SUMMARY REPORT

A Comparative Analysis of the Semi-Industrial Longline Fleet Efficiency in Seychelles

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Funding Organisation: Seychelles Climate Change Adaptation Trust (SeyCCAT)

Study Period: 2017-2023

Project Overview

This comprehensive analysis of Seychelles' semi-industrial longline (SILL) fishery was commissioned to address critical recommendations from a 2022 baseline assessment. The study examines fleet performance, efficiency, and sustainability over a seven-year period (2017-2023), moving beyond traditional catch-and-effort metrics to provide a holistic understanding of the fishery's dynamics.

*** This document provides a summary of the results from the main report and does not contain all findings. For a deeper understanding of the methodologies used and detailed findings please view the main report.

Fleet Expansion and Performance Paradox

The SILL fleet experienced dramatic growth, expanding from **31 vessels in 2017 to 66 vessels in 2023**—more than doubling in size. However, this expansion masks concerning efficiency trends:

2,536	+33%	+47%	-48%
Metric Tons	**Days at sea per trip**	**Hooks per trip**	**CPUE Decline**
Total catch in 2023, **+26% since 2019**	Average days at sea per fishing trip from 18 days (2019) to 24 days (2023)	Average hooks deployed per vessel per trip from 5,800 to 8,500 hooks	Catch per unit effort (CPUE) for all species combined between 2019 and 2023

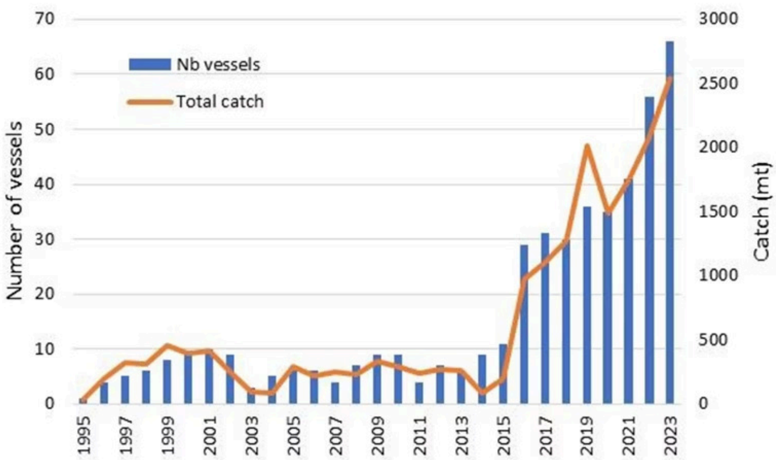


Figure 2: Number of active semi-industrial vessels and total catch, 1995-2023.

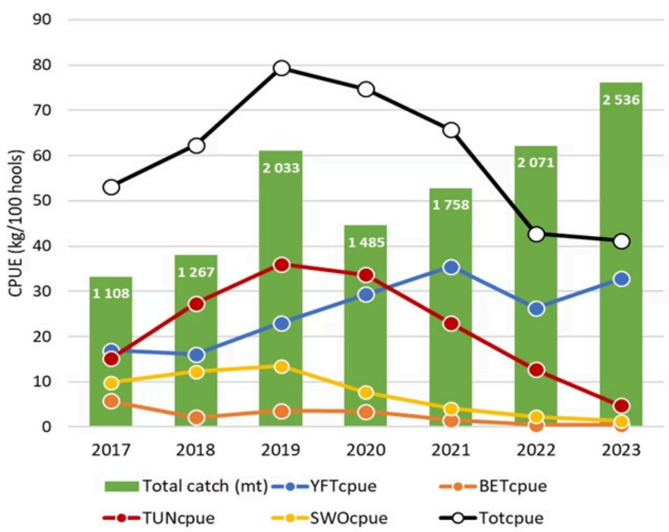


Figure 8: Annual total catch (in mt) and nominal CPUE (kg/100 hooks) by species and all species combined.

- Standardised CPUE fell **15% from 2021 to 2022** without recovery, indicating an increased pressure on the resource.

Species Targeting Evolution

The fishery underwent a major strategic shift:

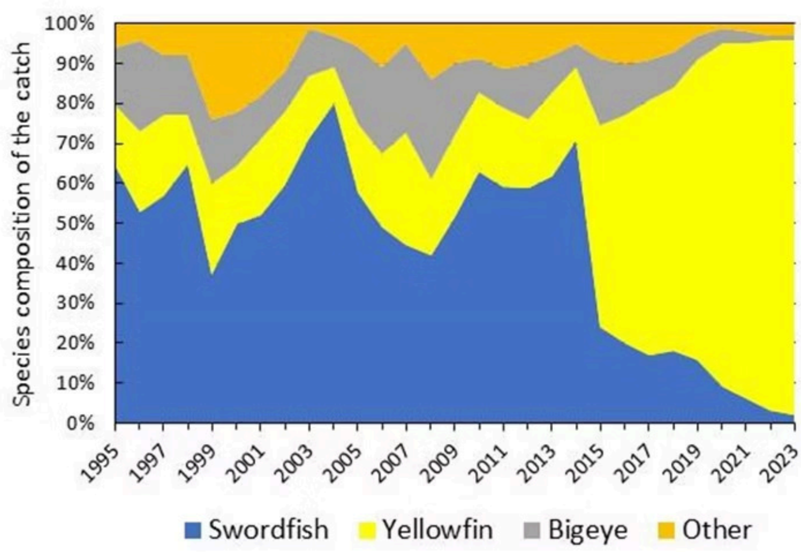


Figure 3: Annual catch in MT by species reported by the semi-industrial fleet, 1995-2023.

- **Yellowfin Tuna Dominance:** **94% of catch in 2023**, up from 64% in 2017
- **Swordfish Decline:** Declined from **55% pre-2016** to minimal levels
- **Strategic Impact:** This specialization improved efficiency but increased exposure to single-species market risks

Financial Performance: A Tale of Two Fleets

The financial analysis, based on comprehensive surveys covering the 2023 financial year, reveals a stark dichotomy that challenges conventional fleet-level assessments:

Revenue Structure and Variability

SCR 202.6M	SCR 3.3M	150x	83%
Total fleet revenue 2023 financial year performance	Average revenue per vessel annual performance	Revenue disparity range from SCR 42,092 to 6.6 million between highest and lowest earners	Yellowfin value of total catch value, confirming successful species targeting transition

Table 1: Profitability assessment of the semi-industrial longline fleet, year 2023.

Revenue	
Value of landings	202,586,636.49
Variable Cost	
Energy Cost	47,059,000.00
Bait	21,933,400.00
Other Variable Cost	39,116,000.00
Fixed Cost	
Maintenance	4,908,333.33
Other Fixed Cost	8,799,666.67
Salary	31,599,850.00
Total Cost	153,416,250.00
Operating Profit	49,170,386.49
Other Information	
Operating Proift without fuel subsidy	24,162,386.49
Profit Margin	24%
Profit Margin without fuel subsidy	12%

Cost Structure

Total operating costs averaged **SCR 2.5 million per vessel (76% of gross revenue)**, with critical dependencies:

Energy Costs

31% of total costs (SCR 771,459 average per vessel)—the single largest expense

Crew Wages

21% (SCR 518,030 per vessel)—entirely Sri Lankan nationals, raising economic leakage concerns

Bait Costs

14% (SCR 359,564 per vessel)—though plastic bait adoption is reducing this burden

Other Variable Costs

25% (SCR 641,246 per vessel)—trip-specific consumables

Fixed Costs

Only **9% combined** (maintenance 3%, other fixed costs 6%)

Profitability Crisis Behind Averages

While aggregate figures suggest health, the reality reveals vulnerability:

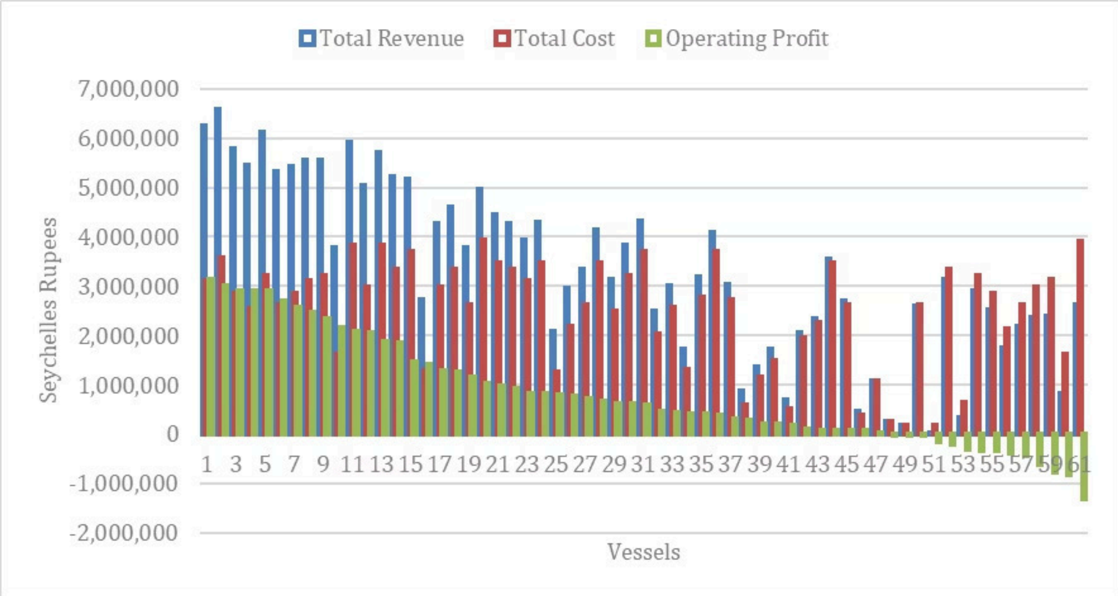


Figure 10: Barplot of total revenue, total cost and operating profit for each fishing vessel.

Fleet Performance Metrics

- Fleet average profit: **SCR 806,072 per vessel (24% margin)**
- Fleet profit range: **-SCR 1.3 million to +SCR 3.1 million**
- **23% of vessels operate at net losses**: 14 out of 61 active vessels

The Three Economic Performance Zones

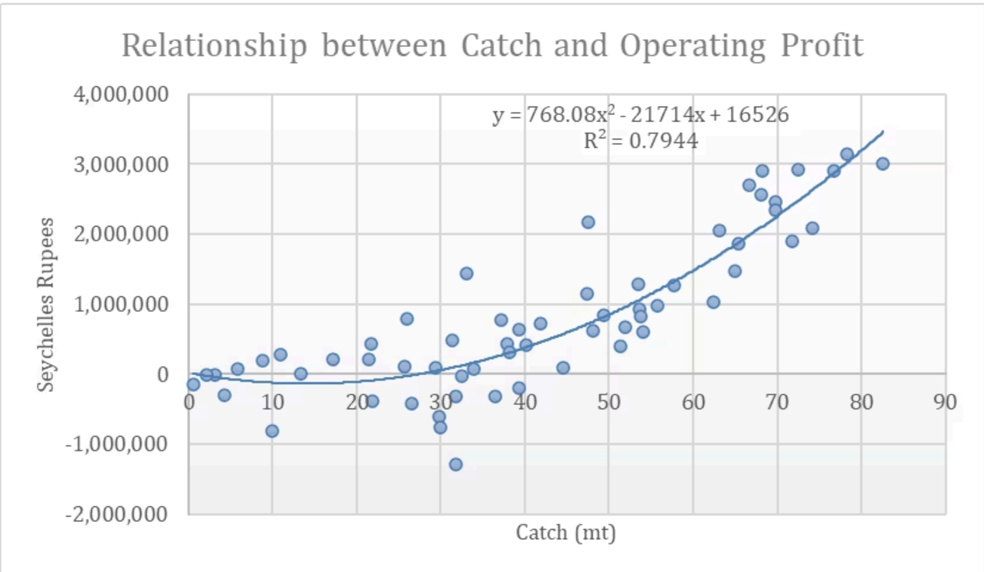


Figure 11: Scatterplot of the relationship between catch (X-axis) and operating profit (Y-axis) for each fishing vessel. The dotted line provides the line of best fit and demonstrates a positive exponential relationship of catch on operating profit.

Loss Zone	Linear Growth Zone	Exponential Profit Zone
Catch <30 MT	**Catch 30-55 MT**	**Catch >55 MT**
Systematic net losses regardless of cost-cutting efforts. Fixed costs exceed revenue generation capacity. Economic break-even threshold clearly established at 30 MT annual catch.	Predictable profit scaling with incremental catch increases. Optimal operational efficiency range for most vessels. Fixed costs covered, variable costs scale proportionally.	Super-normal profits due to economies of scale. Fixed cost dilution creates dramatic profit acceleration. Exponential relationship between catch and profitability confirmed.

Critical Fuel Subsidy Dependency

The analysis exposes fundamental economic vulnerability:

- Fuel subsidy doubles profit margins from **12% to 24%**
- Without subsidy, **46% of fleet would be financially unviable** (28 out of 61 vessels)
- Policy dependency risk: Fleet survival depends on continued government support

Comparison Analysis: 2019 vs. 2023

Fleet expansion effects reveal troubling trends:

	Reference Year 2019	Reference Year 2023
Nb Vessels	33	61
Nb Vessels Group 1	14 (42%)	30 (49%)
Nb Vessels Group 2	8 (24%)	11 (18%)
Nb Vessels Group 3	11 (33%)	20 (33%)
Mean Operating Profit	607,000	806,072
Median Operating Profit	734,000	602,863
Min Operating Profit	-660,000	-1,296,149
Max Operating Profit	2,400,000	3,144,706
Nb Vessels Positive Profit	24 (73%)	47 (77%)
Nb Vessels Negative Profit	9 (27%)	14 (23%)

Table 3: Comparative analysis between year 2019 and 2023 for the semi-industrial longline fishing fleet. Group 1 = Low-Performing Vessels (less than SCR 500,000 and negative profits), Group 2 = Stable Moderate-Performing Vessels (between SCR 500,000 to SCR 1 million in profits), Group 3 = High-Performing Vessels (more than SCR 1 million in profits).

Vessel numbers doubled: 33 to 61 vessels

Profitable vessels remained stable: 73% (2019) vs 77% (2023)

High-performing vessels nearly doubled (+82%): from 11 (2019) to 20 (2023) **vessels**

Low-performing vessels more than doubled (+100%): from 14 (2019) to 30 (2023) **vessels**

Maximum losses deepened on average: From -SCR 660,000 (2019) to -SCR 1.3 million

Spatial Expansion and Resource Competition

The spatial analysis reveals a complex pattern of fleet adaptation and intensifying competition:

Geographic Redistribution

Dramatic southward shift: Fishing effort in northern zones (Z1 & Z2) declined from **65% in 2017-2018 to just 23% in 2022-2023**

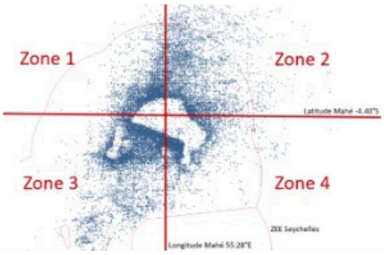


Figure 1 *Division of the SILL fishery is in 4 zones (blue dots = 24,840 fishing sets from 2017 to 2023)*

Table 1 *Proportion of sets per year in each zone*

	Z1	Z2	Z3	Z4	To
2017	38%	32%	16%	14%	10
2018	35%	24%	34%	8%	10
2019	22%	33%	28%	16%	10
2020	17%	26%	25%	32%	10
2021	15%	16%	32%	38%	10
2022	8%	27%	33%	33%	10
2023	5%	18%	57%	20%	10

Southern Concentration

Zone 3 became dominant, capturing **57% of sets in 2023** compared to 16% in 2017

Seasonal Patterns

Clear bi-seasonal distribution with northeast operations (Quarter 1) and southwest operations (Quarters 3 and 4)

Travel Costs Increased

Median vessel travel distance expanded from **900 to 1,500 nautical miles** annually (2020-2023)

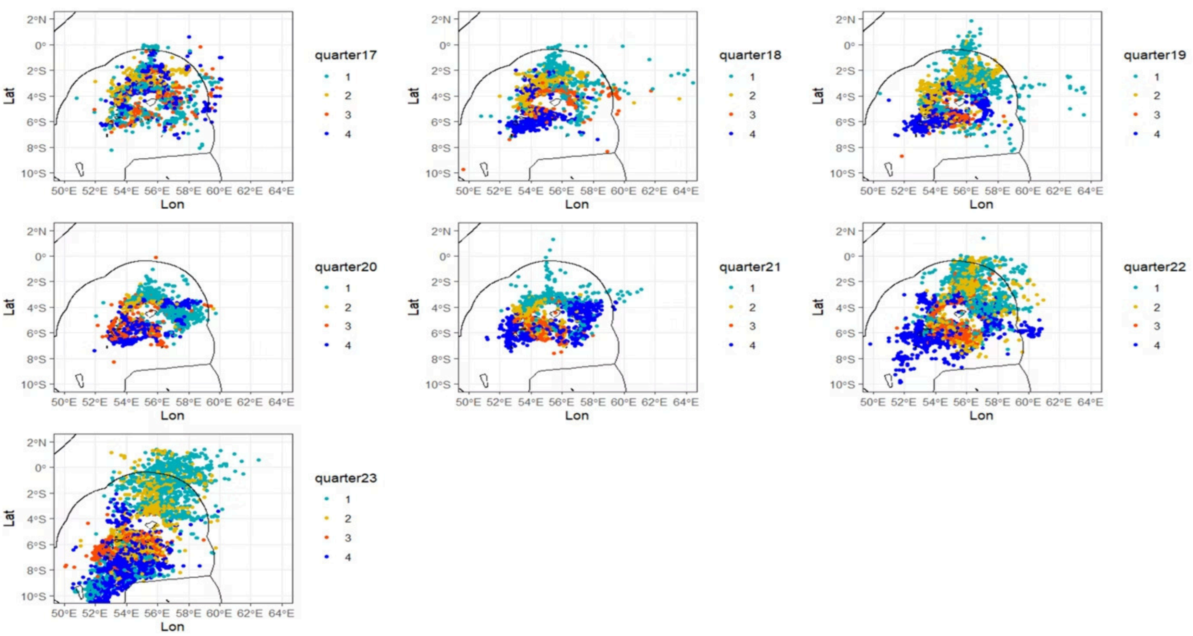


Figure 12: Spatial distribution of the SILL fleet sets by year and quarter (e.g. quarter17 means quarters of year 2027).

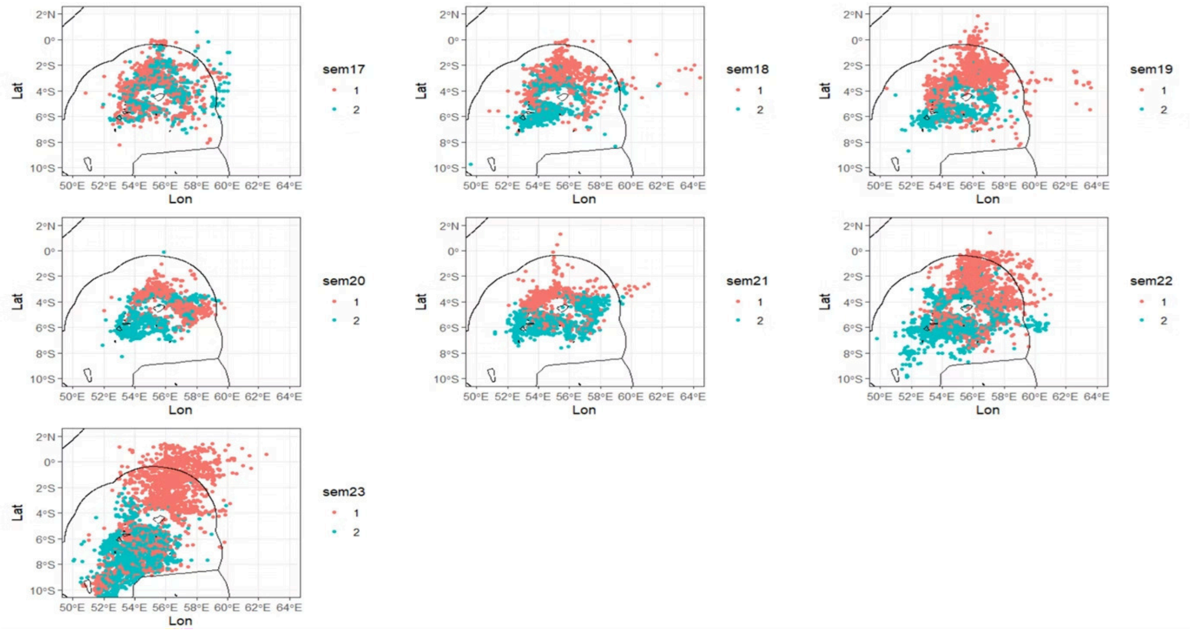


Figure 13: Spatial distribution of the SILL fleet sets by year and semester (e.g. sem17 means semesters of year 2017).

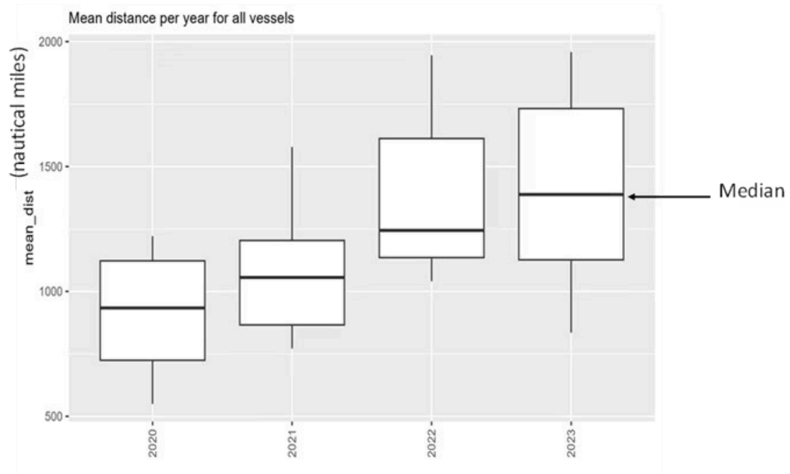


Figure 17: Mean distance per year for all vessels (in nautical miles).

Hotspot Analysis

Yellowfin hotspots expanded from concentrated northeast areas to three distinct core regions (northeast, central, southwest)

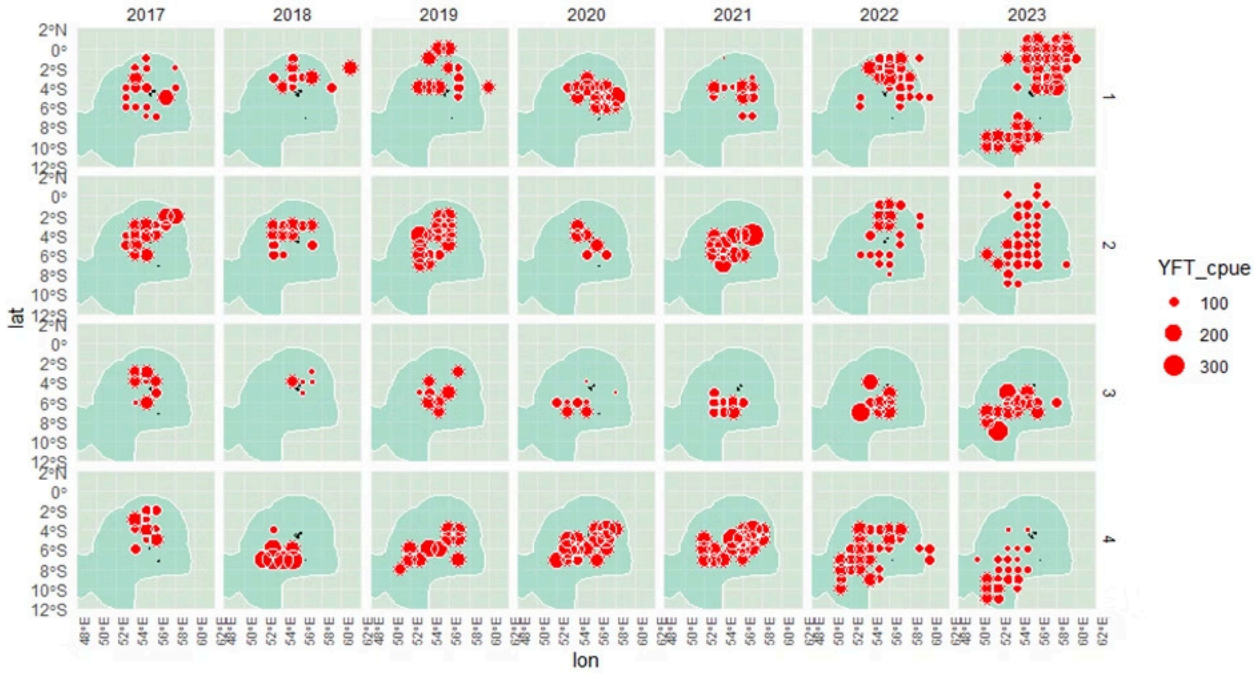


Figure 19: Quarterly distribution of yellowfin hotspots (by 1° grid) from 2017 to 2023. The quarter (1-4) is indicated on the right side of the plots. CPUE is in kg/100 hooks.

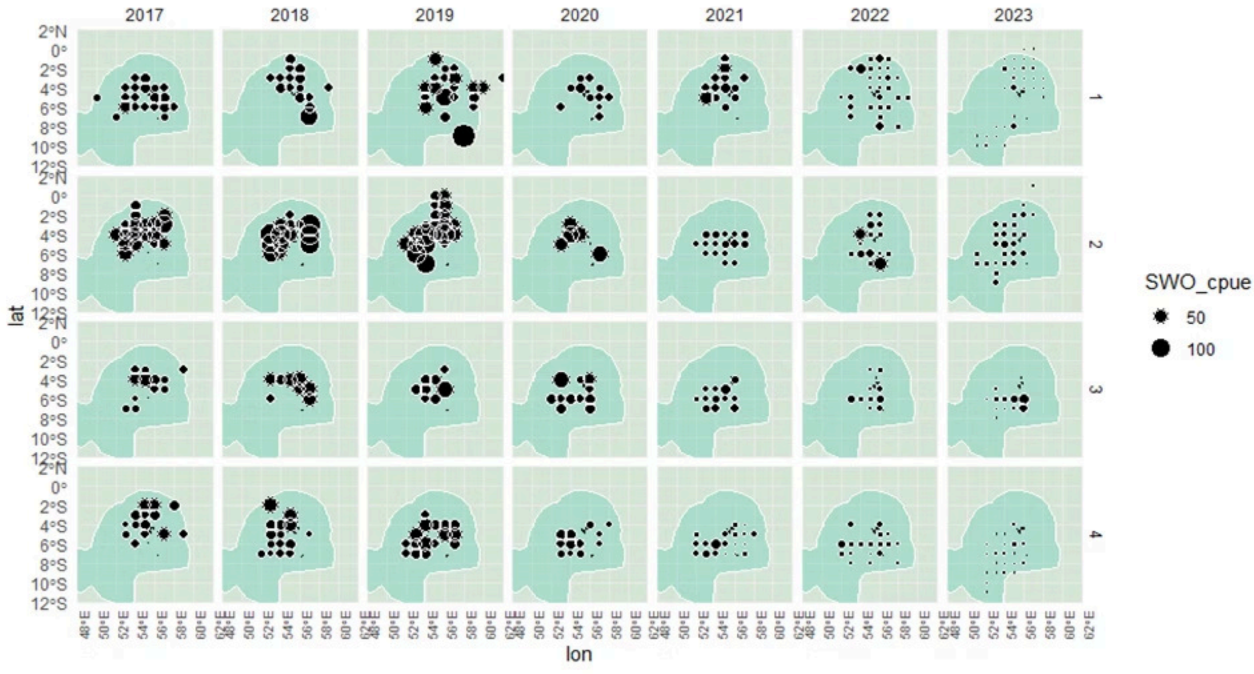


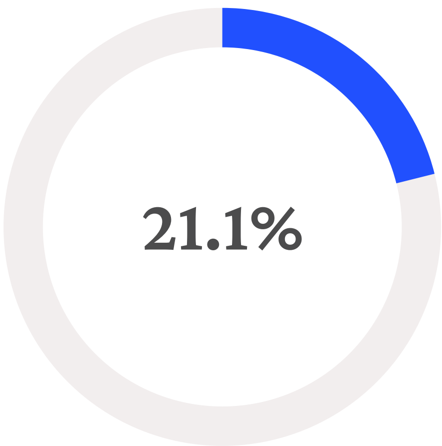
Figure 20: Quarterly distribution of swordfish hotspots (by 1° grid) from 2017 to 2023. The quarter (1-4) is indicated on the right side of the plots. CPUE is in kg/100 hooks.

Figure 22: Quarterly distribution of other (small) tuna hotspots (by 1° grid) from 2017 to 2023. The quarter (1-4) is indicated on the right side of the plots. CPUE is in kg/100 hooks.

- Swordfish hotspots disappeared after 2020, confirming the species targeting shift
- Small tuna productivity declined substantially in 2022-2023, linked to yellowfin-focused fishing practices

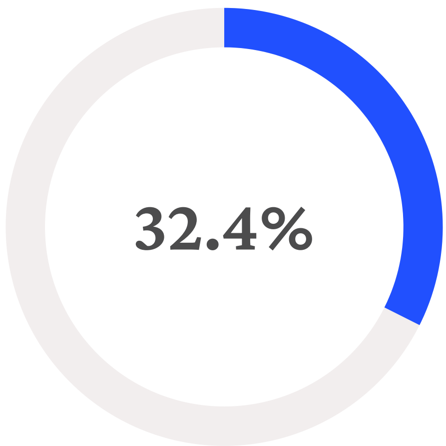
Fleet Interaction and Competition

The study quantified concerning increases in spatial overlap between the SILL fleet and industrial fleets:



Industrial Longline Overlap

Doubled from 10.7% in 2021 to 21.1% in 2023, with peak monthly overlaps reaching 37%



Purse Seine Overlap

Increased from 16.5% in 2021 to 32.4% in 2023, with first quarter 2023 reaching 49.6%

Competition effect: This spatial interaction contributes to the observed CPUE decline and explains the stagnation despite fleet expansion.

Technical Efficiency and Environmental Analysis

The study employed Data Envelopment Analysis (DEA) to move beyond traditional productivity measures and assess the true efficiency potential of individual vessels relative to the fleet's performance frontier.

Efficiency Frontier Evolution

The analysis reveals concerning productivity trends at the fleet level:

Declining Technical Frontier

Production possibility curve shifted downward over the study period, in connection with the CPUE decline

2017 Baseline vs 2023 Decline

Top performers produced **60 tonnes annually** at standard input levels in 2017. Same input level yields **~40 tonnes in 2023**—a 33% productivity decline

Fleet Homogenisation

Efficiency spread between vessels narrowed, but at lower overall productivity levels. The fleet becomes more homogenous and operate at higher levels (**+10%** over the 2017-23) of technical efficiency in overall

Super-Efficiency Performance Rankings

To distinguish between top-performing vessels, super-efficiency scores identified clear performance hierarchies:

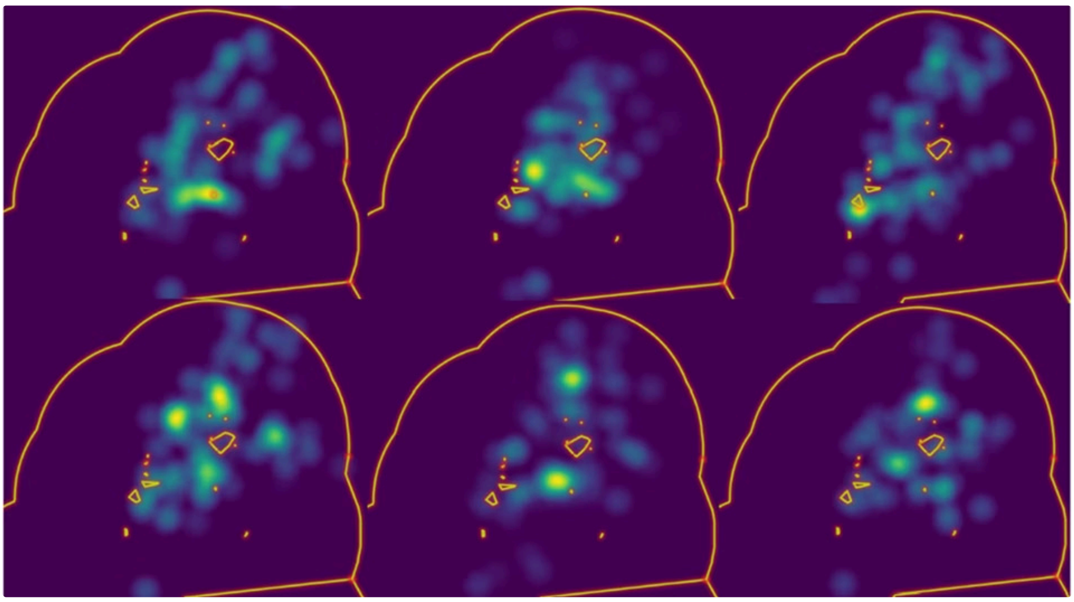


Figure 41: Spatial distribution of the catch for the 3 most efficient vessels (upper maps) and the 3 least efficient vessels (lower maps).

Top Performers (Score >0.90)

Vessel #SZ1751 and #SZ1506: Consistently superior performance across all years. Spatial strategy advantage: Concentrated operations in southwestern EEZ areas. Sustained excellence: Maintained high scores despite fleet expansion pressures.

Mid-Tier Performers (Score 0.70-0.90)

Moderate consistency: Several vessels achieving respectable but not exceptional efficiency. Year-to-year variation: Performance fluctuations suggest operational inconsistencies.

Underperformers (Score <0.60)

Vessels #SZ1457 and #SZ1617: Persistently low efficiency throughout study period. Spatial inefficiency: Equal effort distribution between north and south, missing optimal zones. Systematic underperformance: Consistent bottom-tier rankings suggest structural operational issues.

Environmental Factors and Habitat Analysis

Despite comprehensive analysis of oceanographic conditions using 15 environmental variables, the findings reveal a critical insight: environmental factors explain only **15-18% of fleet performance variance**, indicating that operational and management factors far outweigh natural conditions in determining success.

Environmental Data Analysis: **24,840 fishing sets** analysed across temperature gradients, thermocline depths, salinity levels, current patterns, and chlorophyll concentrations. Three distinct environmental clusters identified through Principal Component Analysis and cluster hierarchical analysis, with the following characteristics by cluster:

- Cluster 1: High chlorophyll, low temperatures, low current velocity
- Cluster 2: High current velocity and shear, higher latitudes/longitudes
- Cluster 3: High temperatures, low chlorophyll, elevated Dipole Mode Index

Surprising Environmental Independence

- No statistically significant difference in yellowfin CPUE across environmental clusters (**27.4, 26.3, and 26.8 kg/100 hooks** respectively)
- Environmental conditions do not significantly affect fishing productivity, contrary to conventional expectations
- Vessel-specific factors and fishing effort variables dominate performance rather than natural oceanographic conditions

Habitat Envelope Modeling: Using Generalized Additive Models (GAMs), four key environmental thresholds were applied to four variables (temperature at 55 m and 110m, thermocline depth and surface salinity) to define an optimal yellowfin habitat:

Seasonal Habitat Patterns (Figure 53:

- **First semester (Jan-May):** Optimal habitat concentrated east of 50°E, expanding from 8°S to 10°S
- **Second semester (Jun-Dec):** Larger optimal zones with northern expansion to 3°S, better correlation with actual hotspots
- **Fourth quarter dominance:** Peak yellowfin targeting occurs when all four environmental stressors align

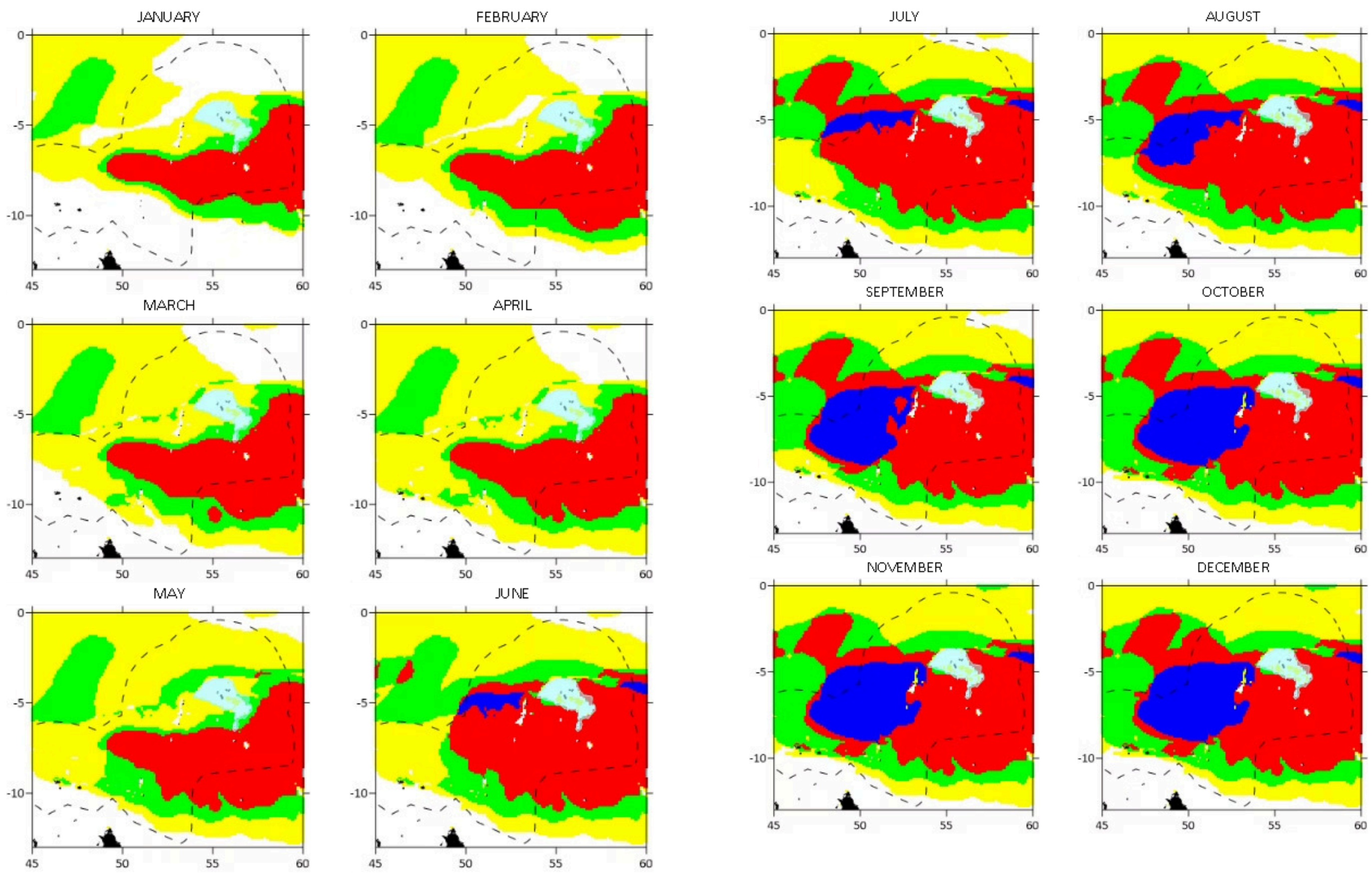


Figure 53 Monthly habitat envelopes (January to June) for yellowfin tuna caught by the semi-industrial longline fleet, based on the combination of 4 environmental stressors of importance: temperature at 55 m, at 110 m, 20°C isothermal depth and surface salinity (see text). The quality of the habitat improves when more stressors are combined. Colours indicate the number of stressors at each location, from 1 to 4 (yellow=1; green=2; red =3; blue=4).

Hook Depth and Temperature Survey

A novel aspect of the study involved deploying Temperature-Depth Recorders (TDRs) on four domestic longliners to precisely measure actual hook depths and ambient temperatures—data previously unavailable for the longline technique used by the SILL fleet.

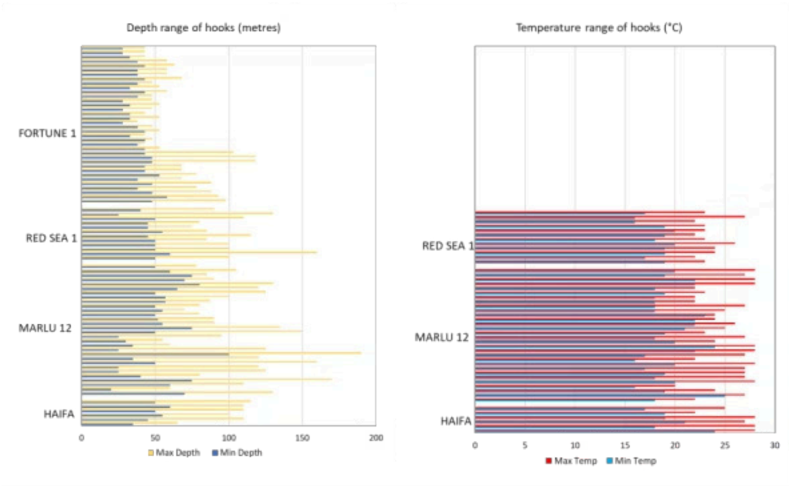


Figure 55: Depth and ambient temperature of the hooks deployed by four domestic longline vessels selected for the experiment. The horizontal bars (one for each set) indicate the minimum and maximum depths and temperatures at which the hooks have been exposed during the sets.

50-102m

Depth Range

Median 75m, maximum 190m observed

16-28°C

Temperature Range

At hook depth

19-25°C

Median Temperature

Lower bound 19°C, upper bound 25°C

Yellowfin Habitat Validation: The recorded temperatures align perfectly with known yellowfin tuna preferences:

- **Temperature compatibility confirmed:** 16-18°C lower range matches archival tag studies
- **Thermocline relationship:** Yellowfin spends significant time along thermocline core
- **Dive behaviour consideration:** While yellowfin can dive to 1000m (5°C), prolonged exposure occurs in the 16-25°C range where SILL hooks operate

Recommendations

Adopt a Multi-Dimensional Performance Framework

The SFA should formally integrate a multi-dimensional performance framework into its management and monitoring strategies. This framework must move beyond simple catch and effort data to incorporate key variables such as vessel characteristics (age, size, engine power), operational efficiency metrics, and vessel-level profitability.

Align Management Strategies with Fleet Dynamics

Future management policies must be directly informed by the data from this new performance framework. This includes a re-evaluation of the moratorium on vessel importation, which should be considered in light of individual vessel efficiency and the overall financial health of the fleet, rather than on aggregate performance alone.

Continue and Expand Monitoring and Research Programs

It is highly recommended that the SFA, in collaboration with research partners, continues and expands its ongoing program to monitor fleet performance using the recommended multi-dimensional approach. Future monitoring should also explore options of identifying hook depths and follow-up research should be undertaken on the long-term economic implications of the fleet's high dependence on the fuel subsidy.

Promote Diversification and Innovation

The government and industry stakeholders should explore and promote alternative technologies and fishing methods to reduce the fleet's reliance on high-cost inputs like fuel. For example, research into the feasibility and economic benefits of alternative bait technologies, such as the use of plastic bait, should be accelerated.

Provide Strategic and Financial Support to the Fleet

Fisheries manager should establish formal knowledge sharing programs between high-performing and struggling vessels such as focusing on spatial strategy optimization, particularly encouraging concentration in southwestern EEZ areas and promoting adoption of proven operational practices from efficient vessels.

Conclusion

While the Seychelles semi-industrial longline fishery has demonstrated remarkable growth in scale, this expansion has not translated to proportional improvements in efficiency or financial sustainability. The fleet faces a critical juncture where continued growth without addressing underlying operational and competitive challenges risks further deteriorating returns and increasing economic fragility.

The path forward requires a fundamental shift from quantity-focused to quality-focused management, emphasizing vessel-level efficiency improvements, operational optimization, and strategic resource allocation. The study's findings demonstrate that environmental factors explain only **15-18% of performance variation**, confirming that success lies primarily in operational excellence rather than natural conditions.

Most critically, the analysis reveals that average fleet statistics mask dangerous underlying vulnerabilities—with **one-quarter of vessels operating at net losses** and **nearly half of the industry dependent on fuel subsidies for viability**. Only through comprehensive, vessel-specific interventions based on the multi-dimensional performance framework can the fishery achieve sustainable growth that benefits all stakeholders while maintaining the resource base for future generations.