Initial Feasibility Matrix of Data-Limited Assessment Approaches for Key Shark Species in the IOTC Region: A Starting Point for Discussion at the Data Preparatory Meeting (15–17 April 2026)

Charlene da Silva[1,2], Mariana Travassos Tolotti[3,4]

Abstract

This document provides a brief review of quantitative ecological risk assessment methods with potential application to shark bycatch in fisheries managed by the Indian Ocean Tuna Commission (IOTC), focusing on the inputs required by different assessment approaches and the data currently available within the IOTC context. Methods considered include Productivity–Susceptibility Analysis (PSA), SAFE, EASI-Fish, SEFRA, and other spatially explicit, rate-based frameworks. Rather than a comprehensive comparison of methods, the document outlines key data requirements related to fishing effort, species distributions, catchability, post-discard survival, and productivity reference points, and evaluates their implications for feasibility. A phased action plan is proposed to audit IOTC-held data, assess species- and method-specific readiness, and pilot quantitative assessments with active engagement of Contracting Parties. The proposed approach is intended as a quantitative escalation tier that complements existing ERA and PSA processes, while acknowledging limitations arising from data coverage, uncertainty, and parameter identifiability.

Introduction

Fisheries that target or incidentally catch pelagic sharks are widely recognised as a primary driver of declines in many pelagic shark populations. A substantial proportion of pelagic shark and ray species are currently considered to be at elevated risk of extinction due to fishing pressure (Dulvy *et al.* 2008, Pacoureau *et al. 2021*). While the extent and rate of decline vary among species and regions, these patterns highlight the need for robust and timely assessments to inform management.

Despite this, for many pelagic shark species, the available data are insufficient to support conventional Tier 1 stock assessments that yield precise and unambiguous estimates of stock status. This limitation is not necessarily due to a lack of management intent but may partially reflect the inherent challenges of assembling the types of long-term, high-resolution datasets required for such analyses. Traditional age-structured or integrated stock assessment models typically rely on extended time series of standardised catch, effort, and size composition data. These data are seldom available for sharks, particularly for species that are not directly targeted, or those taken as bycatch in small-scale or developing-country fisheries, where reporting may be incomplete and catches are often aggregated at coarse taxonomic levels.

This mismatch between management needs and data availability has led to the development and application of a suite of alternative, data-limited assessment approaches tailored to the biological characteristics of sharks. A prominent group of these are semi-quantitative ecological risk assessments, such as productivity–susceptibility analysis (PSA) (Martínez-Candelas *et al.* 2021; Murua *et al*. 2018), which combine basic life-history traits with information on fishery interaction to rank species' relative vulnerability in situations where species-specific abundance data are lacking (Tsai and Huang 2022). Complementary approaches make use of limited demographic and fisheries information to provide insight into stock status or risk, including life-history-based reference point proxies, per-recruit models, and length-based methods (Cortés & Brooks, 2018).

Within this broader context, several approaches are relevant to the IOTC region. These include: (i) general risk assessments that synthesise available biological and fisheries information; (ii) indicator analyses that utilise catch and effort time series (where available) to infer trends; (iii) PSA and related ERA frameworks; (iv) simplified and standardised tools such as EASY-FISH; (v) spatially explicit approaches such as SEFFRA, which incorporate species distributions and fishing effort; and (vi) demographic approaches based on age-structured models (e.g. Leslie matrix implementations), such as those previously applied in the IOTC region following Murua *et al.* (2018). These methods differ in their data requirements, underlying assumptions, and the type of outputs they produce, but collectively provide a toolbox for assessing risk and informing management in data-limited contexts.

Proposed Methods and Discussion

In 2026, oceanic whitetip *Carcharhinus longimanus*, scalloped hammerhead *Sphyrna lewini*, and silky shark *Carcharhinus falciformis* were prioritised under the Workplan of the Working Party on Ecosystems and Bycatch (WPEB) of the IOTC (IOTC-2025-WPEB21(AS)-09_rev1). In support of this work, the current document has been developed as an initial, structured basis for discussion to guide decision-making on feasible analytical pathways given currently available data from the relevant IOTC Executive Summaries. Rather than providing definitive conclusions, it is intended to serve as a starting point for identifying which assessment approaches can be meaningfully applied, where key data gaps lie, and what additional inputs would be required to progress analyses. This method may also be possible for data poor species prioritised for 2027.

Table 1 summarises the feasibility of applying a range of data-limited assessment methods to each of the three species, based on the availability and quality of key data inputs. For each input, its relevance to different assessment approaches is indicated, alongside a qualitative assessment of data availability. The table is intended to (i) highlight which methods are currently feasible, partially feasible, or not feasible; (ii) clarify the specific data requirements associated with each method; and (iii) support a structured discussion on prioritising analyses and data mobilisation efforts. As such, it should be interpreted as an indicative framework to inform deliberations at the Data Preparatory Meeting, rather than as a definitive assessment of feasibility.

The suite of data-limited assessment approaches considered here provides a pragmatic framework for evaluating the risk and, where possible, aspects of stock status of pelagic shark species in the IOTC region, where conventional stock assessments are generally not feasible.

Risk-based methods (e.g. PSA, EASY-FISH) are efficient and suitable for prioritisation but are semi-quantitative and rely on assumptions. Indicator analyses can provide relative trend information where time series exist but are sensitive to data quality and the degree of standardisation. Spatial approaches (e.g. SEFFRA) provide spatially explicit insights into risk, while demographic models (e.g. Leslie matrix methods following Murua *et al.* 2018) offer more mechanistic, but assumption-sensitive, perspectives on population dynamics.

Overall, these approaches are complementary and are most effective when used together to provide multiple lines of evidence, while also highlighting key data gaps. A proposed timeline for the assessment is presented in Table 2, alternatively some of the intermediary stages can be completed in the Shark Research Plan workshop but including species assigned to 2027 period.

Table 1. Preliminary Feasibility Matrix of Data Availability and Requirements for Data-Limited Shark Assessment Methods in the IOTC Region, 1) Good data, 2) Weak data / limited confidence, 3) Data from other regions ,X Required for assessment, XX Useful for assessment, — Not required * not available but can be retrieved from global distribution maps (lower quality) ** Murua et al. 2018. ***Lopetegui-Eguren et al. 2022.**** Mannocci et al. 2020..PS Purse Seine, L Line, GN Gillnet, LL Longline

Species	Input	Data & Quality	RA	IA	ERA	EASY-FISH	SEFRA
Oceanic Whitetip	Life history (growth, maturity, longevity)	3	X	X	X	X	X
	Species-specific catch data	1	X	X	X	X	X
Fisheries:	Effort data	1	X	X	X	XX	X
PS (60.4%)	Standardised CPUE time series	2	—	X	—	—	X
L (33.5%)	Nominal CPUE / presence-absence	2	X	X	—	XX	X
GN (5.7%)	Length-frequency data	2	—	XX	—	X	—
	Maturity information (L50 etc.)	3	X	X	X	X	X
Main fleets:	Gear interaction / selectivity	1	X	X	X	X	X
Mozambique (26.8%)	Spatial overlap (species × fishery)	2	X	X	X	X	X
Madagascar (5.2%)	Post-release mortality estimates	2	—	—	X	X	X
	Observer data (set-level detail)	2	X	X	X	X	X
	Species distribution	2***	—	—	—	—	X
	Expert judgement	1	X	X	X	X	X
	Summary		**TBD**	**Not Feasible**	**Feasible****	**TBD**	**TBD**
Scalloped Hammerhead	Life history (growth, maturity, longevity)	1	X	X	X	X	X
	Species-specific catch data	2	X	X	X	X	X
Fisheries:	Effort data	2	X	X	X	XX	X
GN (54%)	Standardised CPUE time series	—	—	X	—	—	X
L (29.8%)	Nominal CPUE / presence-absence	2	X	X	—	XX	X
Oth (16.3%)	Length-frequency data	2	—	XX	—	X	—
	Maturity information (L50 etc.)	2	X	X	X	X	X
Main Fleets:	Gear interaction / selectivity	2	X	X	X	X	X
Mozambique (73.9%)	Spatial overlap (species × fishery)	2	X	X	X	X	X

Species	Input	Data & Quality	RA	IA	ERA	EASY-FISH	SEFRA
Kenya (16.1%	Post-release mortality estimates	2	—	—	X	X	X
Sri Lanka (6.7%)	Observer data (set-level detail)	2	X	X	X	X	X
	Species distribution*	2	—	—	—	—	X
	Expert judgement	1	X	X	X	X	X
	Summary		**TBD**	**Not Feasible**	**Feasible****	**TBD**	**TBD**
Silky Shark	Life history (growth, maturity, longevity)	2	X	X	X	X	X
	Species-specific catch data	2	X	X	X	X	X
Fisheries:	Effort data (hooks)	1	X	X	X	XX	X
GN (32.7%)	Standardised CPUE time series	2	—	X	—	—	X
L (29%)	Nominal CPUE / presence-absence	1	X	X	—	XX	X
LL (21%)	Length-frequency data	2	—	XX	—	X	—
** PS interactions	Maturity information (L50 etc.)	1	X	X	X	X	X
Main Fleets:	Gear interaction / selectivity	1	X	X	X	X	X
Indonesia (26.4%)	Spatial overlap (species × fishery)	2	X	X	X	X	X
Sri Lanka (20.2%)	Post-release mortality estimates	1	—	—	X	X	X
Taiwan, China (14.6%)	Observer data (set-level detail)	2	X	X	X	X	X
Oth (38.7%)	Species distribution	1****	—	—	—		X
	Expert judgement	1	X	X	X	X	X
	Summary		**Feasible**	**Not Feasible**	**Feasible****	**TBD**	**TBD**

Table 2. Proposed Action plan for piloting a quantitative/ qualitative shark bycatch risk assessment within the IOTC framework.

Phase	Timing	Purpose	Generic Actions (method-independent)	Decision Points
Data Preparatory Meeting	15-17th April 2026	• Expert Audit of Feasibility matrix (Table 1)	• Audit IOTC observer, logbook & auxiliary datasets • CPC validation of fleet, gear & species coverage • Identify data gaps by fleet & region	Agree on assessment-ready vs data-limited species
Problem Formulation	May 2026	Define Assessment Scope	• Select Methods • Identify dominant fleets & gears per species • Define spatial & temporal domains	Confirm candidate assessment methods per species
Data conditioning	May-June 2026	Prepare Inputs	• Compile effort & catch datasets • Harmonise spatial resolution • Review species ID quality • Life-history parameters decision	Confirm minimum data standards met
Core Modelling Inputs	June-July 2026	Build shared components	• Species distribution surfaces (where applicable) • Gear interaction / selectivity assumptions • Post-Discard Survival (PDS) synthesis • Expert judgement elicitation	Lock inputs common across methods
Method-Specific Analysis	July-August 2026	Apply selected framework(s)	• Apply chosen method • Sensitivity tests & uncertainty propagation	Assess robustness and comparability
Integration and Interpretation	August 2026	Management relevance	• Compare outputs across methods (where relevant) • Align results with existing ERA/PSA outcomes	Confirm escalation-tier role
Assessment delivery	September 2026	Formal reporting	• Present results to WPEB • Identify data & research priorities	

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