INTER-AMERICAN TROPICAL TUNA COMMISSION

6TH TECHNICAL MEETING ON SHARKS[1]

ASSESSMENT METHODS FOR SHARK SPECIES

La Jolla, California (USA)
28-29 September 2017

REPORT OF THE WORKSHOP

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EXECUTIVE SUMMARY

The IATTC received funds from the FAO-GEF Common Oceans program for a project aimed at improving data collection for shark fisheries in the eastern Pacific Ocean (EPO). The goals of the project include identifying and describing available fishery data sources for shark species in the EPO, as well as incorporating new and existing data on shark fisheries into a database suitable for stock assessments. In addition, as part of the capacity-building aspect of project, aimed at developing IATTC member countries, two workshops were planned, one on Shark Data Collection and the other on Data-Limited Assessment Methods for Shark Species.

This report describes the work, discussions, and training activities that took place during the two sessions of the second workshop, on: 1) ecological sustainability assessment methods in data-limited fisheries; and 2) single-species assessment methods in data-limited fisheries. The workshop was attended by 16 participants (14 of whom received financial support from the FAO-GEF project) from ten IATTC member countries.

The following points were considered particularly important by the participants: (i) continue and strengthen existing initiatives for increasing scientific capacity in the member countries; (ii) perform Productivity-Susceptibility Analyses (PSAs) for species included in Appendix II of CITES; (iii) perform a regional assessment of commercially-important shark species; and (iv) facilitate access to scientific publications for developing countries.

1. INTRODUCTION

The Antigua Convention requires that the IATTC "adopt, as necessary, conservation and management measures and recommendations for species belonging to the same ecosystem and that are affected by fishing

[1] Organized under the FAO-GEF ABNJ project

for, or dependent on or associated with," the stocks of tunas and tuna-like species in the eastern Pacific Ocean (EPO). Most shark species are highly vulnerable to fishery exploitation due to their typical life-history charateristics of slow growth rates over long lifespans, late age of maturity, and the production of limited offspring after long gestation periods. In the EPO, sharks are targeted or caught incidentally (as bycatch) by multi-species and multi-gear artisanal fisheries of the coastal member countries, and also by large-scale tuna longline fisheries from distant-water members.

Stock assessments of sharks pose several challenges. One of them is that fisheries statistics, such as catch, effort, and size-composition data, are either lacking or, if available, are often incomplete or aggregated into generic taxonomic groups (e.g., "sharks"). As a result, long-term time series of species-specific catch and effort data are rarely available, which makes stock assessments of sharks problematic. Biological information, such as growth rates and reproductive parameters, is also very limited for many species. The fisheries in the EPO, both those targeting sharks and those that take sharks as bycatch, are no exception to such data shortcomings. An additional limitation is the lack of scientific expertise required to carry out the complex data analyses involved in contemporary stock assessments.

The IATTC has received funding from the United Nations Food and Agriculture Organization (FAO) and the Global Environmental Facility (GEF) in the framework of the Common Oceans program, as part of the Sustainable Management of Tuna Fisheries and Biodiversity Conservation in Areas Beyond National Jurisdication (ABNJs) project, of which one component is the reduction of the impacts of tuna fisheries on the ecosystem, and specifically on sharks. The broad goal of the IATTC project is to improve data collection for shark fisheries in the EPO, with a focus on Central America, where much of the shark catch is landed and where the need for better data collection is greatest. Its main objectives are to identify and describe available fishery data sources for shark species in the EPO, and to incorporate new and existing data on shark fisheries into a database suitable for stock assessment. In addition, as part of the capacity-building activities aimed at developing IATTC member countries, two workshops were included in the EPO project, one on Shark Data Collection, and the other on Data Limited Assessment Methods of Shark Species.

The first workshop, the 5th IATTC Technical Meeting on Sharks, held in May 2015, gathered scientific and technical personnel interested in improving the collection of data on sharks in the EPO, with the aim of improving fisheries research and stock assessments.

This report describes the work, discussions and training activities that took place during the two sessions of the second workshop (see agenda, Appendix 1), specifically: 1) ecological sustainability assessment methods in data-limited fisheries; and 2) single-species assessment methods in data-limited fisheries. The workshop was facilitated by four members of the IATTC staff: Alexandre Aires-da-Silva (meeting chair, Stock Assessment Program), Salvador Siu (meeting co-chair, Data Collection and Database Program), Carolina Minte-Vera (Stock Assessment Program), and Shane Griffiths (Biology and Ecosystem Program). The workshop was attended by 16 participants (14 of whom received financial support from the project), from ten IATTC member countries.

2. DATA-LIMITED METHODS

The attendees discussed the problems faced by fisheries researchers and managers in assessing stocks for which very limited catch and/or biological data are available. Two main type of simple data-limited methods were discussed: 1) "scoping methods," such as ecological risk assessments (e.g. Productivity-Susceptibility Analysis), which allow species that are potentially vulnerable to overfishing to be prioritized; 2) "proxy methods", metrics used as indicators that are computed from existing available information for prioritized species (e.g. catch-per-unit-of-effort (CPUE), length-frequency, life-history data). The workshop provided background on relevant methods through practical tutorial sessions, and focused on building capacity among regional shark fishery experts in need of such data-limited methods.

2.1. Session I: Assessing ecological sustainability in data-limited fisheries

Ecological Risk Assessment (ERA) is an increasingly common approach used in fisheries for assessing the sustainability of data-limited fisheries, especially those that interact with large numbers of non-target species. ERA is a suite of flexible tools, ranging from simple qualitative likelihood–consequence analyses driven by stakeholder involvement to quantitative spatially-explicit assessment models. Productivity-Susceptibility Analysis (PSA) has been widely used in data-limited fisheries as it has the flexibility of using various data types to rapidly produce a relative measure of vulnerability for large numbers of species that can be easily interpreted by non-technical audiences, fishery managers, and policy makers. PSA is the primary ecological assessment method recommended by the Marine Stewardship Council for fisheries seeking eco-labelling certification.

PSA operates by ranking each species known to be impacted by a fishery, directly or indirectly, on a number of criteria (called "attributes") related to its susceptibility to capture and its capacity to recover should the population become depleted. For each species, susceptibility attributes (*e.g*. geographic distribution relative to fishing effort) and recovery attributes (*e.g*. growth rate and fecundity) are given a rank of 1 (least susceptible; least productive) to 3 (most susceptible; most productive). The scores for susceptibility and productivity attributes for each species are averaged and then combined to produce an overall vulnerability score from 0 (least vulnerable) to 3 (most vulnerable). The species with the highest ranks across all attributes are considered most vulnerable to becoming unsustainable under current levels of fishing.

Vulnerability in an ERA context can be defined as the potential for the productivity of a stock to be diminished beyond expected natural fluctuations by direct and/or indirect fishing impacts. PSA, like most ERA approaches, and unlike stock assessments of target species, does not provide robust population status estimates against biological reference points; its primary function is to act as a data-driven 'filter' to prioritize vulnerable species for further research or management intervention that will mitigate the risk of population decline.

Session I of the workshop (agenda item 4) discussed ecological sustainability, its definition(s), why it needs to be assessed, and which methods can be used to assess it. An overview of PSA was provided, followed by a demonstration of PSA for the EPO longline fishery. This was followed by a 'hands-on' tutorial, in which each participant constructed a PSA, using a hypothetical example of sharks caught in the Costa Rican longline fishery, and developed attributes relevant to the fishery, using information in published literature to develop productivity attribute scores for each species. Susceptibility scores (e.g. fishing gear selectivity of species) were decided during a group discussion, and participants then applied their attribute scores for each species to produce a PSA x-y plot. Participants presented and interpreted their results, and the group discussed the strengths and shortcomings of the analyses, especially parameter biases, and their implications for the future research and management needs of the hypothetical fishery.

2.2. Session II: Single-species assessment methods in data-limited fisheries

The objective of sustainable fishing is to obtain benefits (catches) without compromising the capacity of the exploited stock to produce those benefits; in other words, guarantee its reproduction and the development of juveniles. Fisheries management is the actions taken to achieve these objectives. Ideally, management should be based on quantitative stock assessments, in order to be able to estimate the effects of fishing on a stock and/or the potential effects of different harvest strategies. Stock assessments consist of two components, models and data. The models are constructs that include hypotheses (assumptions) about how stocks function and about production and loss processes, which increase or decrease the population. Generally, more complex models contain fewer assumptions and produce more realistic results, and are more suitable for specific situations, but they require a great quantity of data. In contrast, simple models are more general and need fewer data, but include rigid assumptions that may not be realistic. There is therefore a trade-off between complexity/usefulness and the practicality of assessment models.

Data-limited fisheries are fisheries that exploit stocks for which the quantities related to (i) maximum sustainable yield, (ii) size of the population, (iii) life history of a critical component of the population, or (iv) fisheries parameters are unknown (Restrepo *et al*. 1998; NOAA Tech. Memo. NMFS-F/SPO 1998). In order to investigate why those quantities are important for managing a stock, the second session of the workshop (agenda item 5) started by exploring a spreadsheet of an age-structured population dynamics model. (A dynamics model relates the current state of a population to its state in the past.) The aim of this exercise was to develop intuition about what the observable population characteristics (e.g. length frequencies of the catches, based on the age structure of the population, and length-at-age and selectivity-at-age assumptions) would look like if perfect information about a stock were available. The four basic processes that determine the dynamics of a population were included in the model: two producion processes (recruitment and somatic growth), and two loss processes (natural mortality and fisheries catches). In addition, the two quantities that are measured to make inferences about the population (length frequencies of the catches and CPUE) were also explored, and the population parameters were varied to observe the effect on those quantities. Once the sampling program for shark fisheries in Central America is implemented in the second phase of the FAO-GEF project, more complete and accurate data on length frequency of the catches and CPUE will be available.

For such data-limited fisheries, the only assessment tools available are indicators and simple models. Indicators are generally statistics based on data, which can be calculated with data from a sample, without needing to know the values for the entire stock. However, for the sample to be usable for drawing inferences, it must be representative of the exploited population. The workshop discussed three indicators, based on: (1) standardized CPUE as an index of relative abundance; (2) the length structure of the catches, such as average catch and average length and length relative to the length at first maturity; (3) more general information that can give an idea of the capacity of the population to support the fishery, such as life history parameters.

CPUE data can be used as an indicator of population tendencies if it is assumed that CPUE is directly proportional to abundance. Factors that can change catchability must be taken into account and included in the model for standardising CPUE, which aims to eliminate the effects of those factors on the CPUE and produce an index of relative abundance. Fishing can reduce the average age of the individuals in the population relative to the unexploited population, and thus change the length structure of a stock. Depending on the characteristics of somatic growth, the distribution of lengths in the population can also change, so that the proportion of smaller individuals is greater. Tendencies in average length can be an indicator of stock status, and can even provide information on the level of exploitation of the stock. Interpretation of length structure, however, depends on the life history of the species, the dynamics of recruitment, the selectivity of fishing gears, and the vulnerability of the species to the fishery. General information about a species, such as life-history data (age at maturity, length at age, *etc*.) and characteristics of its life cycle (the pattern of survival and reproduction typical of a member of the species) helps to improve estimates of the effects of fishing on a population, and also prevent unrealistic interpretations of the length data. In some cases, if such information is not available for a species, data can be “borrowed” from other species or stocks with comparable characteristics that are better studied.

The simple models presented were: (1) demographic analysis, which assumes simple population dynamics (*e.g.*, constant recruitment), information on reproduction (maturity, fecundity) and mortality from natural causes; (2) spawning biomass per recruit, which assumes simple population dynamics (*e.g.*, constant recruitment, constant fisheries selectivity), and requires life-history information (somatic growth, maturity, fecundity, natural mortality) and length-structure data.

Ideally, while using methods that require few data to assess a population, plans for increasing the quantity of information available should be implemented, with the aim of getting away from the more rigid assumptions of data-poor methods and of approximating reality. In this way, data initially used for indicators could later be used in stock assessments.

3. SUGGESTIONS FOR FURTHER CAPACITY-BUILDING INITIATIVES

The attendees urged the staff to continue this type of capacity building for member countries. In particular, the representatives of Venezuela, El Salvador, and Costa Rica highlighted the need to continue the work on PSA for species in Appendix 2 of CITES, in order to carry out a regional assessment of the various species of sharks of commercial importance. El Salvador noted the need for collaboration so that developing countries can have access to the most recent scientific publications.

4. CONCLUSION: DETERMINING FEASIBLE ASSESSMENT OPTIONS

Assessing ecological sustainability can be complex and requires the use of tools, such as PSA, that are suited to the available data, resources, and objectives of such assessments (*e.g*. eco-labelling, CITES assessments).

ERA should be viewed as a continuum of increasingly quantitative assessment tools that can guide fishery managers in prioritizing potentially vulnerable species for specific research (e.g. life history studies), monitoring, assessment or threat mitigation.

Single species assessments are a subsequent step from ERA and can be useful even where limited biological and catch data are available. They can help identify data requirements to more precisely assess the status of exploited species using conventional stock assessment.

Appendix 1. Agenda

1. Opening (*Alexandre Aires-da-Silva*)
2. Introduction to the meeting (*Carolina Minte-Vera*)
3. Participant introductions
4. **SESSION I. Assessing ecological sustainability in data-limited fisheries** (*Shane Griffiths*)
    - 4.1. What is ecological sustainability? Why it needs to be assessed?
    - 4.2. Methods for assessing ecological sustainability
    - 4.3. An overview of Productivity-Susceptibility Analysis (PSA)
    - 4.4. Demonstration of PSA for the EPO longline fishery
    - 4.5. Tutorial – Construction of a PSA for sharks caught in Costa Rican longline fishery (a hypothetical example)
        - a. Develop attributes relevant to the fishery/country
        - b. Using literature to develop productivity attribute scores
        - c. Round table discussion to determine susceptibility scores (e.g. fishing gear selectivity of species)
        - d. Populate the scoring tables
        - e. Produce a PSA x-y plot and interpret the results
    - 4.6. Group discussion to present hypothetical research or management needs for vulnerable species
5. **SESSION II. Single-species assessment methods in data-limited fisheries** (*Carolina Minte-Vera*)
    - 5.1. Indicators:
        - a. Standardized CPUE as index of relative abundance
        - b. Size structure of the catches: changes in average size, size relative to size at maturity
        - c. “Borrowing” information: life-history invariants, meta-analyses
    - 5.2. Simple models:
        - a. Spawning biomass-per-recruit: simple population model, size structure and life-history
        - b. Trends in catch and catch only models: simple population model, catch and life-history assumptions to inform values for the model parameters
        - c. Depletion analysis: simple population model, catch, CPUE, life-history assumptions to inform values for the model parameters
6. **CONCLUSION: Determining feasible assessment options**

Appendix 2.

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