MSY}; F multiplier = 0.99).
e. Current spawning biomass (S) is above the MSY level (S_{recent}/S_{MSY} = 1.08).
f. Recent biomass of fish aged 3+ quarters (B) is above the MSY level (B_{recent}/B_{MSY} = 1.35).
g. The highest F has been on fish aged 11-20 quarters (2.75-5 years). The average annual F has been increasing for all age classes since 2009, but in 2017 it showed a slight decline for all age groups.
h. The following topics continue to be a priority for future research to improve the yellowfin stock assessment:
    i. Analyze whether changes in spatial distribution of effort and in targeting for the southern longline fishery invalidate the use of its CPUE as the main abundance index in the assessment model, and whether a time change in selectivity is needed.
    ii. Explore the use of a model with a monthly time step.
    iii. Implement a large-scale tagging program to address hypotheses about stock structure and regional differences in life-history parameters and depletion.
    iv. Improve estimates of growth, particularly for older fish.
    v. Explore different assumptions in the model, such as weighting of the different data sets, refine fisheries definitions, time-variant selectivity, alternative assumptions about stock structure.

Discussion:

a. Regarding the robustness of the assessment, and whether it had weaknesses similar to the bigeye assessment, it was clarified that the model is anchored to size-composition data, so in that regard is more robust. Also, in the bigeye assessment the size-composition data are down-weighted to resolve the apparent regime shift in bigeye recruitment, but these data are fully considered in the yellowfin assessment. In 2017 the staff compared several models, including depletion, integrated, and age-structured production models; all produced similar results, so the staff has more confidence in the model used this year. The dolphin-associated purse-seine fishery takes most of the yellowfin catch, whereas the bigeye catch is mostly taken him the purse-seine fishery on floating objects, whose selectivity is more variable. The signals from the size data are clearer in the yellowfin analysis because the dolphin fisheries catch much larger fish than the floating-object fisheries.
b. The strong recruitment estimated for 2017 will lead to increased spawning biomass in the future, but the estimate should be viewed with caution because of the retrospective pattern in the model; the terminal-year estimate could decrease when more data are included.

It is important for managers and stakeholders to understand the uncertainty around F_{MSY}, illustrated by the wide confidence intervals around the terminal estimate of F_{MSY} on the Kobe plot (SAC-09-06, Figure 5). Additional results on uncertainty were presented this year for bigeye, using likelihood profiling. Quantifying uncertainty is important as steps are taken towards a comprehensive management strategy evaluation (MSE) process, which will involve scientists, managers and stakeholders.

6.3. Skipjack tuna: indicators of stock status (SAC-09-07)

Mark Maunder presented SAC-09-07.

Key points:

a. Eight data- and model-based indicators were developed for skipjack.
b. These indicators have not detected any adverse impacts on the stock from the fishery.
c. Average weight was below its lower reference level in 2015 and 2016, which could be a consequence of overexploitation, high recent recruitments, or expansion of the fishery into areas of smaller skipjack.
d. The constantly increasing catch and CPUE, and corresponding estimates of recruitment and biomass, are difficult to reconcile.
e. The increasing number of sets remains a concern.
f. Skipjack is assumed to be managed appropriately under the current bigeye and yellowfin measures, but the current bigeye assessment is problematic.

Discussion:

a. An analysis by the staff showed a correspondence of the catch per set of skipjack with the Niño 3 index, with higher catch rates a year after strong El Niño conditions followed by sharp declines with the following La Niña conditions. There was a strong El Niño event during 2015-2016, and thus a high probability of a subsequent large recruitment. The catches in 2016 and 2017 were indeed high, but in 2018 to date were much lower than during the same period in the last three years, because that strong cohort is fished out.
b. A clarification was asked about this year's staff's concern on skipjack stock status, unlike in previous years. It was clarified that in previous years the status of bigeye could be used as an indicator for skipjack. Because skipjack is more productive, it was assumed that if bigeye is not overfished, skipjack would also not be, as both species are managed together. This rationale cannot be used this year since a reliable assessment for bigeye is not available. Also, there is concern about the increasing number of sets on floating objects, whose main target is skipjack.
c. The increase in the floating-object CPUE could be due to an increase in the relative efficiency of the floating-object fishery. However, the CPUE in unassociated sets is also increasing; therefore, there could be other processes in play.

The SAC expressed concern that indicators are still being used to assess skipjack, and supported the implementation of a well-designed, reliable, EPO-wide tagging program, complemented with genetic studies, that could be used to estimate a number of components of a stock assessment model for skipjack, and would also benefit the assessments of other tunas. If the 3-year tagging experiment (Project E.4.a in SAC-09-02b) were fully funded, the initial results could be available in 3-4 years, as specified in the SSP. The **European Union** had indicated interest in funding one year of the project (~US$ 2.5 million).

Alternatives to the proposed tagging project, such as the development of CPUE indices from "intelligent" FADs, the use of a depletion model, and, once the model for bigeye is improved, a method based on the ratio between bigeye and skipjack, could be tested. However, all these have a much lower probability of success than the tagging program in terms of enabling an accurate assessment of skipjack.

6.4. North Pacific albacore tuna: update on Management Strategy Evaluation (MSE) work

Desiree Tommasi presented this topic.

Key points:

a. The ISC Albacore Working Group developed a management strategy evaluation (MSE) framework for North Pacific albacore to test alternative management strategies and reference points for this stock.

The MSE framework contains a set of operating models (OMs) established to test the robustness of such strategies to uncertainty. The 27 OMs developed were conditioned on historical CPUE, length-composition, and catch data; eight that avoided unrealistic biomass trends or duplication of similar trends were selected as the final set of OMs.

b. Fifteen harvest control rules, agreed upon with stakeholders, with a common total allowable catch but different target, limit, and threshold reference points, were tested using this framework, as was a total allowable effort rule based on the IATTC harvest strategy for tropical tunas.
c. Changing target reference points had the largest impact on performance metrics, and highlighted a trade-off between management objectives for depletion and catch. A lower target fishing intensity ($F_{50\%}$, $F_{40\%}$, and $F_{30\%}$) led to a lower probability of total biomass depletion being above the historical (2006-2015) minimum, but a higher probability of catch being above historical (1981-2010) average.
d. Since North Pacific albacore is in a good condition (current total biomass depletion is 63%), the stock did not fall below any of the potential limit reference points in the base case MSE simulation. However, in a low productivity uncertainty scenario, the control rule with the highest fishing intensity ($F_{30\%}$) increased the probability of spawning biomass falling below the limit reference point.

Discussion:

Noting the collaboration of scientists, managers and other stakeholders in defining objectives and harvest strategies in the ISC Albacore Working Group, the SAC agreed on the importance of similar dialogs for communicating the technical details of MSE. It is important for all stakeholders to be involved in any such group from the beginning, so that they can participate in the process and better understand its output.

6.5. Report of the ISC Shark Working Group: shortfin mako assessment

Steve Teo presented this topic.

Key points:

a. The preliminary results of the first stock assessment of shortfin mako shark in the North Pacific Ocean, developed by the ISC Shark Working Group, were presented.
b. Time-series data of catch, relative abundance, and sex-specific length composition from multiple fisheries were developed for the 1975-2016 period. In addition, new biological information, and research into parameterization of the Beverton-Holt stock-recruitment relationship enabled the development of a size-structured model, using Stock Synthesis.
c. The current spawning abundance (SA_{2016}), calculated as the number of adult females, was estimated to be 860,200 sharks (CV=46%), and was 36% (CV=30%) higher than the estimated spawning abundance at MSY (SA_{MSY}).
d. The spawning potential ratio (SPR) was used to describe the fishing intensity (1-SPR) on this stock. It fluctuated between 0.1 and 0.4 during the assessment period. The recent annual fishing intensity (1-$SPR_{2013\text{-}2015}$) was estimated to be 0.16 (CV=38%), and was 62% (CV=38%) of fishing intensity at MSY (1-SPR_{MSY}; 0.26).
e. The preliminary results from the base case model suggest that, relative to MSY, the stock is probably (>50%) not overfished, and overfishing is probably (>50%) not occurring.
f. Several sensitivity analyses were conducted to evaluate the effects of changes in the model. Preliminary results of these models with alternative states of nature were consistent with the base case model.

Discussion:

a. There is uncertainty about life history, reproductive characteristics and the stock-recruitment relationship in shark assessments. Japanese scientists are investigating how to use better-known life

history parameters for estimating priors and parameter values for stock-recruitment relationships for sharks. The **United States** supported the staff's proposals for future research on such relationships.

b. The ISC Shark Working Group completed assessments of the North Pacific blue shark in 2017 and of the shortfin mako shark in 2018. It discussed whether to (i) continue alternating between these two species or (ii) assess other pelagic shark species in the North Pacific, such as salmon or bigeye thresher sharks. Given the limited resources available, the habitat and fisheries of those other species, and the room for improvement in the current assessments, the Working Group chose the first option. The next assessment will thus be of North Pacific blue shark.

7. MODELLING:

7.1. Analyses of the effects of target selection by fisheries on longline CPUE standardization for bigeye tuna in the EPO

Keisuke Satoh presented this topic.

Key points:

a. IATTC staff and NRIFSF, Japan, conducted cooperative work for improving standardization of bigeye CPUE data from Japanese longline fisheries in the EPO, with emphasis on changes in targeting practices by the fleet.
b. Recent EPO-wide changes in species and size composition of the catch and gear configuration in these fisheries were investigated, as were CPUE trends by gear configuration.
c. Possible effects of changes in targeting practices on CPUE in the tropical EPO were discussed.
d. The goal was to gain a better understanding of current fishing strategies through interviews with fishers, according to the interview the in-water hook depth was estimated using observer data, and attempting to incorporate oceanographic data into CPUE standardization models.

Discussion:

a. The choice of the 85% threshold value for defining potential target species was arbitrary, but in preliminary analyses had produced robust results.
b. Scientists from other CPCs with longline fleets, such as China, Chinese Taipei, and Korea, were invited to initiate collaborations similar to the ongoing IATTC-NRIFSF collaborations on topics important for tuna assessments, such as longline CPUE standardization and aging tunas from otoliths.

7.2. Analysis of longline CPUE data from Chinese Taipei

Sheng-Ping Wang presented this topic.

Key points:

a. The analyses were conducted collaboratively with the IATTC staff, using daily operational-level catch and effort data of the Chinese Taipei longline fishery operating in the EPO during 1980-2016.
b. Cluster analysis methods were used to identify fishing operations, defining target for each set, and delta-lognormal general linear models were used for the CPUE standardizations.
c. The models that included cluster identifier as a proxy for targeting effect performed better than the model that included the number of hooks between floats (HBF) as a targeting effect.
d. Standardized CPUE of bigeye decreased before 2014, with fluctuations, with an increasing trend in recent years, while yellowfin CPUE showed a continuously decreasing trend before 2009, and fluctuated since then.

Discussion:

a. This type of collaboration, like that with Japan, should be expanded to all CPCs with longline fleets, and also among CPCs.
b. Effort by the Chinese longline fleet has increased substantially, and is now twice that of the Japanese fleet, so it is important to include data from China in the indices, as well as the other longline fleets.
c. Interest was expressed in extending this type of collaborative work on longline CPUE standardization to other species, such as South Pacific albacore.
d. The group agreed to discuss in the future whether the standardized indices based on Chinese Taipei and Japanese longline data could be compared, and whether a combined index based on data for both fleets could be produced.
e. **Ecuador** voiced support for a recommendation for a stock assessment of South Pacific albacore, noting that it could contribute data on catches by its longline fleet.

7.3. Exploratory spatially-structured assessment model for bigeye tuna (SAC-09-08)

Juan Valero presented SAC-09-08.

Key points:

a. Better understanding of bigeye spatial structure and dynamics will improve not only stock assessments, but also operating models for ongoing MSE work.
b. The current bigeye assessment assumes a single stock in the EPO, and thus no localized spatial dynamics.
c. Spatial mismatch hypothesis: restricted movements in some areas, combined with spatial heterogeneity of catches, suggest that localized depletion of bigeye sub-stocks may occur in the EPO. If the assessment is mis-specified in this regard (*i.e.*, does not take these local spatial patterns into account), this might explain the anomalous "two-regime" recruitment pattern.
d. Two modeling approaches were used to evaluate the spatial mismatch: a spatially-structured ASPM (Age-Structured Production Model), and an integrated model for the EPO Central area.
e. Both approaches show the largest biomass declines in the Equatorial areas. ASPM shows a two-regime recruitment pattern in several areas, but the integrated model does not; this is consistent with the spatial mismatch hypothesis.
f. Using smaller areas alone to resolve the spatial mismatch between purse-seine catches and longline CPUE will not be enough; length-composition data are also needed.
g. The two-regime pattern could possibly be an artifact of assuming that bigeye in the EPO form a single homogeneous stock, when in fact the dynamics of the stock and the fisheries are more localized. This should be taken into account in the assessment model.
h. Alternative spatial management measures for bigeye in the EPO should be evaluated.

Discussion:

a. The work already done for improving the bigeye assessment, which shows that a spatially-structured approach helps resolve the problems in the assessment, including the two-regime recruitment pattern, could potentially allow full use of the length-frequency data, and this will make the model more stable. Research on spatially-structured modeling should continue as a potential basis for recommendations related to spatial closures. The relevance of results should be used to help plan subsequent spatial analysis work. Current research is at an initial, exploratory stage, and cannot be used for management recommendations.
b. It is possible to include new data, such as tagging data, since Stock Synthesis, the modelling platform used, is an integrated approach that allows movement between areas and can handle tagging data,

but there are some challenges, and perhaps the approach should be tested using MSE, by contrasting spatially-structured *vs*. non-spatially-structured models, for example.

c. Defining the connectivity between different areas in a spatial model is a challenging task. A well-designed large-scale tagging project would help parameterize the model. Until such a project is implemented, the available tagging data must be considered with caution, as they can be very influential in the results. Another challenge in defining the areas in the spatial model, as in a metapopulation model, is to assume whether they are sources (of recruitment) or sinks, which have different implications for management.

7.4. Spatial-temporal modeling of yellowfin CPUE data (SAC-09-09)

Haikun Xu presented SAC-09-09.

Key points:

a. The goal of this study is to develop a standardized dolphin-associated purse-seine index of abundance for yellowfin tuna, which is very important because the index of abundance directly informs trends in population biomass and is a key input in the stock assessment.
b. A delta-generalized linear mixed model, which models encounter probability and positive catch rate separately, was used to analyze the spatiotemporal dynamics of yellowfin tuna in the EPO.
c. The standardized index was higher and lower than the nominal index used in the current stock assessment in the first and last decade, respectively, of the assessment period.
d. Each quarter's data were fitted to the spatiotemporal model separately, so the standardized index could be biased if catchability is quarter-specific, spatial and spatiotemporal residuals have different autocorrelation patterns, or imputed catch rates for the unsampled region could be biased in different ways by quarter.
e. However, the standardized index represents an improvement over the nominal index because the standardization approach estimates the coefficient of variation (CV) of the index, and accounts for preferential sampling and vessel effects on catchability.

Discussion:

a. A suggestion was made to examine catch rates for two groups of vessels (300-1000 and 1000+ m^3) for differences to determine whether not grouping the vessels causes a bias.
b. Other distributions (*e.g.* gamma) were tried, and the results were similar.
c. Environmental factors were investigated, but it was not clear whether they impacted density or catchability, and this distinction is important when deriving an index of relative abundance.
d. Environment affects recruitment, but the effect may not be consistent. Environmental data could be used as an indicator of recruitment strength, but are not reliable enough to be used in assessment.
e. In order to reduce the impact of other set types on the calculation of search time, the analysis included only vessels that dedicated at least 75% of their effort to fishing on dolphins.
f. Including vessel effects accounts for technology changing over time. If this is not accounted for, the index of abundance is overestimated.
g. The CPUE in dolphin-associated sets is dependent on the abundance of dolphins, and some of these populations may have increased over time. In addition, the relationship between yellowfin and dolphins may be impacted by the environment (*e.g.* thermocline depth).

7.5. Design of a tropical EPO dolphin survey

Cornelia Oedekoven presented this topic.

Key points:

a. Design options for a new dolphin survey in the eastern tropical Pacific were presented, and new aspects are discussed, including the use of tuna vessels as survey vessels and the use of drones to evaluate whether detection on the trackline is certain, both of which would require a trial survey before the main survey.
b. If tuna vessels are not used, the trial would only need to use one research vessel and one drone, as vessel calibration would not be necessary.
c. If the drones are not (or cannot be) used, then objective 2 (absolute abundance) may need to be dropped.
d. If the survey were to follow immediately after the trial, we recommend (a) only a short trial to test drone performance and (b) not use tuna vessels, since the trial could not deliver adequate precision to calibrate a tuna vessel against a research vessel, if there is evidence of different biases.
e. Limiting the drones to the trials would be unsatisfactory because, if trackline detection probability [*i.e.* g(0)] can be well below 1 for herds of the priority stocks, it likely varies by location, and estimating this probability from a limited trial will add substantial imprecision to an abundance estimate.
f. If the trials indicate that g(0) is at or very close to 1, there is less need for drones in the main survey.

Discussion:

a. Concern was expressed about potential biases in the estimates of abundance caused by the imperfect detection probability on the vessel's trackline. This is probably due to a combination of various factors, and can be approximated by considering how far the observers can see ahead, how long the vessel takes to cover that distance, how long the dolphins stay under water on average and, therefore, whether they can be expected to be at the surface at least once while the vessel passes. Availability bias arises if dolphins are never at the surface while the vessel passes due to long dive times, and are therefore not available to be detected. The distance at which observers can detect dolphins may decrease with high Beaufort sea states, thus reducing the window of opportunity for detecting them.
b. It was suggested that dolphins could be evasive of the research vessel, but may be more evasive of a tuna vessel due to their experience with interacting with such vessels, which could cause biases between vessel types. However, the distance at which dolphins become evasive is not known for either vessel type. Drones have the advantage that they can be flown at a distance in front of the vessel before the evasion occurs, and so this could be investigated.
c. It was noted that there may not be a large difference between the research vessel and tuna vessel since the fishing gear would not be deployed.
d. Regarding other methods that could be used during the survey, mark-recapture distance sampling methods require a second observation platform, and with acoustics it is difficult to get accurate distances from the transect line for herds directly in front of the vessel. Aircraft have also been tested as the second platform, but without success. Hence, at this point drones seem to be the best method available.
e. Regarding the use of observer data for obtaining abundance estimates, they were not used with distance sampling methods, but had been used in previous population dynamics modelling. However, changes in equipment used for searching (*e.g.* from binoculars to bird radar and helicopters) may cause biases, and it is not clear how to correct for the trends in catchability. Also, the observer may not be informed about some dolphin herds detected by radar or helicopter.
f. Regarding the current status of the dolphin populations and the use of reference points, assessments have been conducted and some reference points are used, but the information was not available at the meeting.

g. Previous surveys have used manned helicopters and fixed-wing aircraft to calibrate observers for herd size estimates. In the current plan drones will fill these roles, but these previous methods will be used if drones are not.
h. It was noted that the option to only survey the restricted area (core, core2 and N. coastal strata) with a single survey may be problematic because the distribution of marine mammal populations changes with different environmental conditions, and stocks cross the borders of the survey area. It was clarified that the range of the northeastern offshore spotted dolphin is defined by the geographic boundaries of the core area. The eastern spinner stock is more complicated, but detection rates outside the restricted area would probably be too low to estimate abundance for those strata. However, it was further noted that movement across the boundary due to potential changes in the environment, for example, might be the reason for the apparent increase/decrease in abundance for some stocks.

7.6. Pacific bluefin tuna:

7.6.1. Report of the ISC Bluefin Working Group

Hiromu Fukuda presented this topic. The updated stock assessment of Pacific bluefin tuna was conducted in March 2018 by the Pacific Bluefin Tuna Working Group (PBFWG) of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific Ocean (ISC).

Key points:

a. The base case model represents the data sufficiently, and results were very consistent with the 2016 assessment.
b. Spawning stock biomass (SSB) fluctuated throughout the assessment period (1952-2016), and declined steadily from 1996 to 2010, but the slow increase of the stock since 2011 continues, including the most recent two years.
c. Historical recruitment estimates have fluctuated since 1952, without an apparent trend. The 2018 assessment estimate of 2015 recruitment is low, and similar to estimates from previous years (2012-2014), while the 2016 recruitment estimate is higher than the historical average.
d. A substantial decrease in estimated *F* is observed in 0-2-age fish in 2015-2016, when the stricter management measures in WCPFC and IATTC were in force.
e. No biomass-based limit or target reference points have been adopted to evaluate overfished status for Pacific bluefin. However, the stock is overfished relative to biomass-based reference points adopted by WCPFC for other species.
f. No fishing intensity-based limit or target reference points have been adopted to evaluate overfishing for Pacific bluefin. However, the stock is subject to overfishing relative to most commonly-adopted fishing intensity-based reference points.
g. The projection based on the base-case model mimicking the current WCPFC and IATTC management measures under the low recruitment scenario resulted in an estimated 98% probability of achieving the initial rebuilding target by 2024, which is above the threshold (75% or above in 2024) prescribed by the WCPFC Harvest Strategy for the ISC to advise on catch limit increase options.
h. The 2018 projection results are more optimistic than the 2016 projections, mainly due to the inclusion of the relatively good recruitment in 2016, which is twice as high as the median of the assumed low-recruitment scenario.

Discussion:

a. A parallel was drawn between the selectivity patterns of the bluefin and bigeye fisheries, both of which heavily affect juveniles. There are conservation concerns for both species. However, although

mortality of juvenile bigeye is cause for great concern, this does not seem to be the case with Pacific bluefin. In fact, the first rebuilding target is below any limit reference point considered or adopted for other species; this is of concern.

b. It was noted that the impact of this fishery on juvenile fish is very high, but that fishing mortality has decreased since 2015 for age-0 and -1 fish, and IATTC measures are expected to contribute to this trend.
c. It was pointed out that the Kobe (phase) plot presented was somewhat different from normal Kobe plots, and that it was not clear where MSY is. The plot shows two rebuilding targets. Since there is a limited information about the spawning stock-recruitment relationship, SSB_{MSY} is not calculated, but biomass ratio relative to SSB_0 and the corresponding Spawning Potential Ratio were used as possible reference points.

Because ISC assessments have to be endorsed by the ISC plenary before they are published, and the plenary meets after the SAC, final ISC assessments are not available in time for the SAC meeting. In the past, ISC has provided draft executive summaries of its bluefin assessment to the SAC a few weeks in advance as a courtesy; however, this had not happened this year. **The SAC requested that ISC maintain that courtesy, to allow time for consideration and comment by the SAC**.

7.6.2. Projections for Pacific bluefin tuna

Hiromu Fukuda presented the results of the future projections for the various options for catch increases. The projection scenarios and results were prepared and reviewed by the ISC PBFWG, and are subject to approval by the ISC plenary.

The harvest strategy for the Pacific bluefin fishery proposed at the joint WCPFC-IATTC working group meeting and adopted by the WCPFC (Harvest Strategy 2017-02) guided the projections by the ISC for catch reduction options. Catch would be reduced if the projection results showed that the initial rebuilding target will not be achieved with at least 60% probability by 2024. The projections also provide relevant information for a potential increase in catch if the probability of achieving the initial rebuilding target exceeds 75% by 2024.

The projection based on the ISC base-case assessment model with the current management measures resulted in an estimated 98% probability of achieving the initial rebuilding target by 2024 even if low recruitments were assumed for future years.

Key Points:

a. A scenario of a 15% increase for all the current catch limits still shows a probability greater than 70% of achieving the initial rebuilding target and greater than 60% of achieving the second rebuilding target.
b. If the increased catch limit differentiated between small and large fish, the results confirmed that the measures protecting small fish are more effective than those protecting large fish for rebuilding the stock.

7.6.3. Joint tuna RFMO meeting

Gerard DiNardo presented this topic.

Discussion:

Japan stated that the next Northern Committee Meeting would be held in Fukuoka City, Japan, 3-7 September 2018, and that further details would be circulated through IATTC and WCPFC.

8. DATA COLLECTION:

8.1. Electronic monitoring of small purse-seine vessel activities and catches: progress report

Marlon Román presented this topic.

Key points:

a. The presentation provided an update on the proof-of-concept study of the feasibility of using electronic monitoring (EM) to collect data on small (<Class-6) purse-seine vessels in the EPO.
b. The purpose is not to duplicate data that are already available, for example, in logbooks, but to obtain data that are currently unavailable or limited, such as on bycatch and discards.
c. Bids from EM companies for camera systems, placement and technical support have been received and are being reviewed.
d. Discussions are currently being held with CPCs to identify vessels willing to participate in the study.
e. To aid in selecting vessels for the study, and in identifying camera placement locations, a survey of small vessels was conducted to obtain information on catch handling, operational characteristics, FAD deployments, and vessel characteristics.
f. There was an 84% response rate to the survey.
g. A hierarchical cluster analysis of the survey data identified four groups of vessels, defined by the following criteria: 1) chutes used to load the catch into the wells; 2) accessibility of the wet deck; 3) vessel characteristics, such as well capacity, height of the crow's nest, brailer capacity, number of speedboats; 4) catch composition.

Discussion:

a. The purpose of knowing whether the FAD was inside the net at the time of encirclement, and why a camera should be located in that area, was questioned. It was explained that the FAD can be encircled either because the set was made on the FAD or because the FAD was deployed during the set. The EM data collected on this would be useful to determine set type, and in particular whether the floating object is a FAD, and also to record FAD deployments.
b. Concern was expressed about the cost of an EM system, given the number of cameras proposed for the proof-of-concept study. It was explained that more cameras are being used for the study than may be necessary for actual EM monitoring in the future, to help evaluate the best configurations for data collection so that any future sampling program will be as effective as possible. It was commented that experience in other fisheries in other oceans shows that EM can be a cost-effective alternative to on-board observer programs.
c. An attempt will be made to collect port sampling data for trips by vessels participating in the study so that the EM data could be compared to both observer data and port-sampling data.
d. It would be beneficial to conduct experiments on the use of EM aboard longline vessels, as well as purse-seine vessels.

9. FADS

9.1. Non-entangling and biodegradable FADs: progress report (SAC-09-10)

Martín Hall presented SAC-09-10.

Key points:

a. The objective of the project is to develop new FADs with a smaller ecological footprint.
b. The materials used for the surface and submerged structures in traditional FADs (*e.g.* old fishing nets) create the potential for entanglement of some species, especially sharks and turtles. The best solution would be to avoid using netting in the construction of FADs.

c. The experiment carried out in Panama, although not completed, helped to identify materials and configurations that were accepted by some vessel captains. While some materials, like palm leaves and *cabuya* fiber ropes, were not promising because they degraded too rapidly, others were adopted by the fishermen during workshops where the results of the experiment were presented.
d. An experimental design plan was agreed in October 2017 at a TUNACONS workshop, establishing the materials and characteristics for two prototypes to be tested at sea, and the number of FADs to be deployed, by year and by vessel capacity. The submerged structure consisted of thick ropes and cotton canvas, using *abaca* fiber instead of the *cabuya* fibers used in earlier experiments. The 52 participating Ecuadorian vessels deployed about 780 prototype FADs in the first year, each along with a traditional FAD. For both types, each FAD carries tags sharing same codes on the buoy and on the FAD itself. About 450 FADs will be built by the EU-funded program, for a total of over 1,200 FADs deployed in the first year, distributed among quarters, with all participating vessels contributing in proportion to their size.
e. New ideas were proposed to maintain the integrity of the floating component (a critical issue to ensure the adoption of the FADs) such as wrapping it with cotton canvas, or using bamboo nails, or using bamboo 'pipe' joints. **Martín Hall** acknowledged the lack of data available from the prototypes tested at sea, but the flow of data is gradually increasing.
f. This project is currently suspended, and no additional research has been done in this regard.

Discussion:

a. **Alexandre Aires da Silva** explained the reasons that lead to the temporary suspension of the project. As specified in the EU contract, the aim of the project is to identify means of constructing non-entangling FADs from biodegradable materials. Two experimental phases were planned: Phase 1) testing the durability of biodegradable materials in a coastal environment in order to identify the best prototypes for use in a Phase 2; and Phase 2) deployment of FAD prototypes from tuna purse-seine vessels to examine their effectiveness and viability under real fishing conditions. The project generated two FAD prototypes that were favored by fisherman and are apparently being tested by some vessels. That is a positive result. Unfortunately, these prototypes were the outcome of a poorly designed Phase 1 experiment and no data has been submitted by the industry to the IATTC staff on Phase 2 to date. As a result, the project had to be suspended until the following conditions are met: 1) an adequate workplan that includes a well-designed controlled experiment is presented, discussed, and receives support at the FAD WG and SAC meetings in 2019; 2) cooperation with the industry is secured so that data is collected and reported to the staff; 3) during the presentation, it was stated that data on Phase 2 has started to be collected and is flowing; these data should be reported to the staff as soon as possible so that their value may be considered in the discussions of the FAD WG and SAC meetings.
b. **Guillermo Compeán** reiterated that the staff has encountered challenges in receiving data on FADs deployed voluntarily by the fleet, making scientific analysis of the experimental FADs under real fishing conditions difficult. The matter had been reviewed at the meeting of the *Ad Hoc* Working Group on FADs, where the implementation of the experimental design had been discussed with **Ecuador**. The project would continue once a detailed experimental sampling design had been discussed and adopted by the IATTC scientific staff.
c. **Martín Hall** explained, even though fishers were reluctant to adopt FAD designs they thought might not work, or support experiments that might adversely affect their fishing operations, it was in their interest to collaborate in the development of alternatives, and relevant CPCs and their fleets needed to commit to this and other similar projects.
d. The availability to FAD buoy data to researchers is also key for comparing experimental prototypes with conventional FADs. Other fleets in the EPO should be made aware of the project and encouraged

to collaborate, and coordinating with the WCPO tuna purse-seine fishery was also important, as experimental FADs might end up in the western Pacific, and it would be useful to receive information about any fishing that occurs in the WCPO.

e. **Ecuador** reiterated its commitment to actively participate in this project in the future and to facilitate the commitment and participation of its industry.

9.2. Report of the *Ad hoc* Permanent Working Group on FADs

Josu Santiago, chair of the *Ad Hoc* Working Group on FADs (FAD-WG), presented his report of the group's 3rd meeting and its recommendations. The SAC took note of the report and adopted the recommendations.

10. ECOSYSTEM AND BYCATCH:

10.1. Ecosystem considerations report (SAC-09-11)

Shane Griffiths presented SAC-09-11.

Key points:

a. A new approach to the reporting of bycatch data and ecological indicators will provide greater transparency to stakeholders.
b. Time series of catch, mortalities, and interactions were provided, as well as a detailed table for the current year of data.
c. Environmental indicators were reported for the first time, specifically Pacific Decadal Oscillation (PDO), Oceanic Niño Index (ONI), and Índice Costero El Niño (ICEN).
d. New ecological indicators were presented, derived by extending the ecosystem model of Olson and Watters (2003): 1) fishing-based indicators (Mean Trophic Level (TL) of the Catch, Marine Trophic Index, and the Fishing in Balance (FIB) index), and 2) community-based indicators (Kempton's Q index and Community biomass of low (TL 2.0-3.25), intermediate (TL 3.25-4.0), high (TL > 4.0) trophic levels).
e. Together, the indicators showed the EPO ecosystem has changed over time, although fishing impacts appear not to be detrimental to the structure and functioning of the ecosystem.

Discussion:

a. Various comments were made on the longline data included in the report, noting in particular that the information in Tables 3 and 4 and Figures J-3 and J-4 could be misinterpreted. The tables and figures gave the impression that the longline fishery (with incomplete and unreliable data) has less impact on bycatch species than the purse-seine fishery (with extensive and highly-reliable observer data); the captions should explain the shortcomings of the longline data, to avoid misinterpretation of longline bycatches. It was clarified that the report explains the limitations to the longline data, which were included to show that minimum estimates were available, and emphasized that improved estimates of longline bycatches were possible only if CPCs complied with their obligation to provide set-by-set longline observer data, as highlighted in the presentation on SAC-09 INF-A.
b. In response to a comment that the low abundance of some species can be a useful indicator, but is not meaningful without biological reference points (BRPs) to define the decline, it was explained that the following presentation would address a form of BRP to identify whether a species is vulnerable to declining over time.

10.2. An ecological risk assessment (ERA) approach for quantifying the impact of tuna fisheries on bycatch species in the EPO (SAC-09-12)

Shane Griffiths presented SAC-09-12.

Key points:

a. A new ERA approach comprised of "susceptibility" and "productivity" components.
b. "Susceptibility" describes the horizontal and vertical overlap of each fishery with a species' distribution to estimate the proportion of the species' population that is potentially caught, which is converted to a fishing mortality rate (*F*).
c. The *F* estimate is used in a length-based yield-per-recruit model to assess the vulnerability status of each species by relating to biological reference points (*e.g.* F_{2016}/F_{MSY}, $SSB_{2016}/SSB_{40\%}$).
d. The results for all assessed species are represented on a modified phase (Kobe) plot to identify the most vulnerable species, which are candidates for the development of mitigation measures, or further monitoring to obtain sufficient data for a future conventional stock assessment.
e. The method was applied to 14 species caught in EPO longline and purse-seine fisheries as a 'proof-of-concept' analysis.

Discussion:

a. Tasks for prioritizing species were outlined in the Strategic Science Plan presentation, and the proposed ERA could be seen as an objective approach to help the staff prioritize species for data collection, research and conservation measures.
b. The method was developed as a proof-of-concept, and not all species have yet been included in the analysis. The traditional PSA method is typically applied to species groups, like "teleosts", "marine mammals", "turtles", and because of the extreme differences in life history characteristics of individual species in such groups, productivity attributes are scaled. The new method can be applied to any species regardless of differences in productivity.
c. The was discussion on whether, as part of the prioritization process, it was more important to expand the approach to more species or to focus on method development. It was noted that the results are similar to those of previous PSAs, and that what managers really need to know about is the stock status of a species, so method development should not be a priority. It was clarified that the intention is to include all species impacted by fisheries, and use the method as an objective means to prioritize species for data collection, research and management. Research, monitoring and/or development of mitigation measures should focus on highly vulnerable species, in the red area of the phase plot.
d. Concern was expressed about the potential for confusion over interpretation of model results, since the approach is not a quantitative stock assessment, yet formal stock assessments have been conducted for some of the species included in the model (*e.g.* blue and mako sharks). It was clarified that target species that have been formally assessed are included in the model to validate the approach by checking that the results are similar. A formal stock assessment for a species would take precedence, since stock assessments are beyond the level 3 quantitative analysis outlined in the Ecological Risk Assessment for the Effects of Fishing (ERAEF) framework.
e. There is a long-term plan to hold workshops on this approach as part of IATTC's capacity-building activities, and it would be beneficial to receive input from Members and other interested parties.
f. Regarding estimating proxies for MSY-based reference points for data-poor species, and whether other new methods (*e.g.* maximum impact sustainable threshold (MIST)) were considered when developing this method. It was clarified that the yield-per-recruit (YPR) model has inputs such as natural mortality, fishing mortality, weight-at-length, and von Bertalanffy growth parameters. Fishing mortality, where yield-per-recruit is maximized, can be estimated as a proxy for MSY. If no information is available for a species, then the productivity-susceptibility analysis (PSA) approach is used (*i.e.* data for a similar species are used), and a uniform distribution is assumed instead of a normal distribution. He noted that MIST is similar to the approach presented, although it is heavily based on grid-based

fishing effort, and species are not as data-poor as some of the species impacted by IATTC fisheries. The new ERA approach is conservative, and overestimates risk.

g. Regarding whether the vulnerability status of sharks was determined primarily by life history characteristics, as these species typically have low productivity, it was clarified that biological parameters will influence relative vulnerability, but they are only one component of the analysis. Susceptibility parameters, such as a species' distribution and overlap with the fishery, are also important.

10.2.1. How high- and low-frequency events could be affecting bigeye tuna fishing in the eastern Pacific

Franklin Ormaza presented this topic.

Key points:

a. The possible impact of high- and low-frequency environmental events that could affect catches of bigeye tuna in the eastern Pacific is analyzed.
b. Publicly available data from NOAA, the TOGA-TAO project, and IATTC were included: sea-surface temperatures from the TOGA-TOA project, ONI and MEI indexes in El Niño areas 4, 3.4, 3, 1+2 for high-frequency events, and Pacific Decadal Oscillation Index data for low-frequency events.
c. A series of statistical correlation analyses were run to establish the degree of association between independent (SST, ONI, MEI, PDO) and dependent variables.
d. Results suggest that up to 36.5% of bigeye catches could be affected by high- and low-frequency oceanographic variables.
e. There is a 12-month lag time associated with the impacts.
f. It would be difficult, but beneficial, to account for these variables in the bigeye stock assessment model, in order to have more contextual analyses and management strategies.

Discussion:

a. The staff has made several attempts to add environmental covariates to assessment models, but they have been largely unsuccessful. Nonetheless, there are plans to continue this work in future stock assessments, and beyond that into habitat prediction models.
b. Incorporating environmental variables in stock assessment models is not easy, since they vary considerably and many are interacting, and separating the primary 'driver' variable is very difficult. Unless environmental processes are very well understood, they cannot be reliably included in stock assessment models.
c. Regarding the effects of environmental changes on bigeye recruitment, it was clarified that the analysis focused specifically on catch, not recruitment. However, recruitment is enhanced by upwelling nutrients from the Humboldt and Cromwell Currents, which support an increase in the biomass of primary producers and prey at low trophic levels, eventually reach the higher trophic levels of tunas. but more prey available during upwelling periods would promote recruitment
d. Environmental changes that alter the vertical habitat distribution of the fish affect the availability of bigeye to the fishery, and thus their catchability.

10.3. Report of the Working Group on Bycatch

Yonat Swimmer presented the report of the 8th Meeting of the Working Group on Bycatch, and the group's recommendations to the SAC (Appendix 2 of the report).

Discussion:

a. In the future, all recommendations by the Working Group should be accompanied by up-to-date

supporting references.

b. Of the 12 recommendations made by the Bycatch WG, eight were approved by the SAC unchanged, and two with changes. Two were not approved: #4 (Increasing longline observer coverage to 20%) and #9 (Leatherback turtles).
c. Regarding Recommendation 4, increasing longline observer coverage to 20%, the lack of references supporting the increase was cited as a reason for not supporting it as a recommendation by the SAC. A proposal to change the recommendation to "maintain 5% observer coverage and encourage CPCs to increase coverage to 20%, as necessary" did not achieve consensus, and this recommendation was not approved by the SAC.
d. Regarding Recommendation 7, on seabirds, concern was expressed about the lack of supporting references and, more importantly, the lack of specific guidelines or parameters that could be recommended for adoption by the Commission. Some participants suggested that this issue could still be acted upon by the Commission if specific guidelines and supporting documentation were submitted before the annual meeting. The recommendation was approved "subject to validation of [its] scientific basis".
e. Regarding Recommendation 7a, use of hook-shielding devices ("hookpods"), the consensus was that this technology is not ready for adoption as a mandatory mitigation method because additional research is needed to develop specific guidelines on how it should be deployed (*e.g.* at what depth); its eventual adoption should include plans for training longline fishermen to use it. This section of the recommendation was not approved.
f. Regarding Recommendation 8, on sea turtles, one participant requested that the text be revised to present the regional workshop more positively. After some discussion, the SAC agreed to recommend that "the Secretariat should, in conjunction with CPCs, explore the possibility of organizing a regional workshop on sea turtle bycatch and mitigation methods".
g. Regarding Recommendation 9, on conservation of leatherback turtles, there was no consensus. Some participants expressed the opinion that the measures proposed by the be Working Group were matters for individual CPCs to address.
h. There was considerable discussion as to whether the recommendations from the Bycatch WG accurately reflected the discussion. One participant suggested that, in the future, at the end of the working group meeting, participants receive electronic and printed copies of the recommendations to read and suggest edits, as necessary.

10.4. Cetacean mortality in non-dolphin purse-seine sets

Michael Scott presented information, requested by the United States, on cetacean bycatch during the last 15 years in longline fisheries and in non-dolphin sets in purse-seine fisheries in the IATTC Convention Area.

Key points:

a. The longline data available are insufficient at this time, and will need to be examined when the database is more complete.
b. Data on dolphin bycatch in floating-object and unassociated sets during 2002-2016, available in the AIDCP database, indicate that sets with accidental mortalities were rare: 15 sets (6 on floating objects, 9 unassociated) resulted in 45 cetacean mortalities. The mortality rate was extremely low (0.00008 mortalities per set).
c. All these accidental mortalities are included with the annual incidental mortalities reported for dolphin sets.
d. US scientists should contact the staff to define the purpose of the request and offer input into the analysis.

Discussion:

The **United States** indicated that the purpose of the request was to monitor progress in bycatch reduction, and agreed that US scientists should work jointly with the staff on the analyses.

11. SHARKS:

11.1. Updated results of FAO-GEF shark project: pilot study for shark fishery sampling program in Central America

Alexandre Aires da Silva presented this topic.

Key points:

a. During Phase 1 of the IATTC's FAO-GEF funded ABNJ project (2015-2017), the data available for Central American shark fisheries were identified and compiled, and recommendations were formulated for improving data collection. Also, three workshops were held, on data collection, assessment methods for shark species, and designing a pilot sampling program.

b. Subsequent to the workshop to design a pilot sampling program (September 2017), a pilot study was initiated in April 2018 to collect additional shark fishery data, and develop and test sampling designs for a long-term sampling program for the shark fishery in Central America (Phase 2 of the project).

c. The first planned work under Phase 2 is Task 1. This task focuses first on gathering data to map the location of potential shark landing sites on the Pacific coast of Central America; it will then focus on the fleet of smaller artisanal vessels, called *pangas*, to estimate their number, catches, and effort.

d. Task 2 will focus on the larger vessels, and on the development and testing of different designs for a sampling program to collect reliable data on the sex and size composition of shark catches. Sampling technicians will survey NPG vessels (> 10 m) and their landing sites to identify these strategies; this will take place in Costa Rica and Panama, where these vessels predominate. A total of 63 and 32 surveys have been accomplished to date in Costa Rica and Panama, respectively.

Discussion:

a. The SAC expressed continuing support for the ABNJ work and the pilot study in Central America.
b. Regarding the future of the sampling program after the ABNJ project ends in 2019, the plan is to continue with the pilot study until December 2019 using IATTC capacity building funds. Based upon the results of the pilot study, the staff will present a proposal for a long-term shark fishery sampling program in Central America at SAC-10 which will then be presented to the Commission at its annual meeting in 2019.

11.2. Updated purse-seine indicators for silky sharks in the EPO (SAC-09-13)

Cleridy Lennert-Cody presented SAC-09-13.

Key points:

a. Work presented at SAC-08, and revised last fall, found a correlation between silky shark indices and the Pacific Decadal Oscillation (PDO), the magnitude of which differs by region and shark size category.
b. Correlation was highest for small and medium silky sharks in the western EPO and western Pacific, and weaker for large silky sharks throughout the EPO.
c. It is concluded that ENSO events may strongly influence spatial distribution of juvenile silky sharks in EPO, whereas the large shark index is less likely to be biased and therefore a better stock status indicator.
d. Work is planned to adapt the standardization method to develop indices that are less influenced by

ocean climate forcing, with emphasis on an index for large silky sharks.

e. In the meantime, the silky shark indices were updated for 2017 using previous methods.
f. The 2017 index values remain largely unchanged from 2016: indices for large silky sharks were similar, or increased slightly, while indices for medium and small silky sharks were similar, or decreased slightly.

Discussion:

a. Covariates were selected based on understanding of the process and not on statistical tests, because many variables would be selected due to the large amount of data. The percent deviance explained was initially good, but has dropped in recent years.
b. Time lags for environmental effects, which may not be instantaneous, were investigated, but the best correlation occurred without a lag.

12. LIFE HISTORY

12.1. Review of research at the Achotines Laboratory (SAC-09-14)

Dan Margulies presented SAC-09-14.

Key points:

a. The presentation summarized ongoing and planned research on pre-recruit life stages of yellowfin tuna conducted at the IATTC's Achotines Laboratory, highlighting topics that link to stock assessments and studies of recruitment variability for yellowfin.
b. Ongoing studies of growth variability of larval and early-juvenile yellowfin could provide a larval growth index for use as an index of recruitment variability of yellowfin in the EPO.
c. Growth is strongly density-dependent in the larval stage; this appears to persist into the early-juvenile stage, and may influence pre-recruit survival of yellowfin through differential growth-mediated predation mortality.
d. Ongoing studies of environmental effects on pre-recruit survival indicate that wind-induced microturbulence has order-of-magnitude effects on yellowfin larval survival, and shows regional associations with time-lagged recruitment estimates.
e. Comparative studies of the early life histories of yellowfin and Pacific bluefin have been conducted since 2011, and are providing insights into comparative mortality processes in the pre-recruit stages of both species.
f. Experimental studies have been conducted on the effects of important climate change variables, in particular ocean acidification, on the early life stages of yellowfin, and results are being used to model the effects on larval survival and physiological development.
g. A pre-proposal to study the effects of pollutants on early life stages of yellowfin at the Achotines Laboratory has been submitted to NOAA Sea Grant by the IATTC staff and collaborating scientists at Scripps Institution of Oceanography.

Discussion:

a. **Density-dependent growth deficits:** these pertained to dry weights, and densities were not shown in the results because the goal was to estimate growth deficits for a mid-point range of densities in order to examine a 2- to 4-fold difference in the stocking densities of larvae. It is likely that the slowest-growing individuals are in some state of malnourishment, since the nutritional point-of-no-return for yellowfin larvae is extremely fast, as short as 0.5 day.
b. **Effect of ocean acidification on yellowfin recruitment**: Lehodey *et al.* (2017) estimated that, at a pH of 7.6, the average estimated increase in monthly mortality was 30%, and the high sensitivity estimate could be as high as 70%.

c. The yellowfin juveniles transferred from land tank to sea pens at the Achotines Laboratory in 2015, were 7-11 weeks of age and 6-9 cm in length, and after about one month had grown to 8-12 cm.

13. STAFF RECOMMENDATIONS TO THE COMMISSION (SAC-09-15)

Alexandre Aires-da-Silva presented the staff recommendations, which had already been introduced individually under the relevant agenda item. He welcomed comments from the participants, noting that the SAC can endorse a staff recommendation, or make its own recommendation on any subject.

13.1. Tropical tunas

a. **Ecuador** noted that, since the Commission adopted a multi-annual tuna conservation measure (C-17-02) in 2017, those measures should not be changed until they have been evaluated. The additional 10 days of closure adopted in 2017 were very disruptive, and the proposed combined total limit on FAD and unassociated sets was worrisome: it would create a "race to fish", which was not fair for some participants in the fishery. **Ecuador** could not support such a measure because of the impacts on the industry.
b. Regarding the limits on FADs, **Ecuador** questioned whether it was appropriate or necessary to have both a limit on FAD and unassociated sets, if the conservation concern is related to FADs. **Alexandre Aires da Silva** clarified that although the increase in the number of sets is due mainly to the floating-object fishery, it is not practical to limit that set type alone, so the limit would have to apply to floating-object and unassociated sets combined. The FAD working group was still discussing the definition of a FAD set, and therefore expanding the measure to unassociated sets was considered necessary.
c. **Guillermo Compeán** clarified that the intention is to freeze the number of sets, not reduce it (using the previous 3 years as a basis, as is done in the stock assessments to calculate the *F* multiplier).
d. **Colombia** considered the staff recommendations a good basis for presentation to the Commission, noting that both international law and the Antigua Convention require applying the precautionary approach. The Commission needed to consider the recommendations carefully, because the current measure is likely not sufficient. Also, although the set limit is not expressed as a quota, in practice it could become one, and perhaps it should be defined in terms of national set limits so that CPCs can distribute specific numbers of sets to their vessels. **Guillermo Compeán** noted that such a decision is beyond the purview of the SAC, and would have to be considered by Commission.
e. The **United States,** noting with concern the problems with the bigeye assessment and the increase in the number of sets, despite the closures, agreed that additional measures are needed, although it also agreed that a limit on number of sets could create a race to fish. The **United States** asked whether the proposed set limits would apply to all vessel types, and how compliance would be monitored on vessels without observers. **Alexandre Aires da Silva** acknowledged that it would be difficult to monitor compliance on the smaller vessels without observers. Class 1-5 vessels rarely carry observers, and so cannot be monitored in real time; therefore, the closure would be implemented when the number of sets by Class-6 vessels reached the limit, but would apply to all purse-seine vessels, regardless of capacity. **Mark Maunder** pointed out that, if there was a race to make as many sets as possible before the limit was reached, vessels might be less discriminating about when to make a set, which could mean that catch per set would decrease, compounding some of the issues identified.
f. Regarding whether the staff had considered recommending additional measures for the longline fleets. **Mark Maunder** responded that, because the concern was specific to sets on floating objects, the staff was not recommending any such measures, nor additional closure days for the purse-seine fleet.
g. The **European Union** questioned the scientific basis for this recommendation, and noted that it would have been useful if the staff had provided additional options for measures for the SAC to consider, and asked how possible changes in fishing behavior resulting from the proposed measures might be

accounted for. **Alexandre Aires da Silva** responded that, given the uncertainty in the bigeye assessment, and concerns with the recent trends in the indicators for bigeye and skipjack, the goal of the staff's recommendation for a limit on the numbers of sets is to prevent increases in fishing mortality of these two species, so that Resolution C-17-02 can have its intended effect. Although capacity is restricted, days fished are limited by the closures, and there are now limits of FAD deployments, the number of sets on FADs keep increasing linearly, which could well increase fishing mortality on bigeye and skipjack; the staff's recommendation is therefore an appropriate precautionary measure. The staff is being transparent about uncertainties in the model, but also understands its duty to make precautionary recommendations based on the indicators available.

13.2. North Pacific bluefin tuna

a. The **European Union** commented that more information on trends in fishing effort, catch, *etc*. at future SAC meetings would be useful, so managers can understand changes in the fishery.
b. The **European Union** noted that the north Pacific bluefin tuna stock remains severely depleted, and that it was unclear whether the staff had taken this into account in its recommendations. It should be recognized that the stock is overfished by most conventional reference points, and that it is the most depleted stock discussed at the SAC. The staff should document the risks of the status of stock for managers, and point out the risks when considering future catch scenarios. The presentation on Pacific bluefin stated that the "*Pacific bluefin stock is subject to overfishing relative to most commonly-used reference points*", including IATTC reference points, although these might not be appropriate for Pacific bluefin. Using MSY as a target reference point, as implied in the Antigua Convention, indicates that overfishing is still occurring, as does the Kobe plot. **Mark Maunder** responded that it is not clear that overfishing is occurring; that conclusion depends on the reference points used, and there are currently none adopted for Pacific bluefin, only a harvest control rule. He noted that the projections for rebuilding to 30% of SSB_0 indicate that overfishing is not taking place.

14. SAC RECOMMENDATIONS TO THE COMMISSION

The SAC held an extensive and detailed discussion on proposals for recommendations to the Commission. Several were withdrawn after it was agreed that proposals should be accompanied by supporting documentation in order for them to be considered. The SAC considered the proposals topic by topic, and finally adopted 16 recommendations (Appendix 1) to submit to the Commission.

14.1. Tunas

Tropical tunas (United States): **Nicaragua** and other participants emphasized the importance of adopting measures targeting juveniles. The **European Union**, whose proposal maintained the measures in Resolution C-17-02, argued that agreeing on additional measures would take time, and that, rather than limit the number of FAD sets, it would be better to first assess the effects of the FAD limits in C-17-02. It was difficult to show a link between the increase of FAD sets and the increase in purse-seine catches. **Ecuador** supported these arguments.

Alexandre Aires da Silva explained that, since the *F* multiplier for bigeye could not be used as a basis for management advice this year, other indicators were used to evaluate recent trends, and it became clear that there was a continuing linear trend in the number of FAD sets. In order to maintain the desired effect of the 72-day closure, the fishing mortality should not increase further. The only variable that remains unrestricted and therefore needs to be limited is the number of FAD sets. **Mark Maunder** commented that the per-vessel FAD limit in Resolution C-17-02 should be much lower, perhaps 100. The **United States** stated that the increase in the number of FAD sets should be addressed, and **Colombia**, **Nicaragua,** and **Venezuela** stressed that limiting FAD sets was in keeping with the Antigua Convention and the precautionary approach, which obliged Members to not increase catches in the absence of robust information.

Mexico supported the staff's proposal, noting that Resolution C-99-07, from 1999, called for the "*establishment of a maximum number of sets on floating objects which the tuna fishery in the EPO can support*". **Guatemala** proposed limiting the number of FAD sets to 2017 levels. The **European Union** suggested that other options should be considered, such as further limiting the number of FAD deployments, and the **United States** suggested that the staff and CPCs examine potential options in the interim before Commission meeting in August.

Colombia requested updated information on the number of FAD sets or on the catches of bigeye tuna in 2018.

An amended text was drafted, and the discussions continued. **Colombia** asked whether the alternative spatiotemporal closures presented last year by the staff were still valid as an alternative for augmented measures; **Alexandre Aires da Silva** responded that they were not, in the absence of a *F* multiplier from the bigeye assessment that needs improvements. **Mark Maunder** noted that that analysis was about the duration of the closure, and was not pertinent to the recommendation to limit the number of FAD sets.

Several participants expressed a preference for maintaining the current measures for 2018 at least, while the staff improved the stock assessment and analyzed various options. Ultimately, the SAC was unable to agree on a recommendation regarding the conservation of tropical tunas, although the following proposal won the support of all the delegations except **Ecuador**:

> "*Due to the large uncertainty in the F multiplier, the SAC supports the recommendation of the staff to maintain [Resolution C-17-02]. However, until the stock assessment is improved, the Commission should consider additional measures such as further reduction of FAD numbers, spatiotemporal closures, FAD set limits, etc*."

Pacific bluefin tuna (United States): This proposal was **adopted** with the addition of some language proposed by **Japan**.

South Pacific albacore (European Union): This proposal, aimed at assessing the South Pacific albacore stock, was **adopted** without discussion.

14.2. Research

Strategic Science Plan (European Union): After a clarification by **Alexandre Aires da Silva** that his presentation was merely on the outline of the Plan, and that the complete staff activities workplan will be described in detail in a new format of the Staff Activities Report, the proposal was **adopted** without extensive discussion.

IATTC stock assessment process and output (European Union): After several participants expressed their satisfaction with the transparency of the current process and their concern regarding additional unnecessary meetings, and recalled that the IATTC is the only RFMO with its own scientific staff, the **European Union withdrew** the proposal, while stressing its value for capacity-building and the usefulness of scientists of CPCs contributing their own data for the assessments.

Bigeye growth (European Union): Many participants considered this proposal to convene a workshop of experts useful because of methodological differences between organizations, in particular the IATTC and the WCPFC. It was agreed that holding a workshop on all tunas is not desirable given the priority focus on bigeye, but also not to limit the recommendation to bigeye only. With the appropriate adjustments, the proposal was **adopted**.

Bigeye assessment (Ecuador): Guillermo Compeán stressed his concern that this proposal, that the staff present to the Commission a bigeye assessment that did not include the new data that had led the staff

to discount its assessment, would change the staff's long-standing protocols and practices regarding stock assessments. **Colombia** and **Costa Rica** opposed the proposal, noting that the staff had explained why the new data were included. The proposal was **not adopted**.

Tagging program (United States): Following expressions of support by the **European Union** and **Mexico**, the proposal was **adopted**.

Not publishing assessments with a high level of uncertainty (**Ecuador):** Ecuador explained that this proposal was to avoid giving undue publicity to information that might be misunderstood or misused. After **Colombia** noted the ethical difficulties of the proposal, and **Guillermo Compeán** pointed out a number of practical problems, as well as the obligation of transparency in the Antigua Convention, **Ecuador** withdrew the proposal.

Relationship on the depth of purse-seine nets versus the levels of catch of juvenile bigeye and yellowfin (Ecuador): With the clarification that the staff would present this analysis at the next meeting of the SAC in 2019, the proposal was **adopted**.

Several other proposals by **Ecuador** on issues related to research did not achieve consensus or were withdrawn, without a substantive discussion on any of them.

14.3. Data collection:

Making compulsory the collection of set-by-set, logbook data for all fleets and gears (European Union): **Japan**, **Korea**, **Costa Rica** and **Guatemala** expressed reservations about this proposal, stressing the difficulties in implementing such an obligation, and the **European Union withdrew** the proposal.

Extension of the pilot project on the use of electronic monitoring (EM) to Class-6 purse-seine vessels (**Ecuador): Guillermo Compeán** noted that this project, specifically mentioned in the Strategic Science Plan, originally included Class-6 vessels, but budget considerations had limited the pilot project to Classes 1-5. Following interventions by **Ecuador**, **Guatemala**, **Mexico** and **Venezuela**, a reference to the required financing was added, and the proposal was **adopted**.

Increase observer coverage on longline vessels to cover 20% of effort (**Ecuador): China**, **Japan**, **Korea** and **Chinese Taipei** expressed strong reservations about this proposal. **Colombia** and **Mexico** proposed increasing coverage gradually, but the proposal was **not adopted**.

14.4. Management of FADs

Integrate research proposals on FADs in a strategic plan for the management of the FAD fishery (Ecuador): This proposal was considered redundant given the measures in force, and was **not adopted**.

14.5. Bycatches

Training activities for captains on the handling of bycatches on board (**Ecuador): Guillermo Compeán** noted that it was not clear whether CPCs or the Commission and its staff were responsible for these activities; however, the proposal was **adopted** without a substantive discussion.

Extension of the monitoring and collection of data on sharks and Mobulid rays to the longline fleet (**Ecuador):** Since this proposal duplicated a recommendation by the Working Group on Bycatch, and this issue had not been discussed by the SAC, **Ecuador withdrew** the proposal.

14.6. Longline

Submission of an annual report to the IATTC Secretariat of the operations of the longline fleets by the respective CPCs (European Union): There was a general agreement of the value of this proposal by the **European Union**, including from some of the Members with longline fleets, in particular regarding the

merits of providing the Secretariat with a list of longliners that have effectively fished during the previous year. With the elimination of the express reference to the duration of the fishing operations as one of the data points to be submitted, as requested by Japan and Korea and accepted by the European Union, this recommendation was **adopted**.

Longline CPUE (European Union): This proposal was **withdrawn** in favor of the parallel proposal by the **United States**.

Longline abundance indices (**United States):** This proposal was **adopted** with a drafting modification suggested by **Japan**.

14.7. Other

Scientists-managers dialogue (European Union): This proposal, supported by **Ecuador** and **Guatemala,** was **adopted** without a substantive discussion.

National reports (European Union): Following a clarification by **Jean-Francois Pulvenis**, the text was modified to reflect that the format for these reports, which are still voluntary, was adopted by the SAC at its 2014 meeting, and the proposal was **adopted**,

Publication of SAC/WG documents (European Union): This proposal was **adopted**.

15. OTHER BUSINESS:

No other business was discussed.

15.1. Strengthening and streamlining the IATTC scientific process and the presentation to the Commission of the conclusions and recommendations of the SAC

This item was not discussed.

16. ADJOURNMENT

The meeting was adjourned on 18 May 2018.

Appendix 1.

RECOMMENDATIONS OF THE NINTH SCIENTIFIC ADVISORY COMMITTEE MEETING

The ninth meeting of the Scientific Advisory Committee (SAC) makes the following recommendations to the Commission:

1. **Pacific bluefin tuna**. The SAC notes that fishing mortality on young Pacific bluefin tuna (age-0 to age has been reduced, and that reaching the first rebuilding target is likely (≥ 98%) if current fishing and environmental conditions continue. However, the SAC also notes that the Pacific bluefin tuna stock remains depleted (3.3% of SSB0), and the preliminary assessment results indicate that, even though there are no target or limit reference points adopted, the stock is likely in an overfished condition and overfishing is likely occurring. Therefore, the SAC recommends that the Commission take note of the current status of Pacific bluefin tuna, the different impacts of harvesting small and large bluefin, and of the increased risks of not achieving the rebuilding targets, if the current resolution (C-16-08) is modified to increase current catch limits.

2. **South Pacific albacore**. Recent assessments of south Pacific albacore, which are conducted by SPC, have not considered the fisheries data in all of the EPO, and there are no plans to include these data in the upcoming 2018 assessment. Thus, the eastern part of the stock will remain effectively un- assessed. The SAC recommends that the IATTC staff work with SPC to ensure that the entire South Pacific be included in future assessments.

3. **Strategic Science Plan**. The SAC recognizes the importance and welcomes the presentation of the first draft of the Strategic Science Plan, and requests the scientific staff to send the detailed Plan to the CPCs to receive their feedback before being presented to the Commission in 2018.

4. **Bigeye growth**. The SAC recommends that a joint IATTC-WCPFC workshop of experts be convened to analyze methodologies of age and growth determination of tunas, with priority to bigeye tuna.

5. **Tagging program**. The SAC notes that a well-designed, large-scale tagging program is essential to both developing a fully-integrated assessment model for skipjack tuna and improving the bigeye tuna assessment model. Therefore, the SAC supports the development of such a tagging program and recommends that funding be provided for this project.

6. Present at the next meeting of the SAC an analysis of the relationship on the depth of purse-seine nets versus the levels of catch of juvenile bigeye and yellowfin tunas.

7. That resources be provided to extend the **electronic monitoring pilot** project to vessels of all capacity classes.

8. Maintain training activities for captains on the handling of **bycatches** on board to ensure their return to the sea alive as far as possible.

9. **Longline fleet**. CPCs should provide an annual report to the IATTC Secretariat, with a list of their longline vessels that have fished in the EPO in the previous year.

10. **Longline abundance indices**. The SAC notes that the primary abundance indices for the yellowfin and bigeye tuna assessments are currently based on data from the Japanese longline fleet. However, Japanese longline effort in the EPO has decreased substantially, from about 101 million hooks in 2003 to about 31 million hooks in 2016, and is now a minor component (<20%) of reported longline effort in the EPO. Therefore, in order to improve the abundance indices, the SAC recommends that CPCs with large-

scale longline fleets: 1) share the operational-level data with the IATTC through an appropriate way; and/or 2) collaborate with IATTC staff and other CPCs with large-scale longline fleets to develop improved abundance indices.

11. **Scientists-managers dialogue**. In order to support the establishment of harvest strategies, including an MSE process, the SAC recommends that the Commission create a dedicated working group to facilitate dialogue among scientists, managers, and other stakeholders.

12. **National reports**. The SAC recommends that the CPCs present their national reports to the SAC following the format adopted by the SAC in 2014. CPCs are urged to prepare these reports to be presented annually to the SAC.

13. **Publication of SAC/WG documents**: while noting a clear improvement, the SAC reiterates its previous recommendation that meeting documents (in particular stock assessments) are posted at the IATTC website three weeks in advance of the start of the meetings, and the recommendations regarding tunas two weeks in advance.