Productivity-Susceptibility Analysis (PSA)

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Abstract

A Productivity-Susceptibility Analysis (PSA) was conducted to evaluate the vulnerability of species interacting with the Suriname demersal finfish trawl fishery. The PSA, implemented under the Marine Stewardship Council (MSC) Risk-Based Framework (RBF), provides a semi-quantitative method for assessing ecological risk in data-limited fisheries (Marine Stewardship Council, 2022). The analysis was done with onboard observer data collected between 2023 and early 2025, comprising 16 fishing trips and 369 fully sampled trawl drags. Productivity attributes were derived from life-history characteristics, while susceptibility attributes were informed by fishery-specific interactions, including availability, encounterability, selectivity, and post-capture mortality (Marine Stewardship Council, 2022, 2023). Results indicate consistently high susceptibility across assessed species, reflecting frequent interaction with demersal trawl gear and limited selectivity. Differences in overall vulnerability were primarily driven by productivity, with elasmobranch species exhibiting the highest risk due to their life-history traits. Several Performance Indicators (PIs) failed to meet the MSC threshold score of 60, indicating elevated ecological risk. These findings highlight the importance of management measures aimed at reducing susceptibility and improving data availability to support more refined risk assessments.

Table of contents

1 Introduction **3**

2 Fishery Overview **3**

3 Methodology **3**
3.1 PSA Framework 3
3.2 Productivity Assessment 4
3.3 Susceptibility Assessment 4
3.4 Risk Calculation 4

4 Data Sources **5**

5 Results and discussion **5**
5.1 Susceptibility 5
5.2 Productivity 5
5.3 MSC Scores 6

6 Management Implications **6**

7 Conclusion **6**

References **7**

1 Introduction

Sustainable fisheries management requires an understanding of the ecological risks posed by fishing activities to both target and non-target species. Conventional stock evaluations are often impractical in fisheries with limited data, requiring other methods to estimate risk. By combining biological traits (productivity) with fishery-specific interaction dynamics (susceptibility), the Productivity-Susceptibility Analysis (PSA) is a semi-quantitative technique designed to evaluate a species' susceptibility to fishing pressure (Patrick et al., 2009; MSC, 2022). The PSA forms a key component of the Marine Stewardship Council (MSC) Risk-Based Framework (RBF), which is widely applied in fisheries certification processes (MSC, 2023). The Suriname demersal finfish trawl fishery operates on the continental shelf using twin-rig trawl gear and is known to interact with a wide range of species, including elasmobranchs and other benthic fauna. Given the limited availability of species-specific stock assessments, the PSA provides a suitable approach for evaluating ecological risk in this fishery. The objective of this study is to assess the relative vulnerability of species interacting with the fishery and to identify key drivers of risk to inform management.

2 Fishery Overview

The Suriname demersal finfish trawl fishery operates primarily on the continental shelf at depths of approximately 28 m. The fishery uses twin-rig demersal trawl gear targeting finfish species but also capturing a range of non-target species. Observer data collected between 2023 and early 2025 included 16 trips and 369 fully sampled drags. These data provide information on catch composition, catch rates, and species interactions, forming the basis for susceptibility scoring.

3 Methodology

3.1 PSA Framework

The PSA evaluates species vulnerability as a function of productivity and susceptibility (Patrick et al., 2009; Msc, 2022):

- Productivity reflects the capacity of a species to recover from fishing mortality.
- Susceptibility reflects the likelihood of interaction with the fishery and subsequent mortality.

Each attribute is scored on a scale of 1 (low risk) to 3 (high risk), following MSC guidelines.

The PSA was conducted following the MSC Risk-Based Framework (MSC, 2022), with attribute scoring and implementation guided by the MSC Fisheries Standard Toolbox (MSC, 2023).

3.2 Productivity Assessment

Productivity was assessed using life-history characteristics, including:

- Average age at maturity
- Average maximum age
- Fecundity
- Average max size
- Average size at maturity
- Reproductive strategy
- Trophic level
- Density dependance (only for invertebrates)

Species with slower growth, later maturity, and lower reproductive output were assigned higher risk scores.

3.3 Susceptibility Assessment

Susceptibility was evaluated based on four attributes:

- Availability
- Encounterability
- Selectivity
- Post-capture mortality

The demersal nature of the fishery results in substantial overlap with benthic species, leading to generally high availability and encounterability scores. Where direct data were unavailable, precautionary scoring was applied in accordance with MSC guidelines (MSC, 2022, 2023).

3.4 Risk Calculation

For each component unit (e.g. species) the attributes for productivity are scored [1 3] (high, medium, low productivity). These attribute scores are averaged to provide an overall productivity score in the interval [1 3]. Similarly, for each unit the attributes within the 4 aspects of susceptibility are also scored [1 3] (low, medium, and high susceptibility). These aspects are multiplied and rescaled to the interval [1 3] to provide a susceptibility score. A single risk score is calculated as the Euclidean distance from the nominal origin (0.5, 0.7), calculated as $R = \sqrt{P^2 + S^2}$; where R is the risk score, P is the productivity score, and S the susceptibility score. This single risk score allows a ranking of all units considered (MSC, 2023).

4 Data Sources

The PSA was informed by:

- Onboard observer data
- Scientific literature for biological parameters
- MSC RBF Worksheet outputs

The onboard observer data was very important to assess the susceptibility attributes.

5 Results and discussion

Automated MSC scores		
PI	MSC score	Status
2. PI 1.1.1 PSA	FAIL	FAIL
3. PI 2.1.1 PSA	FAIL	FAIL
4. PI 2.2.1 PSA (Fish + Inv +Amph)	FAIL	FAIL
5. PI 2.2.1 PSA (birds)		
6. PI 2.2.1 PSA (myst + siren)		
7. PI 2.2.1 PSA (odontocetes)	FAIL	FAIL
8. PI 2.2.1 PSA (pinnipeds+otters)		
9. PI 2.2.1 PSA (turtles)	FAIL	FAIL
10. PI 2.2.1 PSA (Sea snakes)		
11. PI 2.3.1 CSA		

Figure 1: Automated MSC scores derived from the PSA. Red cells indicate PIs scoring below the MSC threshold of 60 (fail).

5.1 Susceptibility

All assessed species exhibited high susceptibility scores, indicating frequent interaction with the trawl gear and a high likelihood of capture. This is consistent with the operational characteristics of demersal trawl fisheries, which are known to have high encounterability and relatively low selectivity (FAO, 2009).

5.2 Productivity

Variation in vulnerability was primarily driven by productivity differences. The elasmobranch species exhibited lower productivity and higher vulnerability, reflecting life-history traits such as slow growth, late maturity, and low fecundity (Dulvy et al., 2014; Patrick et al., 2009).

5.3 MSC Scores

Multiple Performance Indicators (PIs) did not meet the MSC threshold score of 60, including PI 1.1.1, PI 2.1.1, and PI 2.2.1. The consistent failure across these PIs reflects both high interaction rates with the fishery and the application of precautionary scoring in the absence of detailed biological and survival data (MSC, 2022, 2023).

6 Management Implications

Management strategies mainly focus on reducing susceptibility through:

- Gear modification
- Bycatch reduction devices
- Improved handling practices
- Enhanced monitoring

These measures aim to reduce interaction rates and improve survival of captured individuals (FAO, 2009; MSC, 2022).

7 Conclusion

In the Suriname demersal finfish trawl fishery, the PSA shows increased ecological risk for several species groups. The results highlight the importance of targeted management strategies and improved data collection to support more refined risk assessments (MSC, 2022).

References

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