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UPDATED STAFF DRAFT RECOMMENDATIONS ON CLIMATE CHANGE

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This document reports the staff's updated recommendations on climate change based on presentations and discussions at the IATTC's 2nd Climate Change Workshop.

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SUMMARY

In 2023, the IATTC adopted Resolution C-23-10 on climate change. Since then, the IATTC staff developed a proposed climate change workplan (SAC-15-12) for the consideration of the Commission, which provided a general structure to promote climate-resilient tuna fisheries in the eastern Pacific Ocean (EPO), in the understanding that the details of the workplan and its implementation would be elaborated in consultation, as appropriate, with all relevant stakeholders. The staff also drafted Terms of Reference (ToRs) (IATTC-102 INF-B) for a series of climate change workshops meant to facilitate staff and relevant stakeholder discussions to begin to fill in the details of the workplan. The 1st and 2nd Climate Change Workshops were held in February 2025 and April 2026, respectively. During the 1st workshop, which spanned three days, external speakers and stakeholder discussion focused on three key elements of the proposed workplan: main goal, scope, and framework. From these discussions, the staff put together recommendations on those three elements for the climate change workplan, which were endorsed during the 16th Meeting of the Science Advisory Committee (SAC). The 2nd workshop, which also spanned three days, was organized as a mini-symposium in which 15 external speakers presented on one or more climate-related fisheries strategic tools. The goal of the 2nd workshop was to foster discussion and educate IATTC stakeholders on the vast variety of tools that IATTC could apply to help understand the impacts of climate change at the ecosystem/ecological, fishery/socioeconomic, and management levels. Staff also shared the current tools that are already being developed in-house. Following the talks, the staff facilitated discussions about the types of tools and shared its preliminary tool recommendations (CC-02-01). Summaries of presentations and discussions at both workshops can be found in CC-01-RPT and CC-02-RPT. This document provides an overview of the available climate-related fisheries tools and revised staff recommendations the Commission should consider within the Climate Change workplan, including on tools that should be prioritized over the next three years.

1. BACKGROUND

In recent decades, research has shown the direct and indirect impacts of climate change on marine species, ecosystems, and fishing communities. In recognition of these impacts on IATTC fisheries, and the conservation and sustainability of target and non-target species covered by the Antigua Convention, the IATTC adopted Resolution C-23-10 on climate change in 2023. The Resolution states that the Working Group on Ecosystem and Bycatch (EBWG), the Scientific Advisory Committee (SAC), and the Commission will include climate change as a recurrent stand alone agenda item at their respective annual meetings, and in general, "*highlight and consider the best scientific information available on the relationships between climate change, target stocks, non-target species, and species belonging to the same ecosystem or associated with the target stocks.*" As a result, the IATTC staff developed a workplan which would provide a general structure to promote climate-resilient tuna fisheries in the EPO (SAC-15-12), in the understanding that the details of the workplan and its implementation would be elaborated in consultation as appropriate with all relevant stakeholders. This approach was welcomed and supported during the 2nd Ecosystem and Bycatch Working Group, as well as by the 15th meeting of the Scientific Advisory Committee (see SAC-15 Recommendations).

This process anticipates five phases: 1) Planning, 2) Deciding on goal and scope, 3) Developing a framework, 4) Creating tools, and 5) Tool application and/or management implementation. Phase 1 was considered complete, following the review of climate tools and frameworks, along with other resources publicly available, as well as with the development of a climate change workplan for the IATTC (SAC-15-12), and associated draft Terms of Reference (ToRs) for a series of climate change workshops (IATTC-102 INF-B). Phases 2 and 3 were completed in 2025 as a result of the 1st Climate Change Workshop, where the main goal, scope, and framework of the climate change workplan were discussed. Based on the information gathered at the workshop, the staff developed revised recommendations on the main goal, scope, and framework of IATTC's climate change workplan (SAC-16 INF-P), which were endorsed by the 16th meeting of the SAC (see SAC-16 Recommendations).

In 2026, Phase 4 (Creating tools) of the climate change workplan started, which aligned with Step 2 of the framework (assess climate impacts and vulnerabilities at the ecosystem, fishery, and management level). Step 1 of the framework, Define goal and scope, was completed and aligned with Phases 2 and 3. There are numerous tools that can be used to assess climate impacts, many of which have been developed for many countries, institutions, and organizations. This led to the 2nd IATTC Climate Change Workshop on April 6-8, 2026, which convened staff, invited global experts, CPC representatives, and other participants to learn about and discuss Phase 4 of the workplan and Step 2 of the framework. Specifically, the workshop consisted of a mini-symposium, where a diverse group of speakers presented on their climate-related fisheries tools. The workshop and talks were organized into three themes: tools to assess the impacts and vulnerabilities at the ecological/ecosystem level, fishery/socioeconomic level, and management level (CC-02-01). There was also a section of talks on multi-level tools that integrate across ecological, fishery, and governance dimensions. The staff also presented the current tools that IATTC has already developed or are being developed and can be used to understand climate impacts as well as draft recommendations on the tools IATTC should focus on in the next three years (the period in which the first cycle of the CC workplan is envisioned to complete).

The purpose of this document is to briefly focus on the various available climate-related fisheries tools and to identify the tools recommended by the staff that IATTC should develop and use over the next three years to better understand the impacts of climate change on IATTC fisheries. It should be noted that the list of available tools, although extensive, could include less common tools not considered by the staff. Recommendations consist of strategic tools that are already being used or developed at IATTC that can help determine climate impacts as well as the tools workshop participants expressed the most interest in

(see CC-02-RPT). The document also serves as the basis to compile the most up to date IATTC staff's recommendations on Climate Change. Therefore, Appendix 1 contains the list of revised staff recommendations discussed so far on climate change.

2. AVAILABLE CLIMATE-RELATED FISHERIES TOOLS

Oceanographic and Climate Data

Oceanographic data are collected via in situ measurements and remote sensing, then assimilated into models to produce environmental variables across a range of spatial and temporal scales. These variables span static features like bathymetry, dynamic surface conditions like sea surface temperature and chlorophyll, and subsurface properties like mixed layer depth — all of which can inform how climate change affects species distributions, physiology, and prey availability. Data products such as GLORYS provide high-resolution contemporary ocean conditions, while climate projection models (e.g., CMIP5/6, GFDL CM2.6) extend these variables into the future at varying resolutions. Together, these datasets form the foundation for many **ecosystem/ecological** and **fisheries** based climate-resilient tools and applications. To date, IATTC staff have downloaded, processed and used many of the variables mentioned above for the EPO from 1995 to 2023 mostly at daily temporal resolution and either 1/4° or 1/12° spatial resolution.

Species/Vessel Distribution Models

Species and vessel distribution models (SDMs/VDMs) link species/vessel occurrence or abundance data (from fishery-dependent or independent sources) with oceanographic variables to model habitat suitability/fishing behavior and predict distributions across space and time, making them an ideal **ecological** and **fishery level** tool. Common approaches include semi-parametric models (e.g., GAMs) and machine learning methods (e.g., boosted regression trees), and outputs can be projected under future climate scenarios to assess distributional shifts. Beyond climate projections, SDMs support spatial management, vulnerability assessments, and bycatch avoidance tools all of which could increase climate resiliency. IATTC is actively building an SDM library, with models developed or in progress for tropical tunas, sea turtles, sharks, mahi mahi, and billfish.

Physiology/Laboratory Experiments

Laboratory physiological experiments complement other **ecological level** tools by identifying species responses to extreme or novel environmental conditions and capturing life stages not represented in fisheries or tagging data. Metrics like metabolic rate, feeding rate, and mortality can inform physiology-based SDMs and hybrid models that combine lab and field relationships. IATTC's Achotines Laboratory has conducted decades of research on the effects of temperature, oxygen, and CO2 on yellowfin tuna early life stages, with results already informing age structured biomass models (e.g., SEAPODYM) and planned expansion to juvenile stages and additional species to support recruitment forecasting and other management tools.

Indicators

Indicators monitor and track changes over time and can be considered a performance measure in a management strategy evaluation-like (MSE) framework. They span climate/environmental metrics (e.g., Oceanic Niño Index, SST anomalies), **ecological** indices (e.g., trophic level, diversity), **fisheries** metrics (e.g., relative catch trends), and socioeconomic factors (e.g., revenue). Effective indicators are most useful when developed collaboratively with managers and stakeholders. IATTC is currently developing an indicator-based ecosystem report card ("EcoCard") and Ecosystem Status Assessment for the EPO in coordination with the EBWG, SAC, and Commission (EB-03-01).

Climate Vulnerability Assessment

Climate Vulnerability Assessments (CVAs) are a tool to identify relative vulnerability of a specific entity or target, whether it be a species, the habitat or ecosystem, or the fishing community. Vulnerability of a specific entity like a species is a function of its exposure to environmental change, its biological sensitivity to that change given its various inherent biological traits, and its adaptive capacity and resiliency to deal with that change. CVAs are intended to be a rapid approach that can inform researchers and managers where to prioritize their resources and efforts. The methods for conducting a CVA take many shapes and are often given different names (e.g., Climate Risk Assessment), but all follow the general qualitative and/or semi-quantitative framework of exposure, sensitivity, and adaptive capacity. CVAs have the capacity to assess vulnerability at the **ecological level**, **socioeconomic level**, or integrate across both socio-ecological levels.

Climate Change Scenario Planning

Scenario planning is a tool to help decision-makers prepare for plausible futures. This tool does not predict the future but rather facilitates presentation of a range of possible futures to prepare for. In a climate-resilient fisheries context it can be used to help fisheries managers and other relevant stakeholders prepare, in a participatory approach, for the range of ways climate change could impact fisheries, both positive and negative. This process usually includes the following steps: i) identify key drivers of change, ii) determine important uncertainties, iii) develop plausible scenarios within the context of those uncertainties, iv) identify actions and recommendations that consider those scenarios, and v) develop key trigger points and monitor for change. Scenario planning has been applied in a variety of fields, including marine fisheries, and can not only assess impacts and vulnerabilities at all three levels (**ecosystem/ecological**, **fisheries/socioeconomic**, and **management**), but also provides potential management adaptation ideas and actions, which aligns with Step 4 (identify possible adaptation actions) of IATTC's climate change framework. The IATTC has also recently received funding to conduct a climate change scenario planning exercise with its stakeholders over the next 2-3 years (2026-2028).

Ecosystem Models

Ecosystem models capture complex trophic relationships between species and their environment, helping researchers understand how fishing, the environment (e.g., climate change), and management decisions alter marine ecosystem structure and dynamics. This allows ecosystem models to explore the impacts of climate change at the **ecosystem/ecological**, **fisheries/socioeconomic**, and **management levels.** Models like Ecopath with Ecosim (EwE) and Atlantis can be driven by climate model outputs to project future changes in biomass, growth, and mortality across trophic levels, and have shown that incorporating climate-driven productivity regimes into fisheries management can improve yields and reduce closures. IATTC has an existing ecosystem model for the EPO that incorporates environmental forcings such as ENSO-driven SST anomalies and their bottom-up effects on productivity and predator-prey dynamics.

Climated-informed Stock Assessments

Stock assessments evaluate the effects of fishing on fish populations and inform sustainable harvest recommendations, and can be expanded to incorporate environmental and climate variables to better account for climate-driven changes in biological processes like recruitment, growth, and distribution (**ecological level**). However, stock assessments vary in their robustness to climate change — they are generally robust to recruitment changes but may be less so for climate-driven shifts in growth, natural mortality, or catchability. Spatial-temporal modeling approaches, including modern CPUE standardization and tagging-based abundance estimation, show particular promise for developing climate-robust assessments, with IATTC already applying a spatial-temporal tagging model to estimate absolute abundance for EPO tuna stocks.

Climate-informed Management Strategy Evaluation

MSE uses simulations to evaluate the robustness of alternative management procedures under various conditions, making it a valuable tool for identifying and adapting to climate and environmental change impacts at the **ecological, fisheries,** and **management levels**. Two main approaches exist for incorporating climate change: the mechanistic approach, which uses climate model outputs to project population trends based on identified climate-process relationships, and the empirical approach, which applies hypothesized climate trends to test which management strategies are robust to changing biological parameters. IATTC is developing its first MSE on bigeye tuna with the hopes of incorporating environment/climate change in the future.

Biomass/Age-Structured Models

Biomass and age-structured models like SEAPODYM can simulate the spatial and temporal dynamics of fish populations by linking biological processes — such as growth, recruitment, and mortality across life stages — to environmental and oceanographic conditions. By incorporating climate-driven changes in temperature, oxygen, and prey availability, these models can project how population structure, distribution, and productivity may shift under future ocean conditions. This makes them valuable tools for understanding climate impacts at both the **ecological** and **fisheries level**, and their outputs can inform stock assessments, ecosystem models, and management strategy evaluations. Currently, there is a SEAPODYM model for tropical tuna in the Pacific Ocean, maintained and updated by SPC.

Fisher Surveys, Interviews, and Workshop Discussions

Direct interactions with fishers through surveys, interviews and workshop discussions provide qualitative and local ecological knowledge that complements quantitative data sources, helping to capture **socioeconomic/fishery level** climate impacts that may not be reflected in catch records or models alone. These approaches can document how fishers are already observing and adapting to environmental changes, identify vulnerable communities and fleets, and surface management concerns and priorities directly from those most affected. Engaging fishers and stakeholders through these methods also supports the co-development of climate adaptation strategies, improving the likelihood of effective and equitable management outcomes. The IATTC staff has been organizing skippers workshops for a long time, and started conducting anonymized skippers questionnaires annually since 2020.

Fisher Behavioral Models

Behavioral models of fisher decision-making — such as discrete choice models — quantify how individual vessels or fleet segments respond to changing conditions by modeling choices around species targeting, fishing location, and participation. By linking these models with species distribution model outputs under climate scenarios, they can predict how fleets (**fishery level**) will redistribute effort as species availability and ocean conditions shift. This identifies which fleets are most vulnerable and which management conditions — such as access to multiple species and flexible permits — best support climate resilience.

Bioeconomic Models

Bioeconomic models couple biological population dynamics with economic processes to evaluate how fishing effort, costs, and revenues interact with stock abundance and productivity over time. By incorporating climate-driven changes in fish distribution, growth, and recruitment, these models can project how both stock status and fishery economics may shift under future conditions, and how different management strategies perform across those scenarios. This makes them a valuable tool for identifying management approaches that are robust to climate change while balancing **ecological** sustainability and **socioeconomic** outcomes for fishing communities.

Fishery Manager Surveys, Interviews, and Workshop Discussions

Fishery manager surveys, interviews, and workshop discussions provide critical insight into **management level** effects of climate change such as on institutional capacity, decision-making processes, and barriers to implementing climate-adaptive management. These approaches help identify gaps in current management frameworks, highlight where existing tools and regulations may be inadequate under climate change, and surface priorities and concerns directly from those responsible for making and enforcing management decisions. Engaging managers through these methods also fosters the co-development of climate adaptation strategies, building the trust and shared understanding needed to translate scientific outputs into effective, actionable management responses.

Conservation and Management Measure Risk Assessments

Conservation and management measure (CMM) risk assessments evaluate the vulnerability of existing fishery regulations and management measures to climate change, identifying which measures may become ineffective, outdated, or counterproductive as ocean conditions shift. By systematically reviewing how climate-driven changes in species distribution, abundance, and fleet behavior interact with current **management** frameworks, these assessments help prioritize which measures need revision or adaptation. This makes them a practical tool for translating climate science into actionable management reform, helping fishery agencies proactively update their regulatory frameworks to remain effective under future conditions.

3. CLIMATE-RELATED FISHERIES TOOLS RECOMMENDATIONS

After a thorough review of the available strategic tools prior to and during the 2nd Climate Change Workshop as well as the current progress that staff has already made on several tools, the staff has provided a preliminary list of recommended climate related tools. These recommendations will be the tools that IATTC could focus on over the next three years to accomplish Step 2 of the IATTC Climate Resilient Fisheries Framework (i.e. assess climate impacts and vulnerabilities). Given the relatively short timeframe (three years for a first iteration in the current Climate Change workplan), the staff has developed or is considering a comprehensive set of tools, or versions of them, that can help improve IATTC's climate resilience. Fortunately, some of the tools are in the process of being developed, making them easy to recommend continued work on (e.g., oceanographic data, SDMs, physiological/laboratory experiments, indicators). Further, many of these tools can be worked on simultaneously. Other tools such as ecosystem models, fisheries surveys, stock assessments, and MSE have already been developed (e.g., stock assessments), are underway (e.g., MSE) or will be updated (e.g., ecosystem model, fisheries surveys), which creates an opportunity to integrate the environment into them. Given this context and to ensure new tools span all three levels (i.e., ecological/ecosystem, fishery/socioeconomic, management), the three most ambitious tools the staff recommends be developed from the bottom up are a CVA, climate change scenario planning, and CMM risk assessments. Each may require additional funding and coordination to engage with stakeholders via in person workshops. Fortunately, the climate change scenario planning exercise has already received external funding from the Blue Convergence Fund. Therefore, regarding strategic tools, and as a priority for the next three years to fulfil Step 2 of the IATTC Climate Resilient Fisheries Framework, the IATTC staff recommends that:

The Commission focus on developing a Climate Vulnerability Assessment (CVA), a climate change scenario planning exercise, and a conservation and management measures (CMM) risk assessment, while concurrently advancing and integrating climate-related tools already underway — including species distribution models, collaborative physiological and laboratory studies (e.g. Achotines Laboratory), ecological/socioeconomic indicators, ecosystem models, fishery surveys, and stock assessments/management strategy evaluation — to assess climate impacts and vulnerabilities of the IATTC.

4. APPENDIX 1

List of staff recommendations of the climate change workplan based on discussions at the 1st and 2nd Workshops on Climate Change and at the EBWG and SAC annual meetings.

Terms of Reference for climate change workshops

Consider adopting the Terms of References proposed by the IATTC staff (IATTC-102 INF-B) to guide the series of climate change workshops aimed to facilitate staff and stakeholder engagement during the development of the proposed climate change workplan (SAC-15-12).

Main goal of the climate change workplan

To ensure climate resiliency for fisheries and all species covered under the Antigua Convention, taking into consideration ecosystems and habitats they live in.

Define the scope of the climate change workplan

1. What decisions are this climate change workplan intended to support?

The workplan is designed to support the development of science-based conservation and management measures that promote climate resiliency for fisheries and all species covered under the Antigua Convention, while also considering the ecosystems and habitats in which they live.

2. Who will be implementing the climate change workplan?

The workplan should be promoted and steered, and its implementation monitored, by the IATTC, with the support of its scientific and policy staff, the Ecosystem and Bycatch Working Group and the Science Advisory Committee.

3. What are the conservation and management targets of the climate change workplan?

The highest priority conservation and management targets of the workplan should include tuna and tuna-like species and the fleets that target them, while also considering bycatch species, particularly vulnerable[1] ones, and all other species covered under the Antigua Convention that belong to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered under the Convention.

4. What is the geographic scope of the climate change workplan?

The primary geographic scope of the workplan should encompass the entire IATTC Convention Area while recognizing the importance of conducting scientific research across the broader Pacific Ocean basin. This includes collaboration with other RFMOs, their scientific bodies and service providers, as well as promoting appropriate coordination and cooperation with them.

5. What is the temporal scope of the climate change workplan?

The temporal scope of the workplan considers multiple time scales, ranging from short (up to one year) to medium term (one year to 10-25 years) to long term (25-100 years in the future), in a manner appropriate to its specific objectives identified for each of these time scales.

6. Who are the key partners and stakeholders and how are they involved in the workplan?

The workplan and related activities should, as much as possible and where appropriate, be participatory and inclusive of all CPCs and other relevant stakeholders. This includes, but is not limited to, scientists, managers, fishers, industry members, RFMOs/RFBs, IGOs, NGOs, and subject matter experts.

7. What resources are available and how will they be covered?

The IATTC should ensure that the resources required for an appropriate development and implementation of the workplan are made available, including through extrabudgetary funding when available.

Climate resilient fisheries framework for the climate change workplan

The framework proposed in SAC-16 INF-P (Section 4 and Figure 1) is considered for adoption and, therefore, guide the IATTC climate change workplan.

Climate-related fisheries tools

The Commission focus on developing a Climate Vulnerability Assessment (CVA), a climate change scenario planning exercise, and a conservation and management measures (CMM) risk assessment, while concurrently advancing and integrating climate-related tools already underway — including species distribution models, collaborative physiological and laboratory studies (e.g. Achotines Laboratory), ecological/socioeconomic indicators, ecosystem models, fishery surveys, and stock assessments/management strategy evaluation — to assess climate impacts and vulnerabilities of the IATTC.