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Development of Harvest Strategies for key SIOFA fish stocks (PAM-2024-03)

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Abstract	

This report outlines the methodology and progress of Project PAM-2024-03, focused on developing harvest strategies for key Southern Indian Ocean Fisheries Agreement (SIOFA) fish stocks.

The project aims to develop and test harvest strategies in alignment with related projects (PAM-2024-01 and PAM-2024-02) and will incorporate advice and insights from the SIOFA Expert and Advisory Panels (PAM-2024-04). This project will also build upon previous workshops and ongoing efforts by the SIOFA Scientific Committee and Meetings of the Parties on Precautionary Approach and Management (PAM).

Harvest strategies involve the management of stocks based on some index, assumed a proxy of stock size / health, and a rule which determines the catch limit in any year. Both index and rule will depend on the species investigated and in particular the quality or the data. Most SIOFA species are data-poor, limiting the options for management.

Workshops and recommendations from SIOFA's 10th and 11th Meetings of Parties (MoP10, MoP11) have proposed a three-tier approach to harvest strategies: based on stock assessment results and biological reference points for the most data-rich species, applying a status-quo exploitation rate for medium-rich species, or maintaining catches at present level for the species

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with least information available. Interim biological reference points have also been developed as part of this process, and will be investigated further as part of project PAM-2024-02.

As part of project PAM-2024-03, we will develop simulation models for orange roughy, toothfish and alfonsino, as well as replicating low information stocks. Projections will be carried out, applying the alternative harvest control rules / biological reference points selected and varying projected productivity of the stocks. The same modelling framework will be used for both PAM-2024-02 and PAM-2024-03 projects. The results of the different simulations will be compared based on outcomes against management objectives, including stock productivity and reference points, risk, and effect on the fishery.

Regular updates and reports will be shared with stakeholders, culminating in a final report by April 2026.

The study provides a foundation for sustainable fisheries management in the SIOFA region, helping to ensure the health of fish stocks and the long-term viability of the fisheries sector.

A tiered framework addresses low, medium, and high-information stocks, incorporating international best practices and life-history data from diverse sources. It will explore regime shifts, environmental variability, and dynamic BRP adjustments.

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Development of Harvest Strategies for key SIOFA fish stocks (PAM-2024-03)

Introduction

This document outlines approaches to be applied in the development of harvest strategies for key SIOFA fish stocks, under the project PAM-03. This project will be carried out in close collaboration with projects PAM-2024-01, which will identify the appropriate policy settings and management approach, and PAM-2024-02 which will develop biological reference points for those key SIOFA species. It will also incorporate feedback from the review panel, covered under PAM-2024-04 (Figure 1). The same modelling frameworks will be used to develop and test both the biological reference points (project PAM-2024-02) and the harvest control rules that use those reference points (project PAM-2024-03). Further details will be determined in collaboration with the SIOFA project Expert Panel, the project Advisory Panel and the research providers of other PAM-2024 projects.
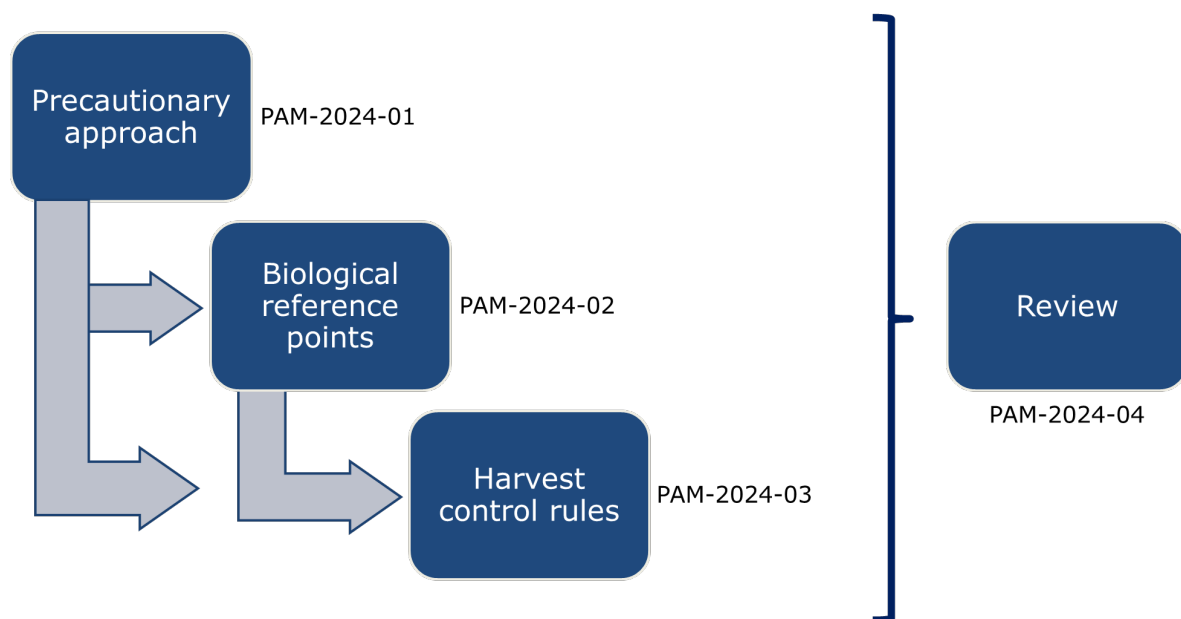

Figure 1: The 2024 SIOFA projects on Precautionary Approach and Management.

Project Objectives

The project objectives, as per the terms of reference of the tender document are as follows.

1. To consider monitoring strategies and develop harvest control rules and undertake management strategy evaluations designed to help ensure sustainable fisheries within the SIOFA Area, including:
   a. Harvest control rules that are suitable for a range of different levels of available data.
   b. Management strategies that consider the trade-offs between different harvest control rules, levels of risk, and achievement of management objectives.

      c.   Breakout rules and default breakout actions.
2. Evaluation of different stock assessment options, based on the level of data available, for key SIOFA fish stocks, and specifically including orange roughy and toothfish.
3. Evaluate how additional objectives such as bycatch, fisheries impacts, benthic impacts, etc., could be included as part of harvest strategies.

Background

Harvest strategies are a way to provide management advice for stocks, potentially more robust than traditional stock assessment methods as it can incorporate more uncertainties and / or management objectives. An introduction to harvest strategies was provided to SIOFA in 2023 (SIOFA Scientific Committee Chair and vice-Chair & SIOFA Meeting of the Parties Chair 2023).

SIOFA has made considerable progress towards management based on biological reference points (BRPs) and harvest strategies, having held a series of harvest strategy workshops: the Workshop on harvest strategy pre-assessment (SIOFA 2023a) in March 2023, the Joint MoP-SC Workshop on Harvest Strategy Management Objectives (SIOFA 2023b) in November 2023, and the Joint MoP-SC Workshop on the Development of Harvest Strategies (SIOFA 2024) in June 2024.

The 10th Meeting of Parties (MoP10) endorsed the recommendations of the 8th Scientific committee (SC8) regarding a framework of interim harvest control rules and BRPs for interim management of orange roughy, alfonsino, and toothfish stocks (see paras 76-79 of the MoP10 meeting report, and paras 176-177 of the SC8 meeting report). In particular, in terms of harvest strategies, (MoP10, para 79):

"The MoP ENDORSED the recommendations in paragraph 178 of the SC8 report regarding candidate Harvest Control Rules for interim management, notably:

a. Maintain catches at present levels (unless there is evidence of a marked downward trend in the resource) until sufficient further informative data becomes available for meaningful improvements to the existing assessments. Where not previously defined for specific stocks, the SC recommends the present level be defined as the average (mean) of the 5 year period 2018–2022. For orange roughy, SC7 agreed that recent levels referred to the average of the last six years of that assessment (2015–2020).

b. Implementing an Fstatus-quo harvest strategy, which varies catches up or down in proportion to the results from continued collection of some measure or index of abundance.

c. Implementing a harvest strategy based primarily on some multiple of a proxy value of FMSY or BMSY, while noting that other proxies or proxy values may be appropriate for some stocks, for instance those in the CCAMLR decision rules for toothfish."

Potential management objectives and performance indicators were drafted by the Joint MoP and SC Intersessional Workshop to Define Harvest Strategy Management Objectives (SIOFA 2023b) in November 2023, and the performance indicators were further refined by SC9 in March 2024 – see Annex H and Annex I of the SC9 report. These were noted by MoP11 in July 2024.

MoP11 in July 2024 also endorsed the recommendations in paragraph 20 and 24 of the Joint MoP-SC Workshop on the Development of Harvest Strategies (SIOFA 2024) Conveners Report that alternative sensitivity choices should be evaluated for orange roughy and toothfish respectively. For orange roughy, analysts should evaluate alternative sensitivity choices of 50-60-70% probability of being at or above a target reference point (TRP) of 30-40-50% B_0, while for toothfish analysts should evaluated the same probability levels but for TRP of 40-50-60% B_0.

MoP11 also adopted a broader set of recommended management objectives and performance indicators for orange roughy and toothfish – see Annexes N and O respectively of the MoP11 report. These included BRPs that were consistent with the interim BRPs discussed above.

For alfonsino, limited CPUE data and simple assessments are available. Although MoP10 endorsed the same BRPs for alfonsino as for orange roughy, MoP11 noted that WS2024-HSS reaffirmed that harvest strategy development work should first focus on toothfish and orange roughy, and that harvest strategies for alfonsino and other SIOFA species could be developed thereafter, as was agreed by MoP10 and SC9.

For other species, data available at present are very limited which creates difficulties for developing reference points and harvest strategies. MoP11 advised that catches should be maintained at the average of recent catches, with sufficient monitoring to identify unsustainable trends. They indicated that it may be feasible to develop BRPs after the completion of work on toothfish, orange roughy and alfonsino.

Methodology

The investigation into harvest control rules will be carried out using the population software Casal2 (Casal2 Development Team 2023) as the main framework for the simulations. Casal2 is an open-source integrated statistical catch-at-age or catch-at-length assessment tool for modelling the population dynamics of marine populations.

Briefly, potential harvest control rules will be developed based on international examples (e.g., Ministry of Fisheries 2011; Mormede 2023) and with feedback from the other PAM-2024 scientists and the SIOFA project Expert Panel and project Advisory Panel. Particular attention will be given to processes used in other Regional Fisheries Management Organisations. Further conditioning of these rules will be considered, to include the effects of climate change (Duplisea et al. 2021), benthic impacts (Mormede 2022) and / or bycatch if desired. In those instances, the harvest control rule outcome would be multiplied by the conditioning factor (see details below). These will be tested on fully Bayesian stock assessments using Casal2 (Casal2 Development Team 2023).

Casal2 models will be developed for the stocks of interest (toothfish and orange roughy) and compared to the assessment currently used for management purposes. In the case of orange roughy, the 2025 stock assessment developed as part of ORY-2024-01 will be used as a starting point. In order to evaluate the effectiveness of these rules for stocks with less data, additional models for these two stocks will be stripped of some information, allowing direct comparison of results.

Simulations will then be carried out by projecting the models into the future, applying the alternative harvest control rules / biological reference points selected and varying projected productivity of the stocks (e.g., steepness, Edgar et al. 2024). The same modelling framework will be used for both PAM-2024-02 and PAM-2024-03 projects.

Harvest control rules will include different functional forms of rules based on exploitation rates (also referred to as F-based or U-based harvest control rules) for the high information stocks (e.g., Ministry of Fisheries 2011; Mormede 2023; Dunn et al. 2024; Ziegler et al. 2024a, 2024b), and catch-based rules based on CPUE values for lower information stocks. Should these be of interest, catch-based rules for high information stocks can also be investigated. Constant catch and constant exploitation rates (options a and b endorsed by the MoP11, see above) will also be included in the series of harvest control rules tested.

The results of the different simulations will be compared based on outcomes against management objectives, including stock productivity and reference points, risk, and effect on the fishery. Performance indicators will include those endorsed by MoP11 (Annexes N and O respectively of the MoP11 report) as well as those recommended by projects PAM-2024-01 and PAM-2024-02.

Potential breakout rules and actions will be tested by pushing simulations to lower stock levels and applying those rules. The effectiveness of the breakout rules and actions will be compared based on outcomes against management objectives, including stock productivity and reference points, risk, and effect on the fishery. The MoP10 endorsed the recommendations to include breakout rules (paragraph 89).

The harvest control rules can be conditioned based on different factors, such as climate change and/or fishing impact. Guidance will be sought from the SIOFA project Expert Panel and project Advisory Panel. If used, the advice coming from the assessment and the harvest control rule will then be multiplied by the desired conditioning factor for that year.

For environmental conditioning, potential relationships between environmental variables and stock productivity could be investigated and applied to some of the simulated projections (Duplisea et al. 2021; Mormede 2023). Alternative environmental conditioning functions could be tested, including the Baione double sigmoid (Baione et al. 2021). ICCAT is currently investigating climate-conditioned stock assessment advice (ICCAT circular #3801/2024), and climate change has been highlighted as a potential source of bias in stock assessments (e.g., Edgar et al. 2024).

The potential conditioning of the harvest control rules based on fishing impact could include threshold rules, or rules with shapes similar to the environmental conditioning factor. These could be conditioned on the level of bycatch or benthic impact.

The work will be carried out in close conjunction with the SIOFA project Expert Panel, project Advisory Panel and the research providers of projects PAM-2024-01 and -02 to ensure the best applicability of the research.

Reporting

Regular reporting to the SIOFA project Expert Panel and the project Advisory Panel will be carried out throughout the project. Feedback will be integrated into the work programme. Presentations will be given at the appropriate SIOFA meetings, as required. Draft and final reports will be provided as per the project tender. All data and code will be provided to the Secretariat.

The project will be carried out in accordance with the tender terms, conditions, and provisions. The timelines detailed in the tender document will be adhered to, specifically:

- regular (i.e. every 2-3 months), proactive updates to the project Expert Panel and project Advisory Panel throughout the project,
- presentation of preliminary methods and results by 18-27 March 2025,
- draft report by 31 December 2025,
- presentation of final results to the SIOFA SC annual meetings (March 2026),
- final report by 1 April 2026,
- provide all the information collected and code developed, by 1 April 2026.

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