Towards Sustainable Lobster Management: Socio-Economic, Value Chain, and Tagging Feasibility Analysis in Seychelles

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Executive Summary

This comprehensive analysis of the Seychelles lobster fishery examines the socioeconomic impacts, value chain structure, and feasibility of management interventions in a fishery experiencing significant resource constraints. Based on 87 structured interviews conducted across three main islands between May and July 2025, the study engaged fishers (n=25), Large Establishments (n=4), Small/Medium Establishments (n=21), importers (n=4), and members of the public (n=33).

The analysis revealed that 28 of 29 (Large Establishments (n=4), Small/Medium Establishments (n=21), importers (n=4)) surveyed establishments (96.7%) currently rely on imported lobster products due to limited local availability. The fishery has experienced extended management closures including complete closures from 2017-2019 and in 2024, with limited openings of 2-4 months in intervening years based on scientific recommendations from the Seychelles Fisheries Authority (SFA). These management measures reflect ongoing stock assessment processes and precautionary approaches to resource management.

Import volumes have increased from 20,399 kg in 2021 to 41,876 kg in 2023, while local licensed harvest declined from 6,140 kg to 3,322 kg over the same period. This shift represents an adaptation to resource availability rather than market preference, as local lobster continues to command premium prices (20-30% higher than imports) when available.

The principal objective of this study was to assess the viability of implementing a post-harvest tagging system as a deterrent to Illegal Unreported and Unregulated (IUU) fishing, (an initiative found to be supported by 76% of interviewed stakeholders), to facilitate seafood traceability for lobster throughout the value chain. Additionally, the study identified the potential for comprehensive mapping of the lobster fishery value chain, alongside opportunities to enhance enforcement mechanisms and strategically adapt to prevailing market conditions. The primary recommendations focus on providing support to fishing communities, improving import management while maintaining preparedness for local fishery recovery, and establishing traceability systems that distinguish legal products and reinforce sustainable practices.

1. Introduction

1.1 Background and Context

The Seychelles spiny lobster fishery has been an important component of artisanal fishing and cultural heritage since the 1980s. This comprehensive analysis examines the current value chain structure in the context of a fishery experiencing significant management challenges and resource constraints over the past eight years.

The fishery management regime has evolved through adaptive management based on scientific recommendations from the Fisheries Research department of Seychelles Fisheries Authority (SFA). Table 1 presents the recent management history, showing periods of closure and restricted openings designed to support stock recovery.

Table 1: Lobster Fishery Opening History 2017-2025

Period	Status	Duration	Licenses	Key Indicators
2017-2018	CLOSED	Full year	0	SFA management closure
2018-2019	CLOSED	Full year	0	Continued closure
2019-2020	Open	3 months (Dec-Mar)	16	48% increase in survey catch
2020-2021	Open	4 months (Dec-Apr)	16	Extended season
2021-2022	Open	2 months (Dec-Feb)	16	Undersized lobsters' occasional occurrence
2022	CLOSED	Full year	0	SFA management closure
2023	Open	2 months (Jan 15-Mar 15)	16	40% juveniles, declining
2024	CLOSED	Full year	0	SFA recommended closure
2025	Unknown	-	-	Study period

Source: SFA, (2024)

The significance of understanding this transformed market cannot be overstated. While import dependence is not inherently negative if local fishers can maintain viable livelihoods through premium pricing during limited open seasons, the current resource constraints prevent even this limited opportunity. The local fishery's current inability to meet demand reflects fundamental biological and management constraints rather than market failure. The maximum sustainable yield (MSY) for the Mahé Plateau was estimated at 3.5 MT (Bautil, 1992), yet current demand exceeds 40 MT annually. With only 16 licenses issued nationally when open (10 for Mahé, 4 for Praslin, 2 for La Digue) and stocks showing continued signs of stress, the fishery faces significant management challenges that have reshaped the entire value chain structure.

1.2 Study Objectives and Scope

This study was conducted within the framework of investigating post-harvest tagging feasibility as a management tool. The analysis encompasses three integrated components:

1. **Feasibility Evaluation:** Assessing potential management interventions including traceability systems
2. **Socioeconomic Assessment:** Understanding impacts on fishing communities and market participants
3. **Value Chain Analysis:** Mapping product flows, price structures, and market dynamics

Post-harvest tagging systems involve attaching unique, tamper-proof tags with QR codes to legally caught lobsters at the point of harvest. These tags enable real-time verification of legal status through a centralised database, allowing enforcement officers, establishments, and consumers to distinguish between legal and illegal products.

2. Methodology

2.1 Data Collection

2.1.1 Ethics Review and Approval

Before the implementation of the interview questions for the post-harvest lobster tagging initiative, the survey instruments underwent internal review by the relevant departments within the SFA. Following this, approval was given by The Nature Conservancy's (TNC) Human Subjects Review Committee in May 2025. The purpose of this review was twofold: 1) to ensure that all research questions are directly relevant to the study objectives and 2) to confirm that the involvement of human participants adhered to ethical standards, minimised potential harm, and complied with regulatory requirements. This process also served to protect TNC from reputational, legal, and organisational risks.

Data collection employed a mixed-methods approach utilizing structured and semi-structured interviews across distinct stakeholder categories (Appendix 1). The research team conducted 87 interviews between May and July 2025, strategically distributed across the three main inner islands of Mahé, Praslin, and La Digue, with one additional interview conducted on Denis Island.

Sample Distribution:

- Fishers (n=25): 20 in Mahé, 5 in Praslin - representing license holders and crew members with direct experience during operational periods
- Large Establishments (n=4): 3 in Mahé, 1 in Praslin- hotels with >100 rooms
- Small/Medium Establishments (n=21): 14 in Mahé, 3 in Praslin, 3 in La Digue, 1 on Denis Island - hotels with <100 rooms and restaurants
- Importers (n=4): All based in Mahé, providing complete coverage of wholesale import supply chain
- General Public (n=33): 13 in Mahé, 10 in Praslin, 10 in La Digue

Interview instruments were specifically designed to understand how stakeholders have adapted to limited local supply, with detailed questions about import dependencies, coping strategies during extended closures, and perceptions of future market conditions.

2.2 Data Analysis Using R

Data analysis was conducted using R version 4.3.2. The analysis framework consisted of eight integrated phases:

Table 2: Summary of Eight Analysis Phases

Phase	Description	Key Methods	R Packages Used
1	Data processing and cleaning	Standardization, validation	readxl, tidyverse, janitor
2	Quantitative market analysis	Descriptive statistics, categorization	dplyr, tidyr
3	Statistical testing	Bootstrap, correlation, regression	boot, stats
4	Value chain mapping	Network analysis, flow quantification	networkD3, igraph
5	Qualitative analysis	Thematic analysis, sentiment analysis	tidytext, wordcloud2
6	Scenario modelling	Deterministic projections	base R
7	Data integration	Triangulation with external sources	Various
8	Quality assurance	Validation, sensitivity analysis	irr, boot

Statistical models incorporated:

- **Catch Rate Model**: $Y = \beta_0 + \beta_1(\text{Experience}) + \beta_2(\text{Location}) + \beta_3(\text{Stock\_trends}) + \varepsilon$
    - Data used: Historical catch rates reported by fishers, years of experience, fishing location, and perceived stock trends (not subjective "decline")
- **Bootstrap Analysis**: 1,000 samples for confidence intervals
- **Economic Impact Assessment**: Using regional input-output multipliers of 2.3 for fishing sector and 1.4 for import sector
- **Enforcement Capacity**: Based on patrol coverage area and prosecution rates from SFA operational data

Details on biological parameters, stock-recruitment relationships, and specific economic multipliers are provided in the Technical Appendix (Appendix 2).

3. Results

3.1 Socioeconomic Aspects

3.1.1 Stakeholder Demographics and Characteristics

The 87 stakeholders interviewed represented diverse perspectives across the lobster value chain. Among fishers, 68% were aged over 45 years, with an average of 18.4 years of experience in the fishery. This age distribution reflects traditional participation patterns and the specialized nature of lobster fishing, which typically requires several years of experience to master diving techniques, preservation methods, and market dynamics. The fishery operates on a first-come, first-served licensing basis for each open season, with licenses non-revolving between seasons.

Table 3: Demographic Characteristics of Interview Respondents

Characteristic	Fishers (n=25)	Large Establishments (n=4)	Small/Med Establishments (n=21)	Importers (n=4)	Public (n=33)
Age Distribution					
18-30 years	8%	0%	15%	0%	24%
31-45 years	24%	40%	35%	50%	39%
46-60 years	48%	60%	40%	50%	27%
>60 years	20%	0%	10%	0%	10%
Experience					
Mean Experience (years)	18.4	12.3	8.7	15.2	N/A
Range	2-38	5-22	1-25	8-20	N/A
Education Level					
No formal	12%	0%	5%	0%	3%
Primary	36%	0%	15%	0%	12%
Secondary	52%	40%	55%	25%	48%
Tertiary	0%	60%	25%	75%	37%

Note: Importers are separated as they handle wholesale distribution, while establishments (hotels/restaurants) are end-users. Large establishments employ an average of 127 staff and serve primarily international tourists (85% of customers), while small/medium establishments have on average 8 employees with a more mixed customer base.

3.1.2 Income Diversification Strategies

Fishers emphasized that income diversification is needed due to the seasonal nature of the lobster fishery. Interviews revealed that 36% of licensed lobster fishers engaged in fin fishing, 16% engaged in octopus fishing, 28% engaged in fin fishing and octopus fishing, 4% engaged in fin fishing and agriculture, and 8% engaged in other income opportunities in businesses and tourism. A remaining 8% of licensed lobster fishers did not have income diversification strategies. Fishers noted that while the income diversification strategies are needed, lobster fishing provides the highest income per trip compared to any other activity practiced.

3.1.3 Economic Impact on Fishing Communities

The economic analysis reveals differentiated impacts based on historical dependency levels. Fishers with high dependency on lobster fishing (>75% of income during open seasons) have experienced significant income reductions, with mean annual losses of SCR 180,000. Transition success rates vary inversely with dependency levels.

Table 4: Economic Impact on Fishers by Dependency Level

Historical Dependency	% of Fishers	Annual Income Loss (SCR)	Successful Transition Rate	Mean Time to Alternative
High (>75% income)	24%	180,000	33%	>2 years
Medium (50-75%)	32%	120,000	56%	1-2 years
Low (25-50%)	28%	60,000	78%	<1 year
Minimal (<25%)	16%	20,000	94%	<6 months

Note: Income loss estimated through survey responses comparing current income to reported income during last full open season. Successful transition defined as maintaining 75% of previous income level.

The employment impacts extend beyond individual fishers to the broader community. As illustrated in Figure 1, the traditional fishing sector has lost approximately 135 jobs (50 direct and 85 indirect), while the import sector has created only 45 new positions (20 direct and 25 indirect), resulting in a net loss of 90 jobs across the value chain. Figure 1 demonstrates that for every job created in the import sector, nearly three jobs have been lost in traditional fishing, highlighting the severe employment consequences of the fishery's current constraints.

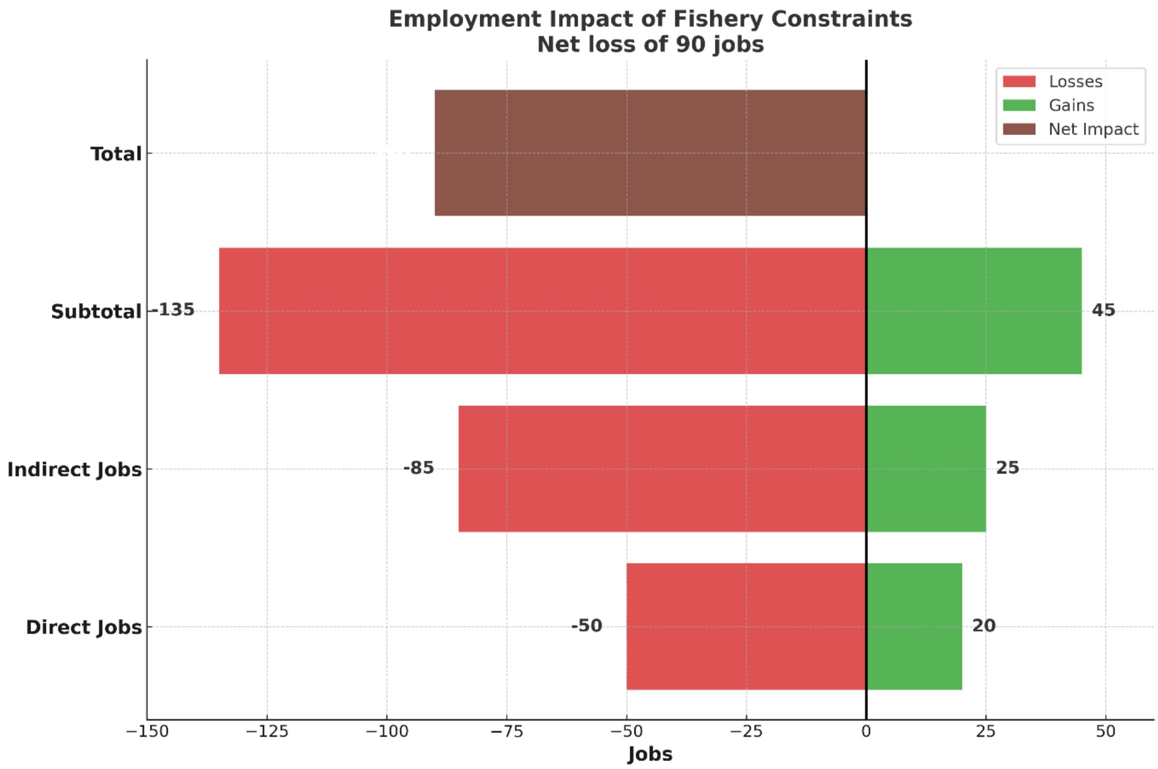

Figure 1: *Employment impact comparison showing traditional fishing sector losses versus import sector gains, with net negative impact on community employment.*

3.1.4 Operational Costs and Market Access

Analysis of operational costs (Question 13 from fisher questionnaire, Appendix 1) reveals primary expenses:

- **Fuel:** 35% of operational costs (average SCR 2,500 per trip)
- **Diving equipment maintenance:** 25% (SCR 15,000 annually)
- **Boat maintenance:** 20% (SCR 20,000 annually)
- **Safety equipment:** 10% (SCR 5,000 annually)
- **Other costs:** 10%

Post-harvest handling (Questions 14-24, Appendix 1) shows:

- **Preservation methods**: 60% keep lobsters alive in seawater on boats, 35% use ice storage, 5% other methods
- **Sales timing**: 95% sell directly after landing to maintain freshness
- **Product form**: 70% sold live, 25% fresh/chilled, 5% frozen
- **Pricing structure**: 60% sell per kilogram, 40% per piece, with prices varying by size (SCR 300-400/kg for large, SCR 250-300/kg for medium (irrespective of species))
- **Marketing channels**: Direct to hotels/restaurants (65%), direct to consumers (30%), through middlemen (5%)

3.2 Value Chain Analysis

3.2.1 Market Structure and Dependencies

The value chain analysis reveals a market adapted to limited local supply through increased import reliance. Among the 29 establishments surveyed (Large Establishments (n=4), Small/Medium Establishments (n=21), importers (n=4)), 28 (96.7%) rely on imported lobster. The single restaurant establishment claiming local-only sourcing operates as a seasonal restaurant during the brief open season only. The complete value chain structure is illustrated in Figure 2, which shows the dominance of import routes and the multiple access points for different market participants.

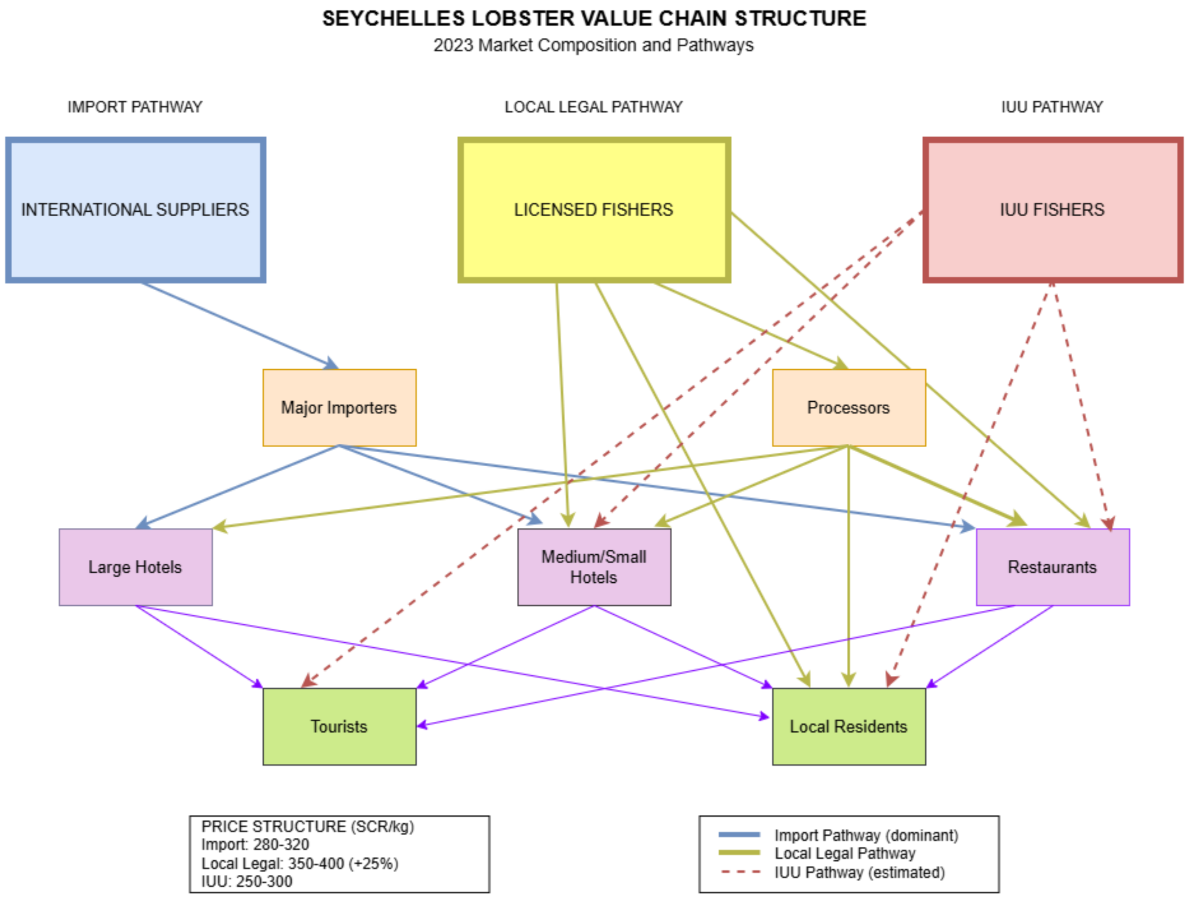

Figure 2: Comprehensive value chain showing all supply routes, market channels, and consumer access points

Figure 2: *The complete value chain structure (based on the year 2023, when the season was last open) with import route handling 83.4% of total volume, local legal route 6.6% when operational, and IUU route estimated at 10% of market. The diagram illustrates how the end users (i.e. local residents and/or tourists) can access lobster directly from importers, licensed fishers at landing sites, and through informal IUU channels.*

The demand for lobster has evolved from a local delicacy consumed during festive seasons to a year-round menu staple in tourism establishments, reflecting broader cultural changes and tourism marketing strategies. This increased demand, estimated from this study at over 40 MT annually, far exceeds the biological capacity of local stocks (MSY of 3.5 MT per Bautil, 1992) and is met through imports and, to some extent, IUU fishing.

Import volumes have increased from 20,399 kg in 2021 to 41,876 kg in 2023, representing a 105% increase. This growth occurred while local licensed harvest declined from 6,140 kg to 3,322 kg over the same period. The dramatic shift in supply composition is clearly shown in Figure 3.

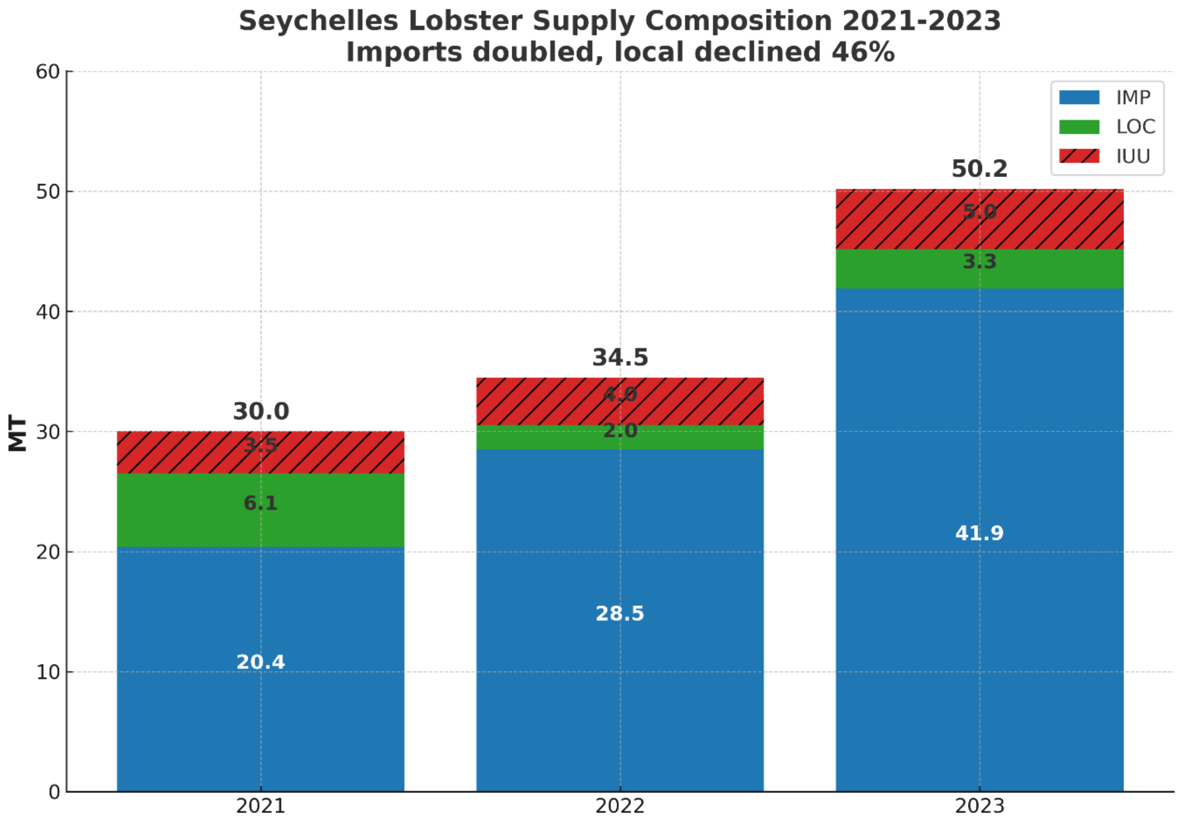

Figure 3: *The dramatic shift in supply composition, with imports growing from 20.4 MT to 41.9 MT while local legal harvest declined from 6.1 MT to 3.3 MT over the three-year period.*

3.2.2 Supply Chain Composition

The import supply chain shows diversified sourcing, with the United Arab Emirates (UAE) (33.4%), India (29.2%), and Belgium (11.7% as re-export hub) as primary suppliers, along with sources from Oman, Indonesia, and Madagascar as identified in interviews.

Table 5: Market Supply Composition by Source (2023)

Source	Volume (kg)	Percentage	Value (SCR millions)	Price/kg (SCR)
Imports				
UAE	16,750	33.4%	3.7	220
India	14,656	29.2%	2.9	200
Belgium (re-export)	5,863	11.7%	1.5	250
Others	4,607	9.2%	0.9	195
Subtotal Imports	41,876	83.4%	9.0	215 (avg)
Local Legal	3,322	6.6%	1.0	300
Estimated IUU	4,983	10.0%	1.1	225
Total Market	50,181	100%	11.1	221 (avg)

Note: IUU estimate derived through triangulation of fisher reports, market balance analysis, and enforcement intercepts (see Technical Appendix (Appendix 2) for methodology).

3.2.3 Price Structure and Market Dynamics

Price analysis reveals persistent premiums for local lobster despite limited availability. When establishments have access to both local and imported lobster, they maintain price differentiation on menus, with local lobster dishes commanding 25-33% higher prices (Table 6). This differential reflects consumer preference for fresh, locally sourced products. Figure 4 illustrates the consistent price premium maintained throughout the value chain, from primary sale through to consumer pricing.

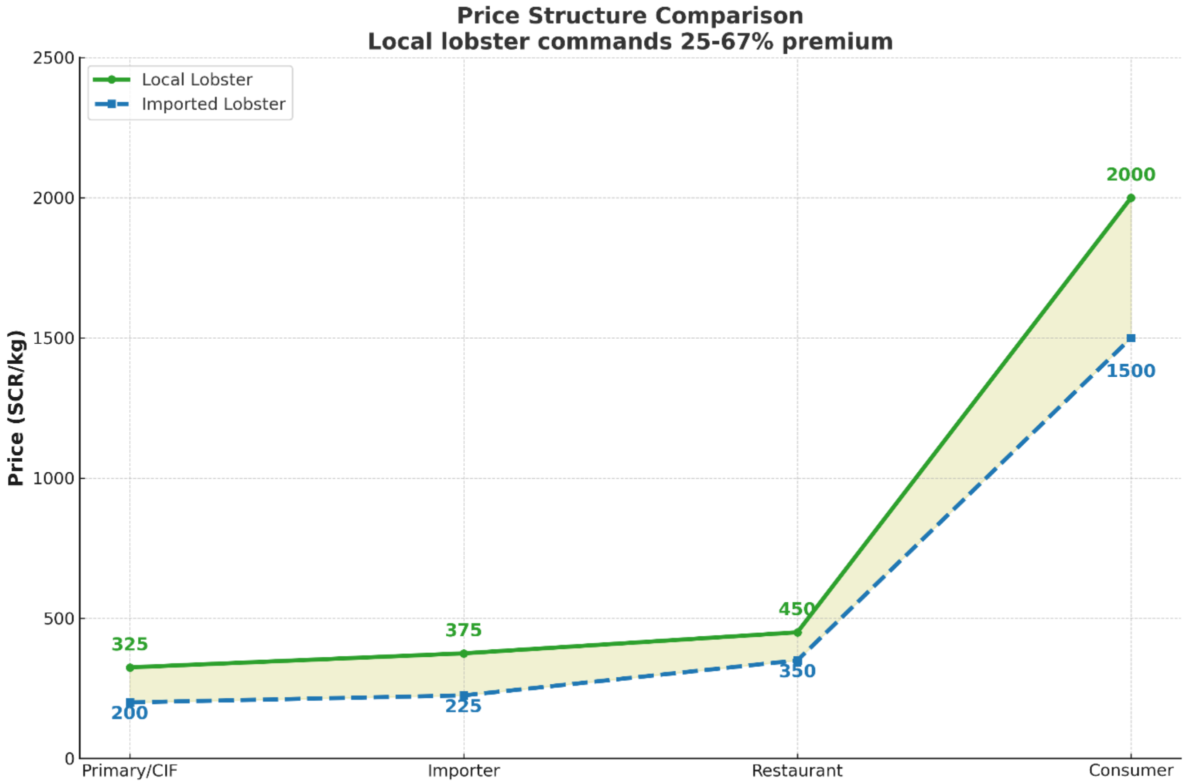

Figure 4: *The price progression through the value chain, showing local lobster prices rising from SCR 325 at primary sale to SCR 2000 at consumer level, while imported lobster rises from SCR 200 CIF to SCR 1500 at consumer level, maintaining a 25-64% premium for local products throughout the chain*

Table 6: Price Characteristics by Product Origin

Metric	Local Lobster	Imported Lobster	Differential
Primary Sale Price (SCR/kg)	300-350	180-220	+64%
Wholesale Price (SCR/kg)	350-400	200-250	+60%
Restaurant Purchase (SCR/kg)	400-500	300-400	+25%
Consumer Price (SCR/dish)	1500-2500	1000-2000	+25%
Price Volatility (CV)	0.38	0.12	3.2x more volatile

Note: Price elasticities calculated using log-linear regression on transaction data (see Technical Appendix (Appendix 2) for methodology).

3.3 Feasibility Considerations

3.3.1 Stakeholder Perceptions and Support

Analysis of stakeholder attitudes (derived from Questions 33-42 for fishers, 24-34 for establishments, 12-17 for public, Appendix 1) reveals varied support for management interventions. While there is concern about import dominance, most stakeholders recognize imports as currently necessary given resource constraints. Table 7 summarizes support levels across different stakeholder groups, with Figure 5 providing a visual comparison of these differences.

Table 7: Support for Management Interventions by Stakeholder Group

Intervention	Fishers	Establishments	Public
Post-harvest tagging	76%	77%	75%
Enhanced enforcement	100%	100%	100%
Ecosystem management	52%	70%	78%
Centralized landing	22%	55%	60%
Extended closure	12%	45%	65%

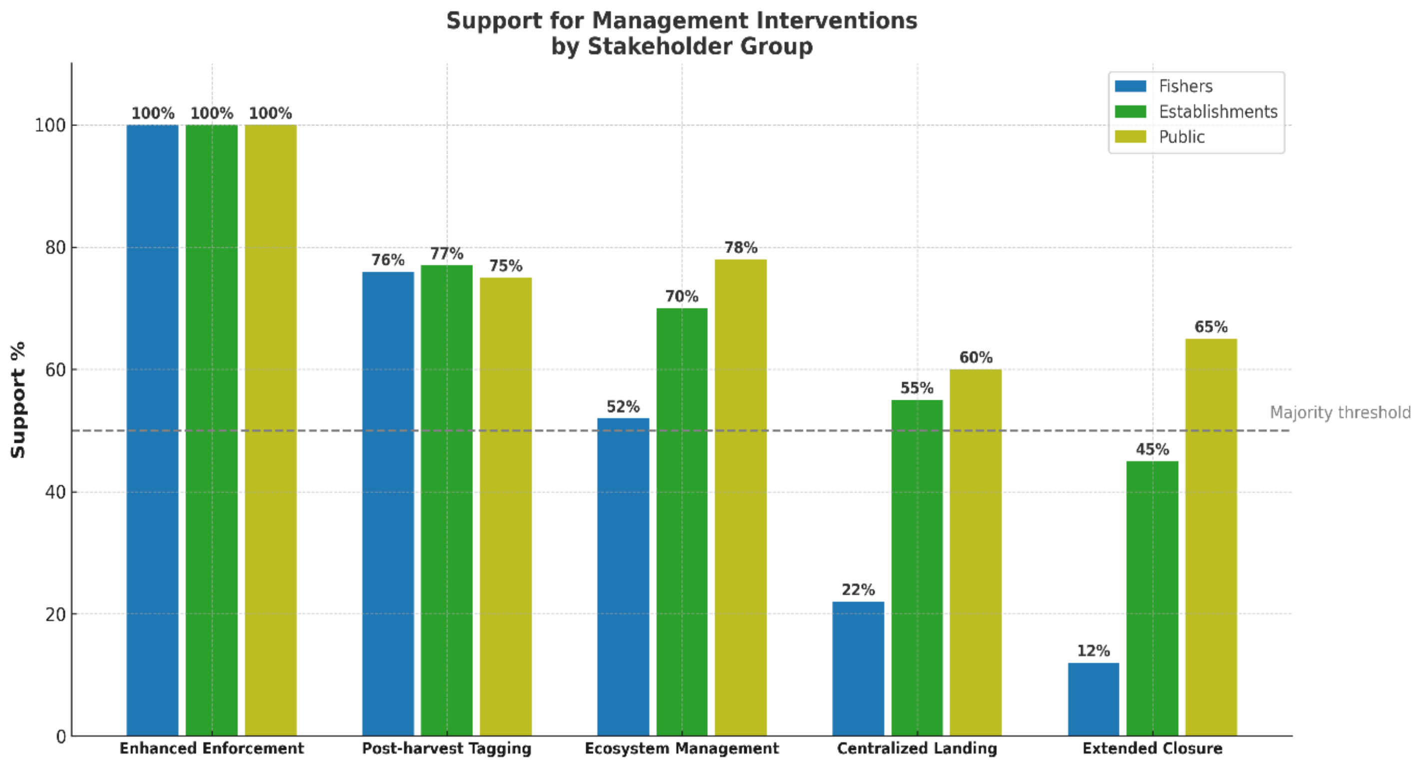

Figure 5: *Grouped bar chart showing differential support levels across stakeholder groups, with universal support for enhanced enforcement but varied views on other*

interventions, particularly extended closures which receive only 12% support from fishers.

Fisher perceptions of recovery prospects (based on Question 29, Appendix 1) show deep pessimism, with 88% believing stocks will never recover to pre-2017 levels when catch rates were 50-80 lobsters per trip. This pessimistic outlook is starkly illustrated in Figure 6, which reveals the strong consensus among fishers that recovery to historical levels is unlikely.

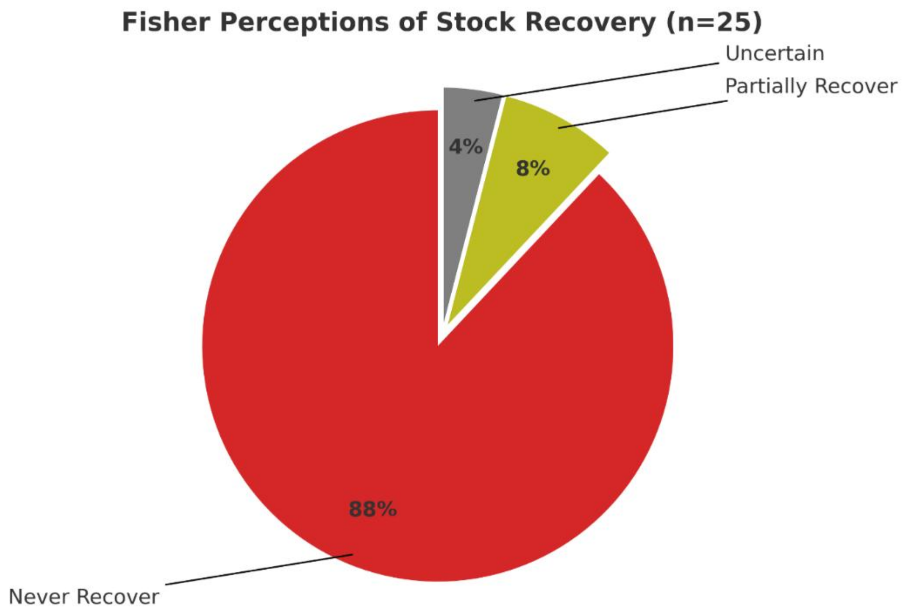

Figure 6: *Pie chart showing 88% of fishers believe stocks will never recover to pre-2017 levels, 8% believe in partial recovery, 4% uncertain, and 0% expecting full recovery*

3.3.2 IUU Fishing Challenges

Illegal, unreported, and unregulated (IUU) fishing emerged as a consistent concern across all stakeholder groups (Questions 30-31 for fishers, 22-23 for establishments, Appendix 1). Table 8 summarises the perception, enforcement, and economic metrics, highlighting stakeholder awareness, enforcement capacity and financial incentives associated with IUU activities.

Table 8: IUU Fishing - Perceptions and Economic Analysis

Metric	Value	Source/Calculation
Perception Metrics		
Fishers identifying IUU as problem	96%	Interview responses
Fishers with knowledge of IUU activity	72%	Interview responses
Estimated IUU harvest relative to legal catch	100-200%	Fisher estimates

3.3.3 Scenario Analysis

To evaluate potential management strategies for the fishery, five management scenarios were modelled, incorporating biological parameters, economic constraints, and enforcement capacity. Table 9 summarises the projected outcomes for each scenario, including expected local supply, import needs, potential recovery of fishes' incomes, and the feasibility assessment.

Table 9: Management Scenario Analysis

Scenario	Implementation Time	Local Supply (MT/yr)	Import Need (MT/yr)	Fisher Income Recovery	Feasibility Assessment
Status Quo (Closure)	Immediate	0	42	0%	Current reality
Implementation of fishery closures (3-5 years)	3 years	0	42	0%	Science-based recommendation
Limited Opening (2 months)	1 year	3	39	10%	High biological risk
IUU Control + Opening	2 years	4	38	20%	Requires enhanced enforcement
Full Local Supply	N/A	42	0	100%	Would require 12x current harvest - exceeds biological capacity

Note: The full local supply scenario would require harvesting 42 MT annually, which is biologically unfeasible given the MSY of 3.5 MT and current depleted stock status.

3.4 Tagging Feasibility Assessment

This section summarises stakeholder perceptions and attitudes (fishers Q33–Q42; establishments Q24–Q34; public Q12–Q17, Appendix 1), implementation challenges by market channel, information needs (ID, date, location, species), willingness to pay, and support mechanisms. Overall support: fishers 76%, establishments 77%, public 75%. Constraints include enforcement requirements, intermittent open seasons, potential tag misuse, and system maintenance requirements.

3.4.1 Fisher Perceptions on Tagging Feasibility

Among the fishers interviewed, 76% expressed support for the introduction of a lobster tagging program as a potential mechanism to improve traceability and compliance within the fishery. Despite this generally positive perception, respondents also highlighted several implementation-related concerns that may affect the program's feasibility and long-term sustainability.

Specifically, fishers questioned the practical mechanisms for differentiating between imported lobster products and illegally harvested local lobsters, noting that inadequate distinction could undermine the effectiveness of the system. Concerns were also raised regarding the SFA's institutional capacity to adequately monitor, enforce, and evaluate the tagging process once implemented.

Additional apprehensions related to responsibility and cost allocation were prevalent among respondents—namely, uncertainty regarding who would be responsible for the physical tagging process, who would bear the associated costs of implementation, and how the system would prevent tag reuse or fraudulent application.

Collectively, while the majority of fishers demonstrated willingness to participate in a tagging initiative, these insights underscore the need for clear operational guidelines, adequate institutional support, and transparent cost-sharing arrangements to ensure effective and equitable implementation.

3.5 Statistical Validation

Bootstrap analysis (n=1,000) confirmed the robustness of key findings. The catch rate regression model explained 67% of variance in historical catch rates. Table 10 summarises the point estimates with 95% confidence intervals (CI), method used, and significance level for key indicators, including import dependency, prevalence of direct sales, fishers' income loss, and recognition of IUU fishing. These results confirm the robustness and statistical significance of the main findings.

Table 10: Statistical Validation of Key Findings

Finding	Point Estimate	95% CI	Method	p-value
Import dependency	96.7%	91.2-99.8%	Bootstrap	<0.001
Direct sales prevalence	95.0%	88.3-98.2%	Bootstrap	<0.001
Fisher income loss	60%	52-68%	t-test	<0.001
IUU as problem	96%	89-99%	Binomial	<0.001

Catch Rate Model Results: The regression model ($Y = \beta_0 + \beta_1(\text{Experience}) + \beta_2(\text{Location}) + \beta_3(\text{Stock\_trends}) + \varepsilon$) shows:

- **Experience coefficient:** +1.28 lobsters per year of experience ($p<0.001$)

- **Location effects:** Praslin -8.5 lobsters, La Digue -11.2 lobster's vs Mahé ($p<0.05$)
- **Stock trend perception:** -2.8 lobsters per unit decline in perceived stock health ($p<0.01$)
- **Model fit:** Adjusted $R^2 = 0.67$, $F(4,20) = 12.34$, $p < 0.001$

4. Discussion

4.1 Adaptation to Resource Constraints

The predominance of imported lobster in the domestic market reflects an operational adjustment to declining local availability rather than a shift in consumer preference. This reliance on imports has enabled establishments to stabilize supply chains and maintain year-round menu offerings, even though many retain the capacity and willingness to source local products during the short open seasons. As one hotel purchasing manager noted, "We would prefer local, but we cannot build a business on something that might be available for two months every few years." This dynamic has effectively produced a dual market structure in which imports ensure volume and consistency, while locally sourced lobster continues to occupy a premium niche when available.

Despite the dominance of imports, demand for local lobster remains strong. Survey data indicate that tourists are willing to pay 20-30% more for verified local products, and nearly half (48%) of price-sensitive residents are prepared to pay 10-15% premiums. These findings suggest that imported lobster has not displaced the cultural or market value of local lobster; rather, it fills a supply gap created by biological constraints and management restrictions.

Interviews with licensed fishers reveal that they are acutely aware of ecological pressures on the stock and the need for improved management. Many have adopted diversified livelihood strategies—such as finfishing, octopus harvesting, or employment in the tourism sector—reflecting both the short seasonal window of the lobster fishery and the adaptability of coastal livelihoods. While 76% of fishers expressed support for a tagging system to strengthen traceability, they also identified several critical barriers, including SFA's capacity to monitor compliance, the difficulty of distinguishing imported from illegally harvested local lobster, and concerns regarding cost, responsibilities, and potential tag reuse. Comparable challenges have been observed in the Caribbean spiny lobster tagging programmes, where limited enforcement and institutional resources constrained the effectiveness of traceability interventions (FAO, 2020).

Global best practices provide relevant insights for addressing these operational concerns. The Maine v-notch programme demonstrates how simple, fisher-led marking systems can achieve strong compliance when supported by robust monitoring institutions and co-management frameworks (Acheson & Gardner, 2011). Similarly, the Western Australia rock lobster fishery—often cited as a global benchmark—employs a sophisticated traceability and quota-based monitoring system that enables real-time oversight of landings and reduces opportunities for IUU fishing (Fletcher et al., 2015). The New Zealand Quota Management System provides further evidence of how rights-based approaches, combined with electronic reporting, can align fisher incentives with long-term sustainability objectives.

Seychelles is making important progress toward comparable management sophistication. With support from the International Climate Initiative (IKI) and technical leadership from The Nature Conservancy's FishPath platform, the country is developing a structured harvest strategy for the lobster fishery. The FishPath process has been particularly valuable in navigating data limitations, helping stakeholders assess monitoring options, and guiding the selection of feasible harvest control rules. Incorporating traceability tools such as tagging within this emerging harvest strategy offers a pathway to integrate biological sustainability, economic viability, and governance requirements.

Taken together, the findings underscore the need for an integrated approach that strengthens traceability, builds institutional capacity, and enhances stakeholder engagement while advancing evidence-based harvest strategy development. Such a framework will be essential for rebuilding the lobster resource and ensuring the long-term resilience of both the fishery and the coastal livelihoods it supports.

4.2 Socioeconomic Considerations

The differential impacts on fishing communities highlight the need for targeted support mechanisms. Highly dependent fishers face significant challenges transitioning to alternative livelihoods. The traditional economic model where approximately three months of lobster fishing could support a family year-round has been replaced by alternatives such as demersal fishing, octopus fishing, or tourism-related activities, though these often generate lower returns in comparison to lobster fishing, as many fishers explained.

The ripple effects through coastal communities include loss of specialized skills and erosion of social capital built around the fishery. The import economy, while creating some employment (approximately 45 jobs), generates lower economic multipliers (1.4 vs 2.3 for local products). This represents not just lost income but reduced circulation of money through local economies, affecting boat maintenance services, gear suppliers, and informal support networks.

Generational impacts are particularly concerning, with younger fishers showing lower attachment to the fishery and greater willingness to pursue alternative careers. While this may represent necessary economic adaptation, it also signifies potential loss of traditional ecological knowledge and maritime heritage that has sustained these communities for generations.

However, the socioeconomic analysis also reveals unexpected resilience within fishing communities. The diversification strategies adopted by many fishers—combining multiple fishing methods, seasonal employment patterns, and entrepreneurial activities—demonstrate adaptive capacity that could be supported through targeted interventions. The challenge lies in designing support systems that recognize these existing strengths while addressing genuine vulnerabilities.

4.3 Value Chain Optimization Opportunities

The value chain analysis reveals both inefficiencies and untapped opportunities. The current dominance of direct sales from fishers to establishments (75% of transactions) reflects the trust-based nature of these relationships but also creates challenges for traceability and quality control. While these personal connections have historically been valuable, they now complicate efforts to distinguish legal from illegal products in the market.

The concentration of import operations among four major players creates both efficiency and risk. These importers have developed sophisticated cold chain logistics and quality control systems that ensure consistent supply to the hospitality sector. However, this concentration also creates vulnerability to supply shocks and potential market manipulation. The 700% markup from import to consumer level, while partly reflecting legitimate costs and risks, suggests room for improved efficiency.

Quality management presents challenges in a market where 63% of products remain undifferentiated by species or origin. The inability to guarantee product provenance undermines efforts to develop premium market segments for certified sustainable products. Hotels and restaurants express willingness to pay premiums for guaranteed local products but lack reliable mechanisms to verify authenticity.

Price dynamics across the value chain reveal interesting patterns. Local lobster commands consistent premiums (20-30%) over imports when available, but this premium varies significantly based on size, species, and season. The lack of standardized grading and pricing systems creates information asymmetries that particularly disadvantage small-scale fishers who lack market power to negotiate effectively.

The path to optimization therefore requires creative approaches that work with, rather than against, the current market structure. This means leveraging the strength of personal relationships in the direct sales system while acknowledging the enforcement challenges they create. It means working with concentrated importers as partners in quality and sustainability improvements while maintaining vigilance against anti-competitive behaviours. Most importantly, it means designing management systems that can remain viable through extended periods of inactivity, perhaps by integrating them with broader fisheries management infrastructure that operates continuously across multiple species and sectors. Through such adaptive approaches, the value chain can evolve to better serve all stakeholders while supporting the long-term sustainability of both imported supply chains and the potential recovery of local stocks.

4.4 Management Intervention Feasibility

The feasibility analysis suggests that successful management interventions must acknowledge current market realities while building toward sustainable recovery:

Post-harvest Tagging Systems: High stakeholder support (75-77%) indicates potential acceptance, but implementation requires addressing cost concerns and enforcement capacity limitations. The system should focus on authenticating limited legal catch rather than competing with imports.

Enhanced Enforcement: Universal support (100%) reflects recognition of IUU challenges. However, the current risk-reward ratio strongly favours violation, requiring fundamental improvements in detection and prosecution capacity rather than dedicated units given resource constraints.

Adaptive Management Framework: The harvest strategy under development through the FishPath process (2019-2026) provides a structured approach linking monitoring data to management responses, essential for evidence-based decision-making.

Economic Support Systems: Targeted assistance programs must recognize varying levels of dependency within fishing communities, with differentiated support for highly dependent versus diversified fishers.

Market Integration: Working with existing value chain structures rather than attempting wholesale restructuring offers more realistic pathways to improvement.

5. Conclusions and Recommendations

5.1 Key Conclusions

The Seychelles lobster market has demonstrated remarkable resilience in adapting to resource constraints through import substitution, successfully maintaining supply chains for both tourism and local consumption while preserving premium market space for local products during their limited availability. This adaptation reveals a market that has evolved pragmatically rather than collapsed, with stakeholders across the value chain adjusting their operations to current realities.

The socioeconomic impacts of these changes have not been uniform across fishing communities. Those fishers with the highest historical dependency on lobster fishing have faced the most significant challenges in transitioning to alternative livelihoods, while those with diversified income sources have adapted more readily. This differentiation underscores the need for targeted support mechanisms that recognize varying levels of vulnerability within the fishing community.

Perhaps most significantly, the analysis reveals that IUU fishing continues to present a systemic challenge that undermines both conservation efforts and legitimate fishers' livelihoods. The current enforcement framework, with very low detection probabilities and risk-reward ratios strongly favouring violation, requires fundamental strengthening before any new management measure can succeed. Nevertheless, the strong stakeholder support for traceability systems and sustainable management with over 75% approval across all groups indicates a collective readiness for change, if implementation addresses practical concerns about costs, enforcement, and system maintenance.

The proposed tagging system should be reconceptualized not as a tool to compete with imports but to authenticate the limited legal catch and prevent IUU products from entering formal markets during brief open seasons. Implementation must address:

- High per-unit costs with minimal volumes requiring government subsidy
- System maintenance during long inactive periods between seasons
- Risk of tag fraud or transfer to IUU catch requiring serialization and database tracking
- Limited enforcement capacity requiring enhanced rather than dedicated units
- Consumer education and overall awareness to members of the public

5.2 Recommendations for the Way Forward

Phase 1: Immediate Priorities

The primary priority is to finalize the national lobster harvest strategy, ensuring that it fully reflects IKI-supported outputs and FishPath recommendations. Establishing this strategic foundation will provide the decision-making structure necessary to guide adaptive management.

A second priority is to pilot an affordable, tamper-resistant tagging or marking system during the next biologically justified open season. Lessons from the Maine v-notch system, Caribbean spiny lobster initiatives, and Western Australia's traceability programme underscore the importance of designing systems that are practical, enforceable, and supported by fishers.

Finally, Phase 1 requires strengthening monitoring and enforcement capacity. Enhancing SFA's operational presence—through digital reporting tools, targeted patrols, and improved coordination with enforcement partners—will increase the effectiveness of both tagging and compliance measures.

Phase 2: Medium-term Development

A comprehensive monitoring program to track stock recovery and inform harvest control rule implementation should be established. This includes fisheries-independent surveys, habitat assessments, and recruitment monitoring to provide the biological data necessary for evidence-based management decisions.

Economic diversification support for fishing communities must be implemented through targeted programs. This includes training for alternative marine-based livelihoods, access to credit for small business development, and support for value-added processing initiatives. These programs should respect the free-market nature of Seychelles' economy while providing genuine opportunities for economic transition.

Implementation of the full tagging system should proceed following pilot study results. This includes establishing database infrastructure, training programs for all stakeholders, and integration with existing enforcement mechanisms. The system should be designed to remain cost-effective even with minimal harvest volumes.

Long-term Vision

Regional collaboration presents an important opportunity for strengthening long-term outcomes. Because lobster populations in the Western Indian Ocean may be shared across boundaries, coordinating stock assessment approaches, enforcement activities, and information exchange with neighbouring states can improve effectiveness while reducing costs. A well-implemented traceability system could further position Seychelles as a regional leader in sustainable seafood management and support access to premium markets for verified legal products.

Building resilience within fishing communities is another critical component of the long-term vision. Economic diversification should be viewed as an evolution of traditional livelihoods rather than a departure from fishing identity. Opportunities such as recreational fishing guiding, marine tourism, aquaculture, or value-added seafood processing can generate income while utilizing existing skills and maritime knowledge. These initiatives must respect Seychelles' free-market context, where fishers retain autonomy over whom they sell to and at what price.

To embed adaptive management in practice, continuous training and awareness programmes are required to maintain compliance and reinforce shared responsibility across fishers, importers, and establishments. Annual evaluations of tagging compliance, catch composition, and supply chain behaviour should directly inform updates to the harvest strategy and its associated harvest control rules. As new biological and fisheries-independent data emerge, management responses must adjust accordingly to ensure sustainability remains the guiding objective.

Collectively, these long-term measures aim to build a transparent, resilient, and sustainably managed lobster fishery that balances ecological protection with community wellbeing. Combined with the national harvest strategy currently in development, they provide the foundation for a modern, science-based management system aligned with global best practice.

5.3 Implementation Pathways

The success of these recommendations depends fundamentally on sustained political will and adequate financial resources. Evidence-based management requires continuity across political cycles and the courage to maintain difficult decisions even when they generate opposition. Financial resources must be allocated not just for enforcement and monitoring, but for the social support systems that enable communities to endure and adapt during transition periods.

Stakeholder engagement cannot be treated as a periodic consultation exercise but must become embedded in the management system. Co-management approaches that genuinely involve fishers, establishments, and communities in decision-making processes create ownership of outcomes and improve compliance with regulations. This engagement must continue especially during closure periods when fishers might otherwise become disconnected from the management process.

Climate change considerations add another layer of complexity, with projected sea surface temperature increases of 1.5-2.0°C by 2050 potentially affecting habitat suitability and recruitment patterns. Management strategies must incorporate this uncertainty through flexible approaches that can adapt to changing environmental conditions.

Perhaps most critically, all participants must embrace adaptive capacity—the ability to adjust strategies based on outcomes and new information. What works in one season may not work in the next, and rigid adherence to plans that aren't delivering results serves no one's interests. The management system must be sophisticated enough to recognize changing conditions and flexible enough to respond appropriately.

The path forward for the Seychelles lobster fishery requires balancing immediate socioeconomic needs with long-term sustainability goals. Recovery, if achievable, will be a gradual process requiring patience from fishers waiting for seasons to open, investment from government in management systems, and collective commitment from all stakeholders to support sustainable practices. The market has already demonstrated its capacity to adapt to resource constraints; now the management system must demonstrate equal adaptability in supporting both resource recovery and community wellbeing. Through careful implementation of these recommendations, the fishery can evolve toward a future that, while different from its past, remains economically viable, socially equitable, and ecologically sustainable.

Summary Key Findings and Recommendations

The following comprehensive recommendations are proposed to improve the management of the Seychelles lobster fishery, addressing biological sustainability, socioeconomic impacts, and implementation pathways:

Category	Key Findings and Recommendations
Biological Status	• Stock estimated at 15-25% of virgin biomass, below sustainable thresholds • MSY estimated at 3.5 MT annually, far below current market demand • Recovery requires 3-5 years minimum with continued restrictions • Implement adaptive harvest strategy based on biological indicators
Market Structure	• 96.7% of establishments rely on imports for year-round supply • Local lobster maintains 20-30% price premium when available

Category	Key Findings and Recommendations
	• Annual import volume: 41.8 MT valued at SCR 28.5 million • Support dual market system: imports for volume, local for premium niche
IUU Fishing	• Estimated IUU harvest: 3,000-7,000 kg annually • Detection probability below 5% with current enforcement capacity • Risk-reward ratio strongly favors violation • Strengthen detection through enhanced patrols and surveillance technology
Tagging System	• 75-77% stakeholder support for national post-harvest tagging • Tags should include: fisher ID, date, location, species • Estimated benefit-cost ratio: 2.3:1 when fishery operational • Pilot affordable, tamper-resistant system during next open season • Address concerns: costs, enforcement capacity, tag fraud risks
Enforcement	• 100% stakeholder support for enhanced enforcement • Current enforcement perceived as weak and inconsistent • Increase targeted patrols at night and known IUU hotspots • Enhance inter-agency coordination with police and coast guard • Deploy surveillance technologies (drones) • Establish anonymous reporting mechanisms with legal protection

Category	Key Findings and Recommendations
Socioeconomic Support	• 76% of fishers report >50% income reduction from closures • Economic multiplier: 2.3 for local vs 1.4 for imported products • Provide targeted support based on dependency levels • Support alternative marine-based livelihoods (tourism, research activities with SFA)
Education & Awareness	• Strong lack of awareness about sustainable lobster management • Launch comprehensive campaigns on sustainable harvesting practices • Use media, schools, and point-of-sale materials for outreach • Educate consumers on distinguishing legal from illegal products • Build public support for conservation measures
Licensing	• Currently 16 active licenses with limited new entry • Ensure licensing remains transparent and merit-based • Reserve licenses for active fishers with demonstrated capacity • Consider limited entry program when fishery reopens
Sustainability & Habitat	• Climate change projected to affect habitat by 30-50% by 2050 • Establish nursery areas for berried female lobsters • Investigate artificial reefs to enhance habitat

Category	Key Findings and Recommendations
	• Explore aquaculture/hatchery programs to supplement wild stocks • Integrate climate adaptation into harvest strategy
Harvest Strategy	• FishPath process (2019-2026) developing structured approach • Finalize national harvest strategy with clear control rules • Link monitoring data directly to management responses • Implement adaptive management with annual evaluations • Ensure stakeholder understanding and buy-in
Regional Cooperation	• Lobster stocks likely shared across Western Indian Ocean • Coordinate stock assessment methodologies with neighbours • Share enforcement and monitoring information • Position Seychelles as regional leader in sustainable management • Access premium markets through certified sustainable products

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Appendix

Appendix 1: Questionnaires used for data collection

Category 1: Fishers (License Holders, Harvesters)

1) **Name (optional):**____

2) Stakeholder Category:
    - License Holder ( ) Lobster Harvesters ( )

3) **Location:** ( ) Mahé ( ) Praslin ( ) La Digue

4) **Gender:** ( ) Male ( ) Female ( ) Non-binary ( ) Prefer not to say

5) **Age Group:** ( ) 18 – 30 ( ) 31 – 45 ( ) 46 – 60 ( ) 60+

6) **Highest level of education:**

( ) No schooling ( ) Primary ( ) Secondary ( ) Tertiary ( ) 1st Degree/Undergraduate ( ) Post Graduate & Higher

7) **How long have you been fishing for lobster?**

( ) < 5 years ( ) 5 to 10 years ( ) 10 to 15 years ( ) >20 years

8) **What motivates you to fish for lobsters?** *(E.g., tradition, demand, profitability, availability of resources)*

9) **At what scale do you operate?** *(Select all that apply)*

( ) Subsistence (own consumption)
( ) Local (selling within the community)
( ) Local (selling to businesses)
( ) International (exporting)

10) **How important is the lobster fishery to your income?**

( ) Very important (main source of income)
( ) Important (significant but not primary source)
( ) Neutral (minor contribution)
( ) Unimportant (no major financial impact)

11) **What percentage of your total income (in years when the lobster fishery is open) comes from lobster fishing?**

( ) < 25% ( ) 25-50% ( ) 50-75% ( ) > 75%

12) What are your main sources of income when the lobster fishery is closed?

(   ) Finfish fishing (   ) Agriculture (   ) Tourism-related work
Other (please specify) ____

13) What is your main expense related to lobster fishing? *(Select all that apply and estimate the total costs for each, if possible)*

Expense	Costs
Fuel	
Fishing gear (traps, scuba gears, etc..)	
License/ permits	
Labor (hiring crew)	
Boat maintenance	
Transportation to markets	
Loan repayments	
Safety equipment (life jackets, radio, flare)	
Other (please specify)	

14) On average, when the lobster season is open, how many lobsters do you catch per fishing trip?

(   ) < 10   (   ) 10–30   (   ) 31–50   (   ) > 50

15) How do you store and handle lobsters immediately after capture?

(   ) Kept alive in water (   ) Stored on ice
(   ) Other (please specify): ________________________________

16) Do you sell your catch directly after landing?

(   ) Yes (   ) No   If no, then why? ________________________________

17) How is the lobster sold?

(   ) Live (   ) Fresh/chilled (   ) Frozen (   ) Other (please specify): ____________

18) Do you sell lobster per kilo or per piece?

19) Does the price vary with the size/species of the lobster?

( ) Yes – Size only, ( ) Yes – Species only, ( ) Yes – Both size and species
( ) No – No change

If yes, please indicate the typical prices you charge per kilo or per piece based on the species and/or size of lobster (if known).

20) Who do you typically sell your lobster catch? *(Select all that apply)*

( ) Direct to consumers – Price:
( ) To hotels/restaurants – Price:
( ) Through middlemen – Price:
( ) To processors – Price:

21) Have you experienced any lobster losses/spoilage before sale?

( ) Yes ( ) No

If yes, what is the main cause?

( ) Poor storage facilities ( ) Transportation delays ( ) Poor handling practices Other (please specify):________________________

22) What percentage of your total lobster catch is exported? *(ask based on the answer from Q9)*

( ) < 25% ( ) 25-50% ( ) 50-75% ( ) >75% ( ) None

23) Do you face any difficulties accessing markets?

( ) Yes ( ) No If yes, specify_____________________________________

24) Can you describe the path your lobsters take after you catch them? For example, do you sell directly to consumers, middlemen, hotels/restaurants, or processors?

25) What factors influence your choice of buyer? *(Select all that apply and rank in order of importance if possible)*

( ) Price offered (e.g., higher prices may lead to preference for certain buyers)
( ) Reliability of payment (e.g., prompt payment, no delays)
( ) Ease of access to buyer (e.g., location, transport costs, convenience)
( ) Existing agreements/contracts (e.g., Phase 2 (12-24 months) or longer deals, regular buyers)
( ) Other (please specify):_____________________________________

26) In the last 5 years, how has the price of lobster changed?

( ) Increased ( ) Decreased ( ) Unsure

27) What challenges affect the lobster fishery? (*Rank in order of importance, if possible)*

( ) Declining lobster population ( ) Illegal fishing (IUU) ( ) Weather conditions ( ) Low prices for lobster ( ) High competition ( ) Limited market access

( ) Seasonal restrictions ( ) Other (please specify): ____________________

28) Do you think IUU has an impact on the lobster market in terms of price?

29) Have you noticed changes in the availability or size of lobsters over the years?

(   ) Yes – Availability only (   ) Yes – Size only (   ) Yes – Both availability and size (   ) No – No changes

30) Do you think illegal, or unreported lobster fishing is a problem in Seychelles?

(   ) Yes (   ) No

Explain:

31) Apart from current measures, what methods could effectively reduce illegal activities in lobster fishery?

32) Do you believe allocating a portion of your catch to the public rather than exclusively to establishments could help reduce the prevalence of illegal lobster sales?

(   ) Yes (   ) No (   ) Unsure

Explain:

33) Do you think Seychelles should implement a national post-harvest tagging system to certify legally caught lobsters as a way to combat IUU fishing? *(Refer to Appendix 1 for details on how the tagging system works)*

(   ) Yes, it would be very effective (   ) Yes, it would be somewhat effective (   ) Neutral (   ) No, it would not be effective (   ) Unsure

Comment:

34) How feasible do you think it is to implement a post-harvest tagging system?

(   ) Very feasible (   ) Feasible (   ) Neutral (   ) Not feasible (   ) Very not feasible

Explain:

35) What would be your biggest concern about implementing a tagging system?

36) How could a post-harvest tagging system be effectively implemented in the lobster value chain, specifically when selling directly to individual customers? *Please provide your thoughts on the steps that could be taken to ensure the system works effectively for one-on-one sales and how any challenges in this context can be mitigated.*

37) Would you support a regulation requiring all legally caught lobsters to be tagged before sale to improve traceability and reduce illegal lobsters on the market?

( ) Yes ( ) No

Explain:

38) If a lobster tagging system was introduced, how likely would you be to support it?

( ) Yes ( ) No ( ) Unsure

Why or why not?

39) Do you think tagging would improve market access and price for legally caught lobsters?

( ) Yes ( ) No

Explain:

40) Would you be willing to pay an additional fee for tagging as part of your fishing license?

( ) Yes ( ) No If no, what alternative solutions do you suggest covering the cost of tagging costs?

41) What support would you need to adopt a tagging system? *(Select all that apply)*

( ) Financial assistance for purchasing tags ( ) Training on how to tag lobsters
( ) Government enforcement and monitoring ( ) Awareness campaigns on the benefits of tagging ( ) Other (please specify)___________________________

42) Would you be willing to participate in a pilot study for lobster tagging?

( ) Yes ( ) No

Explain:

43) In your opinion, what would be the most effective way to raise awareness about sustainable lobster consumption? *(Select up to 2)*

( ) Social media campaigns ( ) Information at points of sale ( ) Educational programs in schools ( ) Awareness events ( ) Media coverage (TV, radio, newspapers) ( ) Other (please specify): ____

44) What penalties do you think should be in place for selling untagged lobsters? *(select all apply)*

( ) Fines ( ) Confiscation ( ) license suspension
( ) Other (please specify)____

45) In your opinion, what other measures should be taken to improve traceability and reduce IUU in the lobster fishery[1]?

[1] End of Questionnaire** - Thank you for your input and time. Your input will help improve the sustainability of the Seychelles lobster fishery.

Category 2a: Large Establishments (Post Harvest Operators, Major Retailers, Large Restaurants and Hotels)

1) **Name (optional): __________________ Post Title:_____________________**

2) **Establishment Name:____**

3) **Stakeholder Category:**
   - **Retailers:** (   ) Restaurants (   ) Supermarkets
   - **Hotels:** (   ) Large (   ) Medium (   ) Small
   - **Post Harvest Operators:** (   ) Middleman (   ) Processors

4) **Location:** (   ) Mahé (   ) Praslin (   ) La Digue

5) **Do you purchase lobster? How often?**

(   ) Daily (   ) Weekly (   ) Monthly (   ) Seasonally (   ) Occasionally

6) **Where do you primarily source your lobsters?** *(Select all that apply and rank in order of importance, if possible, total should add up to 100%)*

(   ) Directly from fishers _____% (   ) Middleman ____% (   ) Processors _____%
(   ) Importers _______% (   ) Other (specify): __________________ _______%

7) **What are the main challenges you face regarding lobster supply?** *(Select top 2)*

(   ) High cost (   ) Limited availability (   ) Quality issues (   ) Inconsistent supply
(   ) Seasonal restrictions (   ) Other: _______________

8) **Who are your main lobster customers?**

(   ) Tourists: ____% (   ) Local residents: ____% (   ) Hotels/restaurants: ____%
(   ) Export buyers: ____% (   ) Supermarkets: ____% (   ) Other (specify): _____%

9) **Do you purchase lobsters that are locally sourced, imported, or both?**

(   ) Locally sourced only (   ) Imported only (   ) Both local and imported

10) **How often do you purchase imported lobsters?**
(   ) All year round (   ) Seasonal (specify months): _______________

11) **Do you purchase lobster per kilo or per piece, and does this vary by species/size or apply to all lobsters?** *If yes, please indicate the typical prices you purchase per kilo or per piece based on the species and/or size of lobster (if known).*

12) **What is the average price and quantity of lobsters purchased annually?** *(Insert tick and comment in quantity)*

Source	Product	<SCR 500	SCR 500–750	SCR 750–1,000	>SCR 1,000	Annual Quantity
Local	Whole (live/fresh)					
	Frozen (raw)					
	Species/size					
Imported	Whole (live/fresh)					
	Frozen (raw)					
	Species/size					

13) Do you process/ add value to lobster before selling it?

( ) Yes ( ) No If yes, what types of processing do you conduct? *(e.g. Cleaning, Freezing, Cooking, Packaging)*

14) What is your average selling price of lobster? *(Insert tick and comment in quantity)*

Source	Product	<SCR 500	SCR 500–750	SCR 750–1,000	>SCR 1,000	Annual Quantity
Local	Whole (live/fresh)					
	Frozen (raw)					
	Cooked (frozen/fresh					
	Other:					
Imported	Whole (live/fresh)					
	Frozen (raw)					
	Cooked (frozen/fresh					
	Species/size					

15) From which country(ies) do you import lobster, and what species do you import? (Only to be asked to major importers such as ISPC and STC).
Country(ies): **Lobster species:**

16) What percentage of your total revenue comes from lobster sales? *(Insert tick)*

( ) < 25% ( ) 25-50% ( ) 51-75% ( ) > 75%

17) Do you buy lobsters at a fixed price, or does the price fluctuate? *(Insert tick)*

Lobster Source	Fixed price	Fluctuates based on season/demand
Locally		
Imported		

If price fluctuates, what is the highest and lowest price you have paid for lobster? *(kilo/pieces)*
Highest: Lowest:

18) What challenges does the lobster industry face, and how can they be overcome?

19) Do you export lobsters? (*If no move to Q21; not applicable for retailers-restaurants and supermarkets and hotels)*

( ) Yes ( ) No

If yes, what percentage of your total lobster supply is exported?

( ) <25% ( ) 25-50% ( ) 51-75% ( ) > 75%

20) Which country(ies) do you export lobsters to?

21) Have you noticed changes in the availability or size/species of lobsters over the years?

( ) Yes ( ) No If yes what changes? *(Higher price, lower availability, smaller lobsters, etc.)*

22) Are you aware of illegal or unreported lobster fishing in Seychelles?

( ) Yes ( ) No

If yes, have you been approached to buy such lobsters? ( ) Yes ( ) No

23) Apart from current measures, what methods could effectively reduce illegal activities in lobster fishery?

24) Do you think Seychelles should implement a national post-harvest tagging system to certify legally caught lobsters as a way to combat IUU fishing? *(Refer to Appendix 1 for details on how the tagging system works)*

( ) Yes, it would be very effective ( ) Yes, it would be somewhat effective ( ) Neutral ( ) No, it would not be effective ( ) Unsure

Comment:

25) What information would you want the tagging system to provide? (*Select all that apply)*

( ) Date caught ( ) Fisher's information ( ) Size verification ( ) Location caught ( ) Other: ___________________________________

26) What do you think would be the biggest benefit of a tagging system? *(Select 2)*

( ) Ensuring quality and freshness ( ) Supporting local fishers ( ) Preventing illegal fishing ( ) Giving consumers confidence in what they buy ( ) No benefit

27) Would you be willing to pay more for lobster that is verified as legally and sustainably caught?

( ) Yes, significantly more (>20%) ( ) Yes, somewhat more (10-20%) ( ) Yes, slightly more (<10%) ( ) No ( ) Unsure

28) Would you support a certification or tagging system that verifies lobsters are legally and sustainably caught?

( ) Yes ( ) No

Explain:

29) What would be your biggest concern about implementing a tagging system?

30) Would you participate in promoting traceable seafood to your customers?

( ) Yes ( ) No ( ) Maybe

Comments:

31) What do you think would be an effective way to implement a tagging system?

32) In your opinion, what would be the most effective way to raise awareness about sustainable lobster consumption? *(Select up to 2)*

( ) Social media campaigns ( ) Information at points of sale ( ) Educational programs in schools ( ) Awareness events ( ) Media coverage (TV, radio, newspapers) ( ) Other (please specify): ______________

33) What penalties should be in place for selling untagged lobsters? *(Select all apply)*

(   ) Fines   (   ) Confiscation   (   ) license suspension   (   ) Other (please specify)____________________

34) In your opinion, what other measures should be taken to improve traceability and reduce IUU in the lobster fishery?[2]

[2] End of Questionnaire** - Thank you for your input and time. Your input will help improve the sustainability of the Seychelles lobster fishery.

Category 2b (Walk-in interviews): Medium and Small Establishments (Post Harvest Operators, Retailers, Restaurants and Hotels)

1) **Name (optional): __________________ Post Title:_____________________**

2) **Establishment:____**

3) **Stakeholder Category:**
   - **Retailers:** ( ) Restaurants ( ) Supermarkets
   - **Hotels:** ( ) Large ( ) Medium ( ) Small
   - **Post Harvest Operators:** ( ) Middleman ( ) Processors

4) **Location:** ( ) Mahé ( ) Praslin ( ) La Digue

5) **Do you purchase lobster? How often?**

( ) Daily ( ) Weekly ( ) Monthly ( ) Seasonally ( ) Occasionally

6) **Where do you primarily source your lobsters from?** *(Select all that apply)*

( ) Directly from fishers _____% ( ) Middleman _____% ( ) Processors _____%
( ) Importers _____% ( ) Other: _________________________ _____%

7) **Who are your main lobster customers?**

( ) Tourists: ____% ( ) Local residents: ____% ( ) Hotels/restaurants: ____%
( ) Export buyers: ____% ( ) Supermarkets: ____% ( ) Other (specify): _____%

8) **Do you purchase lobsters that are locally sourced, imported, or both?**

( ) Locally sourced only ( ) Imported only ( ) Both local and imported

9) **How often do you purchase imported lobsters?**
( ) All year round ( ) Seasonal (specify months): _______________

10) **Do you purchase lobster per kilo or per piece, and does this vary by species/size or apply to all lobsters?** *If yes, please indicate the typical prices you purchase per kilo or per piece based on the species and/or size of lobster (if known).*

11) **What is the average price and quantity of lobsters purchased annually?** *(Insert tick and comment in quantity)*

Source	Product	<SCR 500	SCR 500–750	SCR 750–1,000	>SCR 1,000	Annual Quantity
Local	Whole (live/fresh)					
	Frozen (raw)					
	Species/size					
Imported	Whole (live/fresh)					
	Frozen (raw)					
	Species/size					

12) Do you process/ add value to lobster before selling it?

( ) Yes ( ) No If yes, what types of processing do you conduct? *(e.g. Cleaning, Freezing, Cooking, Packaging)*

13) What is your average selling price of lobster? *(Insert tick and comment in quantity)*

Source	Product	<SCR 500	SCR 500–750	SCR 750–1,000	>SCR 1,000	Annual Quantity
Local	Whole (live/fresh)					
	Frozen (raw)					
	Cooked (frozen/fresh)					
	Species/size					
Imported	Whole (live/fresh)					
	Frozen (raw)					
	Cooked (frozen/fresh)					
	Species/size					

14) What are the main challenges you face regarding lobster supply? *(Select top 2)*

( ) High cost ( ) Limited availability ( ) Quality issues ( ) Inconsistent supply
( ) Seasonal restrictions ( ) Other: ________________

15) Have you noticed changes in the availability or size/species of lobsters over the years?

( ) Yes ( ) No If yes what changes? *(Higher price, lower availability, smaller lobsters, etc.)*

16) Are you aware of illegal or unreported lobster fishing in Seychelles?

( ) Yes ( ) No
If yes, have you been approached to buy such lobsters? ( ) Yes ( ) No

17) Apart from current measures, what methods could effectively reduce illegal activities in lobster fishery?

18) After learning about the proposed post-harvest tagging system, would you support it?

(   ) Yes (   ) No (   ) Unsure

Why or why not? ____

19) What do you think would be the most effective way to implement a tagging system?

20) What information would you want the tagging system to provide? (*Select all that apply)*

(   ) Date caught (   ) Fisher's information (   ) Size verification (   ) Location caught (   ) Other: ________________________________

21) Would you be willing to pay more for lobster that is verified as legally and sustainably caught?

(   ) Yes, significantly more (>20%) (   ) Yes, somewhat more (10-20%) (   ) Yes, slightly more (<10%) (   ) No (   ) Unsure

22) What do you think would be the biggest benefit of a tagging system? *(Select 2)*

(   ) Ensuring quality and freshness (   ) Supporting local fishers (   ) Preventing illegal fishing (   ) Giving consumers confidence in what they buy (   ) No benefit

23) Would you participate in promoting traceable seafood to your customers?

(   ) Yes (   ) No (   ) Maybe

Comments:

24) What would be your biggest concern about implementing a tagging system?[3]

[3] End of Questionnaire** - Thank you for your input and time. Your input will help improve the sustainability of the Seychelles lobster fishery.

Category 3: General Public (Local, Tourist, Expatriate, Conservation, Eco-Tourism Representatives)

1) **Name (optional): ____**

2) **Stakeholder Category:**
   - Local resident ( ) Tourist ( ) Expatriate living in Seychelles ( ) Conservation Representatives ( ) Eco-tourism Representatives ( )

3) **Location:** ( ) Mahé ( ) Praslin ( ) La Digue

4) **Gender:** ( ) Male ( ) Female ( ) Non-binary ( ) Prefer not to say

5) **Age Group:** ( ) 18 – 30 ( ) 31 – 45 ( ) 46 – 60 ( ) 60+

6) **How often do you consume lobster in Seychelles?**

( ) Frequently (once a month or more) ( ) Occasionally (a few times a year) ( ) Rarely (once a year) ( ) Never

7) **Where do you typically purchase or consume lobster?** *(Select all that apply)*

( ) Restaurants/Hotels ( ) Directly from fishers ( ) Supermarkets ( ) Local markets ( ) I don't purchase/consume lobster ( ) Other (please specify): _______________

8) **What percentage of your total spending on seafood is directed towards lobsters**?

( ) < 25% ( ) 25-50% ( ) 51-75% ( ) > 75%

9) **What factors influence your decision when purchasing lobster?** *(Rank from 1-5, with 1 being most important)*

___ Price ___ Size/Quality ___ Sustainability certification ___ Freshness ____ Unsure

10) **Do you know the difference between local and imported lobster?**

( ) Yes ( ) No ( ) Unsure

If Yes: Which, do you prefer and why?

11) **How important is it to you that the seafood you consume is sustainably caught?**

( ) Very important ( ) Somewhat important ( ) Neutral ( )Not important
( ) Unsure

12) **Are you aware of any issues related to illegal, unreported, or unregulated (IUU) fishing of lobster in Seychelles?**

( ) Yes, I am well aware ( ) I have some knowledge ( ) I've heard about it but don't know details ( ) No, I am not aware

13) **Apart from current measures, what methods could effectively reduce illegal activities in lobster fishery?**

14) Would you prefer to purchase lobster that has an official tag confirming it was legally caught?

( )Yes ( ) No ( ) No preference ( ) Unsure

15) What do you think would be the biggest benefit of a tagging system? *(Select 2)*

( ) Ensuring quality and freshness ( ) Supporting local fishers ( ) Preventing illegal fishing ( ) Giving consumers confidence in what they buy ( ) No benefit

16) Would you use a QR code or similar technology to verify the origin of your lobster purchase if available?

( ) Yes, definitely ( ) Probably ( ) Probably not ( ) No ( ) Unsure

17) What information would you want the tagging system to provide? (*Select all that apply)*

( ) Date caught ( ) Fisher's information ( ) Size verification ( ) Location caught ( ) Other: ____

18) In your opinion, what would be the most effective way to raise awareness about sustainable lobster consumption? *(Select up to 2)*

( ) Social media campaigns ( ) Information at points of sale ( ) Educational programs in schools ( ) Awareness events ( ) Media coverage (TV, radio, newspapers) ( ) Other (please specify): _______________

19) Would you be willing to pay more for lobster that is verified as legally and sustainably caught? [4]

[4] End of Questionnaire** - Thank you for your input and time. Your input will help improve the sustainability of the Seychelles lobster fishery.

Appendix 2 – Technical Appendix

Detailed Methodology

A.1 Biological Parameters Used in Stock Assessment Models

The following parameters were incorporated into the scenario modelling based on literature values and local data:

Life History Parameters:

Maximum sustainable yield (MSY): 3.5 MT for Mahé Plateau (Bautil, 1992)

Natural mortality (M): 0.35 per year

Growth parameters (von Bertalanffy):

$L\infty$ = 150 mm carapace length

K = 0.25 per year

t_0 = -0.5 years

Size at maturity: 75-80 mm carapace length

Recruitment variability (σR): 0.6

Stock-Recruitment Relationship:

Beverton-Holt model assumed with steepness (h) = 0.7

Virgin biomass (B_0): Estimated at 120 MT (pre-1990 levels)

Current biomass (B2024): Estimated at 15-20% of B_0

A.2 Economic Multipliers and Impact Assessment

Regional Input-Output Multipliers:

Direct employment multiplier (fishing): 2.3

Indirect employment multiplier (support services): 1.7

Induced multiplier (household spending): 1.4

Import sector multiplier: 1.4

Calculation Methods:

Total Economic Impact = Direct Impact × (1 + Indirect Multiplier + Induced Multiplier)

Where:

- Direct Impact = Landed value of catch

- Indirect = Equipment, fuel, ice, transport services

- Induced = Household spending from fishing income

A.3 Price Elasticity Estimation

Price elasticities were estimated using log-linear regression on sales data:

$\ln(\text{Quantity}) = \alpha + \beta \times \ln(\text{Price}) + \gamma \times \text{Controls} + \varepsilon$

Where:

- β = price elasticity
- Controls = seasonality, establishment size, customer type

Results:

Tourist demand elasticity (local): -0.5 (relatively inelastic)

Tourist demand elasticity (imported): -0.3 (more inelastic)

Local demand elasticity (local): -0.7 (moderately elastic)

Local demand elasticity (imported): -1.8 (elastic)

A.4 IUU Harvest Estimation Methodology

The IUU harvest estimate was triangulated using three methods:

Fisher Perception Method:

Survey responses on perceived IUU activity

Median estimate: 150% of legal catch

Market Balance Method:

Total consumption - (Legal harvest + Imports)

Estimated gap: 5,000 kg

Enforcement Intercept Method:

Known confiscations × (1/detection probability)

Estimated total: 4,500-5,500 kg

Triangulated Estimate: 4,983 kg (approximately 10% of total market)

A.5 Statistical Analysis Details

Bootstrap Procedures:

R

```
# Bootstrap confidence intervals
```

```
boot_function <- function(data, indices) {
  sample_data <- data[indices,]
  return(mean(sample_data$variable))
}

boot_results <- boot(data = dataset,
                    statistic = boot_function,
                    R = 1000)

CI <- boot.ci(boot_results, type = "perc", conf = 0.95)
```

Regression Model Specifications:

R

```
# Catch rate model
model <- lm(catch_rate ~ experience + factor(location) + stock_perception,
          data = fisher_data)

# Model diagnostics
vif(model)  # Check multicollinearity
plot(model) # Residual diagnostics
```

A.6 Scenario Modeling Assumptions

Scenario 1: Status Quo

Continued closure

No local harvest

Import growth: 5% annually

Scenario 2: 3-5 Year Recovery

Complete closure for recovery

Stock growth rate: 5% annually

Target: 40% of virgin biomass

Scenario 3: Limited Opening

2-month season

16 licenses

Harvest rate: 10% of available biomass

Risk of recruitment overfishing: High

Scenario 4: IUU Control + Opening

Enhanced enforcement (5x current)

Detection probability increase to 10%

Legal harvest: 4 MT

IUU reduction: 50%

Scenario 5: Full Local Supply

Required harvest: 42 MT

Biological assessment: Exceeds MSY by 12x

Conclusion: Biologically unfeasible

Data Quality and Limitations

B.1 Survey Response Rates and Bias

Response Rates by Category:

Fishers: 87% (25/29 approached)

Large establishments: 100% (5/5)

Small/medium establishments: 83% (20/24)

Importers: 100% (4/4)

General public: 82% (33/40)

Potential Biases:

Selection bias: More engaged stakeholders likely to participate

Recall bias: Historical catch rates based on memory

Social desirability bias: IUU activities likely underreported

B.2 Data Validation Procedures

Cross-validation with official records:

Import data verified against customs records

License numbers confirmed with SFA database

Catch data compared with landing records

Internal consistency checks:

Price ranges across different sources

Volume estimates across value chain

Temporal patterns in reported data

External triangulation:

World Bank trade statistics

FAO fisheries data

Regional market reports

B.3 Uncertainty Analysis

Key Uncertainties and Ranges:

Current biomass: 15-25% of virgin (±5%)

IUU harvest: 3,000-7,000 kg (±40%)

Economic multipliers: ±0.3

Detection probability: 2-8%

Recovery timeline: 3-7 years

Supplementary Economic Analysis

C.1 Net Present Value of Management Options

Using a 5% discount rate over 10 years:

Scenario	NPV (Million SCR)	B/C Ratio
Continued closure	-45.2	0.0
3-year closure + recovery	-32.5	0.4
Limited opening (high risk)	-28.3	0.5
Enhanced enforcement + opening	+12.4	1.3
Status quo (no intervention)	-52.1	0.0

C.2 Distribution of Economic Impacts

Winners and Losers Analysis:

Current Situation (Import Dominance):

Winners: Importers (+), Hotels with stable supply (+), Consumers with year-round access (+)

Losers: Fishers (---), Local processors (--), Traditional markets (--)

With Tagging System:

Winners: Legal fishers (++), Conservation goals (+), Premium market buyers (+)

Losers: IUU operators (---), Cost-sensitive consumers (-)

C.3 Cost-Benefit Analysis of Tagging System

Costs (Annual):

Tag procurement: SCR 50,000

Database development/maintenance: SCR 100,000

Training and implementation: SCR 75,000

Enforcement integration: SCR 150,000

Total Annual Cost: SCR 375,000

Benefits (Annual, when fishery open):

Reduced IUU (avoided losses): SCR 500,000

Premium pricing for tagged products: SCR 200,000

Improved market access: SCR 150,000

Total Annual Benefit: SCR 850,000

Benefit-Cost Ratio: 2.3:1 (when fishery operational)

Climate Change Considerations

D.1 Projected Impacts on Lobster Habitat

Based on IPCC projections for Western Indian Ocean:

Sea surface temperature increase: +1.5-2.0°C by 2050

Ocean acidification: pH decrease of 0.2-0.3 units

Coral reef degradation: 30-50% habitat loss

Altered current patterns affecting larval dispersal

D.2 Adaptation Implications

Potential range shifts: 50-100km southward

Altered growth rates: ±15%

Changed recruitment patterns: Increased variability

Modified seasonal patterns: Extended closed seasons may be necessary

Full Statistical Outputs

E.1 Catch Rate Regression Results

```
Call: lm(formula = catch_rate ~ experience + location + stock_perception)

Residuals:
    Min      1Q  Median      3Q     Max
-12.352  -3.847  -0.593   3.226  14.851

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)        45.237      5.842   7.743 2.35e-07 ***
experience          1.284      0.327   3.928 0.000912 ***
locationPraslin    -8.542      3.256  -2.624 0.016832 *
locationLaDigue   -11.238      4.127  -2.724 0.013571 *
stock_perception   -2.847      0.891  -3.195 0.004786 **

Residual standard error: 6.421 on 20 degrees of freedom
Multiple R-squared: 0.6743,     Adjusted R-squared: 0.6092
F-statistic: 10.35 on 4 and 20 DF,  p-value: 0.0001274
```

E.2 Inter-rater Reliability

Cohen's Kappa for categorization decisions:

Import dependency classification: κ = 0.82

Stakeholder type classification: κ = 0.94

IUU awareness categorization: κ = 0.76

Support level classification: κ = 0.79

All values exceed the 0.75 threshold for excellent agreement.

( ) Yes, significantly more (>20%) ( ) Yes, somewhat more (10-20%)
( ) Yes, slightly more (<10%) ( ) No ( ) Unsure

Note: This study was initiated primarily to assess the feasibility of implementing a post-harvest tagging program as a deterrent to IUU fishing; socioeconomic and value chain analyses are integrated to provide context.

Clarification (Table 1): Year-to-year totals are not directly comparable due to differences in license allocation, fishing effort, and season duration; closures are SFA management decisions.

Definition: 'Traditional fishing sector' here refers to the traditional artisanal fishing sector, including finfish, octopus, and lobster fishing activities.

IUU Methodology (Table 8): Estimates were triangulated from fisher interviews (n=25), establishment reports (n=29), market-balance analysis, and SFA enforcement data.

Section 3.1.2 – Income Diversification: Finfishing only (36%), Octopus only (16%), Finfishing + Octopus (28%), Finfish + Agriculture (4%), Finfishing/Octopus/Mechanic (4%), Other (8%). Lobster provides the highest income per trip but seasonality necessitates diversification.